massive sediment plume churned up by Tropical Storm Lee in 2011, you’re all but certain of one thing: sediment flowing over Maryland’s Conowingo Dam—the Susquehanna River’s last stop before Chesapeake Bay—has to be the cause of recent declines in Bay water quality.

But results from a three-year feasibility study of sediment moving through the Lower Susquehanna watershed and Conowingo Reservoir, known as the Lower Susquehanna River Watershed Assessment (LSRWA), suggest that nutrients—mainly nitrogen and phosphorous—from upstream of the Conowingo are the real problem, not the clay and sand washing into the Bay. These findings are reported in a special section in the May–June 2016 issue of the Journal of Environmental Quality on the Conowingo Reservoir.

“We had all seen that aerial photo of the plume after Tropical Storm Lee, which was alarming to say the least,” says Carl Cerco, research hydrologist with the U.S. Army Corps of Engineers (USACE) and one of the study principals. “Our natural reaction was that this was the end of aquatic vegetation and that sedimentation had to be the issue. The fact that the impact of the sediment was minor and short-lived was amazing.”

Water Quality Challenges

Chesapeake Bay, the nation’s largest estuary and historically one of its most productive, has had its share of water quality issues to contend with. Runoff from fertilizer-laden farms and discharge from sewage treatment plants add excessive nutrient loads to the watershed that eventually make their way into the Bay and settle to the bottom. There, they spur oxygen consumption in bottom sediments and get recycled back into the water column, fueling algal blooms and oxygen-depleted “dead zones.”

These problems have hit the region hard. Its once-thriving oyster population has shrunk significantly, blue crab harvests have seen steep declines, and underwater grasses in some areas have been depleted. Collectively, the ailing Bay has led to an economic pinch that many in the local seafood

Spotlight on Sediments

How is the Chesapeake Bay affected by storm flows from the Conowingo Reservoir?

by Evan Lubofsky
and tourism industries have been unable to escape.

To clean things up, the USEPA put Chesapeake Bay on a “pollution diet” in 2010 by establishing a Total Maximum Daily Load (TMDL)—a threshold for the amount of pollution the Bay can receive while meeting water quality standards. Reduction of present loads down to TMDL levels is expected to restore Bay living resources as prescribed by state and federal water quality standards.

The compromised Bay water quality coincides with a different, but potentially related, environmental issue—the nearly 200-million tons of sediment caked up in the Conowingo Reservoir just behind a dam.

“Scientists in the U.S. Geological Survey (USGS) had been studying the Conowingo Reservoir and concluded it was filling in and that the sediment buildup could have major detrimental impacts on the Bay,” Cerco says. “The river was operating in a different way than it was 75 years ago, so we needed to look at how the dam was trapping sediment now vs. historically,” says Anna Compton, a biologist with the USACE. “We also needed to look at the cost of removing sediments by dredging or sluicing to potentially lessen impact to the Bay. So we pulled a team from the Army

Following construction in 1928, the Conowingo Dam provided an “unintended benefit” to the Bay by trapping sediment, nutrients, and organic matter. But the reservoir has been losing storage capacity since its first day of operation. By 2011, it had lost about 92% of its sediment-trapping capacity, and today is considered “full.”

“Sediment is our business, and we knew the reservoir was filling in,” Cerco says. “The first question was whether there were any sediment management actions the Corps could take to alleviate this. The other question was how the reservoir could be impacting the Bay downstream.”

Measuring the Impact

Today, the Conowingo Reservoir is maxed to the point where sediment gets easily scoured into the Bay during storm events. Like blasting a puddle of mud with a firehose, storm flows coming down the Susquehanna rip sediment off the reservoir bottom during storm-induced scour events. The mixture of silt, sand, and clay carried by the river clouds the water in the Bay, prevents sunlight from reaching sea grasses, and brings particulate forms of nitrogen and phosphorus along for the ride.

With enough sediment buildup to fill an estimated 75 football stadiums—there’s little question the Conowingo has a sediment management issue on its hands. But determining the true impact of sediment on Bay health required a comprehensive environmental impact study.

“The river was operating in a different way than it was 75 years ago, so we needed to look at how the dam was trapping sediment now vs. historically,” says Anna Compton, a biologist with the USACE. “We also needed to look at the cost of removing sediments by dredging or sluicing to potentially lessen impact to the Bay.

