## Contents

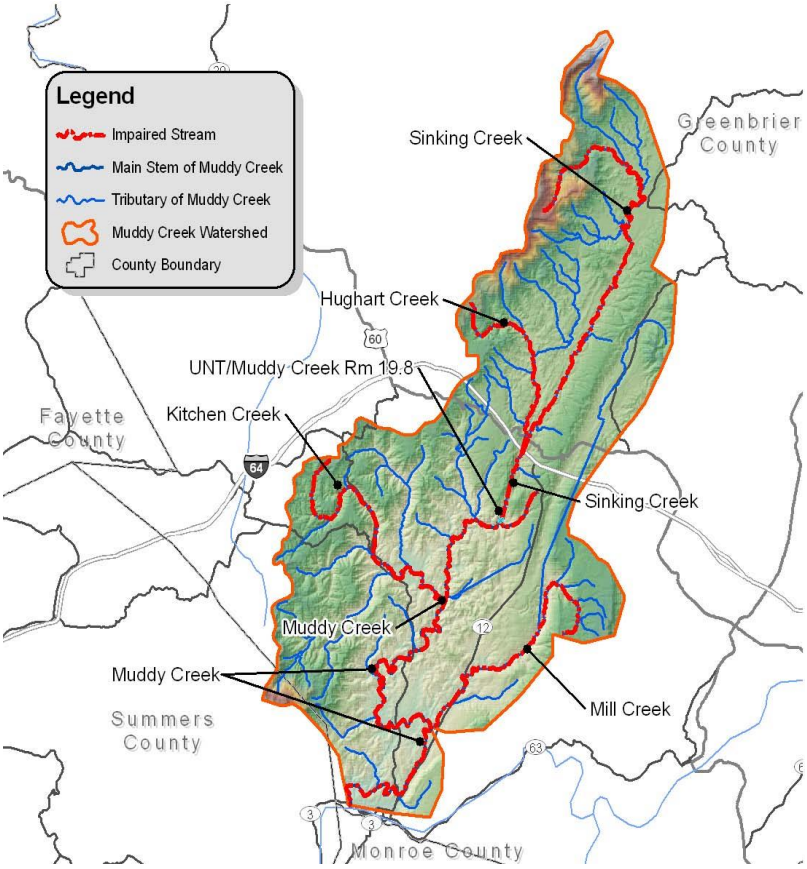
Watershed project highlights ..... 2
Muddy Creek of Greenbrier ..... 2
Knapp Creek ..... 4
Tuscarora Creek ..... 6
Lambert Run Site 7 ..... 8
Success Stories ..... 9

## Watershed project highlights

Multiple projects (but not all) completed in 2015 will be highlighted in this section.

### Muddy Creek of Greenbrier

*Figure 8. Muddy Creek of Greenbrier watershed*




The Muddy Creek watershed covers approximately 79,000 acres and includes the communities of Williamsburg, Blue Sulphur Springs, and Alderson. The watershed has an average elevation of about 2,250 feet with a few steep headwater streams. Muddy Creek itself is a meandering, slow-moving stream, averaging 25 feet of elevation change per mile. The land use is approximately two-thirds forest and one-third pasture and grassland, with other land uses taking up less than one percent of the area.

#### Problem

TMDLs were calculated for the Muddy Creek watershed as part of a broader TMDL report for the Greenbrier River (Tetra Tech 2008). Together, failing septic systems, straight pipes, and residential runoff account for about 2% of the total baseline fecal coliform load in the Muddy Creek watershed. The other 98% of fecal coliform is attributed to agriculture in the watershed. US EPA approved the Muddy Creek watershed plan in 2009. The first Muddy Creek project was funded in 2011 and completed in September 2015.

#### Project highlights

The project focused predominantly on removing livestock away from any direct waterway access. Exclusion fencing has been installed along waterways, which in return created buffer areas to absorb run-off from nearby fields. Alternative watering systems have also been installed to allow livestock cleaner and fresher water. Many of the watering systems installed are being powered by alternative power sources such as solar. Pasture division fence, grazing plans, and nutrient management plans were also implemented on many of the farms. Failing septic systems, completely and intermittently, made up the remainder of the work. Practices installed to date are 19 alternative water sources, 24,027 feet of

exclusion and pasture division fencing, 230 feet of streambank stabilization, 50 septic systems pumped and 23 septic systems replaced or repaired.

*Figure 9. Alternate water sources and divisional fencing used to rotate the cattle between pastures were two of the most important and most popular BMPs.*

## Results

Approximately 650 animal units (AU) were impacted thru agricultural practices decreasing the fecal coliform load by 5.66E+12 cfu/year. Septic system improvements will decrease the fecal coliform load by 3.42E+12 cfu/year. Although pollution reduction is the focus, a better educated and involved local community is what will sustain the efforts. Outreach and education occurred throughout the life of the project and included several community meetings, WVU Extension Service training, mailing efforts to watershed residents, local school involvement and updates in the local newspapers.

