How the Changing Dynamics of the Conowingo Dam Affect the Bay

COG Staff Issue Brief
January 9, 2015

The confluence of a required regulatory process and a new understanding of the water quality impacts of long-term sedimentation have made the Conowingo dam an important policy issue in the Chesapeake Bay restoration effort. The following information provides a brief overview of this issue; while the report's executive summary and a Frequently Asked Questions document prepared by the agencies that funded the study are attached.

Background

The Conowingo dam is the lowermost in a series of three hydroelectric power dams on the lower Susquehanna River and the only one located in Maryland. Its owner, Exelon Corporation, has applied for a renewal of its operating license from the Federal Energy Regulatory Commission. Under that process, the state of Maryland has the authority under Section 401 of the Clean Water Act to certify whether or not the dam's operations meet state water quality standards. Without that certification, FERC cannot grant Exelon a long-term operating license.

A number of recent studies, including the Lower Susquehanna River Watershed Assessment (LSRWA) funded by several state and federal partners to provide information to the certification effort, indicate that the Susquehanna reservoir system has reached a state of dynamic equilibrium as a result of the build-up of sediment behind the dams. In contrast to previous years, the dams no longer have the ability to store significant portions of the sediment washing downstream on a long-term basis. Instead, storm flows of sufficient size will scour some of the deposited sediment. This creates, in turn, some short-term storage capacity, but the overall result is a longer-term equilibrium in which the amount of sediment and associated nutrients flowing into the dams matches what flows out of them. The studies also indicate that the increased flow of sediments and nutrients into the upper Chesapeake Bay, in contrast to the partial storage of these pollutants achieved in the past by the dams, degrades water quality, although the impact is highly variable according to the time of year when scouring flows occur.

Pending Decisions

1. **Maryland must decide what to do about the dam's water quality certification**. In November, the Maryland Department of the Environment announced its intention to deny the certification based on incomplete information on water quality impacts. In December, Exelon withdrew its relicensing application, agreed to contribute $3.5 million to additional water quality studies and announced its intention to quickly refile its application, effectively postponing a final decision for a number of months.

2. **Exelon and the various state and federal regulatory agencies must decide if it makes sense to try to do something about the sediment stored behind the dams.** The LSRWA's preliminary conclusions are that measures such as dredging would not result in significant water quality benefits and may not be cost effective compared to other things that could be done, such as continued implementation of BMPS within the Susquehanna watershed upstream of the dams.

3. **The Chesapeake Bay Program must decide how to account for the negative water quality impact from the higher nutrient and sediment loads now known to be coming from the Susquehanna watershed.** When it was issued in December 2010, the Chesapeake Bay TMDL indicated that the issue of sediment build-up behind the Conowingo and the other Susquehanna dams would need to be addressed as part of the 2017 mid-point re-evaluation process. The studies done to date apear to indicate that the greatest water quality impact derives from the nutrients associated with the sediment particles flowing over the dam rather than the sediment itself. Bay Program staff has floated some estimates of the additional nutrient reductions that would be needed to offset the water quality impacts stemming from dynamic equilibrium. They would add anywhere from 5- 15 percent atop the reductions otherwise needed, although these estimates may change as more studies are completed.

For more information:

The LSRWA and associated materials are available at:
http://mddnr.chesapeakebay.net/LSRWA/index.cfm.

COG staff contact: Karl Berger 202.962-3350 / kberger@mwcog.org

METROPOLITAN WASHINGTON
Council of Governments

Executive Summary

The U.S. Army Corps of Engineers, Baltimore District (USACE), and the Maryland Department of the Environment (MDE) partnered to conduct the Lower Susquehanna River Watershed Assessment (LSRWA). This assessment concludes with this watershed assessment report to better inform all stakeholders undertaking efforts to restore the Chesapeake Bay.

The purpose of this assessment was to analyze the movement of sediment and associated nutrient loads within the lower Susquehanna watershed through the series of hydroelectric dams (Safe Harbor, Holtwood, and Conowingo) located on the lower Susquehanna River to the upper Chesapeake Bay. This included analyzing hydrodynamic and sedimentation processes and interactions within the lower Susquehanna River watershed, considering strategies for sediment management, and assessing cumulative impacts of future conditions and sediment management strategies on the upper Chesapeake Bay. The need for this assessment is to understand how to better protect water quality, habitat and aquatic life in the lower Susquehanna River and Chesapeake Bay.

