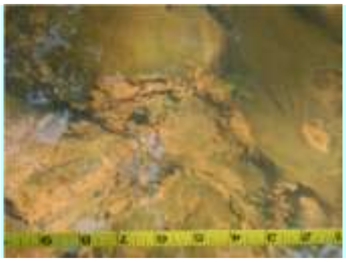
THE STATE OF THE CREEK, 2007

The Clean Creek Program Annual Report

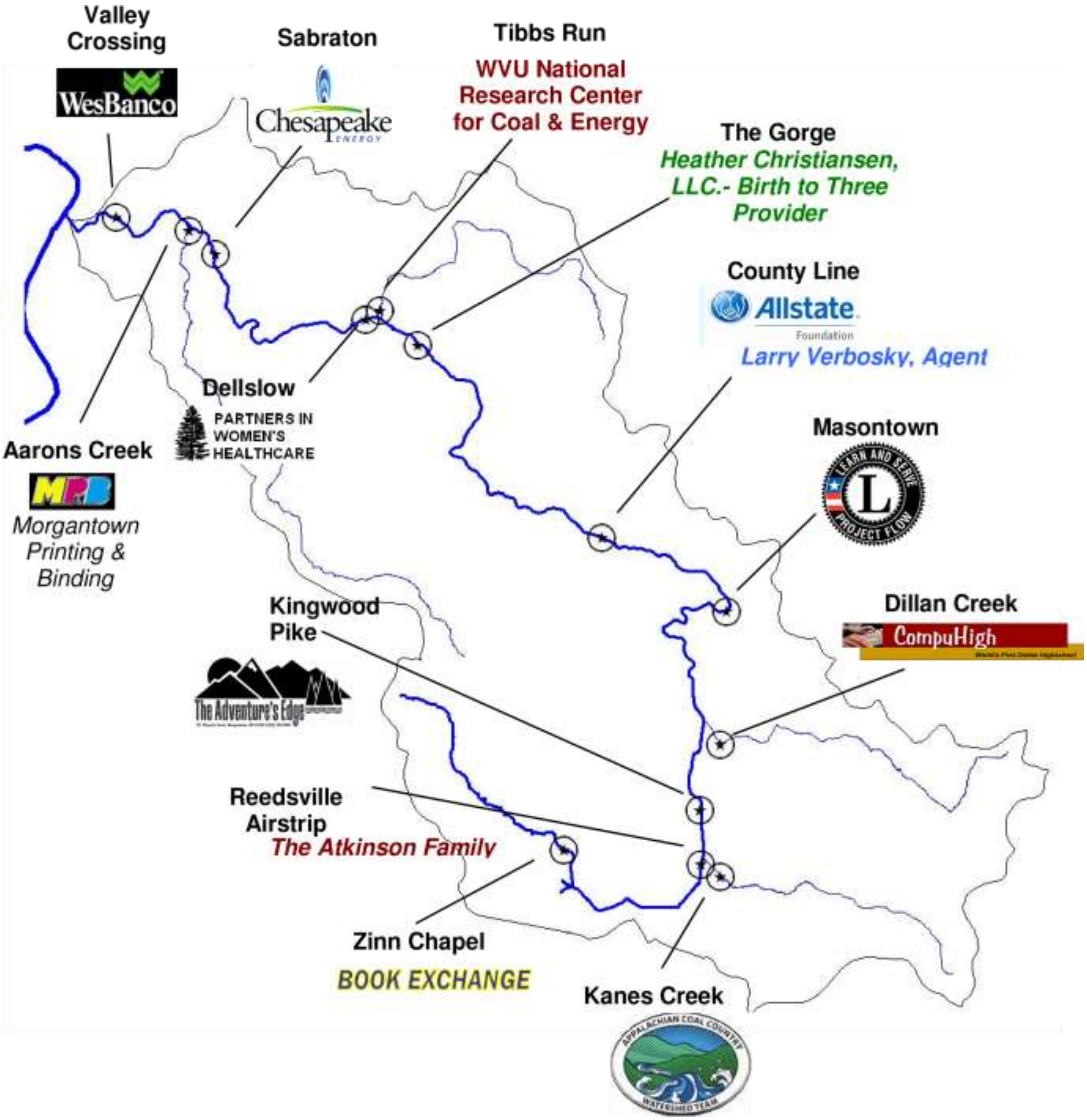


Compiled by

Friends of Deckers Creek

CLEAN CREEK PROGRAM

SAMPLING SITES AND SPONSORS, 2007


Valley Crossing
WesBanco
Sabraton
Chesapeake ENERGY
Tibbs Run
WVU National Research Center for Coal & Energy
The Gorge
Heather Christiansen, LLC.- Birth to Three Provider
County Line
Allstate Foundation
Larry Verbosky, Agent
Dellslow
PARTNERS IN WOMEN'S HEALTHCARE
Aarons Creek
MPB
Morgantown Printing & Binding
Masontown
LEARN AND SERVE
L
PROJECT FLOW
Dillan Creek
CompuHigh
Kingwood Pike
The Adventure's Edge
Reedsville Airstrip
The Atkinson Family
Zinn Chapel
BOOK EXCHANGE
Kanes Creek
APPALACHIAN COAL COUNTRY
WATERSHED TEAM

EXECUTIVE SUMMARY

Friends of Deckers Creek sampled the mainstem of Deckers Creek and four major tributaries quarterly during 2007, the fifth year of the Clean Creek Program. Patterns in water quality matched previous results. Acid mine drainage (AMD) is the most harmful pollution in Deckers Creek. There is a small amount of AMD in the uppermost segment of the creek, but the impact of AMD becomes clear at Kanes Creek, which carries AMD from a large number of abandoned mines. Deckers Creek is impacted by additional AMD between Kanes Creek and Masontown; however, water quality improves in Deckers as it flows through a region with limestone bedrock. Five miles from its mouth, a single abandoned mine, the Richard mine, delivers a large amount of AMD to the creek and severely degrades it for the rest of its length to the Monongahela River.

Although the spatial pattern of damage by AMD remained the same, concentrations of pollution were lower than in previous years. In the first year of the Clean Creek Program, extremely high flows apparently flushed large amounts of AMD from abandoned mines into the upper portion of the watershed. In 2007, however, relatively dry conditions decreased the amount of AMD flowing into the creek. Chemical measurements and fish surveys indicated the potential for rapid recovery, once AMD decreases or is eliminated; however, benthic invertebrate communities indicate a creek still damaged by pollutants.