## Funding and Partners

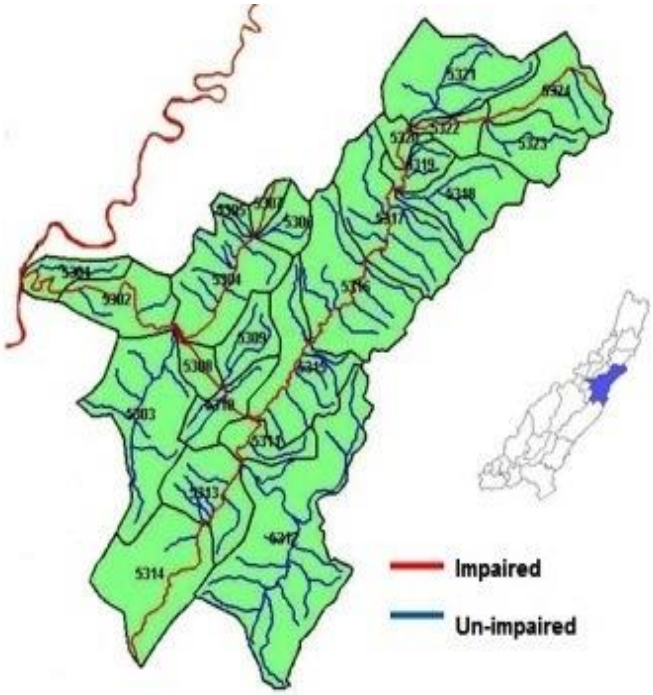
The involvement of local stakeholders and other partners were keys to the project's success. WVCA was the sub-grantee and the lead for the project. WVCA's local CS is responsible for project management and implementation. Friends of the Lower Greenbrier River helped with land owner's solicitation, performed monitoring and provided classroom activities in the local schools that focused on the project. WVU Extension Service provided workshops on septic maintenance and helped facilitate community meetings. The Greenbrier Valley Conservation District was the local fiscal agent.

A total of $244,160 funding from § 319 paid for a large percentage of the BMPs and contributed to monitoring. State funds of $84,068 provide match and paid for a portion of BMP implementation and outreach. Local landowners contributed $78,707, which was also match and paid for equipment and supplies. This project was over-budget but luckily change orders from other projects in the same year provided available funds to finish.

## Knapp Creek

Knapp Creek is a 26.3 mile stream located entirely within Pocahontas County, West Virginia. The watershed encompasses approximately 176 square miles. Its headwaters originate in the mountains that form the West Virginia/Virginia boundary north of the town of Frost. The other towns within the watershed are Minnehaha Springs, Huntersville and Marlinton at the confluence of Knapp Creek and the Greenbrier River. Land use is predominantly in agricultural production and forestry.

*Figure 10. Knapp Creek subwatersheds*




### Problem

Knapp Creek was listed on WV's 303(d) list for fecal coliform in 2006. The 2008 TMDL and the 2013 watershed plan (WP) called for fecal coliform to be reduced by 48% from agriculture and failing septic systems. Through recent surveys, it is speculated that this area is home to over 2,000 head of livestock annually, and is one of the most heavily agricultural areas in Pocahontas County.

Knapp Creek drew attention long before the TMDL and WP. In 2000 the Natural Resource Conservation Service (NRCS) proposed a natural stream restoration project plan for the entire watershed, the first in WV. The first project from the plan was implemented in 2004 and two others in 2011. However, lack of funding has slowed the progress of additional restoration efforts.

### Project highlights

New life was generated when NRCS announced the National Water Quality Initiative (NWQI). WV NRCS, WVCA, and WVDEP's NPS Program discussed possible candidates and selected Knapp Creek to receive NWQI funding. Multiple years of NWQI funding, as well as § 319 funds resulted in 13,042 feet of stream restoration with 35 ft wide buffers, multiple armored stream crossings, 33 acers of grass and forest buffers and 12 septic repairs. NWQI funded BMPs include 5,200 feet of streambank repair, two stream crossings, 900 feet of fencing and three acres of tree planting.