Critical components of this watershed assessment included: (1) identification of watershed-wide sediment management strategies; (2) use of hydrologic and hydraulic and sediment transport models to link incoming sediment and associated nutrient projections to in-reservoir processes at the hydroelectric dams and estimate impacts to living resources in the upper Chesapeake Bay; and (3) assessment of cumulative impacts from sediment management strategies on the upper Chesapeake Bay ecosystem.

Loss of Long-Term Trapping Capacity

Sediment and associated nutrients from the land, floodplain, and streams in the lower Susquehanna River have been transported and stored in the areas (reservoirs) behind the dams over the past century. The dams have historically acted as sediment traps, reducing the amount of sediment and associated nutrients reaching the Chesapeake Bay. At the time that this assessment began, there was concern about the implications of reduced trapping and storage capacity of the reservoirs, and consequent impacts of increasing nutrient and sediment loads to the Chesapeake Bay.

The Chesapeake Bay ecosystem is impacted both physically and biologically by the delivered sediment load from the Susquehanna River basin. These impacts are exacerbated by large storm and flood events which scour additional sediment and associated nutrients from behind the dams on the lower Susquehanna River and adversely affect the Chesapeake Bay ecosystem.

This assessment concludes that each of the three reservoirs' sediment trapping capacity is greatly reduced from historical trapping, and that each reservoir has reached an end state of sediment storage capacity. The evaluations carried out through this assessment demonstrate that Conowingo Dam and Reservoir, as well as upstream Safe Harbor and Holtwood Dams and their reservoirs, are no longer trapping sediment and the associated nutrients over the long term. Instead, the reservoirs are in a state of dynamic equilibrium.

In this dynamic equilibrium state, sediment and associated nutrients will continue to accumulate in the reservoirs until an episodic flood (scouring) event occurs. That is, there is no absolute capacity or point at which the reservoir is "full" and will no longer trap sediment and associated nutrients. Storage capacity will increase after a scouring event, allowing for more deposition within the reservoir in the short term. This state is a periodic "cycle" with an increase in sediment and associated nutrient loads to the Bay from scour also resulting in an increase in storage volume (capacity) behind the dam, followed by reduced sediment and associated nutrient loads transported to the Chesapeake Bay due to reservoir deposition within that increased capacity.

Dynamic equilibrium does not imply equality of sediment inflow and outflow on a daily, monthly, or even annual basis, or similar time scale. It implies a balance between sediment inflow and outflow over a long time period (years to decades) defined by the frequency and timing of scouring events. Sediment and associated nutrients that accumulate between high-flow events are scoured away during storm events, whereby accumulation begins again. Over time, there is no net storage or filling occurring in the reservoirs.

The reservoirs are trapping a smaller amount of the incoming sediment and associated nutrient loads from the upstream watersheds, and scouring more frequently in comparison to historical amounts. For example, upon comparing 1996 bathymetry data to 2011 data, this study estimated that the decrease in reservoir sediment trapping capacity from 1996 to 2011 (within Conowingo) resulted in a 10-percent increase in total sediment load to the Bay (20.3 to 22.3 million tons), a 67-percent increase in bed scour (1.8 to 3.0 million tons), and a 33-percent decrease in reservoir sedimentation (6.0 to 4.0 million tons) over the period of analysis. These additional loads, due to the loss of sediment and associated nutrient trapping capacity in the Conowingo Reservoir, are causing adverse impacts to the Chesapeake Bay ecosystem. These increased loads need to be prevented or offset to restore the health of the Chesapeake Bay ecosystem.

Nutrients, Not Sediment, Have the Greatest Impact on Bay Aquatic Life

Modeling work completed for this assessment estimated that the sediment loads comprised of sand, silt, and clay particles from scouring of Conowingo Reservoir during storm events, are not the major threat to Chesapeake Bay water quality and aquatic life. For most conditions examined, the sediment scoured from the reservoir behind the dam generally settle out on the bottom of the Bay within a period of days to weeks and generally before the period of the year during which light levels in the Bay's shallow waters are critical for the growth of underwater bay grasses or submerged aquatic vegetation (SAV). If a storm event occurs during the SAV growing season, burial and light attenuation impacts could occur causing damage to SAV.

