Written Testimony of Secretary Ben Grumbles

Maryland Department of the Environment

Before the Committee on Environment and Public Works (EPW)

United States Senate

"The Nonpoint Source Management Program Under the Clean Water Act:

Perspectives from States"

Wednesday, January 8, 2020

Chairman Barrasso, Ranking Member Carper and distinguished members of the committee, thank you for the honor of participating in this important hearing on the section 319 nonpoint source pollution program under the Clean Water Act and state perspectives on how it's working and how it can be improved. I am Ben Grumbles, Maryland's Secretary of the Environment appointed under Governor Larry Hogan, and I also serve as Chair of the Chesapeake Bay Program Partnership's Principal Staff Committee and as Secretary Treasurer under the Environmental Council of the States. Before I discuss Maryland's perspective on opportunities and challenges in protecting Maryland and regional waters, and in particular the Chesapeake Bay, from nonpoint source pollution, I would like to emphasize the value of national programs under the Clean Water Act and the need for bipartisan support for continued environmental

progress. Federal and state agencies must work together, in the spirit of cooperative federalism, to meet our national, state, regional and local goals.

BACKGROUND

First, I'd like to express our appreciation for the strong bipartisan commitment to funding national clean water programs, most recently demonstrated by last month's agreement on U.S. States Environmental Protection Agency's (EPA) and other federal agencies' budgets. Continued progress in the states depends on comprehensive, strategic, and robust support for infrastructure, science, regulation, and innovation. Governor Hogan, as Chair of the National Governors Association (NGA), has focused his year-long initiative, Infrastructure: Foundation for Success, on advancing the repair, enhancement, and modernization of our nation's infrastructure, including aging water systems, through innovative public-private partnerships, smarter technologies, and a strong focus on resilience.

In addition, Governor Hogan co-chairs the NGA's Water Policy Institute, providing states the opportunity to focus on policies and programs aimed at resilience, including approaches and technology that states are using to address emerging contaminants in drinking water, rural water needs, increased droughts, agricultural water needs and impacts, stormwater, and funding and

financing water infrastructure improvements. Strategies for clean and safe water, whether focusing on point sources or nonpoint sources, must be comprehensive and integrated, with flexibility that also includes accountability.

PROGRAM GROWTH UNDER THE HOGAN ADMINISTRATION

Under Governor Hogan's strong conservation and environmental leadership, Maryland has made great strides in meeting its commitments to Chesapeake Bay restoration. Maryland has made a significant investment in not only reducing point source discharges of pollution to the Bay, such as from wastewater treatment facilities, but also in reducing nonpoint source pollution. While we have made significant progress in our Bay restoration efforts, we will not be able to fully restore the health of the Bay--a national and ecological treasure with economic value exceeding a trillion dollars--unless all of our state partners and the District of Columbia also meet their commitments. And, we must ensure that we all factor the impacts of climate change into our efforts to reduce nonpoint source pollution, as changes in rainfall patterns that increase runoff into the Bay threaten to undermine progress.

While reducing point source discharges of pollution to the Bay is itself challenging, it has been much more difficult to achieve the needed reductions in nonpoint source pollution, given the

diffuse nature of the sources of pollution and varied authorities for prevention, management, and restoration. Progress has not happened overnight and programs cannot be sustained without strong partnerships.

The National Nonpoint Source Program, under section 319 of the Clean Water Act, is the primary federal program being implemented to address nonpoint sources of pollution. The 319 Program requires states to evaluate water quality holistically at a watershed level in order to identify the sources and causes of water quality impairments and to identify best management practices needed to achieve nonpoint source pollution reductions. States often use federal grant money provided by EPA through the 319 Program, other state funds and partnerships with other entities and programs, such as U.S. Department of Agriculture conservation programs, to achieve reductions in nonpoint source pollution and to provide reasonable assurance in meeting Total Maximum Daily Load (TMDL) allocations. These reductions occur through states engaging with partners who commit to implement best management practices on the land to reduce the movement of pollutants from the land into our waters.

I mentioned climate change in the context of nonpoint source pollution because it is a threat multiplier that is projected to increase the volume and intensity of rainfall in our region and make

our clean water goals harder to achieve. In the Chesapeake Bay Watershed climate impacts are projected to increase pollution loads as a result of increased precipitation volume and intensity as well as reduce the efficiency of current nonpoint source best management practices. Ultimately, climate change impacts will over time increase restoration costs.

PARTNERSHIP

Chesapeake Bay restoration is a partnership effort, which includes EPA, Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia (the six states in the Bay watershed), the District of Columbia, and the Chesapeake Bay Commission. Our Chesapeake Bay restoration partnership efforts are paying off. The Bay Health Report card has been seeing better grades recently, and even with more than double our average rainfall in 2018, we witnessed a more resilient Bay where water quality is recovering more quickly than in the past. We are also seeing improvements in the Bay's living resources, including a significant increase in the acres of submerged aquatic vegetation and increases in blue crab abundance.

THE FRAMEWORK

Critical to the success we have been able to achieve thus far is EPA's 2010 Chesapeake Bay TMDL. The Bay TMDL identifies the pollutant load reductions needed by point sources (to be

implemented through National Pollutant Discharge Elimination System (NPDES) permitting) and then separately, establishes needed reductions by nonpoint sources. As required by the Bay TMDL, all pollution reduction practices to achieve these reductions must be in place by the year 2025. For nonpoint sources, the Bay TMDL contains a "Reasonable Assurance and Accountability Framework" section describing the details of the accountability system for nonpoint source reductions as well as describing what options EPA would have to obtain needed reductions of pollutants if states failed to achieve the needed nonpoint source reductions. This "Framework" was created to help ensure that nonpoint source reductions would occur.

MORE COLLABORATION NECESSARY

In the Chesapeake Bay Watershed, many jurisdictions are upgrading the wastewater treatment plants, or as I refer to them, water reclamation facilities, to the limit of treatment technology through NPDES permits and increasing restoration requirements under Municipal Separate Storm Sewer System (MS4) permits. However, nonpoint source pollution comprises a large proportion of the reductions that still need to be made. Agricultural operations alone are one of the largest sources of nonpoint pollution to the Chesapeake Bay and currently account for almost half of the nitrogen pollution loads to the Bay.

ROLE OF THE EPA

Additional funds as well as additional enforcement and regulatory actions to reduce nonpoint source pollution are still greatly needed as recently demonstrated by Pennsylvania and New York, mostly nonpoint source pollution states in their most recent revisions to their Bay Watershed Implementation Plans that fail to adequately address pollution targets. As a downstream and downwind state impacted by unmanaged upstream and upwind pollution, and as a leader in the race to enhance, restore and preserve the Chesapeake Bay, Maryland considers this shortfall unacceptable and unfair to our citizens and to all who desire and want clean water and a healthy economy.

We will press EPA - with help from our delegation and partners, and through litigation, if we must - to live up to its commitment, obligation and responsibility as a regulatory partner and interstate umpire who holds everyone accountable for doing their fair share for our restoration effort and initiatives as we strive - as a watershed - to meet our agreed-upon 2025 deadlines.

EXAMPLES OF SUCCESS

I want to thank the Committee and its members for the $12 million increase this year in funding EPA's Chesapeake Bay Program Office. The Senate also supported a $50 million increase in

funding to the U.S. Army Corps of Engineers Environmental Restoration and Compliance Program, a $2 million increase in U.S. Geological Survey's Ecosystem Science and Monitoring for Chesapeake Bay, and a $1 million increase in the National Park Service's Chesapeake Bay Gateways Program. This is in addition to the approximately $1 billion dollars a year Maryland spends on Bay restoration-related programs. With the most recent estimates of the Bay's total economic value at over $1 trillion dollars, these restoration dollars provide a tremendous return on investment for Maryland, the region and the nation.

Regarding the federal 319 nonpoint source program in particular, this important program allows states some flexibility and opportunity to focus their planning in nonpoint source sectors at the local scale and develop strong partnerships with the communities that they serve. The 319 Program has allowed Maryland to also focus on protecting and restoring communities outside of the Chesapeake Bay watershed, including areas in western Maryland and our other important estuarine system, like the Atlantic Coastal Bays that we share with Virginia and Delaware. Through it we've developed partnerships with surrounding jurisdictions to come up with cross jurisdictional solutions to mitigate nonpoint source pollution in shared waters. Additionally, the 319 Program serves as a vehicle for aligning our interests in hazard mitigation due to climate

change, ecosystems services, and water quality benefits at the local scale. Our work with EPA in implementing the 319 Program in Maryland has created a forum for sharing ideas to improve state and federal programs, and helps us to adaptively manage the way we reduce nonpoint source pollution.

Maryland receives a little over $2 million dollars a year in 319 Program funds. While the 319 funding is relatively small compared to the state monies being used for nonpoint source pollution reduction, the 319 funds are very important to many of our local communities participating in the program. Currently, Maryland leverages half of the money for state level support of **local** nonpoint source mitigation programs. See the State's attached section 319 success stories, which is also on our web site at https://mde.maryland.gov/programs/Water/319NonPointSource/Pages/index.aspx. This support includes work to develop locally-targeted watershed restoration plans to ensure compliance with EPA requirements and water quality monitoring support for local partners. The other half of the money goes directly to nonpoint source mitigation projects that have been identified through the targeted watershed planning process.

Through this program, we interact with local officials, allowing us the opportunity to better understand and develop restoration plans that will help achieve both TMDL goals and provide added benefit to the community. This is best reflected in the work done in western Maryland. The state developed the watershed plan for the Casselman River. Funding from the 319 program is being used to eliminate numerous acid mine drainage impacts through the use of traditional practices like leach beds and innovative practices like lime sand deposits along the streams. These successes were not only in water quality, but included improvements in the biological communities as well.

IMPROVEMENTS NEEDED

While Maryland is a supporter of the 319 Program, there is always room for improvement. We would like to see the EPA provide more flexibility in where funding is allowed and undertake an effort to reduce administrative requirements that are perceived by local communities to be too prescriptive and burdensome. The grant is structured to reimburse expenses rather than providing funding up-front; therefore, many low-income communities find it difficult to meet the requirements. Additionally, in light of the fact that in most states, nonpoint source pollution is the largest contributor to water quality impairment, increased funding is critical to meeting

states' nonpoint source reduction needs. The 319 program is a vital Clean Water Act tool for states to combat nonpoint source pollution, protect existing resources, and mitigate impacts to public health.

We are doing everything we can in Maryland with the resources we have--using innovative approaches like nutrient trading, and we are partnering as much as we can--to restore water quality in the Bay. However, if the other states and DC do not meet their commitments, and if the EPA is not there to provide a federal backstop as promised, and sufficient funds are not available in programs such as the 319 Program to address nonpoint source pollution issues---- we will likely not meet the 2025 pollution reduction target established in the 2010 TMDL. From Maryland's perspective, that is totally unacceptable. Failure is not an option and delay is not a strategy.

CONCLUSION

The National Nonpoint Source Program, under section 319 of the Clean Water Act, is achieving nonpoint source pollution reductions thanks to the collaboration at the federal, state and local level.

I want to thank Chairman Barrasso, Ranking Member Carper, and all the members of the committee for your time, and I look forward to answering your questions.

NONPOINT SOURCE SUCCESS STORY

Maryland

Remediating Acid Mine Drainage Increases Brook Trout in Spiker Run

Waterbody Improved

Maryland's Spiker Run, a tributary to Casselman River in Garrett County, was affected by episodic low pH associated with acid mine drainage (AMD) and listed as impaired in 1996. An assessment of an AMD seep impacting the headwaters of Spiker Run ranked this stream as a high priority for mitigation in the Casselman River watershed. Successful implementation of two AMD mitigation measures brought the stream into compliance with the state water quality standard for pH. Monitoring of brook trout demonstrated that the standing crop of adults was five times greater after implementation than before. The Maryland Department of the Environment (MDE) will pursue delisting Spiker Run for its pH impairment in Maryland's 2018 Integrated Report.

Problem

Western Maryland's Casselman River watershed drains to Pennsylvania toward the Ohio River. Before World War II, the river and its tributaries were commonly high-quality waterways that supported native brook trout. During several following decades, coal mining changed local hydrology, resulting in AMD that caused pH declines in numerous streams. One of the affected streams is Spiker Run, which flows into the mainstem of Casselman River (Figure 1). Its headwaters are in Maryland's Savage River State Forest near Maryland Route 40, west of Grantsville.

The Casselman River watershed was listed for pH impairment in 1996. About 1.6 miles of Spiker Run exhibited pH impairment. In 2005 water quality monitoring to support pH total maximum daily load (TMDL) development found that pH levels in Spiker Run were intermittently below the Maryland water quality standard, which requires a pH range of 6.5–8.5. Also in 2005, MDE's consultant completed an assessment of streams with pH impairment in the Casselman River watershed and identified Spiker Run as a high priority for AMD remediation.

In 2008 EPA approved the pH TMDL for Spiker Run and other pH-impaired streams in Western Maryland. Water quality monitoring in 2010–2013 showed that in-stream pH continued to intermittently fall below Maryland's water quality pH standard. Maryland's 2014 Integrated Report clarified the pH conditions in the Casselman River watershed by separately listing each stream segment that has pH impairment and a pH TMDL, which includes Spiker Run.

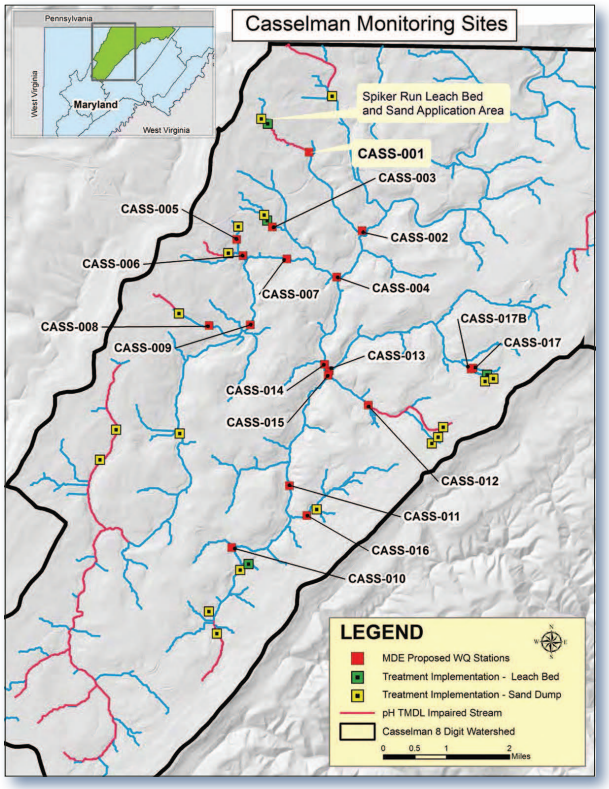


Figure 1. Spiker Run (CASS-01) is in western Maryland.

Story Highlights

In late 2008 MDE initiated watershed planning to make the Casselman River watershed eligible for Clean Water Act (CWA) section 319(h) grant implementation funds. The planning process included an assessment of potential AMD mitigation sites in the watershed, including along Spiker Run, for potential high-priority



Figure 2. A limestone sand application site was installed at the edge of Spiker Run.

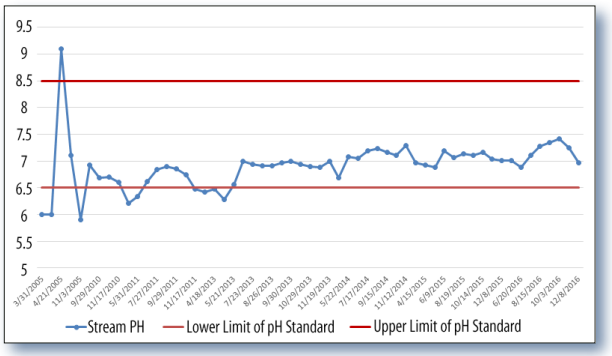


Figure 3. Spiker Run pH has met water quality standards since mid-2013.

action. The plan also analyzed AMD mitigation technologies. One of the technologies recommended to constrain capital, operation and maintenance costs was limestone sand application, sometimes called a limestone sand dump. This technique involves constructing a driveway for a dump truck to pull up adjacent to the stream so that measured quantities of limestone crushed to sand-sized particles can be delivered directly to stream edge. Then, natural variation in stream flow distributes the particles downstream. The limestone particles raise in-stream pH and increase acid neutralizing capacity. The amount and timing of limestone sand application is determined by periodic monitoring and in-stream pH measurements.

In early 2011 the U.S. Environmental Protection Agency accepted the Casselman River Watershed Plan for pH Remediation, and MDE approved CWA section 319(h) grant funding for a project to mitigate AMD-impacted areas in the Casselman River watershed. Spiker Run was selected to be one of 11 Phase I projects for construction because the land was publicly owned, the site was accessible and permit requirements were attainable.

In mid-2013 a leachbed and a limestone sand application site were installed to treat AMD flows entering Spiker Run (Figure 2). During the first year, the application site received 34.89 tons of limestone sand. More applications will continue at varying levels depending on stream conditions for the foreseeable future. Following installation of the leachbed and limestone sand application site, MDE's Abandoned Mine Land Division (AMLD) periodically monitored the pH at Spiker Run and scheduled delivery of limestone sand to the application sites as needed.

Results

After an adjustment period (late 2013 and 2014), data collected in Spiker Run in 2015–2016 demonstrated that in-stream pH consistently met Maryland's water quality standard (Figure 3). In addition, the standing crop of brook trout in Spiker Run increased from 13 kilograms per hectare (kg/ha) in 2008 to 67 kg/ha in 2016. As a result, MDE will pursue delisting Spiker Run for its pH impairment in Maryland's 2018 Integrated Report.

Partners and Funding

MDE's AMLD and Water Quality Protection and Restoration (WQPR) programs wrote the Casselman River Watershed Plan for pH Remediation. AMLD used $55,000 from the federal fiscal year (FFY) 2008 CWA section 319(h) grant for their part of the planning effort. Implementation of the 11 Phase I AMD mitigation projects was led by AMLD, using $644,115 from the FFY 2009 CWA section 319(h) grant. The Garrett Soil Conservation District oversaw contractor hiring, construction management and inspection of projects. Capital cost to install the Spiker Run leach bed and limestone sand application site totaled $71,850.

Other partners contributed work at no cost to the project. Watershed plan drafting by MDE WQPR staff was funded by the 319(h) grant through ongoing projects that support the state nonpoint source management program. Also, water quality monitoring by MDE's Field Services Program were funded by separate ongoing 319(h) grant projects. The Maryland Fisheries Service assessment and analysis was funded by the state of Maryland.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-18-001I
March 2018

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Mitigating Acid Mine Drainage Improves pH Levels in Aaron Run

Waterbody Improved

Water flowing through abandoned coal mines contributed acid mine drainage (AMD) to Maryland's Aaron Run, causing the stream's pH level to fail to meet the state's water quality standard for pH. As a result, the Maryland Department of the Environment (MDE) added Aaron Run to Maryland's 2004 Clean Water Act (CWA) section 303(d) list of impaired waters for low pH. Watershed partners implemented numerous AMD mitigation projects, and pH levels increased. Aaron Run now meets the state water quality standard for pH and supports a population of brook trout. As a result, MDE has proposed removing Aaron Run from the state's list of impaired waters for pH impairment in 2014.

Problem

Western Maryland's Aaron Run (segment 021410060075) begins in Savage River State Forest in Garrett County. It flows about 3 miles to the Savage River, a tributary of the North Branch Potomac River in the Chesapeake Bay watershed (Figure 1).