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Left: Lower Susquehanna River reservoir and dam system (Langland and Cronin, 2003). Right: Tropical Storm Lee brought heavy rainfall to New England in early September, 2011, swelling rivers and streams in the Chesapeake Bay Watershed and carrying sediment downstream. That sediment was visible from NASA satellites. Source: NASA/GSFC/MODIS.
Corps of Engineers together with the State of Maryland and other organizations to plan out the assessment."

The $1.4 million study, co-funded by the USACE and the State of Maryland, focused on a combination of water quality data collection and computer simulation models of the watershed, reservoir, and Bay. Huge data sets of dissolved oxygen, water temperature, chlorophyll, and water depth measurements were fed into a series of models running on supercomputers at the Corps’ Engineer Research and Development Center (ERDC) in Vicksburg, MS as well as at USEPA and USGS offices.

“We ran different simulations to answer a variety of key questions,” Compton says. “For example, if we dredged back to reservoir volume of 1996, what would happen to water quality in the Bay? Or if we had a storm event in a particular month, what would happen to water quality? We had so much data that one simulation would take three days on one of the supercomputers.

“When we simulated the removal of sediments from behind Conowingo Dam, we didn’t see any significant water quality improvements to the Bay.”

Impact of Scour Events Questionable

Cerco suggests that large scour events are “not good” since they can push the Bay out of compliance with water quality regulations. But, he says, the effects are typically short term because the sediment settles so quickly in the Bay.

“A sediment plume looks horrible the day it happens, but it settles out rather quickly and only stays in water columns for a few weeks,” he says. “And because most scour and flooding events happen during times of the year when submerged vegetation is not dependent on sunlight, the events tend not to be that detrimental.”

He also says there are two schools of thought in terms of what is more harmful to the Bay. “In one camp, people view the flooding and scouring

Excessive sediment loads carried by the Susquehanna River clouds the water in the Chesapeake Bay, prevents sunlight from reaching sea grasses, and brings particulate forms of nitrogen and phosphorus along for the ride. But, Carl Cerco says, “because most scour and flooding events happen during times of the year when submerged vegetation is not dependent on sunlight, the events tend not to be that detrimental.” Photos clockwise from top left: Bob Nichols/USDA-ARS, the Chesapeake Bay Program, and Wendy S. McPherson.
events as being the biggest threat,” he says. “A different camp sees the gradual infilling of the reservoir over time as having a bigger impact. There’s truth to both sides of the issue, and both factors play a role.”

Managing Nutrients

While the sediment itself may not have a direct impact on the health of the Chesapeake, the LSRWA reports suggests the nutrients that sediment carries with it are hurting the Bay by increasing oxygen depletion and concentrations of algae.

According to Lewis Linker, modeling coordinator for the USEPA’s Chesapeake Bay Program, healthy deep channel ecosystems need dissolved oxygen concentrations of at least 1 mg L⁻¹—levels that have been compromised by nitrogen and phosphorus flowing into the Bay.

“We track nutrients actively throughout the Chesapeake watershed here, and they are being added to the Bay during scour events,” he says. “This applies to nutrients from sediment coming over the dam as well as legacy sediments that have been around from century-old mill farms once used for hydropower. You can’t see low dissolved oxygen like you can see a sediment plume, but with the model, you can estimate when water quality standards have been violated.”

According to Cerco, a key question remains: how well can algae use the nutrients once they reach the Bay?

“If organic matter and nutrients coming into the Bay are immediately available and contribute to oxygen demand, they lower dissolved oxygen at the bottom and create a problem,” he says. “The real crux is maintaining the bottom-water dissolved oxygen concentrations since the TMDL really hinges on it.”

Moving Forward

Despite the lost sediment trapping efficiency at Conowingo, existing TMDL requirements will remain in place at least through 2017, at which time there will be a mid-point assessment of the Chesapeake TMDL nutrient load reduction progress. In the meantime, the LSRWA suggests the best way to offset recent declines in Bay water quality is to “enhance nutrient reductions” from the entire watershed upstream.

“Something needs to be done to limit or offset these loads,” Cerco says. “Managing the sediment is part of it, but one of the things my colleagues in the Corps found out is that you can’t just dredge the reservoir. It would be much too costly. And even if you could, there’s no place to put the material. Ultimately, it is the people up in the watershed who are going to have to reduce their nutrient loads.”

E. Lubofsky, contributing writer for CSA News magazine

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