Conversely, the nutrients associated with the scoured sediment were determined to be more harmful to Bay aquatic life than the sediment itself. The particulate nutrients settle to the bottom and are recycled back up into the water column in dissolved form and stimulate algal production. Algal organic matter decays and consumes oxygen in the classic eutrophication cycle. As a consequence, DO in the Bay's deep-water habitat is diminished following Conowingo scour events. Additionally, increased algal growth (living and then dead) create murky waters that impede water clarity limiting growth of SAV. The primary impact to Bay aquatic life from the Susquehanna River watershed and the high river flows moving through the series of dams and reservoirs is lower dissolved oxygen concentrations and reduced water clarity from increased algal growth. It is the nutrients associated with the sediment that are the most detrimental factor from scoured loads to healthy Bay habitats and aquatic life versus sediment alone.

Watershed is the Principal Source of Sediment

While the Chesapeake Bay ecosystem impacts from all three dams and reservoirs are important, this assessment estimates that the majority of the sediment load from the lower Susquehanna River entering Chesapeake Bay during storm events, originates from the watershed rather than from scour from the reservoirs. However, storm characteristics are highly variable and variations in track, timing, and duration can alter the amount of sediment entering the system from both the watershed and from behind the dams. Consequently, the relative proportion of scour and watershed contributions can vary as well, so this concept is not universal to all storms, but it does provide a good sense of magnitude.

It was estimated that during a major storm event, that is, one that occurs on average every 4 to 5 years, approximately 20 to 30 percent of the sediment that flows into Chesapeake Bay from the Susquehanna River is from scour of bed material stored behind Conowingo Reservoir, and the rest is from the upstream watershed (which includes scour from behind Holtwood and Safe Harbor Dams). During lower flow periods, the three reservoirs act as a sediment trap and in essence, aid in the health of the Bay until the next high-flow event occurs. Given the often smaller contribution of the sediment load to the Bay from Conowingo Reservoir scour in comparison to the watershed (under most hydrologic conditions), the primary impact to aquatic life in the Bay is from sediment and nutrients from the Susquehanna River watershed and rest of the Chesapeake Bay watershed. However, both sources of sediment and nutrient loads, reservoir scour and watershed load should be addressed to protect aquatic life in Chesapeake Bay.

The seven Chesapeake Bay watershed jurisdictions (Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia) have developed watershed implementation plans (WIPs), which detail how each of the Bay watershed jurisdictions will meet their assigned nitrogen, phosphorus, and sediment load allocations as part of the Chesapeake Bay total maximum daily loads (TMDLs), and achieve all dissolved oxygen (DO), water clarity, SAV and algae (measured as chlorophyll) levels required for healthy aquatic life. Implementation of the WIPs were estimated to have a far larger influence on the health of Chesapeake Bay in comparison to scouring of the lower Susquehanna River reservoirs. Modeling done for this assessment estimated that currently more than half of the deep-channel habitat in the Bay is frequently not suitable for healthy aquatic life. However, it was estimated that with full implementation of the WIPs by 2025 (which should yield 100% suitable habitat for aquatic life), DO levels required to protect aquatic life in the Bay's deeper northern waters will not be achieved (in 3 of the 92 Bay segments) due to loads of extra nutrients associated with the increased frequency and the amount of sediment from behind the dams on the lower Susquehanna River.

Sediment Management Strategy Analysis

This assessment included a survey-level screening of management strategies to address the additional loads to Chesapeake Bay from scour. The focus was managing and evaluating sediment loads with the understanding that there are nutrients associated with those sediment loads; thus, in managing sediment, one is also managing nutrients.

A variety of sediment management strategies were considered to reduce the amount of sediment available for a future storm (scour) event. Sediment management strategies were broadly divided into: (1) reducing sediment yield from the Susquehanna River watershed (reducing sediment inflow from upstream of the three reservoirs above what is required for the WIPs); (2) minimizing sediment deposition within the reservoirs (routing sediment around or through the reservoir storage); and (3) increasing or recovering volume in the reservoirs.

Additional management strategies for reducing sediment yield from the Susquehanna River watershed beyond the WIPs appear to be higher in cost, and ultimately, have a low influence on reducing the amount of sediment available for a storm event. This is because the majority of the effective lower cost opportunities to manage sediment are already being pursued in Pennsylvania, New York and Maryland WIPs to meet the Chesapeake Bay TMDL mandated by the U.S. Environmental Protection Agency (EPA).