About 102 acres of the 2,270-acre Aaron Run watershed are underlain by abandoned deep coal mines, and several hundred acres of the watershed are composed of reclaimed surface coal mines. Water flowing from these mined areas contributed AMD to the middle and upper watershed. Erosion of coal waste piles that had been dumped along stream banks also contributed acidity to the stream. As a result, pH levels in parts of Aaron Run fell to as low as 3.5—well below the state minimum of 6.5. MDE believed that the low pH levels caused brook trout to be unable to survive in Aaron Run even though similar Savage River tributary streams supported healthy native brook trout populations. Habitat degradation associated with the AMD sources (e.g., low pH and the associated iron sediments/precipitates clogging interstitial spaces in the streambed) was also observed in the Savage River near the Aaron Run confluence. Because of these problems, in 2004 MDE added Aaron Run to the CWA section 303(d) list for impairment by low pH and for failure to support its aquatic life and wildlife designated use.

In 2008 EPA approved MDE's pH total maximum daily load (TMDL) for Aaron Run. The TMDL requires that the state water quality standard for pH (6.5 to 8.5) be met at all times.



Figure 1. Aaron Run flows into the Savage River in eastern Garrett County, just upstream of the Savage River's confluence with the North Branch Potomac River.

Project Highlights

An assessment of AMD sources and impacts in 1987 concluded that mitigation of AMD in the Aaron Run watershed was feasible. Project funding for AMD mitigation was initially obtained in 2005. Project implementation, conducted by MDE's Abandoned Mine Land Division, occurred through 2011. The project included construction of one limestone doser, one limestone leach bed, two successive alkalinity-producing system cells, and one oxidizing pond (Figure 2). The project also created 1 acre of treatment wetlands and restored 600 linear

feet of eroding stream bank. In 2012 the Maryland Department of Natural Resources' Fisheries Service restocked Aaron Run with native brook trout.

Results

Water quality data collected from 2011 through 2013 in Aaron Run, after completion of the AMD mitigation projects, demonstrated that the water quality standard for pH (a minimum of 6.5) is being met and that the TMDL requirements for pH are being satisfied (Figure 3). On the basis of these data, MDE has proposed removing Aaron Run from the state's list of impaired waters for pH impairment in 2014. Aaron Run fully supports its aquatic life and wildlife designated use.

In addition, in-stream conditions had improved enough by August 2012 to allow the Fisheries Service to reintroduce native coldwater stream fish species, including brook trout, blacknose dace, longnose dace, fantailed darters, and Blue Ridge sculpins, into Aaron Run. In October 2013 the Fisheries Service assessed the stream's brook trout population and found adults and several smaller individuals. An additional year or more of assessment will be needed to verify whether a naturally reproducing brook trout population resides in Aaron Run.

Partners and Funding

MDE's Abandoned Mine Land Division conducted the project. In addition, MDE contracted with the Garrett Soil Conservation District to provide technical and management oversight services for the construction phase of the project. Funding from CWA section 319 in three consecutive years (fiscal years 2005–2007) aided in planning, design, and construction from late 2005 through late 2011. The total project cost was about $1.01 million, including about $812,000 reimbursed by the CWA section 319 grant. Other project funding was provided by the U.S. Department of the Interior's Office of Surface Mining Reclamation and Enforcement (about $124,000 in Title IV grant funds) and by the Eastern Brook Trout Joint Venture (about $75,000). The Fisheries Service provided fisheries management and related stream assessment services at no cost. MDE's Field Services Division provided some of the pre- and post-construction stream monitoring through a separate ongoing CWA section 319-funded nonpoint source monitoring and analysis project. Volunteers from the nonprofit Savage River Watershed Association assisted with water quality monitoring along Aaron Run.



Photograph by Connie Loucks, MDE Abandoned Mine Land Division.

Figure 2. The Owens South AMD mitigation site includes an oxidizing pond (foreground) and successive alkalinity-producing system cells (background).

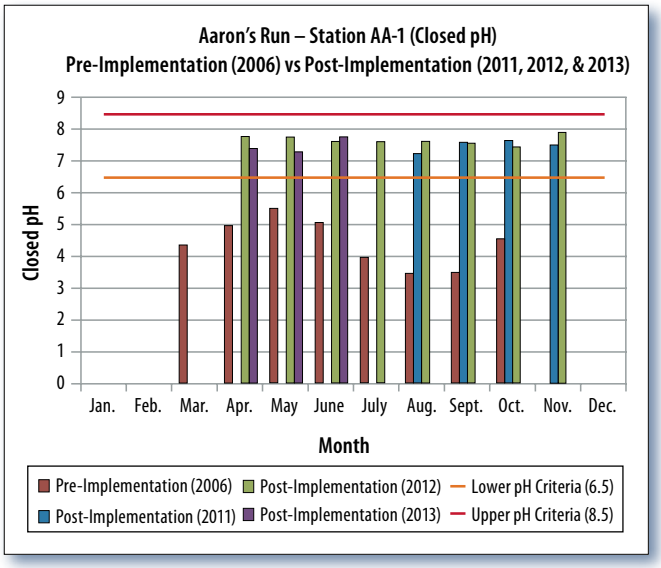


Figure 3. After restoration efforts, pH levels in Aaron Run increased; they now meet water quality standards.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-14-001UU
August 2014

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Protecting Riparian Areas Yields In-Stream Improvement in First Year

Waterbody Improved

Runoff from agricultural activities and urbanization contribute to sediment and nutrient impairments in the lower Monocacy River and Lake Linganore. As a result, Maryland Department of the Environment (MDE) added the waterbodies to the 1996 Clean Water Act (CWA) section 303(d) list, on which they have since remained. A landowner installed agricultural best management practices (BMPs), including cattle fencing, alternative watering facilities and riparian planting on a small, unnamed tributary of Lake Linganore. The BMPs have resulted in water quality improvements in the first year. MDE will continue monitoring progress toward meeting the total maximum daily load (TMDL) and water quality standards.

Problem

Lake Linganore is an impoundment in eastern Frederick County, Maryland. An earthen dam was installed across Linganore Creek in 1972 to create the 216-acre lake as a water supply and for recreational use. Water from Lake Linganore empties back into Linganore Creek and then flows to the Monocacy River, the Potomac River and the Chesapeake Bay. The lake's primary inflows include Bens Branch and Linganore Creek. Many of the streams in the area were affected by agricultural land uses historically and are now also affected by suburban development. For example, grazing cattle's uncontrolled access to headwater streams caused severe sedimentation in tributaries upstream of Lake Linganore (Figure 1).

Sediment and nutrients in agriculture and suburban runoff impaired the lake, preventing it from meeting two of its designated uses—water supply and recreation. As a result, MDE added the lake to its 1996 CWA section 303(d) list of impaired waters. A TMDL for phosphorus and sediment was approved for Lake Linganore. Nutrient and sediment TMDLs are being developed for the entire watershed.

Project Highlights

To meet the TMDL requirements, the Maryland Department of Agriculture (MDA) targeted the entire watershed for technical and financial assistance to local farmers who are willing to implement BMPs. For example, MDA worked with the owner of Hunting Lotte Farm to implement improvements along a small, unnamed headwater tributary to Bens Branch. The 450-acre crop and livestock farm produces a variety of crops and supports about 150 head of Black Angus cattle on approximately 80 acres of pasture. Before 2006, stream riparian conditions on the tributary were poor because of cattle overgrazing and trampling the streambanks.



Figure 1. Before the 2006 fence installation, uncontrolled cattle access to an unnamed tributary of Bens Branch caused visible erosion.



Figure 2. In autumn 2007, after fence installation, the riparian area is recovering. Numerous tree tubes indicate that trees will soon dominate the area.

The landowner installed more than 8,800 feet of fencing along streambanks, developed three alternative water sources that use natural springs instead of allowing cattle to drink from the stream, and improved three heavy-use areas and two stream crossings. Trees were planted during Earth Day celebrations in 2006 and 2007 in cooperation with MDA, Natural Resources Conservation Service and the Chesapeake Bay Foundation (CBF). The landowner planted more than nine acres of cool-season grasses along the streambanks. By autumn 2007 riparian vegetation had rapidly begun to cover and stabilize the streambanks (Figure 2). The farm also participates in the cover crop program, uses no-till and minimum tillage practices, and complies with and participates in the Maryland Nutrient Management Program.

Results

To track in-stream changes for this and other projects statewide, MDE's Targeted Watershed Project staff conducted the following: quarterly water monitoring to track nutrient changes, annual quantitative stream channel surveys to track substrate changes, and periodic sampling of stream bugs (benthic macroinvertebrates) to track changes in the local biological community.

MDE maintains monitoring sites on the unnamed tributary running through Hunting Lotte Farm. Within one year of BMP installation, the rapid return of riparian vegetation provided extensive summer stream shading and improved bank stability. The percentage of in-stream gravel substrate has increased and in-stream sand/mud substrate has decreased (Figure 3). The stream channel survey that MDE conducted in 2006 and 2007 shows that substrate quality in both stream reaches is improving, including a decrease in clay and sand and an increase in gravel and cobbles.

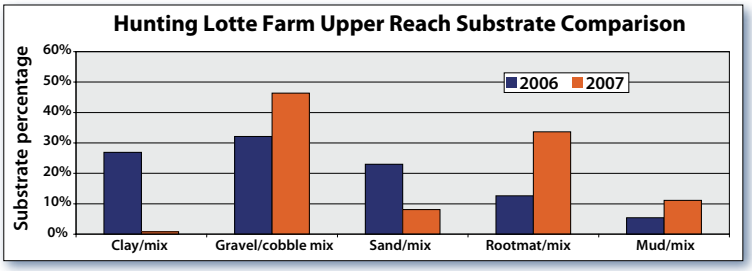


Figure 3. Monitoring conducted before (2006) and after (2007) the landowner installed BMPs shows that the in-stream gravel substrate increased, and the percentage of in-stream sand/mud substrate decreased.

Phosphorus concentrations have also decreased from a high of 0.2 milligram per liter (mg/L) in 2006 to a low of 0.025 mg/L in 2007, which indicates that erosion and sediment movement have decreased (Figure 4). Declining phosphorus concentrations can be attributed to reduced erosion in the riparian area and the streambanks as result of restricting cattle's access to the stream. More time is needed

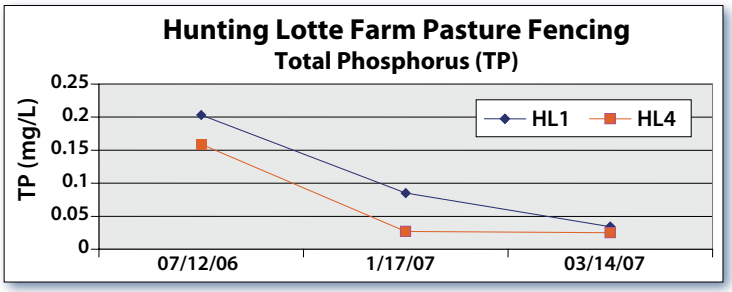


Figure 4. Installing fences to keep cattle away from streams helped reduce phosphorus levels. Data from monitoring sites HL1 and HL4 show steady phosphorus declines.

to assess the biological community change of macroinvertebrate populations. Total nitrogen data did not change significantly, which could be associated with a lag in the BMP effect—plant roots in the riparian area have not yet developed to the point where they can uptake higher amounts of nitrogen.

While sediment and phosphorus loads have been significantly reduced, Lake Linganore and the Lower Monocacy River are not yet meeting water quality standards and remain on Maryland's list of impaired waters. However, visible improvements in the unnamed tributary and elsewhere in the Lake Linganore watershed are soon expected to measurably reduce impairments in the lake.

Partners and Funding

Mostly in 2006, the farm owner invested nearly $100,000 in BMPs, approximately $79,000 of which was supported by grants. The Maryland Agricultural Cost Share program provided about $57,000; the Conservation Reserve Enhancement Program provided $19,400; and CBF provided nearly $2,600. To track in-stream changes for this and other projects statewide, the MDE Targeted Watershed Project is using CWA section 319 grant funds to pay for technicians and analyses, including quarterly water quality monitoring, annual stream substrate surveys and periodic biological sampling of benthic macroinvertebrates.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-10-001B
January 2010

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NONPOINT SOURCE SUCCESS STORY

Maryland

Treating Acid Mine Drainage Improves Big Laurel Run pH Levels

Waterbody Improved

Acid mine drainage (AMD) from historic mining operations led to low pH levels in Maryland's Big Laurel Run, a tributary to the Casselman River. As a result, Maryland added the Casselman River watershed to its 1996 Clean Water Act (CWA) section 303(d) list for pH. AMD mitigation projects implemented in the watershed's headwaters from 2012 to 2014 increased pH levels. Due to this improvement, Maryland intends to remove the pH impairment from the Big Laurel Run segment of the Casselman River watershed in the 2016 integrated report.

Problem

Big Laurel Run is a tributary to the South Branch Casselman River in Garrett County. The river begins in Maryland's Savage River State Forest and flows across southwestern Pennsylvania toward the Ohio River (Figure 1). Before World War II, the Casselman River and its tributaries were high-quality waterways that supported native brook trout. During the following decades, water quality in these streams degraded due to AMD from the watershed's abandoned mines. The Casselman River watershed was listed for pH impairment in 1996 as a result of these acidic conditions.

Monitoring in 2011–2013 near the headwaters showed that in-stream pH ranged from 4.5 to 6.0, which failed to meet Maryland's water quality pH standard of 6.5 to 8.5. The low-pH waters flow about 6 miles to the South Branch Casselman River, which supports a healthy brook trout population and is designated as a Maryland Tier II high-quality water.

A 2004–2006 assessment of Maryland's Casselman River tributaries identified Big Laurel Run as a high priority for AMD mitigation. A 2008 Maryland Department of Natural Resource Fisheries Service assessment determined that improving pH in Big Laurel Run could expand the area available to native brook trout, despite the stream's sub-optimal physical habitat. A pH total maximum daily load was finalized in 2008.

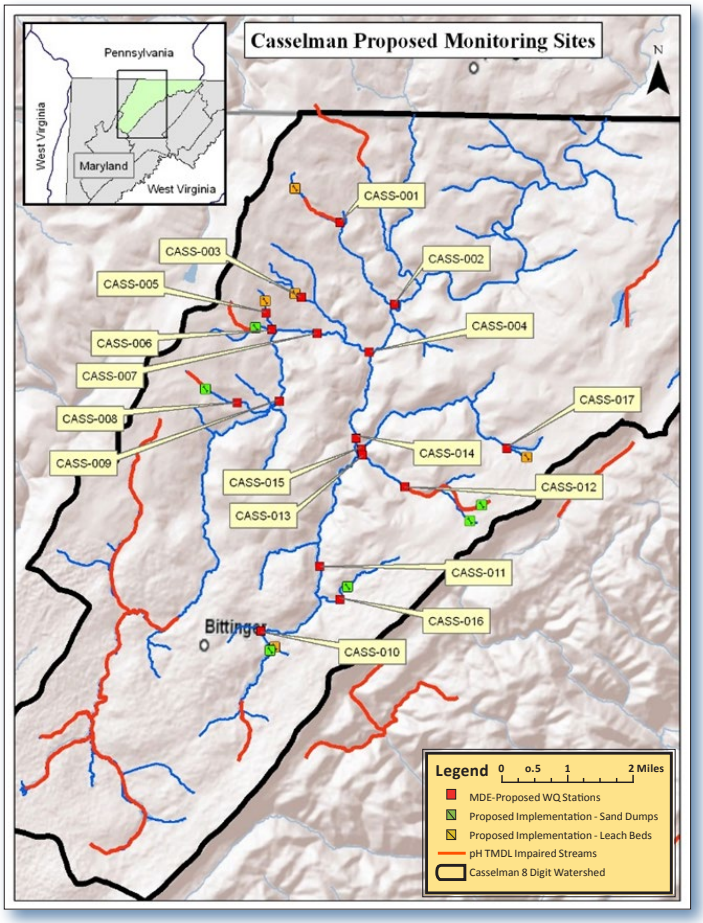


Figure 1. Northwest Maryland's Casselman River watershed was listed as impaired for pH in 1996. To address the impairment, partners developed a watershed plan that outlined proposed monitoring and project implementation site locations throughout the watershed, including in Big Laurel Run (near CASS-017 sampling site). Work is ongoing.

Project Highlights

In late 2008 the Maryland Department of the Environment (MDE) initiated watershed planning to allow the Casselman River watershed to be eligible for



Figure 2. Limestone leach bed, installed in 2014 in the headwaters of Big Laurel Run.

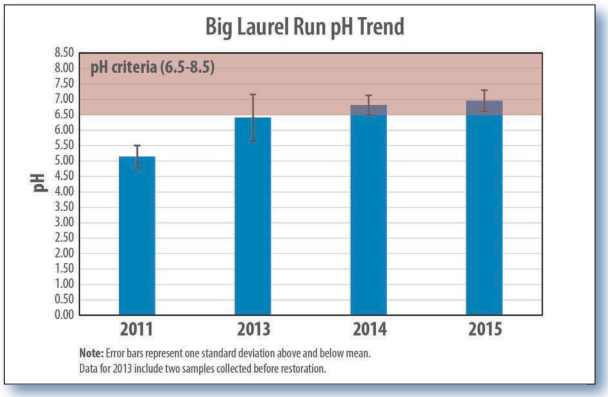


Figure 3. Data show pH improvements at the Casselman River sampling site CASS-017B (Big Laurel Run).

CWA section 319(h) grant implementation funds. The planning process included assessing potential AMD mitigation sites, including Big Laurel Run. The plan recommended particular AMD mitigation technologies, such as limestone leach beds and limestone sand application that would help keep capital and operation and maintenance costs low. In early 2011 EPA accepted the *Casselman River Watershed Plan for pH Remediation*. MDE selected the Big Laurel Run headwaters area project as one of the first for construction because the land was publicly owned, the site was accessible and permit requirements were attainable.

Construction occurred from late 2011 through early 2012 at Big Laurel Run to implement two technologies recommended by the watershed plan. A limestone leach bed (Figure 2) employs a siphon to draw low-pH water from the stream and feed the water through the leach bed, where gravity flow returns pH-adjusted water to the stream. In addition, two limestone sand application sites were constructed, one on each branch of the stream's headwaters. During 2013 and 2014, nearly 65 tons of limestone sand were delivered to these two sites.

Results

After completion of the AMD mitigation projects, data collected in 2013 and 2014 in Big Laurel Run demonstrated that the water quality standard for pH was being met (Figure 3). The average pH before the project was 5.4; the average after project implementation was 6.8. In addition, the average acid neutralizing capacity in Big Laurel Run increased from less than 10 microequivalents per liter (ueq/L) before AMD mitigation to more than 150 ueq/L after the project.

In addition, the Maryland Fisheries Service has identified limited fishery improvement. Juvenile native brook trout abundance in Big Laurel Run increased by a factor of 1.3 in 2014 compared to 2008 (before implementation). Maryland Fisheries Service found that adult population numbers and density remained about the same, and that most previously existing suboptimal habitat conditions persisted throughout the study period, indicating that full recovery of aquatic life will take time.