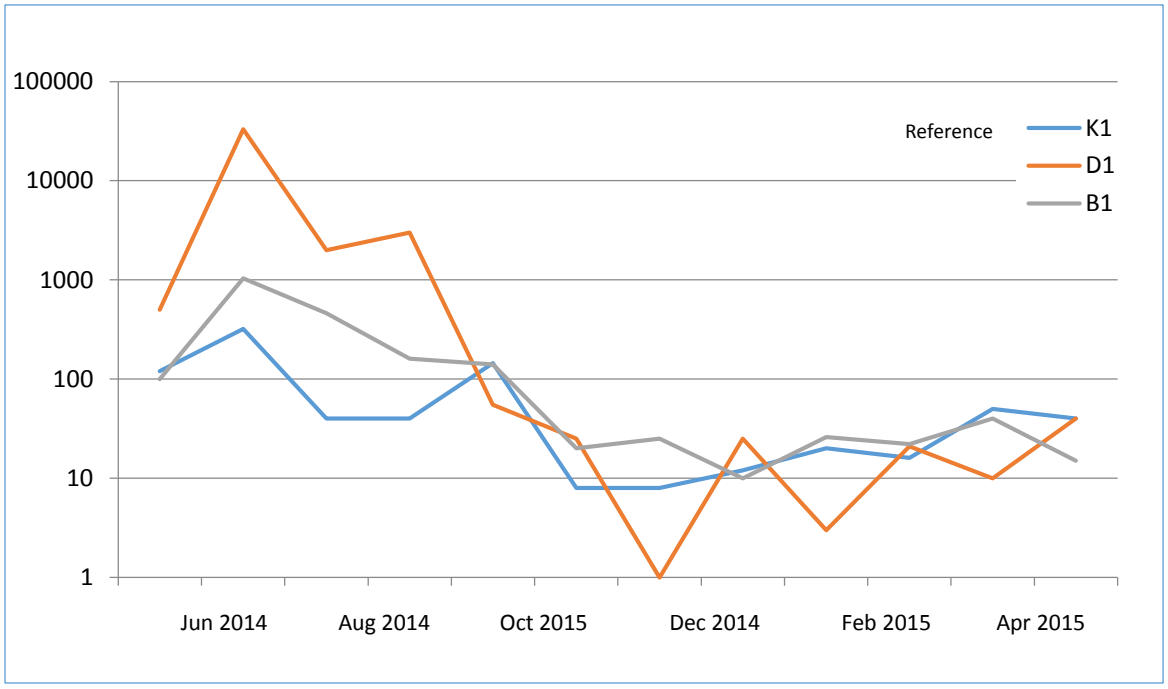
### Results

The results are mixed and somewhat disappointing thus far. A 2013 § 319 funded monitoring project showed fluctuation in fecal coliform concentrations with summer numbers from 1,000 – 10,000 in portions of the watershed, and even the reference site violated water quality standards for fecal coliform, although much lower than most of the watershed. Figure 1 shows the fecal concentrations at three

different stations in the watershed. Initial baseline monitoring focused above and below tributaries and mainstem locations. The next steps are to locate additional sampling sites closer to projects (edge of field).

Biological monitoring paints a slightly different picture, with most of the watershed producing good index scores, and slight improvements at the stream restoration sites. The WP calls for additional agricultural projects and septic repairs but as time passes and the BMPs installed begin to mature (especially the buffers) we believe improvements will be more noticeable. Thus far fecal coliform has been reduced by 3.79E+12 cfu/year.

*Figure 11. Knapp Creek baseline fecal monitoring*



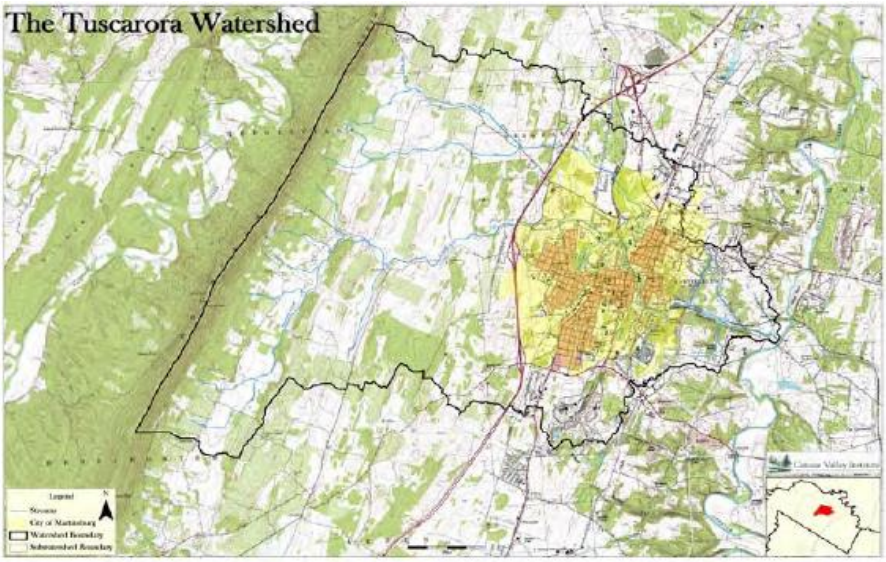

## Funding and Partners

Thus far the restoration efforts in the watershed have been agency driven. Leading the way is NRCS using NWQI funds, and two state agencies WVDEP and WVCA using § 319, state and local funds. Recently other stakeholders have shown interest including the town of Marlinton, Pocahontas County Health Dept. and the Pocahontas County Water Resource Task Force. As the efforts to improve the watershed continue these local stakeholders will play a greater role.

WVDEP awarded a total of $272,662 in § 319 funds to WVCA for work in the Knapp Creek watershed. Approximately $10,000 was used for WP development, $100,000 for monitoring support and the remainder for project implementation. State and local contributions total $82,253. About 50% of the total has been spent. NRCS has reimbursed landowners $447,792 from NWQI funding.

## Tuscarora Creek

*Figure 12. Tuscarora Creek watershed*




Tuscarora Creek drains approximately 26 square miles, and is approximately 11.7 miles long. Its major tributary, Dry Run, is 5 miles long. Tuscarora Creek flows into the Opequon Creek, which is part of the Potomac River watershed. The entire Tuscarora Creek watershed is within Berkeley County in the Eastern Panhandle of West Virginia.

### Problem

Tuscarora Creek and its major tributary, Dry Run, were listed on the 303(d) list as impaired for biological criteria and fecal coliform bacteria. The 2008 TMDL for Selected Streams in the Potomac Direct Drains addressed these impairments for Tuscarora Creek and Dry Run. The impairments impact stream biology due to organic enrichment and sedimentation. The Tuscarora watershed plan was approved by EPA in 2012, and the first watershed project began in about the same time frame.