Sediment bypassing (minimizing sediment deposition behind the dams), defined here as routing sediment around reservoirs and downstream, appears to be lower in cost in comparison to other management strategies but ultimately increase the total sediment and associated nutrient loads to the Bay and have high adverse impacts to the Chesapeake Bay ecosystem. As a result of the continuous discharge of nutrients associated with the bypassed sediment, the environmental costs lower dissolved oxygen concentrations, increased algae levels are roughly 10 times greater than the benefits gained from reducing future scour from the Conowingo Reservoir.

Increasing or recovering storage volume of reservoirs via dredging or other methods is possible, but the Chesapeake Bay ecosystem benefits are minimal and short-lived, and the costs are high. When sediment is strategically removed from the reservoirs behind the dams, there was a predicted minor influence on scour load (reduction) and sediment deposition (increase); there was also a predicted minor reduction in adverse impacts to Chesapeake Bay ecosystem health for a future similar storm event. Scour events would still occur, but lower amounts of sediment and associated nutrients were estimated to be mobilized during these events.

However, Chesapeake Bay ecosystem benefits from sediment removal are short-lived due to the constant deposition of sediment and associated nutrients that originate throughout the Susquehanna River watershed in this very active system, as well as the unpredictable nature of storms (i.e., it is impossible to reduce all impacts from all storm events and it is unknown exactly when the next storm will occur as well as the magnitude of that storm). Sediment removal would be required annually, or on some similar regular cycle, to achieve any actual net improvement to the health of the Bay. This positive influence is minimized due to sediment loads coming from the Susquehanna River watershed during a flood event.

The estimated cost range for the suite of sediment management strategies evaluated was $5 to $90 per cubic yard of sediment removed. The removal of the specific amount of 3 million cubic yards of sediment which is estimated to be slightly more than what deposits and is temporarily stored behind the dams entering the Conowingo reservoir on an annual basis (average for 1993-2012), would cost $15 to $270 million annually (all strategies considered). For the dredging strategies investigated, the cost was estimated to be $16 to $89 per cubic yard, or $48 to $267 million annually for removal of 3 million cubic yards of sediment. Costs for reductions in sediment yield from the watershed were on the order of a one-time cost of $1.5 to $3.5 billion which is estimated to annually prevent approximately 117,000 cubic yards of sediment from reaching the Chesapeake Bay.

The conclusion that the primary impact to living resources in Chesapeake Bay was from nutrients and not sediment, was not determined until late in the assessment process. Further study on this is warranted. Management opportunities in the Chesapeake Bay watershed to reduce nutrient delivery are likely to be more effective than sediment reduction opportunities at reducing impacts to the Chesapeake Bay water quality and aquatic life from scour events, but these management opportunities were not investigated in detail during this assessment. The relative importance of nutrient load impacts from the lower Susquehanna River reservoirs is a finding that indicates that nutrient management and mitigation options could be more effective and provide more management flexibility, than solely relying on sediment management options only.

It should be noted that the LSRWA effort was a watershed assessment and not a detailed investigation of a specific project alternative(s) proposed for implementation. That latter would likely require preparation of a NEPA (National Environmental Policy Act) document. The evaluation of sediment management strategies in the assessment focused on water quality impacts, with some consideration of impacts to SAV. Other environmental and social impacts were only minimally evaluated or not evaluated at all. A full investigation of environmental impacts would be performed in any future, project-specific NEPA effort.

Future Needs and Opportunities in the Watershed

Based on these LSRWA findings, future needs and opportunities were identified by the LSRWA team. Four specific recommendations have been identified for follow-through actions to address needs to provide state, federal, and local decision makers with the additional information needed to take further actions to protect water and living resources of the lower Susquehanna River watershed and Chesapeake Bay.

1. Before 2017, quantify the full impact on Chesapeake Bay aquatic resources and water quality from the changed conditions in the lower Susquehanna River's dams and reservoirs.

2. U.S. EPA and Bay watershed jurisdictional partners should integrate findings from the LSRWA into their ongoing analyses and development of the seven watershed jurisdictions' Phase III WIPs as part of the Chesapeake Bay TMDL 2017 mid-point assessment.

3. Develop and implement management options that offset impacts to the upper Chesapeake Bay ecosystem from increased sediment-associated nutrient loads.

4. Commit to enhanced long-term monitoring and analysis of sediment and nutrient processes in the lower Susquehanna River and upper Chesapeake Bay to promote adaptive management.