Partners and Funding

MDE's Abandoned Mine Land Division (AMLD) and Water Quality Protection and Restoration Program cooperated to write the watershed plan, using $55,000 in CWA section 319(h) funds through ongoing projects that support the state nonpoint source management program. AMLD led the project implementation at 11 Phase 1 Casselman River watershed AMD mitigation sites, using $644,115 in CWA section 319(h) grant funds. The Garrett Soil Conservation District oversaw contractor hiring, construction management and project inspection. Capital cost of the Big Laurel Run portion of the section 319 project included $8,000 for the two limestone sand application sites and $60,000 for the limestone leach bed and siphon system. Pre- and post-implementation water quality monitoring by MDE's Field Services Program was funded through separate ongoing section 319(h) grant projects. Maryland Fisheries Service assessment services work was independently funded by the state.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-16-001L
July 2016

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Treating Acid Mine Drainage Improves Cherry Creek

Waterbody Improved

Abandoned coal mines contributed high levels of acidity and metals to Maryland's Cherry Creek, which flows into Deep Creek Lake. As a result, the Maryland Department of the Environment (MDE) added the Deep Creek Lake watershed, including Cherry Creek, to the state's 1996 Clean Water Act (CWA) section 303(d) list of impaired waters for pH. Acid mine drainage (AMD) mitigation projects were implemented in Cherry Creek, which now consistently meets the total maximum daily load (TMDL) goal for pH. In addition, acidity, iron and aluminum levels have declined.

Problem

Western Maryland's Cherry Creek begins near Savage River State Forest, flows about eight miles through a 7900-acre watershed, and empties into Deep Creek Lake (Figure 1). Outflow from the lake enters the Youghiogheny River, which is in the Ohio River Basin. The Cherry Creek watershed is composed of 69 percent woodlands and 12 percent wetlands; the remainder is mixed agriculture and developed lands. Deep Creek Lake is a manmade recreational impoundment that is popular for fishing and boating.

The name Cherry Creek can be traced to the waterbody's deep reddish color, which was historically caused by bog tannins from sphagnum wetlands. These wetland complexes include coniferous forest and marshes, and they contribute natural organic acidity to the stream.

In the 1920s Cherry Creek was a natural trout stream and the site of a trout-rearing station. During the next several decades, AMD associated with coal mining increased. In 1957 a large fish kill caused by low pH brought an end to trout stocking in Cherry Creek. A 1973 study reported that almost the entire main stem of Cherry Creek was severely or moderately polluted by AMD. That study also estimated that one-fourth of the acid load in the stream is derived from mines; the rest is from natural sources. In the 1980s it was estimated that Cherry Creek was the source of half the acidity entering Deep Creek Lake.

Before project implementation, AMD generally caused the in-stream pH to fall to between 4.0 and 4.3,with a pH as low as 3.2 during periods of low flow. To address this impairment, the TMDL approved for Cherry Creek calls for a pH of 4.6 or higher. That level takes into account the naturally low pH arising from the sphagnum wetlands that characterize Cherry Creek.

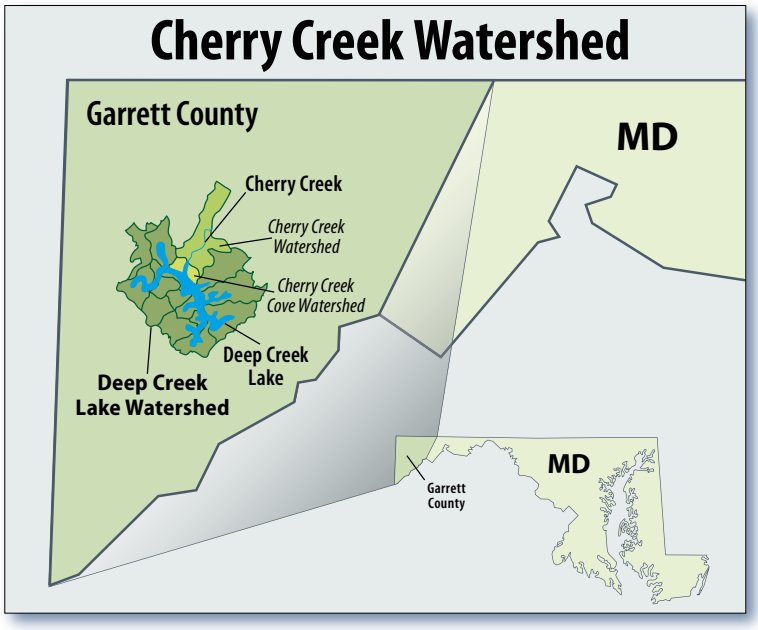


Figure 1. The Cherry Creek watershed is in western Maryland.

Project Highlights

Between 1986 and 1989, MDE created a series of treatment wetlands to help reduce AMD impacts in the Cherry Creek watershed. The Department constructed additional AMD treatment systems between 1998 and 2001, including successive acid treatment systems and more treatment wetlands. Several commercial AMD treatment systems were also introduced, including an Aluminator® (a successive



Figure 2 . Partners installed a successive alkalinity-producing system at the Everhart project site.

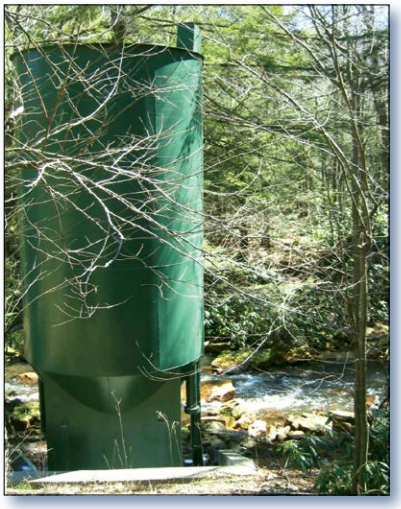


Figure 3 . Partners installed a limestone doser adjacent to Cherry Creek.

alkalinity-producing system that includes a treatment cell designed to precipitate aluminum while keeping iron in a soluble form), a Pyrolusite® cell (bioremediation using limestone and bacteria to remove metals), and a Boxholm® doser (a system that introduces lime to the water at a given rate). (See Figures 2 and 3.) The Cherry Creek mitigation effort used approximately 6,760 tons of limestone, not including the lime used for the doser.

Results

In-stream sampling conducted after AMD implementation (2003–present) shows that pH is generally greater than 6.0 and is always greater than 5.2, meeting the TMDL goal (a pH of 4.6 or greater). Data also show that individual AMD treatment sites have significantly reduced concentrations of pollutants while also increasing alkalinity (Table 1).

Fish surveys show that fish populations have increased. In 1971 only three species of lake fishes were found in Cherry Creek, and they were found only near the confluence of the creek with Deep Creek Lake. In 2004, after implementation of AMD mitigation, a survey found seven fish species in the stream. The survey report stated that rainbow trout, brown trout and smallmouth bass were common enough to support some recreational fishing and that the range of several fish species extended from the stream mouth upstream about 1.5 miles to the vicinity of the lime doser. According to the 2004 survey report, fish have not progressed farther upstream because of a complete blockage by an old mill dam and inflow from a small unnamed tributary, which might be contributing additional AMD. A 2012 analysis of all benthic macroinvertebrate data for Cherry Creek found that the Benthic Index of Biological Integrity might have improved, but the stream's condition continues to be classified as poor overall. The sources of this continuing biological impairment are believed to include AMD.

Partners and Funding

MDE's Abandoned Mine Lands Division was the primary implementer of the Cherry Creek AMD mitigation projects. The total capital cost for the restoration project was $496,000 over 15 years; funds were provided by the State of Maryland; the U.S. Department of the Interior, Office of Surface Mining; and the U.S. Environmental Protection Agency. In addition, the private Sprenger Lang Foundation paid for the purchase and construction of the lime doser, which is located on property owned by the Rock Creek Trust. Funds for operation and maintenance of the doser ($30,000 annually) come from the State of Maryland and the U.S. Department of the Interior. Other partners that help manage and monitor Cherry Creek include the Maryland Department of Natural Resources' Fisheries Service and the University of Maryland's Appalachian Lab.

Table 1. Monitoring Data for Cherry Creek Project Sites, Before and After Installation of AMD Treatment (Average)

Project Site	pH [a]		Acidity [b]		Alkalinty [b]		Iron [b]		Aluminum [b]	
	Before	After	Before	After	Before	After	Before	After	Before	After
Everhart site	3.5	6.1	300	21	0.0	23	65	1.5	4.9	0.1
Glotfelty site	5.3–5.9	6.9	372	0.0	N/A [c]	N/A [c]	111–147	0.83	1.5–3.5	0.1
Teets site	3.1	7.1	486	0.0	0.0	106	73	1.2	37	0.1

[a] In standard units. [b] In milligrams per liter (mg/L). [c] Not available.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA #
December 2012

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Implementing Best Management Practices Reduces Nitrogen in Two Corsica River Tributaries

Waterbodies Improved

Algae blooms in the upper tidal reaches of Maryland's Corsica River prompted the Maryland Department of the Environment (MDE) to add the river to the state's Clean Water Act (CWA) section 303(d) list of impaired waters in 1996 for impairment of aquatic life and recreational use. MDE developed a total maximum daily load (TMDL) for nitrogen and phosphorus. After six years of restoration efforts, water quality monitoring in two nontidal Corsica River tributaries shows a significant decrease in nitrogen concentrations. These improvements indicate that project partners are making progress toward meeting the Corsica River nutrient TMDL.

Problem

The six-mile-long Corsica River is a tidal tributary on Maryland's Eastern Shore. It flows through Queen Anne's County and the town of Centreville before entering the Chester River, which discharges into the Chesapeake Bay (Figure 1). Major land uses in the 40-square-mile watershed are agriculture (64 percent), woodland (28 percent) and developed areas. The nontidal portions of the Corsica River are designated for aquatic life protection and contact recreation; most of the estuarine portions are designated as shellfish harvesting areas.

Algal blooms and other water quality problems in the tidal portions of the Corsica River prompted MDE to add this watershed assessment unit to the CWA section 303(d) list in 1996 for impairment by nutrients, suspended sediment and fecal coliform bacteria. Water quality surveys conducted in 1997 found that the local eutrophication problems (the overenrichment of aquatic systems caused by excessive nutrient input) tended to be the greatest slightly downstream of the tidal/nontidal interface. Data showed chlorophyll *a* concentrations (a measure of algal content) as high as 146 micrograms per liter (μg/L).

MDE developed a TMDL for nitrogen and phosphorus, which EPA approved in 2000. According to the TMDL, the major source of nutrient loading was agricultural runoff (85 percent); other sources were forest and urban nonpoint sources and the town of Centreville's wastewater treatment plant (WWTP). The TMDL established the following water quality goals for the Corsica River: (1) chlorophyll *a* concentrations should remain below 50 μg/L, and (2) dissolved oxygen (DO) levels should remain above the state's minimum water quality standard, 5 milligrams per liter (mg/L).

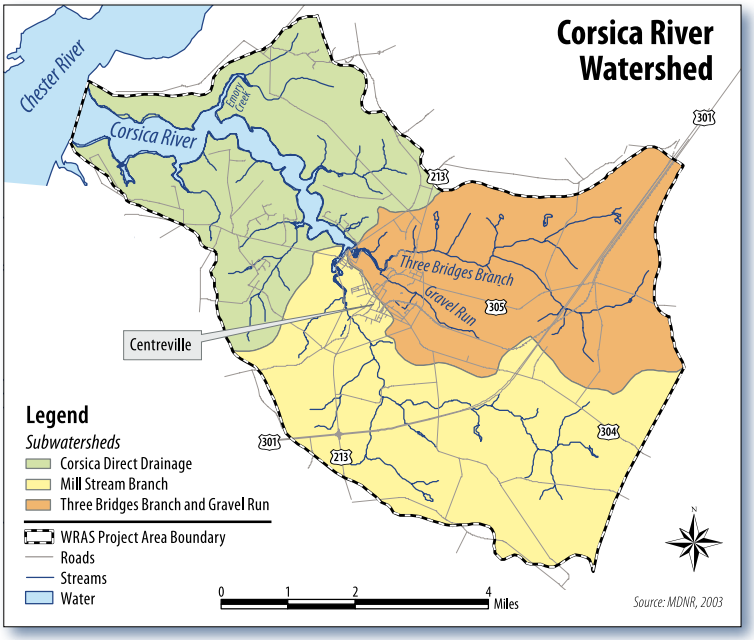


Figure 1. The Corsica River's three subwatersheds are part of the Corsica River Watershed Restoration Action Strategy (WRAS).

Project Highlights

In 1998 the Maryland General Assembly passed the Water Quality Improvement Act, which required that all agricultural operations with gross annual income over $2,500 and any livestock operations with more than eight animal units develop and implement nutrient management plans. All plans were developed by 2004, helping to reduce nutrient pollutant loading.

In 2004 the town of Centreville, along with several key local partners and with support and cooperation from MDE and the Maryland Department of Natural

Resources (MDNR), finalized the *Corsica River Watershed Restoration Action Strategy* (WRAS). The plan outlined implementation strategies needed to protect and restore the watershed. In 2005 EPA accepted the Corsica River WRAS, which was highlighted as one of the nation's best watershed plans at the CWA section 319 nonpoint source annual meeting. That same year, Maryland's governor selected the Corsica River for the state's targeted restoration watershed program.

Watershed partners have worked to implement agricultural best management practices (BMPs) since 2004. Over the last several years, farmers have annually planted increasing acres of cover crops. Since 2010, annual cover crop coverage has exceeded the WRAS goal of 3,000 acres per year. Other agricultural BMPs implemented include approximately 5 acres of natural buffer, 30 acres of grassed buffers, 30 acres of riparian herbaceous cover, 3 acres of grassed waterways and 2 miles of stream fencing.

In 2005 the Maryland Department of Agriculture (MDA) received CWA section 319 funds to promote and partially reimburse cover crop planting on farm fields in the watershed. Since then, CWA section 319 funds have also supported efforts by an MDA agricultural technician to help local farmers select and target agricultural BMPs.



Figure 2. From 2009–2010 the town of Centerville and MDNR converted an existing stormwater management pond into a multi-cell pond-wetland complex to more effectively capture and treat runoff.

In 2006 the town of Centreville and Queen Anne's County began a series of CWA section 319-funded projects, including urban stormwater infiltration projects and support for education and outreach efforts. Local partners installed stormwater wetland ponds and bio-retention practices, which capture and hold excess stormwater runoff during heavy precipitation events. The town installed stormwater retrofits on 112 acres (Figure 2). Local residents volunteering through the Corsica River Conservancy have installed more than 300 rain gardens.

Maryland legislation established the Bay Restoration Fund in 2004. It supports upgrading WWTPs with enhanced nutrient removal technology, improving on-site septic systems and implementing cover crops to reduce nutrient loading to the Chesapeake Bay. As of May 2012, 13 on-site septic systems in the Corsica River watershed were enhanced with nitrogen-reducing treatment capability. In 2010 the town of Centerville completed upgrades of its WWTP to include biological nutrient reduction technology. In addition, Centerville now applies its WWTP discharge to farmland through spray irrigation for nine months each year, which has greatly reduced the amount of discharge directly entering the upper tidal reaches of the Corsica River.

Results

Monitoring data from 2005–2011 show decreasing trends of instream nitrogen and phosphorus concentrations in the nontidal tributaries of the Three Bridges Branch and Gravel Run subwatershed. Groundwater monitoring conducted on crop fields in the watershed during 2005–2007 spring sampling periods indicates that cover crop planting may be reducing nutrient loadings.

The upgrades to Centerville's WWTP have also reduced nutrient loading. Comparing discharge monitoring records from 1997 (before upgrades) to the period 2007–2012 (after upgrades) shows that total nitrogen loads from the plant have declined by 87 percent (from 11,175 pounds per year to 1,424 lb/yr) and that total phosphorus loads have declined by 96 percent (from 2,395 lb/yr to 92 lb/yr).

Partners and Funding

Key partners have included local government entities (the town of Centreville, Queen Anne's County and the Queen Anne's Soil Conservation District), local watershed groups (Corsica Conservancy and the Chester River Association), state agencies (MDE, MDA and MDNR), and federal agencies (EPA and the U.S. Department of Agriculture's Natural Resources Conservation Service [NRCS]). To date, partners have invested almost $3.5 million in nonpoint source implementation projects. Maryland's agricultural cost-share program and NRCS have provided funding to implement BMPs in the watershed. From 2004 through 2012, $450,000 in federal CWA section 319 funds supported agricultural technical assistance to local farmers for selecting and targeting BMPs. Another $920,000 funded urban BMP implementation and provided local nonpoint source program support. As of May 2012, Maryland's Bay Restoration Fund had provided more than $150,000 for 13 septic system upgrades in the Corsica River watershed. The WWTP upgrade and capital cost of seasonal land treatment (farmland application of discharge) totaled about $4.5 million.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-13-001P
April 2013

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY

Maryland

Stream Restoration Reduces Peak Storm Flow and Improves Aquatic Life in Sligo Creek

Waterbody Improved

Stormwater runoff and extensive habitat destruction contributed to eliminating all but four of the most pollution-tolerant fish species in Maryland's Sligo Creek, a tributary to the Anacostia River. The Maryland Department of the Environment (MDE) added the Anacostia River (including the Sligo Creek subwatershed) to the state's Clean Water Act (CWA) section 303(d) list of impaired waters in 2002 for biological impairment, as measured by combined fish/benthic bioassessment. As a result of restoration efforts in the Sligo Creek subwatershed, in-stream conditions improved, as measured by a shift in the fish Index of Biotic Integrity (IBI) from a "poor" to a "fair" rating. Water quality improvements have contributed to progress in meeting the Anacostia River's total maximum daily load (TMDL) limits for phosphorus, nitrogen and sediment.

Problem

The Sligo Creek subwatershed is home to 82,000 people. It encompasses 11.1 square miles of highly developed land in Montgomery County, Maryland, a northern suburb of Washington, DC (Figure 1). Sligo Creek is one of 14 tributaries to the Anacostia River, which flows into the Potomac River, which in turn empties into the Chesapeake Bay.

Maryland has a narrative water quality standard for freshwater benthic community health that guides how the state assesses the designated use for aquatic life. MDE evaluates fish and benthic IBI data reported in the Maryland Biological Stream Survey to assess CWA section 303(d) listings of impaired waters. In 2000 only four fish species (all extremely pollution-tolerant) were found in Sligo Creek. Consequently, Sligo Creek received a rating of "poor" on EPA's IBI for fish. MDE therefore added the Anacostia River watershed assessment unit (which includes Sligo Creek) to the state's 2002 CWA section 303(d) list for biological impairment. The source of impairment was unknown.

In addition, MDE has listed the Anacostia watershed for the following impairments (with listing years): nutrients (1996), sediments (1996), fecal coliform bacteria–non-tidal waters (2002), toxics–polychlorinated biphenyls (PCBs) (2002), toxics–heptachlor epoxide (2002), fecal coliform bacteria–tidal waters (2004), and debris/floatables/trash (2006). TMDLs have been approved for biological oxygen demand/dissolved oxygen, phosphorus, nitrogen, sediments, fecal coliform, PCBs and trash.



Figure 1. Maryland's Sligo Creek subwatershed drains a densely populated area near Washington, DC.

Project Highlights

Efforts to address water quality and habitat problems in Sligo Creek began more than 20 years ago. Since the enactment of the Anacostia Watershed Restoration Agreement in 1987, an evolving interjurisdictional blueprint has guided restoration efforts across the Anacostia watershed, including Sligo Creek. In 1989 Montgomery County embarked on an ambitious effort to restore water quality and habitat conditions in the creek.

In Phase I (1989), the county transformed a dry stormwater pond that collects runoff from 805 acres into a three-celled, extended-detention wet pond with wetland plantings. The detention wet pond improved appearance, provided fish and wildlife habitat, and captured sediment and trash. Below the pond, the county restored 1,000 linear feet of downstream aquatic habitat by creating two vernal pools for amphibian breeding habitat and repairing 1,200 feet of riparian stream corridor.