### Project highlight

*Figure 13. Shown here are the risers of the De-nitrifying system installed at Poor House Farms. Tuscarora Creek can be seen in the background.*

Fecal coliform from septic systems were addressed through incentive programs for pumping, replacement or repair. Homeowners were targeted through a variety of outreach efforts. Flyers were distributed to schools, county offices and other businesses. Regular news articles were written and published in the Martinsburg Journal. Personnel from Canaan Valley Institute (CVI), Opequon Project Team (OPT) and WVDEP's Potomac BC gave multiple radio interviews encouraging participation. Even though outreach efforts were significant, the response from homeowners has been slow.

However, progress from other efforts were better. A Norweco Singular Denitrifying System was installed at Poor House Farm Park near the headwaters of Tuscarora Creek.

The system replaced the traditional failing system, improving bacteria reduction and adding nitrogen removal capability. This will help WV's Potomac Tributary Strategy reach its goal of installing 100 denitrifying systems in West Virginia's eight-county region that drain to the Chesapeake Bay. Other programs/efforts also contributed. WV Division of Forestry (WVDOF) completed multiple tree planting and buffer enhancements throughout the watershed. The effort was funded by the CommuniTree Program and Chesapeake Bay grants. The design of a 448 feet natural stream restoration project was completed by CVI.

## Results

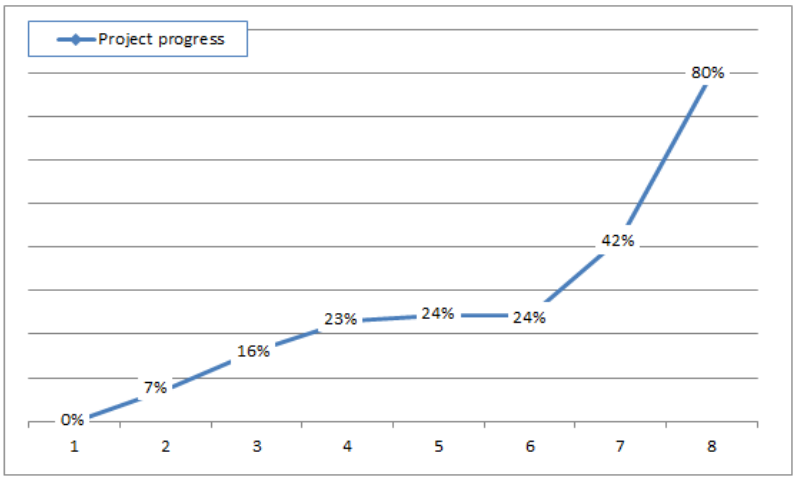
During the grant period, 13 septic systems were pumped and three failing systems were replaced or repaired accounting for a fecal coliform reduction of 1.88E+13 cfu/year. A review of the bids showed that original estimates of $7,000/repair were low. Average cost were closer to $11,000. The 50% cost share rate was not sufficient enough to encourage homeowners to sign-up. Those few who participated took advantage of the low interest rates provided by WVDEP's Clean Water State Revolving Loan (CWSRL) Program to pay remaining costs. We are hopeful that future efforts will provide funds adjusted to the higher rates, and are optimistic that participation will improve.

## Funding and Partners

Volunteers and multiple partners were involved in the implementation of the project. In addition to the implementation above, volunteers from OPT, the city and local schools completed a streambank assessment of Dry Run. The multiple teams documented erosion and other problems, which will provide the groundwork for future projects in Dry Run portion of the watershed. Regular project team meetings occurred throughout the life of the project and will continue on a regular basis. A second Tuscarora Creek watershed project was funded in fiscal year 2015.

*Figure 14. Tuscarora Creek project progress tracking*

| Tuscarora milestones | FY12-1 | FY12-2 | FY13-1 | FY13-2 | FY14-1 | FY14-2 | FY15-1 | FY15-2 | Remaining |
|---|---|---|---|---|---|---|---|---|---|
| Septic repair (6) | 0 | 16% | 16% | 16% | 16% | 16% | 50% | 50% | 50% |
| Septic pumping (8) | 0 | 0% | 10% | 10% | 10% | 10% | 40% | 50% | 50% |
| Volunteer streambank assessment | 0 | 10% | 10% | 20% | 10% | 10% | 10% | 100% | 0% |
| NSD design | 0 | 10% | 25% | 50% | 65% | 65% | 90% | 100% | 0% |
| 1 De-nitification system | 0 | 0% | 20% | 20% | 20% | 20% | 20% | 100% | 0% |
| Project progress | 0% | 7% | 16% | 23% | 24% | 24% | 42% | 80% | - |




All of the § 319 funds requested for the 2011 Tuscarora watershed project were not spent. $43,911 was spent which is 80% of the funding request, $37,776 in match was spent. Other funding sources that contributed included CB grants and the WVDOF Communi-Tree Program totaling about $35,000.

See more about efforts in the Potomac in the watershed plans section.

## Lambert Run Site 7

*Figure 15. Lambert Run confluence with the West Fork*

Lambert Run is a 4.4 mile long stream located northwest of Clarksburg in Harrison County, West Virginia. Abandoned coal mining operations dating back to the 1900s occurred throughout the length of Lambert Run. These abandoned mine sites produce both acid and alkaline mine drainage.