Lower Susquehanna River Watershed Assessment FAQ: Conowingo Dam & the Chesapeake Bay

The Conowingo Hydroelectric Generating Station (or Conowingo Dam) is a hydroelectric power plant located in Maryland at the head of the Chesapeake Bay on the lower Susquehanna River above Havre de Grace. It is owned and operated by Exelon Corporation and is the largest renewable energy project in Maryland. The U.S. Army Corps of Engineers in coordination with the Maryland Department of the Environment released a draft report entitled the "Lower Susquehanna River Watershed Assessment," which, among other findings, has determined the reservoir behind Conowingo Dam is in "dynamic equilibrium" or a balance between sediment inflow and outflow over years to decades.–Due to this state of equilibrium, the Conowingo Dam is trapping smaller amounts of incoming sediment than it was historically and, during large storms, sending more silt and attached nutrients into the river and to the upper Chesapeake Bay more often. Using this new information, the Chesapeake Bay Program partners factor changes in the trapping capacity of the Conowingo as part of the midpoint assessment of the Chesapeake Bay Total Maximum Daily Load ("TMDL" or pollution limits) to be completed in 2017. As appropriate, the most current information will be incorporated into the Chesapeake Bay Program partners' decision-making process for updating their local restoration blueprints, known as Watershed Implementation Plans (WIPs) in 2018.

PART I: The Conowingo Dam and the Chesapeake Bay

What effect does the Conowingo Dam have on water quality in the Chesapeake Bay and its tributaries?
Since its construction, the reservoir behind the Conowingo Dam has been capturing sediment—and the nutrients that are often attached—flowing down the Susquehanna River, reducing the amount of sand, silt, nitrogen and phosphorous entering the Chesapeake Bay. While this reservoir has long served as an effective "pollution gate," recent studies have drawn attention to its changing effectiveness during high-flow events as it reaches dynamic equilibrium.

How does this pollution impact Bay restoration efforts?
It is important to recognize that the Conowingo Dam is not the Bay's main problem. Between 2008 and 2011, just 13 percent of the Susquehanna River's sediment load came from the reservoir behind the Conowingo Dam. The remaining 87 percent originated from the 26,000 square mile Susquehanna River watershed. Therefore, reducing upstream nutrient and sediment loads through the Chesapeake Bay's "pollution diet"— or TMDL — and supporting the jurisdictions' WIPs offers along-term solution to the Bay's water quality issues and is essential for the jurisdictions to attain their water quality goals.

What does dynamic equilibrium mean?
The reservoirs behind the Holtwood, Safe Harbor, and Conowingo dams no longer have the long-term ability to store sediment and associated nutrients: a state of dynamic equilibrium now exists. In this state of dynamic equilibrium, sediment and associated nutrient loads will continue to accumulate until a high-flow event or storm occurs. Large periodic storm events, like Tropical Storm Lee in 2011, wash away sediment from behind the dams, increasing associated nutrient loads to the Bay. This creates a short-term increase in storage volume in the reservoirs for trapping sediment and associated nutrients. This cycle creates a balance, or equilibrium, between sediment inflow and outflow over years to decades.

Is the Susquehanna River the only river that contributes sediment to the Bay during large rainfall events?
No, all rivers contribute sediment and nutrient loads during large storm events – the satellite photo on the left panel shows sediment plumes coming down the mainstem of the Bay on both the Annapolis and Eastern Shore side of the Bay during the large August 2014 storm event.

Wouldn't it make sense to remove the sediments from behind the dam to improve the trapping efficiency and reduce the impacts of scour?
The LSRWA team identified and evaluated 38 sediment management strategies, including large-scale dredging, dam operation modifications, etc. Sediment removal yields minimal short-lived water quality improvements due to the constant deposition of sediment and associated nutrients that come from the watershed. Long-term, large volumes of sediment are depositing annually. Therefore, the net removal of sediments out of the reservoirs via dredging is reduced because part of the operation would simply be keeping up with deposition. Additionally, water quality improvements are reduced due to the majority of sediment loads coming from the watershed during high-flow events. Results of this study suggest that management opportunities in the watershed that reduce nutrient delivery to the Bay- as opposed to sediment only- are likely more effective at reducing impacts to water quality, low dissolved oxygen, and aquatic life from high-flow events.

What sediment management recommendations are provided in the Lower Susquehanna River Watershed Assessment report?
While increasing or recovering storage volume of reservoirs via dredging or other methods is possible, the report concluded that the Chesapeake Bay ecosystem benefits are minimal and short-lived, and the costs are high. The benefits are short lived due to the constant deposition of sediment and associated nutrients that originate throughout the Susquehanna River watershed in this very active system, as well as the unpredictable nature of storms (i.e., it is impossible to reduce all impacts from all storm events and it is unknown exactly when the next storm will occur as well as the magnitude of that storm). Even with increased storage volume as a result of dredging, scour events would still occur, and sediment and associated nutrients would still be mobilized during these events.