Several groups have begun projects to eliminate AMD, to protect the creek and its communities as rains return and flows from mined areas increase. These groups work together as the Deckers Creek Restoration Team, which includes Friends of Deckers Creek, several state and federal agencies, local governments, and individuals. The team continues to implement a watershed based plan to address AMD throughout the watershed.

As of September 2008, Friends of Deckers Creek has completed two of several passive AMD remediation projects to be funded by the West Virginia Department of Environmental Protection and the Office of Surface Mining. The Natural Resources Conservation Service (NRCS) has also completed AMD remediation systems near Masontown and Dillan Creek and continues to design additional projects. The NRCS is also leading the effort to eliminate the pollution from the Richard mine, which discharges too much AMD to be treated passively.

Front cover:

Top—Volunteer NaYoung Park takes a break to enjoy the beautiful scenery of the Deckers Creek gorge

Bottom left to right – Algal bloom in Deckers Creek at Valley Crossing, FODC Executive Director Sarah Veselka samples stream benthic macroinvertebrates, a sauger caught during fish sampling in Deckers Creek at Valley Crossing.

ACKNOWLEDGEMENTS

Friends of Deckers Creek relies on the support of foundations, agencies, local businesses, and volunteers.

Ten businesses from the watershed and surrounding areas, one family, and two non-profit organizations supported the 2007 project by sponsoring Clean Creek Program monitoring sites:

Deckers Creek at Valley Crossing	**WesBanco, Monongalia County**
Aarons Creek	**Morgantown Printing & Binding**
Deckers Creek in Sabraton	**Chesapeake Energy**
Deckers Creek in Dellslow	**Partners in Women's Health Care** Tom Harman, Patsy Harman, Jane Koch and Julie Armistead
Tibbs Run	**WVU National Research Center for Coal and Energy**
Deckers Creek Gorge	**Heather Christiansen, LLC** – Birth to Three Provider
Deckers Creek at the County Line	**Allstate Foundation** – Larry Verbosky, Agent
Deckers Creek in Masontown	The West Virginia Commission for National and Community Service - **Future Leaders of Watersheds**
Deckers Creek at the Kingwood Pike	**Adventure's Edge**
Kanes Creek	**The Appalachian Coal Country Watershed Team**
Deckers Creek at the Reedsville Airstrip	**The Atkinson Family**
Dillan Creek	**CompuHigh**
Deckers Creek at Zinn Chapel	**The Book Exchange**

Additional information about these sponsors can be found at www.DeckersCreek.org.