In Phase II (1992–1994), another stormwater pond serving 434 acres was rebuilt as a two-celled, extended-detention wet pond/marsh. Other projects included restoring 2.5 miles of aquatic habitat, creating a quarter-acre marsh, replanting five acres of forest, implementing 19 small physical aquatic habitat improvement projects and reintroducing native fish species.

In Phase III (1996), the county constructed a one-acre detention wet pond at a Sligo Creek golf course to capture stormwater runoff from 70 acres, including a one-mile portion of Interstate 495.

In Phase IV (1999), the county created two stormwater wetlands and conducted restoration work in middle Sligo Creek to help return stream segments to more natural conditions that support aquatic life habitat needs (e.g., replacing straight-line concrete channels and pipes with meandering channels with varied stable bottom).



Figure 2. LID project installed during Phase V of the Sligo Creek restoration effort.

In Phase V (2005–2007), the county installed low impact development (LID) stormwater management bioretention systems (Figure 2). The county also established a new goal to improve the fish IBI from "poor" to "fair" through targeted reintroduction of native fish.

Phase VI (2010–present) involves implementing numerous small restoration projects in a 45-acre subwatershed, including integrating upland watershed source control measures, such as LID, with stream/wetland restoration and vegetated control practices (e.g., replacing mowed grass areas with vegetation that has greater potential for stormwater retention, infiltration and evapotranspiration).

Results

Phases I–V implemented stormwater management practices on 1,425 acres (48 percent) of the upper Sligo Creek subwatershed, resulting in a 41 percent reduction in peak flow discharge. This has led to improvements in water quality, streambed and bank stability, and in-stream habitat. MDE indicates that benthic macroinvertebrate populations have become more abundant and diverse, helping to support increased fish populations. Between 2000 and 2009, IBI scores for fish throughout most of upper Sligo Creek improved from "poor" to "fair" (Figure 3). Monitoring data confirmed the presence of 14 naturally sustaining fish species, including habitat specialists (species that prefer specific types of habitat).

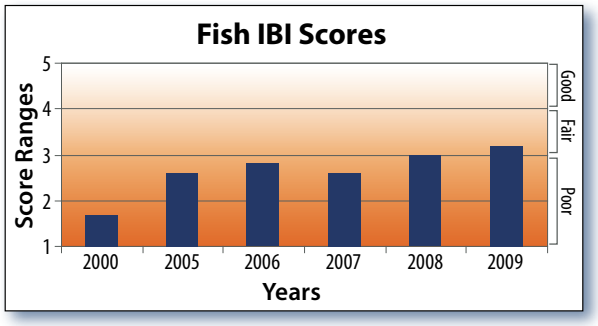


Figure 3. Fish Index of Biotic Integrity scores for Sligo Creek (2000–2009).

Partners and Funding

The Sligo Creek restoration effort is the result of a cooperative partnership with Montgomery County, MDE, Maryland National Park and Planning Commission, Washington Metropolitan Council of Governments, Interstate Commission on the Potomac River Basin, U.S. Army Corps of Engineers and U.S. Environmental Protection Agency.

Approximately $3 million (excluding monitoring costs) has been invested in the upper Sligo Creek restoration effort, including $1.8 million from the Montgomery County capital budget, $1 million from the MDE's Small Creeks and Estuaries Reserve cost share program, and $256,000 from the U.S. Army Corps of Engineers.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-12-001J
May 2012

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Restoring Stream Reduces Nitrogen in an Urbanized Watershed

Waterbody Improved

Uncontrolled stormwater runoff caused stream erosion and degraded riparian habitat in Maryland's Minebank Run and Lower Gunpowder Falls watersheds. Maryland Department of the Environment (MDE) added Lower Gunpowder Falls (including Minebank Run) to the state's Clean Water Act (CWA) section 303(d) list of impaired waters for nutrients (phosphorus) in 1996. On the basis of benthic and fish assessments, MDE also classified the waterbody as impaired for biological integrity in 2006. Project partners implemented numerous stream restoration activities that led to visible and measurable water quality improvements. Until additional improvements are documented, however, the segment will remain on the impaired waters list.

Problem

Minebank Run and Lower Gunpowder Falls are in the scenic Cromwell Valley in eastern Maryland's Baltimore County. Minebank Run is an urban headwater stream that joins the Gunpowder River just south of Loch Raven Reservoir, at which point the watershed is called Lower Gunpowder Falls. Minebank Run drains 2,135 acres and makes up approximately 7 percent of Lower Gunpowder Falls' 29,470-acre watershed. The watershed was once primarily used for agriculture but is now densely developed in specific areas.

Minebank Run receives a high volume of runoff from impervious surfaces in suburban residential areas, office parks, highways and other areas surrounding Towson, Maryland. MDE first added the Lower Gunpowder Falls watershed, including Minebank Run, to the state's CWA section 303(d) list for phosphorus impairments in 1996. In 2006 MDE also listed it as impaired because it did not meet its designated use of aquatic life and wildlife support.

Before the restoration, Minebank Run exhibited severe bank incision, a disconnected floodplain, degraded fish and invertebrate habitat, loss of the riparian zone, and high sediment and nutrient loads from stormwater runoff. Stormwater conveyance channels, built to remove stormwater from roads quickly and not to protect hydrologic morphology, caused flashy, high-volume flows that eroded streambanks (Figure 1), exposed sewage trunk lines and damaged park roads and access bridges. Maryland Biological Stream Survey data confirmed that the number and diversity of macrovertabrates and fish were lower than they should be, indicating that Minebank Run was in an unhealthy, degraded condition.



Figure 1. High-volume stormwater flows damaged this stretch of Minebank Run.

Project Highlights

Baltimore County Department of Environmental Protection and Resource Management (DEPRM) conducted two phases of restoration activities—the first in 1999 and the second in 2005—on Minebank Run, a subwatershed within the Lower Gunpowder Falls watershed. In 1999 DEPRM worked to stabilize highly erodible banks, construct point bars, and add riffles and meander features with step-pool habitats along 8,000 linear feet in a headwaters portion of Minebank Run (Figure 2).

The project reduced the stream gradient to allow the stream to overflow its banks and reconnect to the floodplain. Reconnecting the floodplain allows phosphorus and sediment to be deposited on the floodplain rather than be carried downstream. It also provides a greater residence time for nitrogen to be removed by native vegetation uptake and

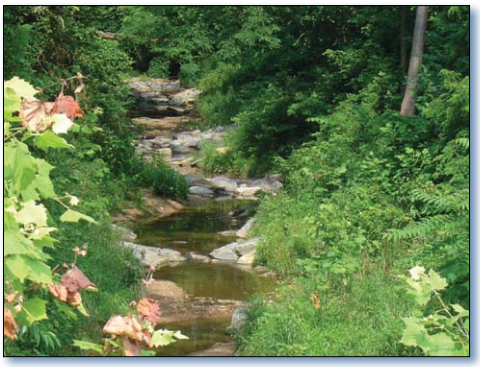


Figure 2. DEPRM added riffles, meanders and step-pool habitats during phase one of the project.



Figure 3. Minebank Run at Loch Raven High School, before restoration.

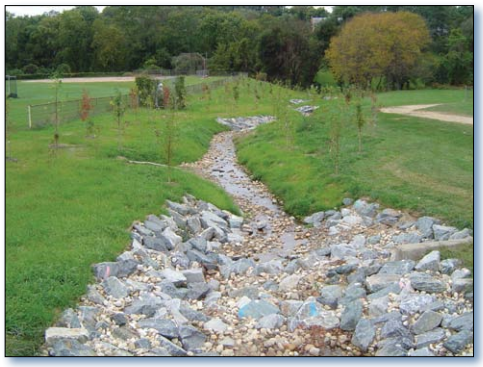


Figure 4. Minebank Run at Loch Raven High School, after phase two of the restoration project.

denitrification. The restoration involved planting 3,000 trees and 6,000 shrubs, which created a buffer and encouraged the uptake of available nitrogen.

DEPRM began the second phase of restoration in 2005 on a downstream reach of approximately 9,500 linear feet of Minebank Run. This phase had similar objectives as the first but was more extensive, involving removing a 500-foot concrete channel that coveys stormwater from Cromwell Road to Minebank Run (Figures 3 and 4). The restoration, on the grounds of Loch Raven High School, included adding step-pools, increasing the stream's sinuosity and planting riparian vegetation—all of which help dissipate flow energy, reduce erosion, moderate water temperatures and create stream channel and riparian habitat. Once the projects were complete, monitoring and geomorphologic evaluations were conducted over several years by a variety of project partners.

DEPRM armored stream banks at key locations to protect existing infrastructure such as sewer lines, bridges and roads. That has the beneficial effect of making the stream more hospitable to benthic macroinvertebrates and fish by decreasing flow speed, preventing scour and minimizing damage to aquatic habitat.

Results

The second phase of the Minebank Run project included reconnecting the stream to the floodplain and evaluating the results. A number of study partners collaborated to assess the projects between late 2003 and mid-2004. Results indicate that the project measurably reduced the bioreactive nitrogen (nitrate and nitrite) concentration in the surface water and groundwater. Nitrogen concentrations declined by 25 to 50 percent [1.5 milligrams per liter (mg/L) to 0.8 mg/L], while denitrification rates increased nearly twofold in test wells.

The project efforts removed an estimated 50,000 pounds (25 tons) of sediment typically discharged from the stream annually. Associated phosphorus reductions could range from 100 to 200 pounds annually. The projects have had many beneficial effects by reducing flow and increasing dissolved oxygen levels. The stream's physical and hydrological conditions appear to have improved substantially; however, measurable water quality and biological improvements will likely not occur a several years. In the meantime, DEPRM will continue to monitor biological conditions in both waterbodies.

Partners and Funding

DEPRM led the restoration and mitigation efforts. Partners in the nationally recognized floodplain denitrification study include the U.S. Geological Survey, Institute of Ecosystem Studies, DEPRM, and the University of Maryland's Center for Environmental Science.

Some state and federal funding partners participated at different stages to assist with and document the work. In 2003 Maryland's CWA section 319 program provided $150,000 to support DEPRM's efforts; that was complemented by another $100,000 in local match funding. Overall, Baltimore County estimates that the costs for Phases I and II were $2.2 million and $4.4 million, respectively.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-09-001KK
November 2009

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Restoring Stream Improves Water Quality and Fish Community Health

Waterbodies Improved

During rainstorms, high volumes of rapidly moving stormwater flow off of impervious surfaces and into Maryland's Spring Branch, causing destructive erosion of the stream channel and contributing sediments and nutrients to a drinking water reservoir. The Maryland Department of the Environment (MDE) added Spring Branch to the state's Clean Water Act (CWA) section 303(d) list in 1996 for nutrient and sediment impairments and expanded the listing in 2002 to include biological impairments. Restoring two miles of stream has significantly reduced nutrient and sediment loads and improved fish habitat. Water quality continues to show progress toward meeting the total maximum daily load (TMDL) limits for phosphorus and sediment in the Loch Raven Reservoir, which is immediately downstream of the project area.

Problem

The 1,005-acre Spring Branch watershed drains a portion of Baltimore County in the urbanized Baltimore metropolitan region and empties into the Loch Raven Reservoir. Spring Branch is designated for water contact recreation use, aquatic life use and public water supply use.

Spring Branch was once a narrow, shallow trout stream. Fifty years of rapid urbanization created many impervious surfaces with few stormwater controls (Figure 1). Consequently, rainfall generates high volumes of runoff that quickly exceed the capacity of Spring Branch. Stormwater flows have eroded the stream channel so that it is now 30 feet deep and 15 feet wide. Erosion has exposed sewer pipes and created high sediment and nutrient loads that flow into the Loch Raven Reservoir.

MDE first added Spring Branch to the CWA section 303(d) list in 1996 for nutrient and sediment impairments. On the basis of biological monitoring results, MDE expanded the list of impairments to include a biological impairment in 2002.

In 2007 the U.S. Environmental Protection Agency approved MDE's TMDL for Loch Raven Reservoir, which includes the Spring Branch subwatershed. The TMDL requires that total phosphorus be reduced by 50 percent to meet water quality standards for dissolved oxygen and chlorophyll *a* (to prevent algae blooms in the reservoir). The TMDL also requires that suspended sediment be reduced by 25 percent to preserve the reservoir's volume. A TMDL for biological impairments has not yet been developed.

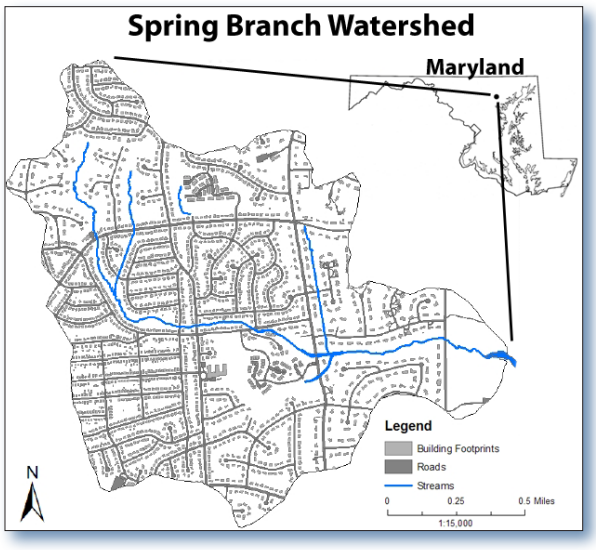


Figure 1. Impervious surfaces in northern Maryland's Spring Branch watershed.

Project Highlights

In 1997 Baltimore County developed a water quality management plan for the Loch Raven watershed. The plan identified and evaluated nonpoint sources of pollution and provided a watershed restoration and management framework. The Baltimore Metropolitan Council's Reservoir Technical Group wrote a *2005 Action Strategy for the Loch Raven Reservoir Watersheds*, which called for Baltimore County to reduce nutrient and sediment inputs to the reservoir through a variety of best management practices, including stream restoration. Baltimore County chose to focus restoration efforts on Spring Branch because of its proximity to the reservoir

and other factors, and completed a *Spring Branch Subwatershed Small Watershed Action Plan* in 2008.

The Baltimore County Department of Environmental Protection and Resource Management (DEPRM) conducted two phases of restoration activities on Spring Branch—one beginning in 1997 and the second in 2008. Both phases addressed effects of urbanization, including the flashy (quick-to-flood) flow regime, erosion, declining ecological function, failing infrastructure, poor water quality and property damage.

In phase I, DEPRM created a new channel of Spring Branch and added step pools, meander patterns and flood plains. That and other parts of the stream channel were stabilized using natural materials such as boulders, tree root wads, brush mattresses and live branch layers. In addition, DEPRM removed 1,740 feet of concrete channel (Figure 2), stabilized or removed sanitary sewer lines, added rock-lined step pools below storm drain pipes to dissipate energy from the flow, and constructed a stormwater wet pond to treat runoff from the headwaters. Replanting 12 acres with native trees and shrubs restored 10,000 linear feet of stream (Figure 3).

In phase II, DEPRM removed another 524 feet of concrete channel and restored 3.23 acres of native riparian buffer using 219 trees; 547 shrubs; 2,133 live stakes; 295 linear feet of live branch layering and 102 pounds of native riparian seed. Phase II restored 2,814 linear feet of stream.



Figure 2. At this site (looking toward Pot Spring Road) before restoration efforts, Spring Branch flowed through a concrete channel. The concrete step seen here obstructed fish passage.



Figure 3. After restoration, the concrete channel seen in Figure 2 has been removed. Sewer lines running along both sides of the stream prevented partners from restoring a natural meandering pattern.

Results

The phase I work reduced phosphorus loads by 27 percent, nitrogen loads by more than 30 percent and sediment loads by 45 percent. In 2003 and 2004, monitoring at station SB-2 (downstream end of the phase I portion of the project) showed that few or no fish were present, and the fish index of biotic integrity score (IBI) was classified as *very poor* (score of less than 1.9). However, the fish community responded to phase II restoration efforts. Fish monitoring in 2009 (less than one year after phase I was completed) showed significant increases in fish biomass and fish IBI at stations SB-2 and SB-8 (headwaters). Removing the concrete channel (see Figure 2) allowed the fish to swim upstream and colonize the area. As seen in Figure 4, Fish IBI scores at both stations improved to a classification of *poor* (scores between 2.0 and 2.9).

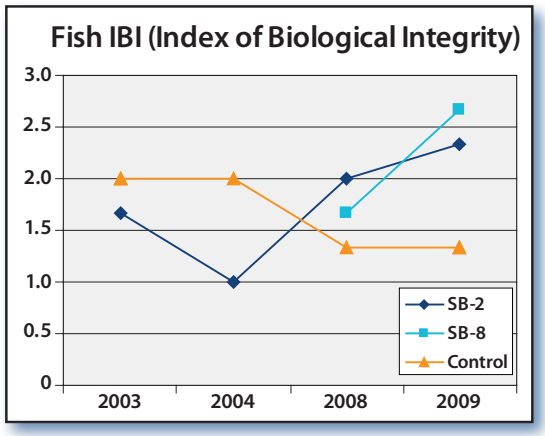


Figure 4. After phase II of the restoration (2008), fish IBI levels increased above (SB-8) and below (SB-2) the project area.

Although Spring Branch does not yet meet water quality standards, reduced pollutant loads and improving biological data indicate that progress is being made.

Partners and Funding

Project costs included $276,473 for a new wet pond serving 47 acres, $1.9 million for phase I work and $1.1 million for phase II work. Most of the funding came from Baltimore County bonds, MDE Small Creeks and Estuaries Grant and MDE stormwater cost share funds. A developer fee, required in lieu of mitigation funds, helped fund plantings. CWA section 319(h) funds contributed $240,000 for phase II work. Baltimore City, which owns and operates the Loch Raven Reservoir, was also a project partner.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-10-001LL
December 2010

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NONPOINT SOURCE SUCCESS STORY

Maryland

Tarkiln Run pH Impairment Remedied by Successful Acid Mine Drainage Treatment

Waterbody Improved

Maryland's Tarkiln Run, a tributary to Casselman River in Garrett County, was impaired by low pH associated with acid mine drainage (AMD) and was added to the Clean Water Act (CWA) section 303(d) list in 1996. An assessment of an AMD seep impacting Casselman River tributaries ranked this stream high priority for mitigation. Successful AMD mitigation brought the stream into compliance with the state water quality standard for pH. As a result, the Maryland Department of the Environment (MDE) is delisting Tarkiln Run for pH impairment in Maryland's 2018 Integrated Report.

Problem

Tarkiln Run headwaters are in Maryland's Savage River State Forest south of US I-68 near Amish Road; it is a tributary to the Casselman River's North Branch (Figure 1). Western Maryland's Casselman River watershed drains to Pennsylvania toward the Ohio River. Prior to WWII, the river and its tributaries were commonly high-quality waterways that supported native brook trout. During several following decades, coal mining changed the local hydrology, which resulted in AMD that caused pH declines in numerous streams, including Tarkiln Run.

The Casselman River watershed, including Tarkiln Run and other streams, was listed for pH impairment in 1996. In 2005, water quality monitoring to support pH total maximum daily load (TMDL) development found that Tarkiln Run was consistently below the Maryland water quality standard for pH, which requires that pH be within the range 6.5–8.5.

In 2008 EPA approved the pH TMDL for pH-impaired streams in western Maryland, including Tarkiln Run. Water quality monitoring in 2010–2013 showed that Tarkiln Run pH continued to fall below Maryland's water quality pH standard most of the time.

A benthic macroinvertebrate assessment performed in 2011 and 2012 rated the stream as 2.25, which is classified as *poor* on the benthic index of biological integrity. Maryland's 2014 Integrated Report clarified the pH conditions in the Casselman River watershed by separately listing Tarkiln Run for pH impairment.