Another conclusion from the report is that the primary impact to living resources in Chesapeake Bay was from nutrients contained in the sediments and not the sediment itself. Further study on this is warranted to determine appropriate and cost effective management strategies. The report suggested that management opportunities in the Chesapeake Bay watershed to reduce nutrient delivery are likely to be more effective than sediment reduction opportunities at reducing impacts to the Chesapeake Bay water quality and aquatic life from scour events, but these management opportunities were not investigated in detail during this assessment. The importance of nutrient load impacts from the lower Susquehanna River reservoirs is a finding that indicates that nutrient management and mitigation options would be more effective and provide more management flexibility than sediment management.

From a cost to benefit perspective, how does addressing nutrients at their source, like implementing nutrient management best practices on farm lands, improving sewage treatment, and reducing stormwater runoff compare with taking action behind the dam?
Prevention of pollution is almost always more cost effective and efficient than restoring an impaired water body like the Bay or addressing legacy sediments. If you do not address the problem at its source, you will have to continue to remediate, increasing your costs, which is why we are dealing with this issue today.

What effect does improving local water quality have on the overall Bay water quality?
The key to restoring the Bay and its tributaries lies in reducing pollution from sources located in all of the Bay's watersheds – following the jurisdictions' Watershed Implementation Plans. Over time, as the Bay watershed is cleaned up, storms will have less impact and the Bay will be healthier and more resilient. Local water quality improvement will eventually provide better water quality and habitat for the Bay as all water flows downstream. We are continuing to see improvement upstream in areas such as the tidal fresh Potomac and the upper Patuxent rivers, where nutrient concentrations and underwater grasses have been improving due to nutrient reduction strategies, such as upgrades to Wastewater Treatment Plants, and use of best management practices on farms. We cannot restore the Bay if we do not also improve our local water quality. The LSRWA draft report indicates that approximately 70 to 80 percent of sediment that flows into the Chesapeake Bay from the Susquehanna River during a major storm event is from the upstream watershed. Upstream sources include runoff from land, floodplain, streams and sediment from behind Holtwood and Safe Harbor dams. Approximately 20 to 30 percent of sediment is from material stored behind Conowingo Dam.

Are all states doing their part? What mechanisms are in place to ensure that everyone is pulling their weight?
All Bay watershed states are required under the EPA's Clean Water Act Chesapeake Bay TMDL to meet their targeted nutrient and sediment load allocations by the year 2025. The Bay TMDL requires reasonable assurance that all states can meet their load allocations and most importantly incorporates accountability through 2-year milestone commitments by the states and EPA's evaluation of progress towards those milestones. Federal consequences have been identified for states not making adequate progress.

What would happen to Bay water quality if the Dam, and the other dams upstream, were removed?
If the dams were not there:

- Millions of tons of sediment have been trapped behind the dams. These legacy sediments and associated nutrients stored in the reservoirs would be eroded and carried downstream by flood events of all sizes.
- During lower flow periods, the three reservoirs act as sediment traps and aid in the health of the Bay until the next high-flow event or storm occurs.
- The river would continue to carry sediment to the Bay from throughout the watershed, including coarse grain sediments that can provide good fish habitat.
- Fish passage would not be an issue, allowing migratory fish (American shad, river herring and American eels) to swim upstream and spawn.
- If the dams were breeched or removed, there would be less trapping of phosphorus and sediment during lower flows and scour of the legacy sediments and associated nutrients during the higher flows would continue to occur until the sediments and associated nutrients had been removed. This would take many years.

PART II: The LSWRA Report

What did the report conclude?

- Finding #1: Conditions in the Lower Susquehanna reservoir system are different than previously understood. The reservoirs behind the Holtwood, Safe Harbor, and Conowingo dams no longer have the long-term ability to store sediment and associated nutrients: a state of dynamic equilibrium now exists. In this state of dynamic equilibrium, large periodic storm events that occur on average every four to five years wash away sediment from behind the dams, increasing associated nutrient loads to the Bay. This creates a short-term increase in storage volume in the reservoirs for trapping sediment and associated nutrients. This cycle creates a balance, or equilibrium, between sediment inflow and outflow over years to decades.