### Problem

Acidity to a lesser extent, and metal sources of impairment caused the degradation of Lambert Run and its inclusion on the state's 303(d) list in 1996. In 2002 WVDEP completed a TMDL for the West Fork watershed, which included Lamberts Run. The TMDL identified metals and pH as the impairments, and established the necessary load reductions for the metals: Aluminum (Al) 81%, Iron (Fe) 97% and Manganese (Mg) 99%. Since 2003 after the watershed plan was completed and approved, nearly two million dollars in funding has been secured for projects in the watershed. Several of the major contributors of mine drainage have been remediated and the mainstem of Lambert Run is showing improved water quality. However, Site 7 is one of the largest sources in the watershed, estimated to contribute > 166,000 lbs/year of metals pollution.

### Project highlights

*Figure 16. Aeration weir at Site 7 in wetland cell #1*

The project consisted of a combination of passive treatment technologies. The main treatment method for the passive treatment system at Site 7 is five aerobic wetland cells. Discharge from the impoundment makes its way over an in-channel aeration weir and is then culverted into wetland #1. Wetland #1 has three large aeration weirs to encourage oxidation of the metals. The water then makes its way through four more wetland cells with aeration drops at various locations. After the fifth and final wetland, the water then discharges into Lambert Run. Total wetland area is approximately four acres. In addition, baffles have been installed in the existing impoundment to increase retention time and encourage oxidation.

## Results

*Figure 17. View of the wetland treatment cells taken during the 2015 EPA tour*

Table 6 is recent data from the impoundment discharge at Site 7 (inflow). National Mine Land Reclamation Center (NMLRC) and Guardians of the West Fork (GWF) have yet to collect data from the outfall of the passive system. Initial visual results indicate that the system is working as intended. However, performance cannot be fully quantified until after next growing season when the wetlands have had ample growing time. The system is expected to reduce iron by 132,832 lbs/year and aluminum by 416 lbs/year.

*Table 7. Recent influent data at Lambert Run Site 7*

| Date | Site Name | pH* Lab | Alk mg/L | Acd mg/L | D.Al mg/L | D.Fe mg/L | D.Mn mg/L | Discharge gal/min | tons per year | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | D. Fe | D. Al | D. Mn | Acidity |
| 9/16/2015 | Site 7 (In) | 6.56 | 116.83 | 54.97 | 0.005 | 24.03 | 2.28 | 994 | 52.5488 | 0.010934 | 4.985904 | 120.2084 |

## Partners and funding

The Lambert Run Site 7 AMD treatment system was completed in September 2015 through the cooperative efforts of WVDEP; the watershed group, GWF) and NMLRC at West Virginia University. NMLRC also worked with the GWF to obtain funds from the Office of Surface Mining's (OSM) Watershed Cooperative Agreement Program (WCAP). WCAP funds and WVDEP's stream restoration funds (SRF) covered construction costs and match. Table 2 provides a breakdown of the final costs.

*Table 8. Lambert Run Site 7 final costs*

| Funding | Award | Spent | Balance |
|---|---|---|---|
| § 319 | $384,933 | $384,376 | - |
| SRF | $200,000 | $200,000 | - |
| WCAP | $56,622 | $56,622 | - |
| Total | $641,555 | $640,998 | $577 |

## Success Stories

§ 319 NPS Success Stories highlight waterbodies identified by states as being primarily nonpoint source-impaired and having achieved water quality improvements. States are required to submit at least one story within a fiscal year. There are three categories of Success Stories: 1) fully or partially restored, 2) progress towards water quality goals, and 3) ecological restoration. In 2015 two West Virginia stories were published on EPA's Success Story website. These are provided on the next four pages.

# NONPOINT SOURCE SUCCESS STORY

West Virginia

## Controlling Contaminant Sources and Restricting Livestock Access to the Riparian Corridor Improves Water Quality and Aquatic Habitat in Kitchen Creek

### Waterbody Improved

Waste from agricultural production and the presence of livestock in riparian areas degraded water quality in Kitchen Creek. As a result, the stream was placed on the 2006 Clean Water Act (CWA) section 303(d) list as impaired for fecal coliform. The West Virginia Conservation Agency (WVCA) developed and implemented a watershed-based plan to address the problem through practices such as limiting livestock access to the stream and constructing waste storage facilities. Water quality has generally improved in response to this restoration work; bacteria levels have decreased and habitat conditions have improved.

## Problem

Kitchen Creek is in the Gap Mills area of Monroe County in southeastern West Virginia. It flows along the northeast foot of Peters Mountain from the continental divide, and travels southwest to Second Creek. Second Creek flows northwest to the Greenbrier River. Kitchen Creek is a 5.5-mile-long stream that flows into Second Creek at Gap Mills (Figure 1). The Kitchen Creek watershed consists mostly of grassland pasture used for beef cattle and dairy operations.