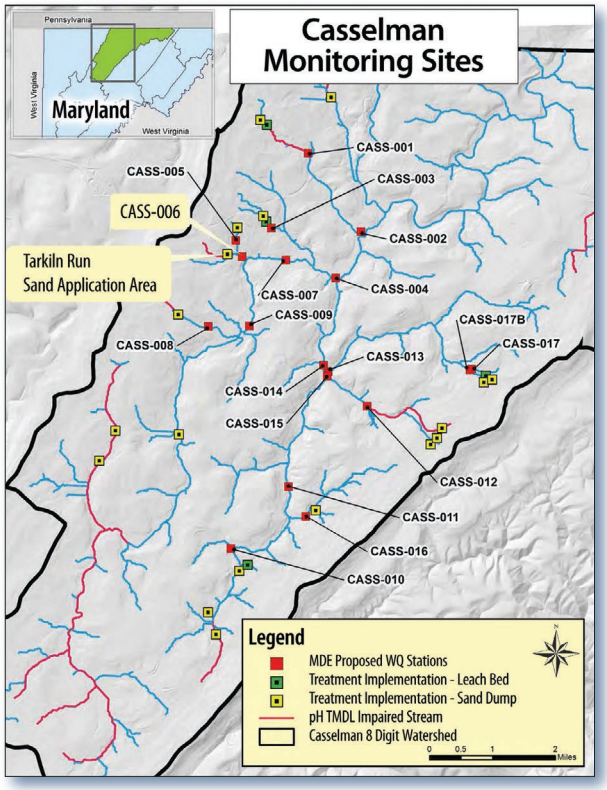


Figure 1. Casselman River watershed monitoring sites.

Story Highlights

In late 2008 MDE initiated watershed planning to make the Casselman River watershed eligible for CWA section 319(h) grant implementation funds. The planning process included assessment of potential AMD



Figure 2. Tarkiln Run sand dump site.

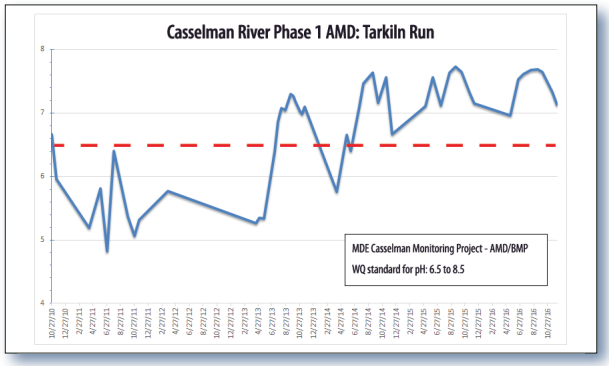


Figure 3. Tarkiln Run meets the pH standard.

mitigation sites like Tarkiln Run. The plan also analyzed AMD mitigation technologies. One of the technologies recommended to address pH while also minimizing capital and operation and maintenance costs was limestone sand application, sometimes called a limestone "sand dump." This technique involves constructing a driveway for a dump truck to pull up adjacent to the stream so that measured quantities of pulverized limestone can be delivered directly to stream edge. Then, natural variation in stream flow distributes the particles of limestone downstream. The limestone sand particles in the stream tend to raise in-stream pH and increase acid neutralizing capacity. The amount and timing of limestone sand application at each site is determined by periodic monitoring of in-stream pH.

In 2011 the U.S. Environmental Protection Agency accepted the Casselman River Watershed Plan for pH Remediation, and section 319(h) grant funds were approved to help mitigate AMD-impacted areas. Tarkiln Run was selected to be one of 11 Phase I projects because the land was publicly owned, the site was accessible and permit requirements were attainable. In mid-2013 one limestone sand application site was constructed. During its first year of operation, the Tarkiln Run site received 41.65 tons of limestone sand (Figure 2).

Results

After installing the limestone sand application sites, MDE's Abandoned Mine Land Division (AMLD) periodically monitored the pH at Tarkiln Run and scheduled delivery of limestone sand to the application sites as needed. After a period of adjustment in late 2013 and early 2014, water quality data collected in Tarkiln Run from mid-2014 through 2016 demonstrated that in-stream pH consistently met Maryland's water quality standard (Figure 3). As a result, MDE is delisting Tarkiln Run for pH impairment in Maryland's 2018 Integrated Report.

Benthic macroinvertebrate assessments were performed in 2014, 2015 and 2016. The overall average rating was 3.167, which is categorized as *fair* on the benthic index of biological integrity—an improvement from the *poor* rating received in 2011–2012.

Partners and Funding

MDE AMLD and MDE Integrated Water Planning Program (IWPP) cooperated to write the Casselman River Watershed Plan for pH Remediation. Drafting the plan used $55,000 from the federal fiscal year (FFY) 2008 CWA section 319(h) grant. MDE was awarded $644,115 from the FFY2009 CWA section 319(h) grant to help pay for mitigating more than a dozen different sites impaired by AMD in the Casselman River watershed. The Garrett Soil Conservation District (SCD) was hired to oversee contractor hiring, construction management and inspection for all these project sites, including the Tarkiln Run limestone sand application project. The SCD's total capital cost for the Tarkiln Run site was only $8,868.

Other partners contributed work at no cost to the project. Watershed plan drafting by MDE IWPP staff was funded by the section 319(h) grant that supports the state Nonpoint Source Management Program. Also, before/after water quality monitoring by MDE's Field Services Program was funded by separate ongoing section 319(h) grant projects. The Maryland Fisheries Service assessment and analysis was independently funded by the state of Maryland.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-19-001P
April 2019

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NONPOINT SOURCE SUCCESS STORY

Maryland

Remediating Acid Mine Drainage Increases Brook Trout in Spiker Run

Waterbody Improved

Maryland's Spiker Run, a tributary to Casselman River in Garrett County, was affected by episodic low pH associated with acid mine drainage (AMD) and listed as impaired in 1996. An assessment of an AMD seep impacting the headwaters of Spiker Run ranked this stream as a high priority for mitigation in the Casselman River watershed. Successful implementation of two AMD mitigation measures brought the stream into compliance with the state water quality standard for pH. Monitoring of brook trout demonstrated that the standing crop of adults was five times greater after implementation than before. The Maryland Department of the Environment (MDE) will pursue delisting Spiker Run for its pH impairment in Maryland's 2018 Integrated Report.

Problem

Western Maryland's Casselman River watershed drains to Pennsylvania toward the Ohio River. Before World War II, the river and its tributaries were commonly high-quality waterways that supported native brook trout. During several following decades, coal mining changed local hydrology, resulting in AMD that caused pH declines in numerous streams. One of the affected streams is Spiker Run, which flows into the mainstem of Casselman River (Figure 1). Its headwaters are in Maryland's Savage River State Forest near Maryland Route 40, west of Grantsville.

The Casselman River watershed was listed for pH impairment in 1996. About 1.6 miles of Spiker Run exhibited pH impairment. In 2005 water quality monitoring to support pH total maximum daily load (TMDL) development found that pH levels in Spiker Run were intermittently below the Maryland water quality standard, which requires a pH range of 6.5–8.5. Also in 2005, MDE's consultant completed an assessment of streams with pH impairment in the Casselman River watershed and identified Spiker Run as a high priority for AMD remediation.

In 2008 EPA approved the pH TMDL for Spiker Run and other pH-impaired streams in Western Maryland. Water quality monitoring in 2010–2013 showed that in-stream pH continued to intermittently fall below Maryland's water quality pH standard. Maryland's 2014 Integrated Report clarified the pH conditions in the Casselman River watershed by separately listing each stream segment that has pH impairment and a pH TMDL, which includes Spiker Run.

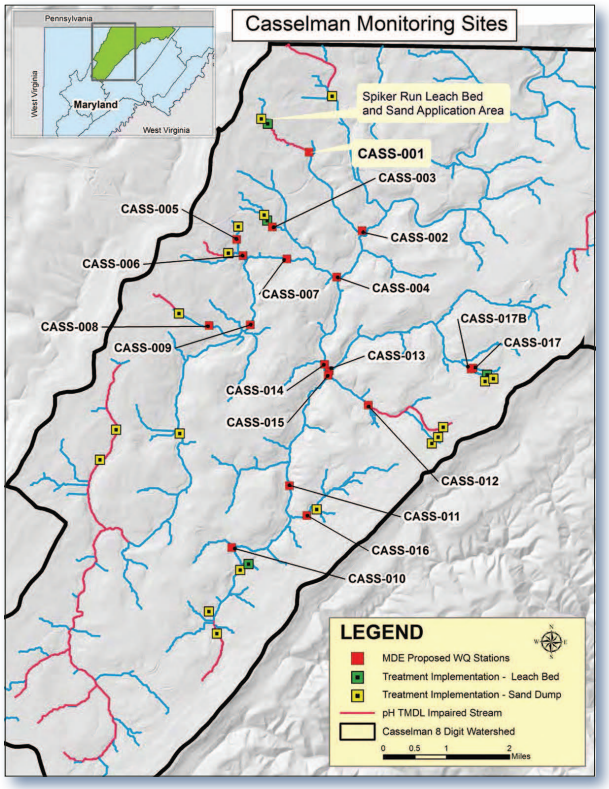


Figure 1. Spiker Run (CASS-01) is in western Maryland.

Story Highlights

In late 2008 MDE initiated watershed planning to make the Casselman River watershed eligible for Clean Water Act (CWA) section 319(h) grant implementation funds. The planning process included an assessment of potential AMD mitigation sites in the watershed, including along Spiker Run, for potential high-priority



Figure 2. A limestone sand application site was installed at the edge of Spiker Run.

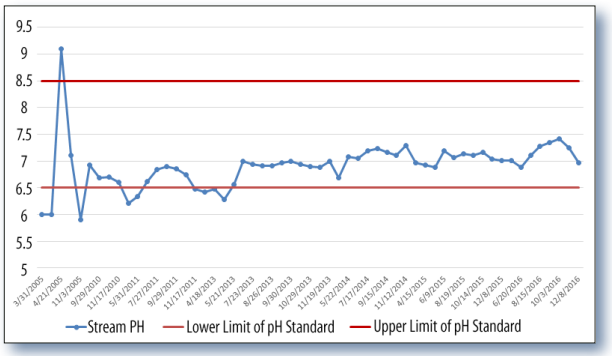


Figure 3. Spiker Run pH has met water quality standards since mid-2013.

action. The plan also analyzed AMD mitigation technologies. One of the technologies recommended to constrain capital, operation and maintenance costs was limestone sand application, sometimes called a limestone sand dump. This technique involves constructing a driveway for a dump truck to pull up adjacent to the stream so that measured quantities of limestone crushed to sand-sized particles can be delivered directly to stream edge. Then, natural variation in stream flow distributes the particles downstream. The limestone particles raise in-stream pH and increase acid neutralizing capacity. The amount and timing of limestone sand application is determined by periodic monitoring and in-stream pH measurements.

In early 2011 the U.S. Environmental Protection Agency accepted the Casselman River Watershed Plan for pH Remediation, and MDE approved CWA section 319(h) grant funding for a project to mitigate AMD-impacted areas in the Casselman River watershed. Spiker Run was selected to be one of 11 Phase I projects for construction because the land was publicly owned, the site was accessible and permit requirements were attainable.

In mid-2013 a leachbed and a limestone sand application site were installed to treat AMD flows entering Spiker Run (Figure 2). During the first year, the application site received 34.89 tons of limestone sand. More applications will continue at varying levels depending on stream conditions for the foreseeable future. Following installation of the leachbed and limestone sand application site, MDE's Abandoned Mine Land Division (AMLD) periodically monitored the pH at Spiker Run and scheduled delivery of limestone sand to the application sites as needed.

Results

After an adjustment period (late 2013 and 2014), data collected in Spiker Run in 2015–2016 demonstrated that in-stream pH consistently met Maryland's water quality standard (Figure 3). In addition, the standing crop of brook trout in Spiker Run increased from 13 kilograms per hectare (kg/ha) in 2008 to 67 kg/ha in 2016. As a result, MDE will pursue delisting Spiker Run for its pH impairment in Maryland's 2018 Integrated Report.

Partners and Funding

MDE's AMLD and Water Quality Protection and Restoration (WQPR) programs wrote the Casselman River Watershed Plan for pH Remediation. AMLD used $55,000 from the federal fiscal year (FFY) 2008 CWA section 319(h) grant for their part of the planning effort. Implementation of the 11 Phase I AMD mitigation projects was led by AMLD, using $644,115 from the FFY 2009 CWA section 319(h) grant. The Garrett Soil Conservation District oversaw contractor hiring, construction management and inspection of projects. Capital cost to install the Spiker Run leach bed and limestone sand application site totaled $71,850.

Other partners contributed work at no cost to the project. Watershed plan drafting by MDE WQPR staff was funded by the 319(h) grant through ongoing projects that support the state nonpoint source management program. Also, water quality monitoring by MDE's Field Services Program were funded by separate ongoing 319(h) grant projects. The Maryland Fisheries Service assessment and analysis was funded by the state of Maryland.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-18-001I
March 2018

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Mitigating Acid Mine Drainage Improves pH Levels in Aaron Run

Waterbody Improved

Water flowing through abandoned coal mines contributed acid mine drainage (AMD) to Maryland's Aaron Run, causing the stream's pH level to fail to meet the state's water quality standard for pH. As a result, the Maryland Department of the Environment (MDE) added Aaron Run to Maryland's 2004 Clean Water Act (CWA) section 303(d) list of impaired waters for low pH. Watershed partners implemented numerous AMD mitigation projects, and pH levels increased. Aaron Run now meets the state water quality standard for pH and supports a population of brook trout. As a result, MDE has proposed removing Aaron Run from the state's list of impaired waters for pH impairment in 2014.

Problem

Western Maryland's Aaron Run (segment 021410060075) begins in Savage River State Forest in Garrett County. It flows about 3 miles to the Savage River, a tributary of the North Branch Potomac River in the Chesapeake Bay watershed (Figure 1).

About 102 acres of the 2,270-acre Aaron Run watershed are underlain by abandoned deep coal mines, and several hundred acres of the watershed are composed of reclaimed surface coal mines. Water flowing from these mined areas contributed AMD to the middle and upper watershed. Erosion of coal waste piles that had been dumped along stream banks also contributed acidity to the stream. As a result, pH levels in parts of Aaron Run fell to as low as 3.5—well below the state minimum of 6.5. MDE believed that the low pH levels caused brook trout to be unable to survive in Aaron Run even though similar Savage River tributary streams supported healthy native brook trout populations. Habitat degradation associated with the AMD sources (e.g., low pH and the associated iron sediments/precipitates clogging interstitial spaces in the streambed) was also observed in the Savage River near the Aaron Run confluence. Because of these problems, in 2004 MDE added Aaron Run to the CWA section 303(d) list for impairment by low pH and for failure to support its aquatic life and wildlife designated use.

In 2008 EPA approved MDE's pH total maximum daily load (TMDL) for Aaron Run. The TMDL requires that the state water quality standard for pH (6.5 to 8.5) be met at all times.



Figure 1. Aaron Run flows into the Savage River in eastern Garrett County, just upstream of the Savage River's confluence with the North Branch Potomac River.

Project Highlights

An assessment of AMD sources and impacts in 1987 concluded that mitigation of AMD in the Aaron Run watershed was feasible. Project funding for AMD mitigation was initially obtained in 2005. Project implementation, conducted by MDE's Abandoned Mine Land Division, occurred through 2011. The project included construction of one limestone doser, one limestone leach bed, two successive alkalinity-producing system cells, and one oxidizing pond (Figure 2). The project also created 1 acre of treatment wetlands and restored 600 linear

feet of eroding stream bank. In 2012 the Maryland Department of Natural Resources' Fisheries Service restocked Aaron Run with native brook trout.

Results

Water quality data collected from 2011 through 2013 in Aaron Run, after completion of the AMD mitigation projects, demonstrated that the water quality standard for pH (a minimum of 6.5) is being met and that the TMDL requirements for pH are being satisfied (Figure 3). On the basis of these data, MDE has proposed removing Aaron Run from the state's list of impaired waters for pH impairment in 2014. Aaron Run fully supports its aquatic life and wildlife designated use.

In addition, in-stream conditions had improved enough by August 2012 to allow the Fisheries Service to reintroduce native coldwater stream fish species, including brook trout, blacknose dace, longnose dace, fantailed darters, and Blue Ridge sculpins, into Aaron Run. In October 2013 the Fisheries Service assessed the stream's brook trout population and found adults and several smaller individuals. An additional year or more of assessment will be needed to verify whether a naturally reproducing brook trout population resides in Aaron Run.

Partners and Funding

MDE's Abandoned Mine Land Division conducted the project. In addition, MDE contracted with the Garrett Soil Conservation District to provide technical and management oversight services for the construction phase of the project. Funding from CWA section 319 in three consecutive years (fiscal years 2005–2007) aided in planning, design, and construction from late 2005 through late 2011. The total project cost was about $1.01 million, including about $812,000 reimbursed by the CWA section 319 grant. Other project funding was provided by the U.S. Department of the Interior's Office of Surface Mining Reclamation and Enforcement (about $124,000 in Title IV grant funds) and by the Eastern Brook Trout Joint Venture (about $75,000). The Fisheries Service provided fisheries management and related stream assessment services at no cost. MDE's Field Services Division provided some of the pre- and post-construction stream monitoring through a separate ongoing CWA section 319-funded nonpoint source monitoring and analysis project. Volunteers from the nonprofit Savage River Watershed Association assisted with water quality monitoring along Aaron Run.



Photograph by Connie Loucks, MDE Abandoned Mine Land Division.

Figure 2. The Owens South AMD mitigation site includes an oxidizing pond (foreground) and successive alkalinity-producing system cells (background).

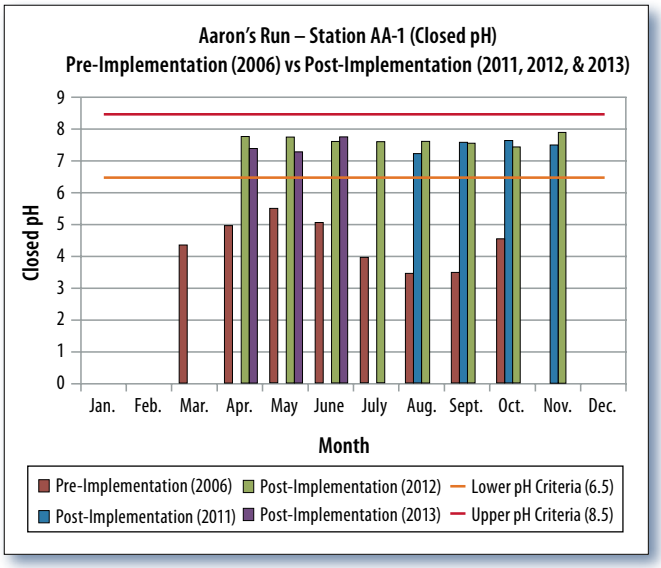


Figure 3. After restoration efforts, pH levels in Aaron Run increased; they now meet water quality standards.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-14-001UU
August 2014

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Protecting Riparian Areas Yields In-Stream Improvement in First Year

Waterbody Improved

Runoff from agricultural activities and urbanization contribute to sediment and nutrient impairments in the lower Monocacy River and Lake Linganore. As a result, Maryland Department of the Environment (MDE) added the waterbodies to the 1996 Clean Water Act (CWA) section 303(d) list, on which they have since remained. A landowner installed agricultural best management practices (BMPs), including cattle fencing, alternative watering facilities and riparian planting on a small, unnamed tributary of Lake Linganore. The BMPs have resulted in water quality improvements in the first year. MDE will continue monitoring progress toward meeting the total maximum daily load (TMDL) and water quality standards.