A number of volunteers participated in gathering the data for our 2007 Clean Creek Program. These tasks included quarterly water monitoring, and fish and macroinvertebrate community sampling. We would like thank the following for their assistance with field work for our 2007 Clean Creek Program:

Brett Atkinson, Aldona Bird, Ben Brinkman, Adam Cotchen, Melanie Davis, Rickie Dunlap, Justin Frye, Jered Garrison, Dave Hansen, Walt Hodgkiss, Jeremy Hoffman, Derrick Hoover, Mathew Jordan, Amanda Lachowski, Susan Lambert, Jake Mathes, Lydia McDowell, Eric Merriam, JamesNutaitis, Shane O'berry, Jon Offredo, Nick Ohi, Bryan Olejasz, Jesse Primavera, Eric Rapp, Jen Roberts, Charlie Russell, Elizabeth Russell, Erin Shcultz, Rob Stenger, Thomas Stevens, Corey Stricker, Evan Supak, Lora Tennant, and Walt Veselka.

Dr. George Merovich's Fish Management class at West Virginia University also helped FODC with fish community sampling. The over 20 students collected fish community data from Aarons Creek and Deckers Creek at Valley Crossing and were even kind enough to enter the data and send it along to FODC.

The 2006 State of the Creek report took the form of a brochure describing water quality at the 13 Clean Creek Program sites. Volunteers helping with the 2005 sampling included Jeffrey Atknison, Sarah Bitter, Chris Campbell, Alina Chitac, Seth Davis, Nathan Fazio, Danny Feuillet, Lee Haggerty, Lara Hedrick, Mark Hepner, Heather Hildebrand, Chris Horn, Meghann Kent, Zack Liller, Chad Lykins, Roy Martin, Sarah McClurg, George Merovich, Travis Metcalf, Robert Miller, Megan Mowers, Meredith Pavlick, Linsay Pierce, Ira Poplar-Jeffers, Erin Shultz, Dustin Smith, Garrett Staines, Rob Stenger, Tim Szczypinski, Derek Tettenburn, Christina Venable, Logan Wamsley, Hanna Wheeler, Aaraon Yeager, and Jessica Zamias

Thank you for your help!

The Clean Creek Program was created by Friends of Deckers Creek (FODC). The mission of FODC is to improve the natural qualities of, increase public concern for, and promote the enjoyment of the Deckers Creek Watershed.

For further information about FODC and its Clean Creek Program, or to sponsor a monitoring site, contact

Sarah Veselka or Martin Christ
Executive Director Water Remediation Director sarah@deckerscreek.org martin@deckerscreek.org
(304) 292-3970 (304) 292-3970

Friends of Deckers Creek contact information:

www.DeckersCreek.org
Friends of Deckers Creek P.O.
Box 877
Dellslow, WV 26531

Friends of Deckers Creek Board of Directors:

Evan Hansen, President
Patty Diefenbach, Treasurer
Ella Belling, Secretary

Pam Kasey Garth Lindley Angie Lindley George Merovich Tim Stranko Tom Belden

THE DECKERS CREEK RESTORATION TEAM

These groups meet quarterly to discuss ways to improve the natural qualities of Deckers Creek, especially by eliminating sources of acid mine drainage.
Meetings are open to the public.

Friends of Deckers Creek
Greer Industries
Monongalia Soil Conservation District
Monongalia County Commission
Morgantown City Council
Masontown Town Council
Reedsville Town Council
USDA Natural Resources Conservation Service
USDI Office of Surface Mining
WVDEP Office of Abandoned Mine Lands and Reclamation
WVDEP Division of Water and Waste Management
WVU Division of Forestry
WVU Division of Plant and Soil Sciences
West Virginia Conservation Association

ABBREVIATIONS AND TECHNICAL TERMS

Acidity	The ability of water to maintain low pH levels when basic chemicals are added. Acidity is quantified as the amount of base (measured as milligrams of calcium carbonate) required to raise the pH of a liter of water to a pH of 8.3.
Alkalinity	The ability of water to maintain high pH levels when acidic chemicals are added. Alkalinity is quantified as the amount of acid required to lower the pH of a volume of water to a pH of 4.5. Alkalinity is expressed as milligrams per liter of calcium carbonate.
AMD	Acid mine drainage