West Virginia's fecal coliform (FC) bacteria standard states that water samples are not to exceed 200 colonies (col) per 100 milliliters (mL) as a monthly mean, based on at least five samples per month. In addition, no more than 10 percent of all samples taken during the month may exceed 400 col/100 mL. Data collected in 2004 and 2005 failed these criteria, causing Kitchen Creek (segment WVKNG-23-G) to be placed on the 2006 CWA section 303(d) list for FC bacteria. A total maximum daily load (TMDL) was developed for the Greenbrier River in 2008, which included Kitchen Creek and Second Creek. The TMDL analysis revealed that the use of the stream for agricultural purposes was the root of the bacteria contamination. At one time there were three dairies and two large beef feedlot with very little, if any, waste storage, and much of that waste was able to enter the stream (Figure 2).

Other farms in the area allowed unrestricted grazing of beef cattle along the riparian areas, while also over-applying liquid and solid manure, poultry litter, and fertilizer to pasture and cropland. In addition, the karst geology of the area might have led to a slow release of bacteria into the stream from underground sources.

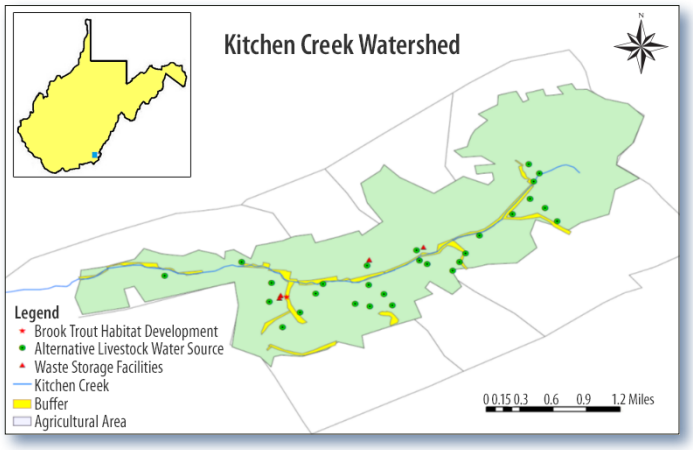



Figure 1. Kitchen Creek watershed and BMP locations.

## Project Highlights

The key best management practices (BMPs) implemented to address the FC bacteria contamination included installing alternative water systems, limiting livestock access to the riparian area, and building waste storage facilities. The majority of these practices were implemented from 2009 to 2014 as part of the Second Creek watershed-based plan (see Figure 1 for BMP implementation locations).

The 11 alternative watering systems were vital to restricting livestock access to the riparian pasture. These systems provided cleaner and fresher water for livestock while grazing, and also allowed farmers to implement rotational grazing systems to decrease bacteria-laden runoff. Some of the alternative water sources also used renewable energy such as wind and solar power for pumping.

Figure 2. Before project implementation, this section of stream flowed through the middle of a beef feedlot.

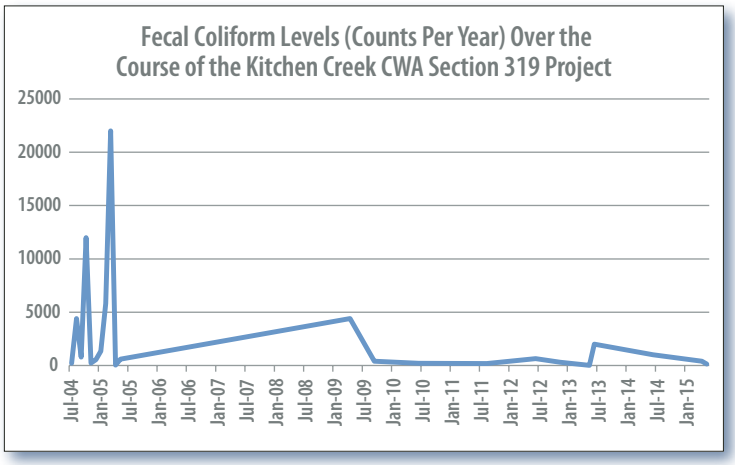



Figure 3. FC bacteria levels in Kitchen Creek generally declined after 2009, thanks to project implementation.

More than 100 acres of riparian area and more than 6 miles of stream were developed into buffers once the alternative water sources were in place. These riparian areas are mostly grass buffers; farmers allow livestock to graze on a limited basis in accordance with a rotational grazing plan that is designed to meet or exceed the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) standards for riparian grazing. Allowing livestock to graze the buffers facilitates the plants' ability to uptake nutrients. These buffers and grazing management plans have reduced the overall time livestock can access the stream from 5 percent to 0.12 percent.

Finally, three waste storage facilities were constructed or repaired to stop the direct flow of manure to the stream. The nutrients from these waste storage facilities were then used in nutrient management plans for additional forage production, further reducing the need for riparian pasture and improving water quality.

## Results

FC bacteria levels have dramatically decreased as a result of the restoration work in Kitchen Creek (Figure 3). Unexplained spikes in bacteria levels shown in recent monitoring data might be linked to above-average precipitation and legacy sources of livestock waste in the karst system that will take a significant amount of time to flush out completely. WVCA will conduct further sampling along Kitchen Creek to confirm that FC levels continue to improve as a result of better land management.

Wildlife habitat has also improved due to the restoration work. A fish population evaluation conducted one year after brook trout reintroduction to the stream in 2013 showed that the trout population reestablished itself. In addition, the fish surveys indicated a change in the primary nongame fish population from dace to sculpin, an indicator of high-quality water. Terrestrial species, including river otters, bald eagles, golden eagles, golden winged warblers and bobwhite quail, were also spotted in the area after Kitchen Creek water quality began improving (even though the creek does not yet meet state standards).