- Finding #2: The loss of long-term sediment trapping capacity is causing impacts to the health of the Chesapeake Bay ecosystem. Because the reservoirs are in dynamic equilibrium, they are trapping smaller amounts of incoming sediment than they were historically and, during large storms, sending more silt and attached nutrients into the river and to the upper Chesapeake Bay more often. The nutrients that enter the river upstream and attach to particles of sediment are a bigger threat to water quality than sediment alone. The water clarity effects of sediment essentially decline once the particles settle; however, nutrient pollution has a lingering effect that leads to algae blooms and dead zones that have the potential to suffocate and stress marine life. Additional nutrient loadings associated with changed conditions in the lower Susquehanna River system may result in not being able to meet jurisdictions' Chesapeake Bay water quality standards, even with full implementation of Watershed Implementation Plans in some of the Bay's deeper northern waters.

- Finding #3: Sources upstream of Conowingo Dam deliver more sediment and nutrients, and therefore, have more impact on the upper Chesapeake Bay ecosystem, than do the scoured sediment and associated nutrients from the reservoir behind Conowingo Dam. The Susquehanna River watershed, not the Conowingo Reservoir, is the principal source of impact on the upper Chesapeake Bay – this includes runoff from land, floodplain, streams and sediment from behind Holtwood and Safe Harbor dams. Large storm events will continue to contribute sediment from the watershed to the Bay and impact its health.

- Finding #4: Modeling results indicate that managing sediment through strategies like large-scale dredging, bypassing and dam operational changes, by themselves, do not provide sufficient benefits to offset the adverse impacts to upper Chesapeake Bay water quality from the loss of the ability to trap sediment and nutrients in the long-term. Long-term, large volumes of sediment are depositing annually. Therefore, the net removal of sediments out the reservoirs via dredging is reduced because part of the operation would simply be keeping up with deposition. Additionally, water quality improvements are reduced due to the majority of sediment loads coming from the watershed during high-flow events. Strategies to reduce sediment in the Susquehanna River watershed beyond what is required in the jurisdictions' WIPs are likely limited in their ability to improve upper Chesapeake Bay water quality. Strategies focused on reducing nutrients, as opposed to sediments, are likely more effective at addressing impacts to Chesapeake Bay water quality and aquatic life.

How was the assessment conducted?
For the assessment, inter-agency experts used the best modeling tools available in order to understand the complex relationship between river flow and sediment and ecological resources in the lower Susquehanna River watershed and upper Chesapeake Bay. The entire draft assessment report had multiple peer reviews by Federal and State agencies, stakeholder groups and the Chesapeake Bay Program Scientific Technical Advisory Committee (STAC). STAC review was a thorough scientific review of the report by an assembled team of 11 professionals with backgrounds in resource economics, and watershed, riverine, and estuarine processes. STAC supported the report conclusions and recommendations. (See Draft Report Appendix I-7 for full STAC review.)

Who was involved in conducting the analysis?
The LSRWA inter-agency team of experts is led by federal sponsor the U.S. Army Corps of Engineers, along with non-federal sponsor the Maryland Department of the Environment. The team is also comprised of the Corps' Engineering Research and Development Center, U.S. Geological Survey, Susquehanna River Basin Commission, Nature Conservancy, U.S. Environmental Protection Agency – Chesapeake Bay Program Office, the Maryland Department of Natural Resources, and the Maryland Geological Survey.

What areas were included in the assessment?
The study area consists of the Lower Susquehanna River Watershed from Sunbury, Pennsylvania, to the confluence with the Chesapeake Bay and includes the Holtwood, Safe Harbor, and Conowingo hydroelectric dams located on the lower Susquehanna River. Much of the modeling efforts in the LSRWA were focused on the Conowingo Dam, as this is the largest dam and reservoir closest to the Chesapeake Bay and was understood to have remaining capacity left to trap sediment.

<u>Part III: Next Steps</u>
What happens now?
After the public comment period closes and any relevant changes are made to the assessment, this report will be revised as necessary and released in its final version. The report is anticipated for release in summer 2015 and intends to better inform decision makers and stakeholders undertaking efforts to restore the Chesapeake Bay.