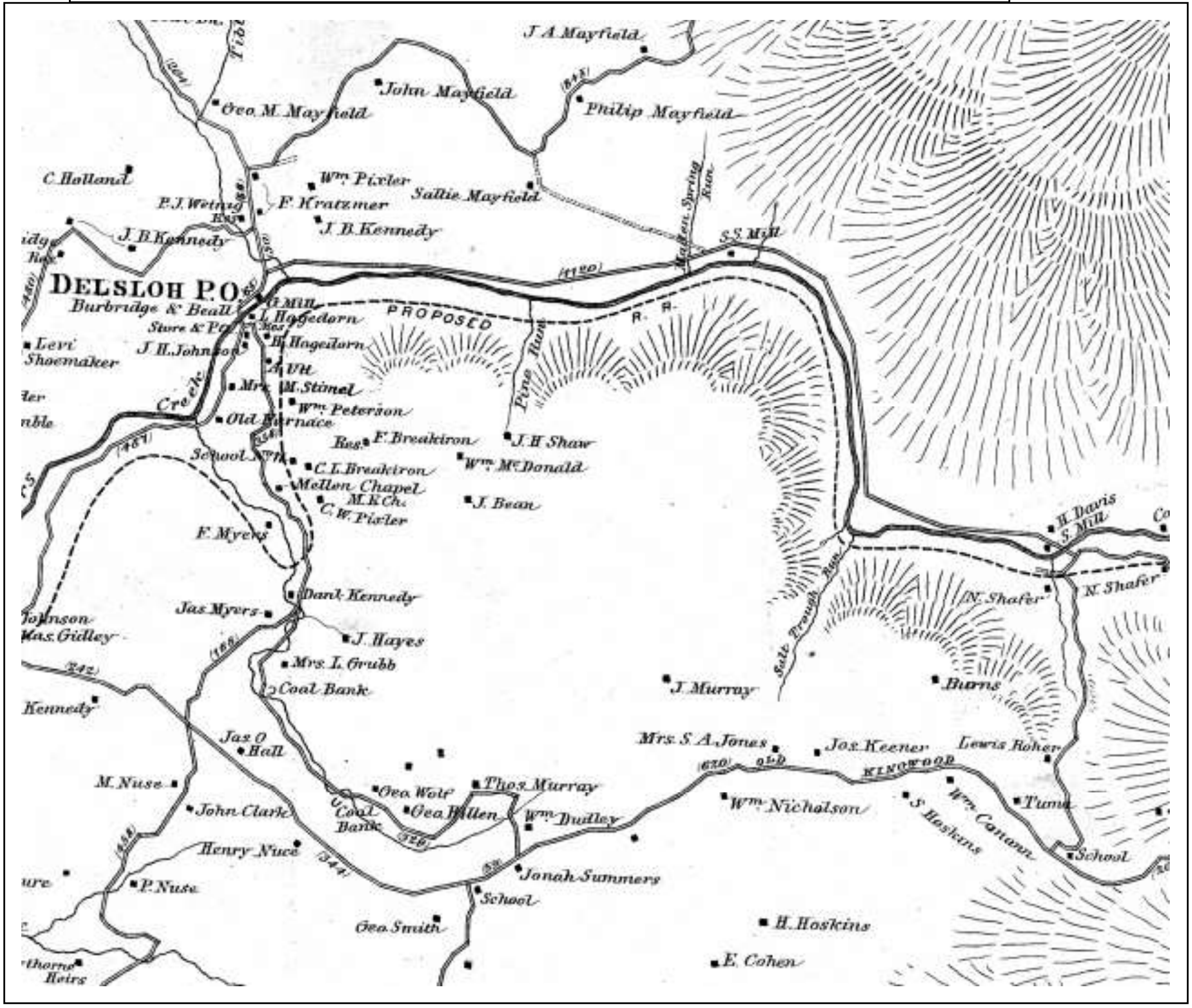
AML	Abandoned mine lands. Areas mined before 1977, not subject to rules outlined under SMCRA.
Anticline	A fold in bedrock with the concave part of the fold facing downwards
Benthic macroinvertebrates	Animals that inhabit stream bottoms that have no backbone and are large enough to be seen with the naked eye. Assemblages of such creatures may be used to judge water quality.
$CaCO_3$	Calcite, the most common mineral in limestone
cfu/100 mL	Colony-forming units per 100 milliliters. A unit for enumerating levels of bacteria, especially fecal coliforms, in water.
DWWM	Division of Water and Waste Management, within WVDEP
EMAP	Environmental Monitoring and Assessment Program
Fecal coliform bacteria	Bacteria that normally live in digestive tracts of animals, including humans. Their presence in high levels in surface water indicates pollution by sewage, farm runoff, or wildlife.
FODC	Friends of Deckers Creek
mg/L	milligrams per liter
Net alkalinity	In samples with any acidity, this value is equal to negative acidity. In samples with no measurable acidity, this value is equal to alkalinity
OAMLR	Office of Abandoned Mine Lands and Reclamation, within WVDEP
OSM	U.S. Department of the Interior Office of Surface Mining, Reclamation and Enforcement
pH	A measure of how acidic water is. Water at pH 7 is neither acidic nor basic. pH levels below 7 indicate that water is acidic.
Pyrite	A mineral with the chemical formula FeS_2 that occurs in coal and that oxidizes in the presence of air and water to form dissolved iron and sulfuric acid. The oxidation of pyrite generates acid mine drainage.
SMCRA	Surface Mining Control and Reclamation Act. Law passed in 1977 regulating coal mines and establishing the Abandoned Mine Land Trust Fund to reclaim abandoned mines.
SOS	Save Our Stream. A method for evaluating water quality using benthic macroinvertebrates that was developed by the Izaak Walton League.
RAPS	Reducing and alkalinity producing system. A form of passive AMD treatment where water is passed through a layer of compost and then through a layer of limestone. Bacteria in the compost consume oxygen and prevent the iron from becoming