## Partners and Funding

Many project partners were involved in the Kitchen Creek improvement project. WVCA was the primary lead for this project, while the Greenbrier Valley Conservation District served as the local funds holder. NRCS provided engineering and plant materials support. The U.S. Fish and Wildlife Service's White Sulfur Springs National Fish Hatchery and Partners for Fish and Wildlife Program provided support for implementing BMPs and establishing brook trout. Trout Unlimited was closely involved with fence construction on most of the projects.

Federal funding ($556,560 total) was provided by the CWA section 319 program. State funds included $120,811 from the WVCA; additional state funds were provided in the form of staff time and resources. Participating farmers and landowners contributed over $100,000 of their personal funds, time, labor and other resources to assure this project's success.

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

EPA 841-F-15-001HHH
December 2015

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# Section 319
# NONPOINT SOURCE PROGRAM SUCCESS STORY
## West Virginia

# Treating Acid Mine Drainage Allows Aquatic Life to Rebound in Kanes Creek

**Waterbody Improved**

Acid mine drainage (AMD) from mines in West Virginia's sulfur-rich Upper Freeport Coal Seam polluted Kanes Creek. The West Virginia Department of Environmental Protection (WVDEP) added the 4.3-mile-long stream to its Clean Water Act (CWA) section 303(d) list of impaired waters in 1998. Project partners have installed passive and active AMD treatment systems that have reduced metals and acidity loadings into Kanes Creek, allowing benthic macroinvertebrate and fish communities to increase in the lower reaches of the creek. A 7.2-acre impoundment upstream is meeting water quality standards and will be ready for volunteer or stocked fish communities after a few more projects solidify water quality gains.

## Problem

Kanes Creek is a tributary to Deckers Creek, which is a tributary to the Monongahela River. Kanes Creek is a 4.3-mile stream that flows into Deckers Creek in Reedsville, West Virginia. Deckers Creek flows into the Monongahela River in Morgantown, West Virginia (Figure 1).

The Upper Freeport Coal Seam is rich in sulfur, and it generates sulfuric acid when exposed to air and water. Before 1977, no regulations were in place restricting the discharge of AMD from mines. Many of those mines were abandoned before the Surface Mining Control and Reclamation Act (SMCRA) went into effect, and continue to discharge polluted water to this day. Kanes Creek received AMD from 10 abandoned mine sites, leading to high metal concentrations and acidity. WVDEP's Watershed Assessment Branch (WAB) and Friends of Deckers Creek (FODC) collected data from 1994 to 1996 that led to the 1998 CWA section 303(d) listings for iron, manganese, pH and biological impairments of Kanes Creek.

## Project Highlights

In 1997 and 2003, the WVDEP reclaimed abandoned mine lands as part of the SMCRA funded-effort to reduce problems from abandoned coal mines. In 2002 the U.S. Environmental Protection Agency (EPA) completed a total maximum daily load (TMDL) for the Monongahela River watershed, which includes Kanes and Deckers creeks. From 2003 to 2006 a permitted mine adjusted its operation to better capture AMD surging from the mine. In 2005 a nonprofit organization, Friends of Deckers Creek (FODC), completed a watershed-based plan that served as a road map to eliminating all impairments from mine drainage in the Kanes Creek and Deckers Creek watersheds. In 2008, 2010, 2011 and 2013 FODC completed acid mine drainage treatment projects in the Kanes Creek watershed with sulfate-reducing bioreactors, water-powered lime dosing devices, limestone leachbeds and an anaerobic vertical flow wetland (see Figure 1 for project locations). One more project using a limestone leachbed and an anaerobic vertical flow wetland is in development.

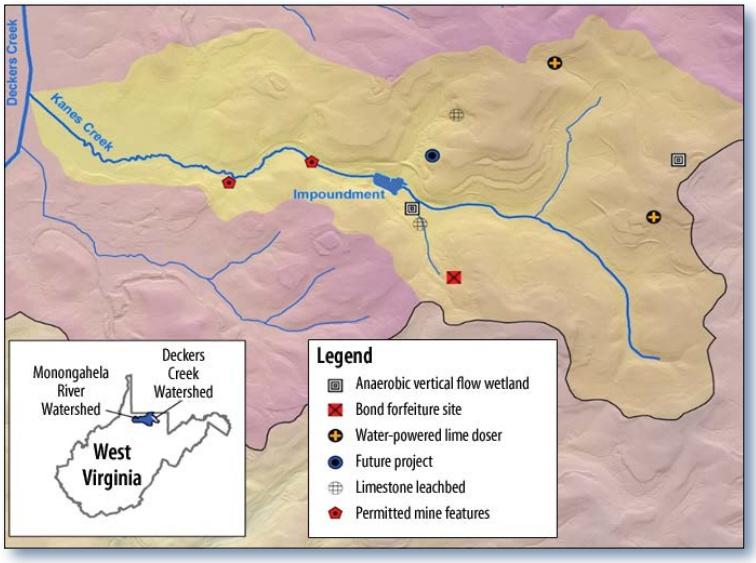


Figure 1. The Kanes Creek watershed is in northern West Virginia.