Problem

Lake Linganore is an impoundment in eastern Frederick County, Maryland. An earthen dam was installed across Linganore Creek in 1972 to create the 216-acre lake as a water supply and for recreational use. Water from Lake Linganore empties back into Linganore Creek and then flows to the Monocacy River, the Potomac River and the Chesapeake Bay. The lake's primary inflows include Bens Branch and Linganore Creek. Many of the streams in the area were affected by agricultural land uses historically and are now also affected by suburban development. For example, grazing cattle's uncontrolled access to headwater streams caused severe sedimentation in tributaries upstream of Lake Linganore (Figure 1).

Sediment and nutrients in agriculture and suburban runoff impaired the lake, preventing it from meeting two of its designated uses—water supply and recreation. As a result, MDE added the lake to its 1996 CWA section 303(d) list of impaired waters. A TMDL for phosphorus and sediment was approved for Lake Linganore. Nutrient and sediment TMDLs are being developed for the entire watershed.

Project Highlights

To meet the TMDL requirements, the Maryland Department of Agriculture (MDA) targeted the entire watershed for technical and financial assistance to local farmers who are willing to implement BMPs. For example, MDA worked with the owner of Hunting Lotte Farm to implement improvements along a small, unnamed headwater tributary to Bens Branch. The 450-acre crop and livestock farm produces a variety of crops and supports about 150 head of Black Angus cattle on approximately 80 acres of pasture. Before 2006, stream riparian conditions on the tributary were poor because of cattle overgrazing and trampling the streambanks.



Figure 1. Before the 2006 fence installation, uncontrolled cattle access to an unnamed tributary of Bens Branch caused visible erosion.



Figure 2. In autumn 2007, after fence installation, the riparian area is recovering. Numerous tree tubes indicate that trees will soon dominate the area.

The landowner installed more than 8,800 feet of fencing along streambanks, developed three alternative water sources that use natural springs instead of allowing cattle to drink from the stream, and improved three heavy-use areas and two stream crossings. Trees were planted during Earth Day celebrations in 2006 and 2007 in cooperation with MDA, Natural Resources Conservation Service and the Chesapeake Bay Foundation (CBF). The landowner planted more than nine acres of cool-season grasses along the streambanks. By autumn 2007 riparian vegetation had rapidly begun to cover and stabilize the streambanks (Figure 2). The farm also participates in the cover crop program, uses no-till and minimum tillage practices, and complies with and participates in the Maryland Nutrient Management Program.

Results

To track in-stream changes for this and other projects statewide, MDE's Targeted Watershed Project staff conducted the following: quarterly water monitoring to track nutrient changes, annual quantitative stream channel surveys to track substrate changes, and periodic sampling of stream bugs (benthic macroinvertebrates) to track changes in the local biological community.

MDE maintains monitoring sites on the unnamed tributary running through Hunting Lotte Farm. Within one year of BMP installation, the rapid return of riparian vegetation provided extensive summer stream shading and improved bank stability. The percentage of in-stream gravel substrate has increased and in-stream sand/mud substrate has decreased (Figure 3). The stream channel survey that MDE conducted in 2006 and 2007 shows that substrate quality in both stream reaches is improving, including a decrease in clay and sand and an increase in gravel and cobbles.

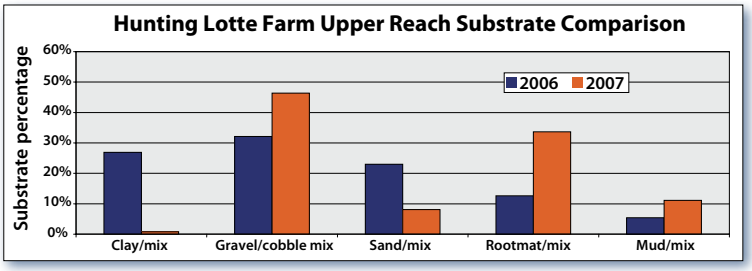


Figure 3. Monitoring conducted before (2006) and after (2007) the landowner installed BMPs shows that the in-stream gravel substrate increased, and the percentage of in-stream sand/mud substrate decreased.

Phosphorus concentrations have also decreased from a high of 0.2 milligram per liter (mg/L) in 2006 to a low of 0.025 mg/L in 2007, which indicates that erosion and sediment movement have decreased (Figure 4). Declining phosphorus concentrations can be attributed to reduced erosion in the riparian area and the streambanks as result of restricting cattle's access to the stream. More time is needed

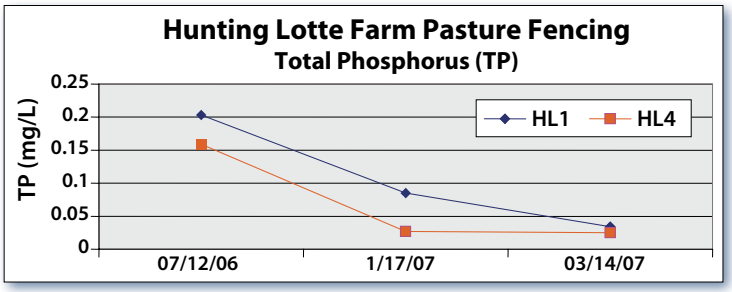


Figure 4. Installing fences to keep cattle away from streams helped reduce phosphorus levels. Data from monitoring sites HL1 and HL4 show steady phosphorus declines.

to assess the biological community change of macroinvertebrate populations. Total nitrogen data did not change significantly, which could be associated with a lag in the BMP effect—plant roots in the riparian area have not yet developed to the point where they can uptake higher amounts of nitrogen.

While sediment and phosphorus loads have been significantly reduced, Lake Linganore and the Lower Monocacy River are not yet meeting water quality standards and remain on Maryland's list of impaired waters. However, visible improvements in the unnamed tributary and elsewhere in the Lake Linganore watershed are soon expected to measurably reduce impairments in the lake.

Partners and Funding

Mostly in 2006, the farm owner invested nearly $100,000 in BMPs, approximately $79,000 of which was supported by grants. The Maryland Agricultural Cost Share program provided about $57,000; the Conservation Reserve Enhancement Program provided $19,400; and CBF provided nearly $2,600. To track in-stream changes for this and other projects statewide, the MDE Targeted Watershed Project is using CWA section 319 grant funds to pay for technicians and analyses, including quarterly water quality monitoring, annual stream substrate surveys and periodic biological sampling of benthic macroinvertebrates.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-10-001B
January 2010

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NONPOINT SOURCE SUCCESS STORY

Maryland

Treating Acid Mine Drainage Improves Big Laurel Run pH Levels

Waterbody Improved

Acid mine drainage (AMD) from historic mining operations led to low pH levels in Maryland's Big Laurel Run, a tributary to the Casselman River. As a result, Maryland added the Casselman River watershed to its 1996 Clean Water Act (CWA) section 303(d) list for pH. AMD mitigation projects implemented in the watershed's headwaters from 2012 to 2014 increased pH levels. Due to this improvement, Maryland intends to remove the pH impairment from the Big Laurel Run segment of the Casselman River watershed in the 2016 integrated report.

Problem

Big Laurel Run is a tributary to the South Branch Casselman River in Garrett County. The river begins in Maryland's Savage River State Forest and flows across southwestern Pennsylvania toward the Ohio River (Figure 1). Before World War II, the Casselman River and its tributaries were high-quality waterways that supported native brook trout. During the following decades, water quality in these streams degraded due to AMD from the watershed's abandoned mines. The Casselman River watershed was listed for pH impairment in 1996 as a result of these acidic conditions.

Monitoring in 2011–2013 near the headwaters showed that in-stream pH ranged from 4.5 to 6.0, which failed to meet Maryland's water quality pH standard of 6.5 to 8.5. The low-pH waters flow about 6 miles to the South Branch Casselman River, which supports a healthy brook trout population and is designated as a Maryland Tier II high-quality water.

A 2004–2006 assessment of Maryland's Casselman River tributaries identified Big Laurel Run as a high priority for AMD mitigation. A 2008 Maryland Department of Natural Resource Fisheries Service assessment determined that improving pH in Big Laurel Run could expand the area available to native brook trout, despite the stream's sub-optimal physical habitat. A pH total maximum daily load was finalized in 2008.

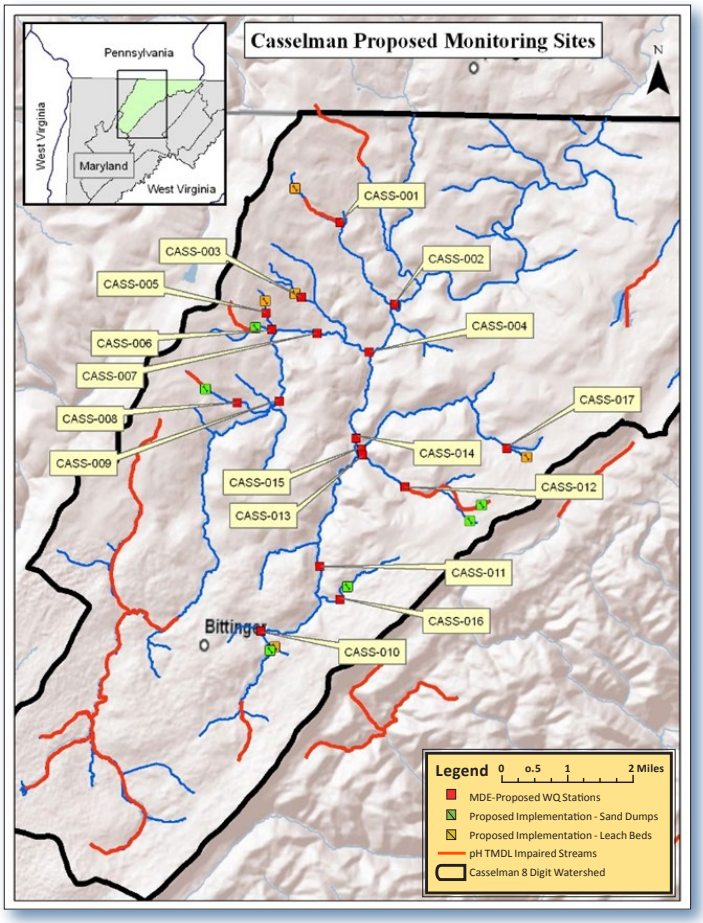


Figure 1. Northwest Maryland's Casselman River watershed was listed as impaired for pH in 1996. To address the impairment, partners developed a watershed plan that outlined proposed monitoring and project implementation site locations throughout the watershed, including in Big Laurel Run (near CASS-017 sampling site). Work is ongoing.

Project Highlights

In late 2008 the Maryland Department of the Environment (MDE) initiated watershed planning to allow the Casselman River watershed to be eligible for



Figure 2. Limestone leach bed, installed in 2014 in the headwaters of Big Laurel Run.

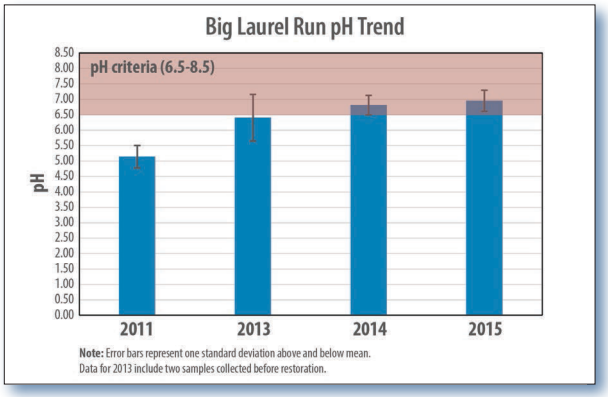


Figure 3. Data show pH improvements at the Casselman River sampling site CASS-017B (Big Laurel Run).

CWA section 319(h) grant implementation funds. The planning process included assessing potential AMD mitigation sites, including Big Laurel Run. The plan recommended particular AMD mitigation technologies, such as limestone leach beds and limestone sand application that would help keep capital and operation and maintenance costs low. In early 2011 EPA accepted the *Casselman River Watershed Plan for pH Remediation*. MDE selected the Big Laurel Run headwaters area project as one of the first for construction because the land was publicly owned, the site was accessible and permit requirements were attainable.

Construction occurred from late 2011 through early 2012 at Big Laurel Run to implement two technologies recommended by the watershed plan. A limestone leach bed (Figure 2) employs a siphon to draw low-pH water from the stream and feed the water through the leach bed, where gravity flow returns pH-adjusted water to the stream. In addition, two limestone sand application sites were constructed, one on each branch of the stream's headwaters. During 2013 and 2014, nearly 65 tons of limestone sand were delivered to these two sites.

Results

After completion of the AMD mitigation projects, data collected in 2013 and 2014 in Big Laurel Run demonstrated that the water quality standard for pH was being met (Figure 3). The average pH before the project was 5.4; the average after project implementation was 6.8. In addition, the average acid neutralizing capacity in Big Laurel Run increased from less than 10 microequivalents per liter (ueq/L) before AMD mitigation to more than 150 ueq/L after the project.

In addition, the Maryland Fisheries Service has identified limited fishery improvement. Juvenile native brook trout abundance in Big Laurel Run increased by a factor of 1.3 in 2014 compared to 2008 (before implementation). Maryland Fisheries Service found that adult population numbers and density remained about the same, and that most previously existing suboptimal habitat conditions persisted throughout the study period, indicating that full recovery of aquatic life will take time.

Partners and Funding

MDE's Abandoned Mine Land Division (AMLD) and Water Quality Protection and Restoration Program cooperated to write the watershed plan, using $55,000 in CWA section 319(h) funds through ongoing projects that support the state nonpoint source management program. AMLD led the project implementation at 11 Phase 1 Casselman River watershed AMD mitigation sites, using $644,115 in CWA section 319(h) grant funds. The Garrett Soil Conservation District oversaw contractor hiring, construction management and project inspection. Capital cost of the Big Laurel Run portion of the section 319 project included $8,000 for the two limestone sand application sites and $60,000 for the limestone leach bed and siphon system. Pre- and post-implementation water quality monitoring by MDE's Field Services Program was funded through separate ongoing section 319(h) grant projects. Maryland Fisheries Service assessment services work was independently funded by the state.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-16-001L
July 2016

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Treating Acid Mine Drainage Improves Cherry Creek

Waterbody Improved

Abandoned coal mines contributed high levels of acidity and metals to Maryland's Cherry Creek, which flows into Deep Creek Lake. As a result, the Maryland Department of the Environment (MDE) added the Deep Creek Lake watershed, including Cherry Creek, to the state's 1996 Clean Water Act (CWA) section 303(d) list of impaired waters for pH. Acid mine drainage (AMD) mitigation projects were implemented in Cherry Creek, which now consistently meets the total maximum daily load (TMDL) goal for pH. In addition, acidity, iron and aluminum levels have declined.

Problem

Western Maryland's Cherry Creek begins near Savage River State Forest, flows about eight miles through a 7900-acre watershed, and empties into Deep Creek Lake (Figure 1). Outflow from the lake enters the Youghiogheny River, which is in the Ohio River Basin. The Cherry Creek watershed is composed of 69 percent woodlands and 12 percent wetlands; the remainder is mixed agriculture and developed lands. Deep Creek Lake is a manmade recreational impoundment that is popular for fishing and boating.

The name Cherry Creek can be traced to the waterbody's deep reddish color, which was historically caused by bog tannins from sphagnum wetlands. These wetland complexes include coniferous forest and marshes, and they contribute natural organic acidity to the stream.

In the 1920s Cherry Creek was a natural trout stream and the site of a trout-rearing station. During the next several decades, AMD associated with coal mining increased. In 1957 a large fish kill caused by low pH brought an end to trout stocking in Cherry Creek. A 1973 study reported that almost the entire main stem of Cherry Creek was severely or moderately polluted by AMD. That study also estimated that one-fourth of the acid load in the stream is derived from mines; the rest is from natural sources. In the 1980s it was estimated that Cherry Creek was the source of half the acidity entering Deep Creek Lake.

Before project implementation, AMD generally caused the in-stream pH to fall to between 4.0 and 4.3,with a pH as low as 3.2 during periods of low flow. To address this impairment, the TMDL approved for Cherry Creek calls for a pH of 4.6 or higher. That level takes into account the naturally low pH arising from the sphagnum wetlands that characterize Cherry Creek.

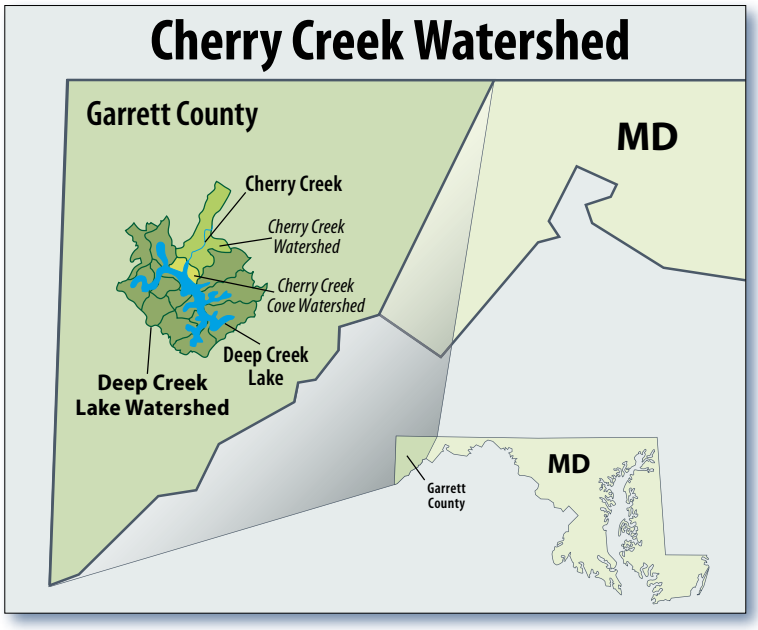


Figure 1. The Cherry Creek watershed is in western Maryland.

Project Highlights

Between 1986 and 1989, MDE created a series of treatment wetlands to help reduce AMD impacts in the Cherry Creek watershed. The Department constructed additional AMD treatment systems between 1998 and 2001, including successive acid treatment systems and more treatment wetlands. Several commercial AMD treatment systems were also introduced, including an Aluminator® (a successive



Figure 2 . Partners installed a successive alkalinity-producing system at the Everhart project site.

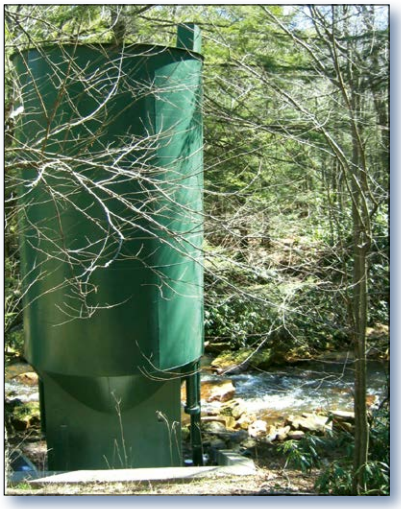


Figure 3 . Partners installed a limestone doser adjacent to Cherry Creek.

alkalinity-producing system that includes a treatment cell designed to precipitate aluminum while keeping iron in a soluble form), a Pyrolusite® cell (bioremediation using limestone and bacteria to remove metals), and a Boxholm® doser (a system that introduces lime to the water at a given rate). (See Figures 2 and 3.) The Cherry Creek mitigation effort used approximately 6,760 tons of limestone, not including the lime used for the doser.