This assessment indicates that the additional nutrient loadings associated with changed conditions in the lower Susquehanna River system may result in of the failure to meet jurisdictions' Chesapeake Bay water quality standards, even with full implementation of the jurisdictions' watershed implementation plans. The Chesapeake Bay TMDL was designed by the CBP Partnership to collect and integrate new information through a planned 2017 mid-point assessment of the Bay TMDL. This assessment will serve as an important part of the information needed to adapt the strategies to meet the Chesapeake Bay TMDL.

What is being done to understand the effects of Conowingo Dam on water quality in the Chesapeake Bay and its tributaries and examine options to address the effects?

The LSWRA report analyzed the movement of sediment and associated nutrient loads within the lower Susquehanna River watershed, including the reservoir at the Conowingo Dam, with the use of current scientific information and the best available modeling tools. The report recommends that we conduct enhanced monitoring in the Lower Susquehanna River. We are implementing this monitoring over the next two years, for both storm event water quality and sediment, on the lower Susquehanna River proper, four additional tributaries that flow into Conowingo Reservoir, and the upper Chesapeake Bay where sediment and nutrients are deposited during high flow events. We have also implemented continuous monitoring below the Dam and have plans for above the Conowingo Reservoir. Multiple sediment samples will be taken in the Reservoir and in the upper Chesapeake Bay to assess the sediment and nutrient content of the material and its potential impact to Bay water quality. All data collected as part of the enhanced monitoring will be used to inform the Bay TMDL 2017 Mid Point Assessment.

What are the future needs or recommendations outlined in the report?

1. Before 2017, quantify the full impact on Chesapeake Bay water quality and living resources based on our new understanding that the Conowingo Dam and its reservoir, along with the two other dams in the lower Susquehanna River watershed, are not trapping and storing sediment and associated nutrients in the long term.
2. U.S. EPA and their seven Chesapeake Bay watershed jurisdictional partners should integrate findings from the LSRWA into their ongoing analyses and development of their Phase 3 watershed implementation plans as part of the Chesapeake Bay TMDL 2017 mid-point assessment.
3. Develop and implement management options that offset impacts to the upper Chesapeake Bay ecosystem from increased sediment-associated nutrient loads due to changed conditions in the lower Susquehanna River's three dams and reservoirs.
4. Commit to enhanced long-term monitoring and analysis of sediment and nutrient processes in the lower Susquehanna River and upper Chesapeake Bay to promote adaptive management into the future.

How will this information inform the Federal Energy Regulatory Commission's (FERC) 401 certification for the Dam?

The information from the enhanced monitoring, analysis and modeling efforts will be integrated into the Chesapeake Bay Program Partnership's models, which will be used to inform the Chesapeake Bay TMDL 2017 midpoint assessment and will provide a more robust accounting of the Dam's impacts on meeting the states' Chesapeake Bay water quality standards.

Will Maryland insist that FERC take into consideration the changing condition of the Dam and its future impact on water quality during its relicensing process?

Maryland has authority under section 401 of the Clean Water Act to issue a water quality certification, ensuring that the Conowingo Dam relicensing process will meet the state's water quality standards. If Maryland does not grant the applicant's Water Quality Certification, FERC cannot issue a permanent long-term license to operate the facility.

How does this study's findings relate to the Conowingo Dam relicensing and Water Quality Certification?

In addition to FERC's requirements, a license for continued operation of Conowingo Dam cannot be granted to Exelon without a section 401 water quality certification from the State of Maryland. The Maryland Department of the Environment (MDE) is the agency with authority to approve or deny section 401 certifications. Issuance of a certification is contingent upon the applicant demonstrating to MDE that the proposed project will comply with State water quality standards. Exelon filed its 401 WQC Application on January 31, 2014. In November 2014, MDE issued public notice of the application, solicited public comments and scheduled a public hearing. At that time, MDE stated its intent to deny the application due to insufficient information provided by the applicant regarding the impacts of the activity on State water quality standards.

In December 2014, Exelon withdrew its application and stated it would refile an application within 90 days. Exelon also agreed to provide up to $3.5 million to study the effects of sediment related to the Dam on water quality in the Susquehanna River and the Chesapeake Bay.

How can I provide comment on the draft report?
- Via e-mail* at LSRWAcomments@usace.army.mil, or via mail* at

U.S. Army Corps of Engineers, Baltimore District
Attn: Anna Compton
P.O. Box 1715
Baltimore, MD 21203
*Please have comments in or postmarked by January 9, 2015

- Attend the public meeting on Dec. 9 at Harford Community College in Bel Air, Maryland.

For more information, please visit the LSRWA website at http://bit.ly/LSRWA.