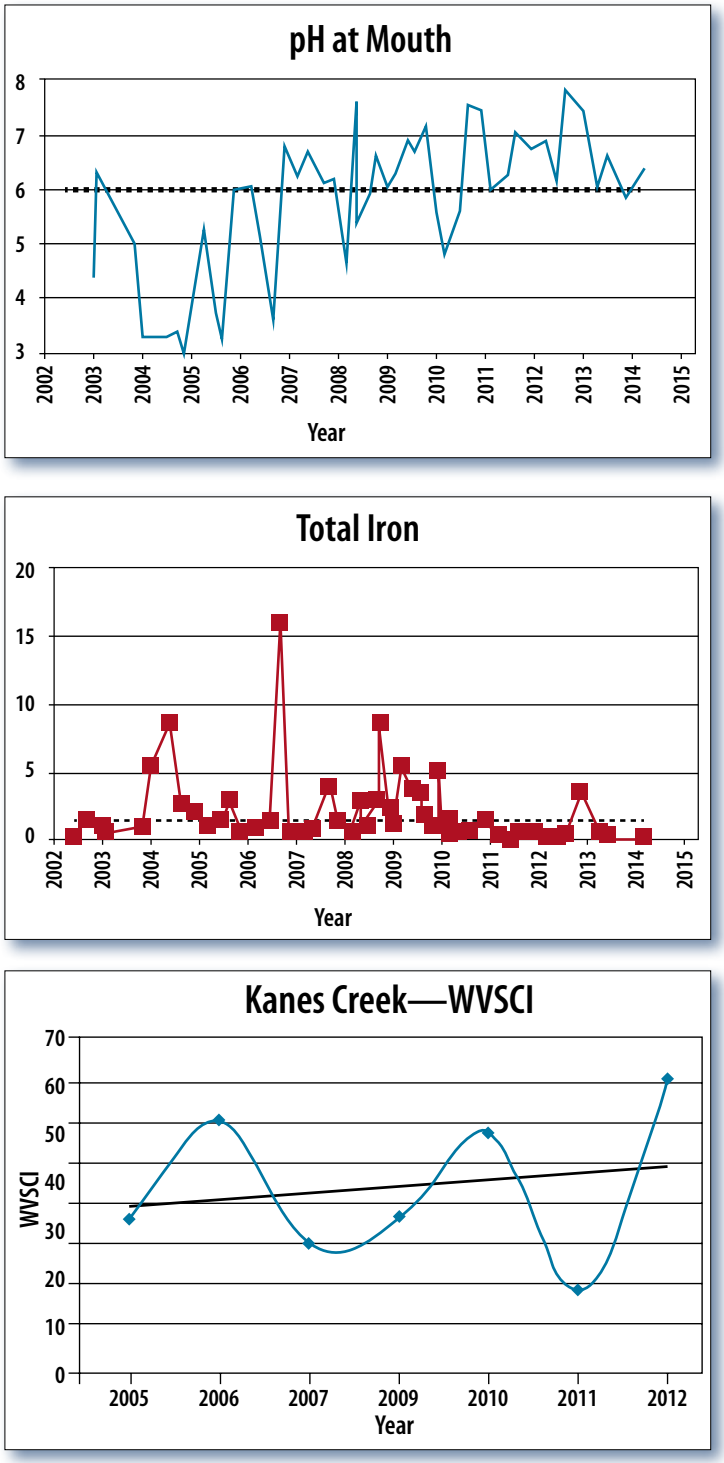


Figure 2. Trends in pH (top), iron (middle) and the WVSCI (bottom) index over time show improvements. Dotted lines in the pH (6) and iron (1.5 mg/L) plots indicate state criteria for those parameters.

## Results

The lowest reach of Kanes Creek has met water quality standards for AMD parameters, including pH and total iron, more than 90 percent of the time since April 2010 (Figure 2). An impoundment 2.5 miles from the mouth had a pH level near 4.0 when Kanes Creek was placed on the CWA section 303(d) list in 1998; since 2010, this site has met pH standards in excess of 6.0 approximately 20 percent of the time.

Recent fish surveys have found creek chub, yellow bullhead catfish and green sunfish in sections of the stream where no fish were found before 2006. Benthic macroinvertebrate sampling yielded six individuals per square meter in 2003. Similar sampling in 2012 yielded 275 organisms per square meter. Total taxa, which is the total number of families, improved 58.8 percent from 2007 to 2012.

The West Virginia Stream Condition Index (WVSCI) is a family-level index for biological integrity for benthics that incorporate six different metrics. WVSCI scores in Kanes Creek have fluctuated over the years but the trend shows an overall improvement. The 2012 scores are only slightly below the threshold for biological impairment.

Lastly, although AMD has a major impact on Kane Creek, other factors such as changes in habitat and hydrologic conditions also have greatly influenced the benthic communities. With additional evaluation of existing water quality data and potentially more sampling, West Virginia hopes for Kanes Creek to be delisted in the near future.

## Partners and Funding

WVDEP conducted its projects with support ($1.8 million) from the U.S. Office of Surface Mining (OSM) and the Natural Resources Conservation Service. FODC conducted its projects with support from CWA section 319 funds ($613,000), OSM's Watershed Cooperative Agreement Program ($463,000) and an EPA Brownfield Assessment Grant ($74,000).

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

EPA 841-F-15-001LL
August 2015

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