Results

In-stream sampling conducted after AMD implementation (2003–present) shows that pH is generally greater than 6.0 and is always greater than 5.2, meeting the TMDL goal (a pH of 4.6 or greater). Data also show that individual AMD treatment sites have significantly reduced concentrations of pollutants while also increasing alkalinity (Table 1).

Fish surveys show that fish populations have increased. In 1971 only three species of lake fishes were found in Cherry Creek, and they were found only near the confluence of the creek with Deep Creek Lake. In 2004, after implementation of AMD mitigation, a survey found seven fish species in the stream. The survey report stated that rainbow trout, brown trout and smallmouth bass were common enough to support some recreational fishing and that the range of several fish species extended from the stream mouth upstream about 1.5 miles to the vicinity of the lime doser. According to the 2004 survey report, fish have not progressed farther upstream because of a complete blockage by an old mill dam and inflow from a small unnamed tributary, which might be contributing additional AMD. A 2012 analysis of all benthic macroinvertebrate data for Cherry Creek found that the Benthic Index of Biological Integrity might have improved, but the stream's condition continues to be classified as poor overall. The sources of this continuing biological impairment are believed to include AMD.

Partners and Funding

MDE's Abandoned Mine Lands Division was the primary implementer of the Cherry Creek AMD mitigation projects. The total capital cost for the restoration project was $496,000 over 15 years; funds were provided by the State of Maryland; the U.S. Department of the Interior, Office of Surface Mining; and the U.S. Environmental Protection Agency. In addition, the private Sprenger Lang Foundation paid for the purchase and construction of the lime doser, which is located on property owned by the Rock Creek Trust. Funds for operation and maintenance of the doser ($30,000 annually) come from the State of Maryland and the U.S. Department of the Interior. Other partners that help manage and monitor Cherry Creek include the Maryland Department of Natural Resources' Fisheries Service and the University of Maryland's Appalachian Lab.

Table 1. Monitoring Data for Cherry Creek Project Sites, Before and After Installation of AMD Treatment (Average)

Project Site	pH [a]		Acidity [b]		Alkalinty [b]		Iron [b]		Aluminum [b]	
	Before	After	Before	After	Before	After	Before	After	Before	After
Everhart site	3.5	6.1	300	21	0.0	23	65	1.5	4.9	0.1
Glotfelty site	5.3–5.9	6.9	372	0.0	N/A [c]	N/A [c]	111–147	0.83	1.5–3.5	0.1
Teets site	3.1	7.1	486	0.0	0.0	106	73	1.2	37	0.1

[a] In standard units. [b] In milligrams per liter (mg/L). [c] Not available.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA #
December 2012

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Implementing Best Management Practices Reduces Nitrogen in Two Corsica River Tributaries

Waterbodies Improved

Algae blooms in the upper tidal reaches of Maryland's Corsica River prompted the Maryland Department of the Environment (MDE) to add the river to the state's Clean Water Act (CWA) section 303(d) list of impaired waters in 1996 for impairment of aquatic life and recreational use. MDE developed a total maximum daily load (TMDL) for nitrogen and phosphorus. After six years of restoration efforts, water quality monitoring in two nontidal Corsica River tributaries shows a significant decrease in nitrogen concentrations. These improvements indicate that project partners are making progress toward meeting the Corsica River nutrient TMDL.

Problem

The six-mile-long Corsica River is a tidal tributary on Maryland's Eastern Shore. It flows through Queen Anne's County and the town of Centreville before entering the Chester River, which discharges into the Chesapeake Bay (Figure 1). Major land uses in the 40-square-mile watershed are agriculture (64 percent), woodland (28 percent) and developed areas. The nontidal portions of the Corsica River are designated for aquatic life protection and contact recreation; most of the estuarine portions are designated as shellfish harvesting areas.

Algal blooms and other water quality problems in the tidal portions of the Corsica River prompted MDE to add this watershed assessment unit to the CWA section 303(d) list in 1996 for impairment by nutrients, suspended sediment and fecal coliform bacteria. Water quality surveys conducted in 1997 found that the local eutrophication problems (the overenrichment of aquatic systems caused by excessive nutrient input) tended to be the greatest slightly downstream of the tidal/nontidal interface. Data showed chlorophyll *a* concentrations (a measure of algal content) as high as 146 micrograms per liter (μg/L).

MDE developed a TMDL for nitrogen and phosphorus, which EPA approved in 2000. According to the TMDL, the major source of nutrient loading was agricultural runoff (85 percent); other sources were forest and urban nonpoint sources and the town of Centreville's wastewater treatment plant (WWTP). The TMDL established the following water quality goals for the Corsica River: (1) chlorophyll *a* concentrations should remain below 50 μg/L, and (2) dissolved oxygen (DO) levels should remain above the state's minimum water quality standard, 5 milligrams per liter (mg/L).

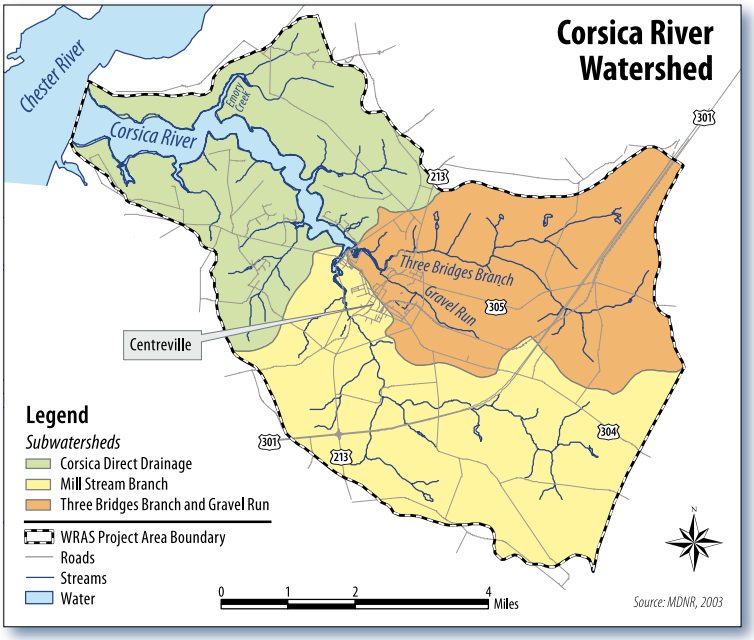


Figure 1. The Corsica River's three subwatersheds are part of the Corsica River Watershed Restoration Action Strategy (WRAS).

Project Highlights

In 1998 the Maryland General Assembly passed the Water Quality Improvement Act, which required that all agricultural operations with gross annual income over $2,500 and any livestock operations with more than eight animal units develop and implement nutrient management plans. All plans were developed by 2004, helping to reduce nutrient pollutant loading.

In 2004 the town of Centreville, along with several key local partners and with support and cooperation from MDE and the Maryland Department of Natural

Resources (MDNR), finalized the *Corsica River Watershed Restoration Action Strategy* (WRAS). The plan outlined implementation strategies needed to protect and restore the watershed. In 2005 EPA accepted the Corsica River WRAS, which was highlighted as one of the nation's best watershed plans at the CWA section 319 nonpoint source annual meeting. That same year, Maryland's governor selected the Corsica River for the state's targeted restoration watershed program.

Watershed partners have worked to implement agricultural best management practices (BMPs) since 2004. Over the last several years, farmers have annually planted increasing acres of cover crops. Since 2010, annual cover crop coverage has exceeded the WRAS goal of 3,000 acres per year. Other agricultural BMPs implemented include approximately 5 acres of natural buffer, 30 acres of grassed buffers, 30 acres of riparian herbaceous cover, 3 acres of grassed waterways and 2 miles of stream fencing.

In 2005 the Maryland Department of Agriculture (MDA) received CWA section 319 funds to promote and partially reimburse cover crop planting on farm fields in the watershed. Since then, CWA section 319 funds have also supported efforts by an MDA agricultural technician to help local farmers select and target agricultural BMPs.



Figure 2. From 2009–2010 the town of Centerville and MDNR converted an existing stormwater management pond into a multi-cell pond-wetland complex to more effectively capture and treat runoff.

In 2006 the town of Centreville and Queen Anne's County began a series of CWA section 319-funded projects, including urban stormwater infiltration projects and support for education and outreach efforts. Local partners installed stormwater wetland ponds and bio-retention practices, which capture and hold excess stormwater runoff during heavy precipitation events. The town installed stormwater retrofits on 112 acres (Figure 2). Local residents volunteering through the Corsica River Conservancy have installed more than 300 rain gardens.

Maryland legislation established the Bay Restoration Fund in 2004. It supports upgrading WWTPs with enhanced nutrient removal technology, improving on-site septic systems and implementing cover crops to reduce nutrient loading to the Chesapeake Bay. As of May 2012, 13 on-site septic systems in the Corsica River watershed were enhanced with nitrogen-reducing treatment capability. In 2010 the town of Centerville completed upgrades of its WWTP to include biological nutrient reduction technology. In addition, Centerville now applies its WWTP discharge to farmland through spray irrigation for nine months each year, which has greatly reduced the amount of discharge directly entering the upper tidal reaches of the Corsica River.

Results

Monitoring data from 2005–2011 show decreasing trends of instream nitrogen and phosphorus concentrations in the nontidal tributaries of the Three Bridges Branch and Gravel Run subwatershed. Groundwater monitoring conducted on crop fields in the watershed during 2005–2007 spring sampling periods indicates that cover crop planting may be reducing nutrient loadings.

The upgrades to Centerville's WWTP have also reduced nutrient loading. Comparing discharge monitoring records from 1997 (before upgrades) to the period 2007–2012 (after upgrades) shows that total nitrogen loads from the plant have declined by 87 percent (from 11,175 pounds per year to 1,424 lb/yr) and that total phosphorus loads have declined by 96 percent (from 2,395 lb/yr to 92 lb/yr).

Partners and Funding

Key partners have included local government entities (the town of Centreville, Queen Anne's County and the Queen Anne's Soil Conservation District), local watershed groups (Corsica Conservancy and the Chester River Association), state agencies (MDE, MDA and MDNR), and federal agencies (EPA and the U.S. Department of Agriculture's Natural Resources Conservation Service [NRCS]). To date, partners have invested almost $3.5 million in nonpoint source implementation projects. Maryland's agricultural cost-share program and NRCS have provided funding to implement BMPs in the watershed. From 2004 through 2012, $450,000 in federal CWA section 319 funds supported agricultural technical assistance to local farmers for selecting and targeting BMPs. Another $920,000 funded urban BMP implementation and provided local nonpoint source program support. As of May 2012, Maryland's Bay Restoration Fund had provided more than $150,000 for 13 septic system upgrades in the Corsica River watershed. The WWTP upgrade and capital cost of seasonal land treatment (farmland application of discharge) totaled about $4.5 million.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-13-001P
April 2013

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY

Maryland

Stream Restoration Reduces Peak Storm Flow and Improves Aquatic Life in Sligo Creek

Waterbody Improved

Stormwater runoff and extensive habitat destruction contributed to eliminating all but four of the most pollution-tolerant fish species in Maryland's Sligo Creek, a tributary to the Anacostia River. The Maryland Department of the Environment (MDE) added the Anacostia River (including the Sligo Creek subwatershed) to the state's Clean Water Act (CWA) section 303(d) list of impaired waters in 2002 for biological impairment, as measured by combined fish/benthic bioassessment. As a result of restoration efforts in the Sligo Creek subwatershed, in-stream conditions improved, as measured by a shift in the fish Index of Biotic Integrity (IBI) from a "poor" to a "fair" rating. Water quality improvements have contributed to progress in meeting the Anacostia River's total maximum daily load (TMDL) limits for phosphorus, nitrogen and sediment.

Problem

The Sligo Creek subwatershed is home to 82,000 people. It encompasses 11.1 square miles of highly developed land in Montgomery County, Maryland, a northern suburb of Washington, DC (Figure 1). Sligo Creek is one of 14 tributaries to the Anacostia River, which flows into the Potomac River, which in turn empties into the Chesapeake Bay.

Maryland has a narrative water quality standard for freshwater benthic community health that guides how the state assesses the designated use for aquatic life. MDE evaluates fish and benthic IBI data reported in the Maryland Biological Stream Survey to assess CWA section 303(d) listings of impaired waters. In 2000 only four fish species (all extremely pollution-tolerant) were found in Sligo Creek. Consequently, Sligo Creek received a rating of "poor" on EPA's IBI for fish. MDE therefore added the Anacostia River watershed assessment unit (which includes Sligo Creek) to the state's 2002 CWA section 303(d) list for biological impairment. The source of impairment was unknown.

In addition, MDE has listed the Anacostia watershed for the following impairments (with listing years): nutrients (1996), sediments (1996), fecal coliform bacteria–non-tidal waters (2002), toxics–polychlorinated biphenyls (PCBs) (2002), toxics–heptachlor epoxide (2002), fecal coliform bacteria–tidal waters (2004), and debris/floatables/trash (2006). TMDLs have been approved for biological oxygen demand/dissolved oxygen, phosphorus, nitrogen, sediments, fecal coliform, PCBs and trash.



Figure 1. Maryland's Sligo Creek subwatershed drains a densely populated area near Washington, DC.

Project Highlights

Efforts to address water quality and habitat problems in Sligo Creek began more than 20 years ago. Since the enactment of the Anacostia Watershed Restoration Agreement in 1987, an evolving interjurisdictional blueprint has guided restoration efforts across the Anacostia watershed, including Sligo Creek. In 1989 Montgomery County embarked on an ambitious effort to restore water quality and habitat conditions in the creek.

In Phase I (1989), the county transformed a dry stormwater pond that collects runoff from 805 acres into a three-celled, extended-detention wet pond with wetland plantings. The detention wet pond improved appearance, provided fish and wildlife habitat, and captured sediment and trash. Below the pond, the county restored 1,000 linear feet of downstream aquatic habitat by creating two vernal pools for amphibian breeding habitat and repairing 1,200 feet of riparian stream corridor.

In Phase II (1992–1994), another stormwater pond serving 434 acres was rebuilt as a two-celled, extended-detention wet pond/marsh. Other projects included restoring 2.5 miles of aquatic habitat, creating a quarter-acre marsh, replanting five acres of forest, implementing 19 small physical aquatic habitat improvement projects and reintroducing native fish species.

In Phase III (1996), the county constructed a one-acre detention wet pond at a Sligo Creek golf course to capture stormwater runoff from 70 acres, including a one-mile portion of Interstate 495.

In Phase IV (1999), the county created two stormwater wetlands and conducted restoration work in middle Sligo Creek to help return stream segments to more natural conditions that support aquatic life habitat needs (e.g., replacing straight-line concrete channels and pipes with meandering channels with varied stable bottom).



Figure 2. LID project installed during Phase V of the Sligo Creek restoration effort.

In Phase V (2005–2007), the county installed low impact development (LID) stormwater management bioretention systems (Figure 2). The county also established a new goal to improve the fish IBI from "poor" to "fair" through targeted reintroduction of native fish.

Phase VI (2010–present) involves implementing numerous small restoration projects in a 45-acre subwatershed, including integrating upland watershed source control measures, such as LID, with stream/wetland restoration and vegetated control practices (e.g., replacing mowed grass areas with vegetation that has greater potential for stormwater retention, infiltration and evapotranspiration).

Results

Phases I–V implemented stormwater management practices on 1,425 acres (48 percent) of the upper Sligo Creek subwatershed, resulting in a 41 percent reduction in peak flow discharge. This has led to improvements in water quality, streambed and bank stability, and in-stream habitat. MDE indicates that benthic macroinvertebrate populations have become more abundant and diverse, helping to support increased fish populations. Between 2000 and 2009, IBI scores for fish throughout most of upper Sligo Creek improved from "poor" to "fair" (Figure 3). Monitoring data confirmed the presence of 14 naturally sustaining fish species, including habitat specialists (species that prefer specific types of habitat).

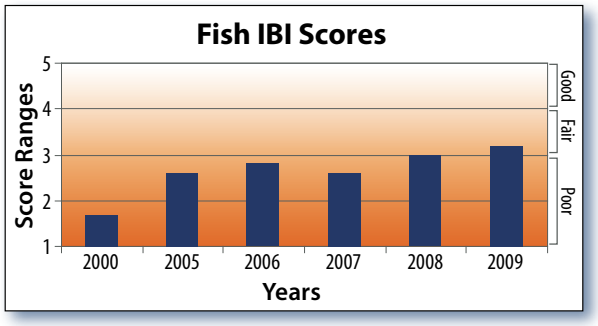


Figure 3. Fish Index of Biotic Integrity scores for Sligo Creek (2000–2009).

Partners and Funding

The Sligo Creek restoration effort is the result of a cooperative partnership with Montgomery County, MDE, Maryland National Park and Planning Commission, Washington Metropolitan Council of Governments, Interstate Commission on the Potomac River Basin, U.S. Army Corps of Engineers and U.S. Environmental Protection Agency.

Approximately $3 million (excluding monitoring costs) has been invested in the upper Sligo Creek restoration effort, including $1.8 million from the Montgomery County capital budget, $1 million from the MDE's Small Creeks and Estuaries Reserve cost share program, and $256,000 from the U.S. Army Corps of Engineers.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-12-001J
May 2012

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Restoring Stream Reduces Nitrogen in an Urbanized Watershed

Waterbody Improved

Uncontrolled stormwater runoff caused stream erosion and degraded riparian habitat in Maryland's Minebank Run and Lower Gunpowder Falls watersheds. Maryland Department of the Environment (MDE) added Lower Gunpowder Falls (including Minebank Run) to the state's Clean Water Act (CWA) section 303(d) list of impaired waters for nutrients (phosphorus) in 1996. On the basis of benthic and fish assessments, MDE also classified the waterbody as impaired for biological integrity in 2006. Project partners implemented numerous stream restoration activities that led to visible and measurable water quality improvements. Until additional improvements are documented, however, the segment will remain on the impaired waters list.

Problem

Minebank Run and Lower Gunpowder Falls are in the scenic Cromwell Valley in eastern Maryland's Baltimore County. Minebank Run is an urban headwater stream that joins the Gunpowder River just south of Loch Raven Reservoir, at which point the watershed is called Lower Gunpowder Falls. Minebank Run drains 2,135 acres and makes up approximately 7 percent of Lower Gunpowder Falls' 29,470-acre watershed. The watershed was once primarily used for agriculture but is now densely developed in specific areas.

Minebank Run receives a high volume of runoff from impervious surfaces in suburban residential areas, office parks, highways and other areas surrounding Towson, Maryland. MDE first added the Lower Gunpowder Falls watershed, including Minebank Run, to the state's CWA section 303(d) list for phosphorus impairments in 1996. In 2006 MDE also listed it as impaired because it did not meet its designated use of aquatic life and wildlife support.

Before the restoration, Minebank Run exhibited severe bank incision, a disconnected floodplain, degraded fish and invertebrate habitat, loss of the riparian zone, and high sediment and nutrient loads from stormwater runoff. Stormwater conveyance channels, built to remove stormwater from roads quickly and not to protect hydrologic morphology, caused flashy, high-volume flows that eroded streambanks (Figure 1), exposed sewage trunk lines and damaged park roads and access bridges. Maryland Biological Stream Survey data confirmed that the number and diversity of macrovertabrates and fish were lower than they should be, indicating that Minebank Run was in an unhealthy, degraded condition.



Figure 1. High-volume stormwater flows damaged this stretch of Minebank Run.

Project Highlights

Baltimore County Department of Environmental Protection and Resource Management (DEPRM) conducted two phases of restoration activities—the first in 1999 and the second in 2005—on Minebank Run, a subwatershed within the Lower Gunpowder Falls watershed. In 1999 DEPRM worked to stabilize highly erodible banks, construct point bars, and add riffles and meander features with step-pool habitats along 8,000 linear feet in a headwaters portion of Minebank Run (Figure 2).

The project reduced the stream gradient to allow the stream to overflow its banks and reconnect to the floodplain. Reconnecting the floodplain allows phosphorus and sediment to be deposited on the floodplain rather than be carried downstream. It also provides a greater residence time for nitrogen to be removed by native vegetation uptake and

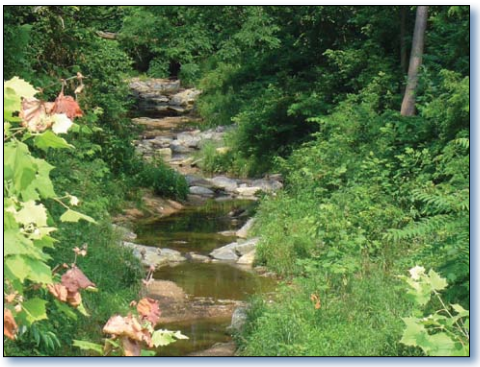


Figure 2. DEPRM added riffles, meanders and step-pool habitats during phase one of the project.



Figure 3. Minebank Run at Loch Raven High School, before restoration.

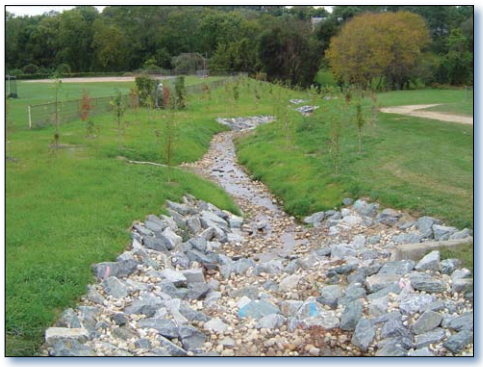


Figure 4. Minebank Run at Loch Raven High School, after phase two of the restoration project.

denitrification. The restoration involved planting 3,000 trees and 6,000 shrubs, which created a buffer and encouraged the uptake of available nitrogen.

DEPRM began the second phase of restoration in 2005 on a downstream reach of approximately 9,500 linear feet of Minebank Run. This phase had similar objectives as the first but was more extensive, involving removing a 500-foot concrete channel that coveys stormwater from Cromwell Road to Minebank Run (Figures 3 and 4). The restoration, on the grounds of Loch Raven High School, included adding step-pools, increasing the stream's sinuosity and planting riparian vegetation—all of which help dissipate flow energy, reduce erosion, moderate water temperatures and create stream channel and riparian habitat. Once the projects were complete, monitoring and geomorphologic evaluations were conducted over several years by a variety of project partners.

DEPRM armored stream banks at key locations to protect existing infrastructure such as sewer lines, bridges and roads. That has the beneficial effect of making the stream more hospitable to benthic macroinvertebrates and fish by decreasing flow speed, preventing scour and minimizing damage to aquatic habitat.

Results

The second phase of the Minebank Run project included reconnecting the stream to the floodplain and evaluating the results. A number of study partners collaborated to assess the projects between late 2003 and mid-2004. Results indicate that the project measurably reduced the bioreactive nitrogen (nitrate and nitrite) concentration in the surface water and groundwater. Nitrogen concentrations declined by 25 to 50 percent [1.5 milligrams per liter (mg/L) to 0.8 mg/L], while denitrification rates increased nearly twofold in test wells.

The project efforts removed an estimated 50,000 pounds (25 tons) of sediment typically discharged from the stream annually. Associated phosphorus reductions could range from 100 to 200 pounds annually. The projects have had many beneficial effects by reducing flow and increasing dissolved oxygen levels. The stream's physical and hydrological conditions appear to have improved substantially; however, measurable water quality and biological improvements will likely not occur a several years. In the meantime, DEPRM will continue to monitor biological conditions in both waterbodies.

Partners and Funding

DEPRM led the restoration and mitigation efforts. Partners in the nationally recognized floodplain denitrification study include the U.S. Geological Survey, Institute of Ecosystem Studies, DEPRM, and the University of Maryland's Center for Environmental Science.

Some state and federal funding partners participated at different stages to assist with and document the work. In 2003 Maryland's CWA section 319 program provided $150,000 to support DEPRM's efforts; that was complemented by another $100,000 in local match funding. Overall, Baltimore County estimates that the costs for Phases I and II were $2.2 million and $4.4 million, respectively.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-09-001KK
November 2009

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Maryland

Restoring Stream Improves Water Quality and Fish Community Health

Waterbodies Improved

During rainstorms, high volumes of rapidly moving stormwater flow off of impervious surfaces and into Maryland's Spring Branch, causing destructive erosion of the stream channel and contributing sediments and nutrients to a drinking water reservoir. The Maryland Department of the Environment (MDE) added Spring Branch to the state's Clean Water Act (CWA) section 303(d) list in 1996 for nutrient and sediment impairments and expanded the listing in 2002 to include biological impairments. Restoring two miles of stream has significantly reduced nutrient and sediment loads and improved fish habitat. Water quality continues to show progress toward meeting the total maximum daily load (TMDL) limits for phosphorus and sediment in the Loch Raven Reservoir, which is immediately downstream of the project area.

Problem

The 1,005-acre Spring Branch watershed drains a portion of Baltimore County in the urbanized Baltimore metropolitan region and empties into the Loch Raven Reservoir. Spring Branch is designated for water contact recreation use, aquatic life use and public water supply use.

Spring Branch was once a narrow, shallow trout stream. Fifty years of rapid urbanization created many impervious surfaces with few stormwater controls (Figure 1). Consequently, rainfall generates high volumes of runoff that quickly exceed the capacity of Spring Branch. Stormwater flows have eroded the stream channel so that it is now 30 feet deep and 15 feet wide. Erosion has exposed sewer pipes and created high sediment and nutrient loads that flow into the Loch Raven Reservoir.

MDE first added Spring Branch to the CWA section 303(d) list in 1996 for nutrient and sediment impairments. On the basis of biological monitoring results, MDE expanded the list of impairments to include a biological impairment in 2002.

In 2007 the U.S. Environmental Protection Agency approved MDE's TMDL for Loch Raven Reservoir, which includes the Spring Branch subwatershed. The TMDL requires that total phosphorus be reduced by 50 percent to meet water quality standards for dissolved oxygen and chlorophyll *a* (to prevent algae blooms in the reservoir). The TMDL also requires that suspended sediment be reduced by 25 percent to preserve the reservoir's volume. A TMDL for biological impairments has not yet been developed.

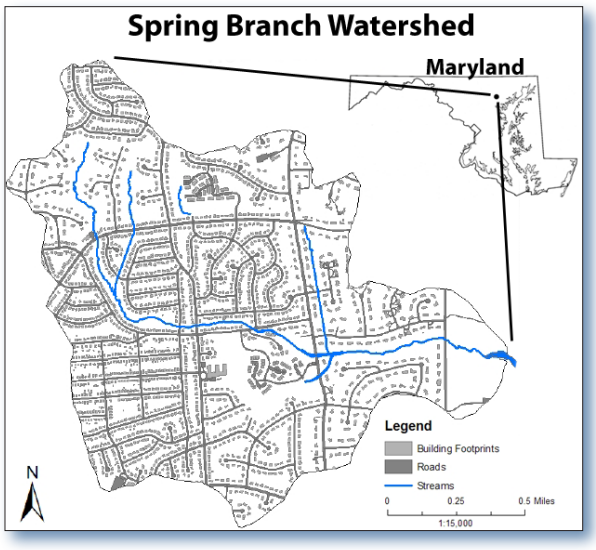


Figure 1. Impervious surfaces in northern Maryland's Spring Branch watershed.

Project Highlights

In 1997 Baltimore County developed a water quality management plan for the Loch Raven watershed. The plan identified and evaluated nonpoint sources of pollution and provided a watershed restoration and management framework. The Baltimore Metropolitan Council's Reservoir Technical Group wrote a *2005 Action Strategy for the Loch Raven Reservoir Watersheds*, which called for Baltimore County to reduce nutrient and sediment inputs to the reservoir through a variety of best management practices, including stream restoration. Baltimore County chose to focus restoration efforts on Spring Branch because of its proximity to the reservoir

and other factors, and completed a *Spring Branch Subwatershed Small Watershed Action Plan* in 2008.

The Baltimore County Department of Environmental Protection and Resource Management (DEPRM) conducted two phases of restoration activities on Spring Branch—one beginning in 1997 and the second in 2008. Both phases addressed effects of urbanization, including the flashy (quick-to-flood) flow regime, erosion, declining ecological function, failing infrastructure, poor water quality and property damage.

In phase I, DEPRM created a new channel of Spring Branch and added step pools, meander patterns and flood plains. That and other parts of the stream channel were stabilized using natural materials such as boulders, tree root wads, brush mattresses and live branch layers. In addition, DEPRM removed 1,740 feet of concrete channel (Figure 2), stabilized or removed sanitary sewer lines, added rock-lined step pools below storm drain pipes to dissipate energy from the flow, and constructed a stormwater wet pond to treat runoff from the headwaters. Replanting 12 acres with native trees and shrubs restored 10,000 linear feet of stream (Figure 3).

In phase II, DEPRM removed another 524 feet of concrete channel and restored 3.23 acres of native riparian buffer using 219 trees; 547 shrubs; 2,133 live stakes; 295 linear feet of live branch layering and 102 pounds of native riparian seed. Phase II restored 2,814 linear feet of stream.



Figure 2. At this site (looking toward Pot Spring Road) before restoration efforts, Spring Branch flowed through a concrete channel. The concrete step seen here obstructed fish passage.



Figure 3. After restoration, the concrete channel seen in Figure 2 has been removed. Sewer lines running along both sides of the stream prevented partners from restoring a natural meandering pattern.

Results

The phase I work reduced phosphorus loads by 27 percent, nitrogen loads by more than 30 percent and sediment loads by 45 percent. In 2003 and 2004, monitoring at station SB-2 (downstream end of the phase I portion of the project) showed that few or no fish were present, and the fish index of biotic integrity score (IBI) was classified as *very poor* (score of less than 1.9). However, the fish community responded to phase II restoration efforts. Fish monitoring in 2009 (less than one year after phase I was completed) showed significant increases in fish biomass and fish IBI at stations SB-2 and SB-8 (headwaters). Removing the concrete channel (see Figure 2) allowed the fish to swim upstream and colonize the area. As seen in Figure 4, Fish IBI scores at both stations improved to a classification of *poor* (scores between 2.0 and 2.9).

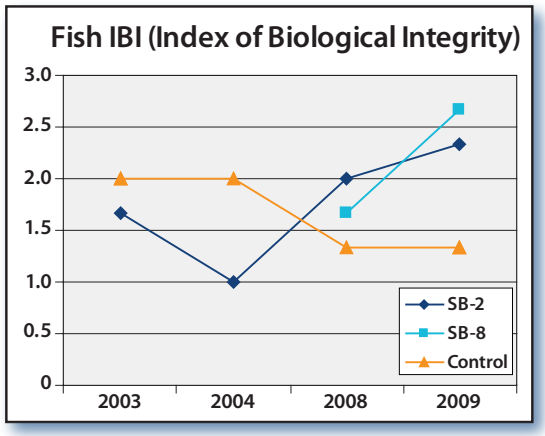


Figure 4. After phase II of the restoration (2008), fish IBI levels increased above (SB-8) and below (SB-2) the project area.

Although Spring Branch does not yet meet water quality standards, reduced pollutant loads and improving biological data indicate that progress is being made.

Partners and Funding

Project costs included $276,473 for a new wet pond serving 47 acres, $1.9 million for phase I work and $1.1 million for phase II work. Most of the funding came from Baltimore County bonds, MDE Small Creeks and Estuaries Grant and MDE stormwater cost share funds. A developer fee, required in lieu of mitigation funds, helped fund plantings. CWA section 319(h) funds contributed $240,000 for phase II work. Baltimore City, which owns and operates the Loch Raven Reservoir, was also a project partner.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-10-001LL
December 2010

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NONPOINT SOURCE SUCCESS STORY

Maryland

Tarkiln Run pH Impairment Remedied by Successful Acid Mine Drainage Treatment

Waterbody Improved

Maryland's Tarkiln Run, a tributary to Casselman River in Garrett County, was impaired by low pH associated with acid mine drainage (AMD) and was added to the Clean Water Act (CWA) section 303(d) list in 1996. An assessment of an AMD seep impacting Casselman River tributaries ranked this stream high priority for mitigation. Successful AMD mitigation brought the stream into compliance with the state water quality standard for pH. As a result, the Maryland Department of the Environment (MDE) is delisting Tarkiln Run for pH impairment in Maryland's 2018 Integrated Report.

Problem

Tarkiln Run headwaters are in Maryland's Savage River State Forest south of US I-68 near Amish Road; it is a tributary to the Casselman River's North Branch (Figure 1). Western Maryland's Casselman River watershed drains to Pennsylvania toward the Ohio River. Prior to WWII, the river and its tributaries were commonly high-quality waterways that supported native brook trout. During several following decades, coal mining changed the local hydrology, which resulted in AMD that caused pH declines in numerous streams, including Tarkiln Run.

The Casselman River watershed, including Tarkiln Run and other streams, was listed for pH impairment in 1996. In 2005, water quality monitoring to support pH total maximum daily load (TMDL) development found that Tarkiln Run was consistently below the Maryland water quality standard for pH, which requires that pH be within the range 6.5–8.5.

In 2008 EPA approved the pH TMDL for pH-impaired streams in western Maryland, including Tarkiln Run. Water quality monitoring in 2010–2013 showed that Tarkiln Run pH continued to fall below Maryland's water quality pH standard most of the time.

A benthic macroinvertebrate assessment performed in 2011 and 2012 rated the stream as 2.25, which is classified as *poor* on the benthic index of biological integrity. Maryland's 2014 Integrated Report clarified the pH conditions in the Casselman River watershed by separately listing Tarkiln Run for pH impairment.

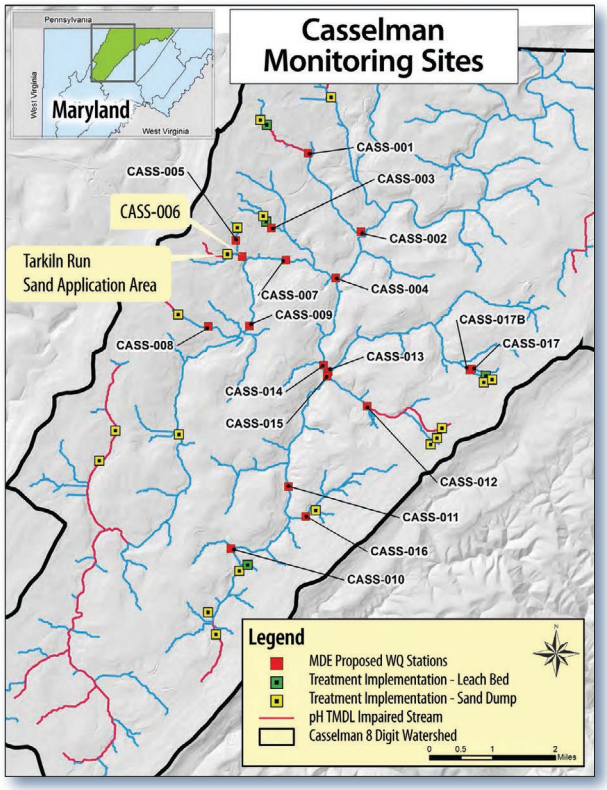


Figure 1. Casselman River watershed monitoring sites.

Story Highlights

In late 2008 MDE initiated watershed planning to make the Casselman River watershed eligible for CWA section 319(h) grant implementation funds. The planning process included assessment of potential AMD



Figure 2. Tarkiln Run sand dump site.

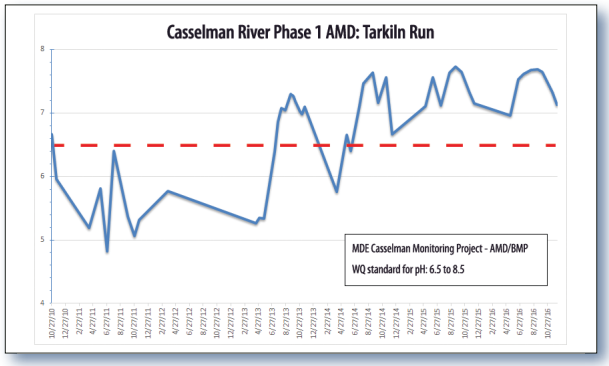


Figure 3. Tarkiln Run meets the pH standard.

mitigation sites like Tarkiln Run. The plan also analyzed AMD mitigation technologies. One of the technologies recommended to address pH while also minimizing capital and operation and maintenance costs was limestone sand application, sometimes called a limestone "sand dump." This technique involves constructing a driveway for a dump truck to pull up adjacent to the stream so that measured quantities of pulverized limestone can be delivered directly to stream edge. Then, natural variation in stream flow distributes the particles of limestone downstream. The limestone sand particles in the stream tend to raise in-stream pH and increase acid neutralizing capacity. The amount and timing of limestone sand application at each site is determined by periodic monitoring of in-stream pH.

In 2011 the U.S. Environmental Protection Agency accepted the Casselman River Watershed Plan for pH Remediation, and section 319(h) grant funds were approved to help mitigate AMD-impacted areas. Tarkiln Run was selected to be one of 11 Phase I projects because the land was publicly owned, the site was accessible and permit requirements were attainable. In mid-2013 one limestone sand application site was constructed. During its first year of operation, the Tarkiln Run site received 41.65 tons of limestone sand (Figure 2).

Results

After installing the limestone sand application sites, MDE's Abandoned Mine Land Division (AMLD) periodically monitored the pH at Tarkiln Run and scheduled delivery of limestone sand to the application sites as needed. After a period of adjustment in late 2013 and early 2014, water quality data collected in Tarkiln Run from mid-2014 through 2016 demonstrated that in-stream pH consistently met Maryland's water quality standard (Figure 3). As a result, MDE is delisting Tarkiln Run for pH impairment in Maryland's 2018 Integrated Report.

Benthic macroinvertebrate assessments were performed in 2014, 2015 and 2016. The overall average rating was 3.167, which is categorized as *fair* on the benthic index of biological integrity—an improvement from the *poor* rating received in 2011–2012.

Partners and Funding

MDE AMLD and MDE Integrated Water Planning Program (IWPP) cooperated to write the Casselman River Watershed Plan for pH Remediation. Drafting the plan used $55,000 from the federal fiscal year (FFY) 2008 CWA section 319(h) grant. MDE was awarded $644,115 from the FFY2009 CWA section 319(h) grant to help pay for mitigating more than a dozen different sites impaired by AMD in the Casselman River watershed. The Garrett Soil Conservation District (SCD) was hired to oversee contractor hiring, construction management and inspection for all these project sites, including the Tarkiln Run limestone sand application project. The SCD's total capital cost for the Tarkiln Run site was only $8,868.

Other partners contributed work at no cost to the project. Watershed plan drafting by MDE IWPP staff was funded by the section 319(h) grant that supports the state Nonpoint Source Management Program. Also, before/after water quality monitoring by MDE's Field Services Program was funded by separate ongoing section 319(h) grant projects. The Maryland Fisheries Service assessment and analysis was independently funded by the state of Maryland.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-19-001P
April 2019

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