	oxidized to the ferric state. Iron in that state will armor limestone with iron hydroxide, and slow down its reaction with acid.
USGS	United States Geological Survey
Water quality standard	A concentration set by West Virginia as a threshold for the designation of impairment. When the concentration of a pollutant exceeds the water quality standard, the water is considered impaired.
WVDEP	West Virginia Department of Environmental Protection
WVSCI	West Virginia Stream Condition Index
WVU	West Virginia University

TABLE OF CONTENTS

Suggested Reference for this Report:

Veselka, S.E., and M. Christ. 2008. The State of the Creek, 2007: The Clean Creek Program Annual Report. Friends of Deckers Creek. Dellslow, West Virginia. January.



Detail of an 1886 map of Morgan District of Monongalia County, showing terrain, roads and landowners between Dellslow and the location of Deckers Creek Limestone mine. Deckers Creek flows from right to left. West Virginia and Regional History Collection, West Virginia University Libraries (Lathrop et al., 1886).

INTRODUCTION

Purpose

This is the final report of the fifth year (January through December, 2007) of Friends of Deckers Creek's Clean Creek Program. This report illustrates the most recent water quality and biological survey results and compares them to earlier data from the Clean Creek Program and other sources.

This report also provides context for these data, including information about the geography and geology of Deckers Creek and its watershed and about the groups that are working to solve its pollution problems.

At the first sight of the steep sections of Deckers Creek, many people assume that this rugged, rocky stream represents the clean, wild whitewater of West Virginia. Unfortunately, that is not the case. Deckers Creek reflects the impact of extraction of natural resources. In particular, coal mining through most of the 20th century has left Deckers Creek with a legacy of acid mine drainage (AMD) that can be read in its turbid waters, its red rocks, and its impoverished insect and fish communities.

About Deckers Creek

Geography

Deckers Creek flows into the Monongahela River at Morgantown, West Virginia (Figure 1). The features of the creek are becoming more well-known through the popular Deckers Creek Rail-Trail, which runs beside the creek.

Deckers Creek, however, is not in a city for its entire 23 miles (Figure 2). It begins on the southeast facing slope of a ridge as a small woodland brook. It sweeps to the north and flows through a long flat valley as a straightened ditch among pastures and fields. It then turns to the northwest and cuts a steep gorge down to Morgantown, plunging over falls and rapids on the way. It also runs strong and fast through Morgantown, but is often constrained by steep walls of either creekcut bedrock or human-built stone.

Its watershed includes most of Valley District in Preston County, including Arthurdale, Reedsville and Masontown, and most of Morgan District in

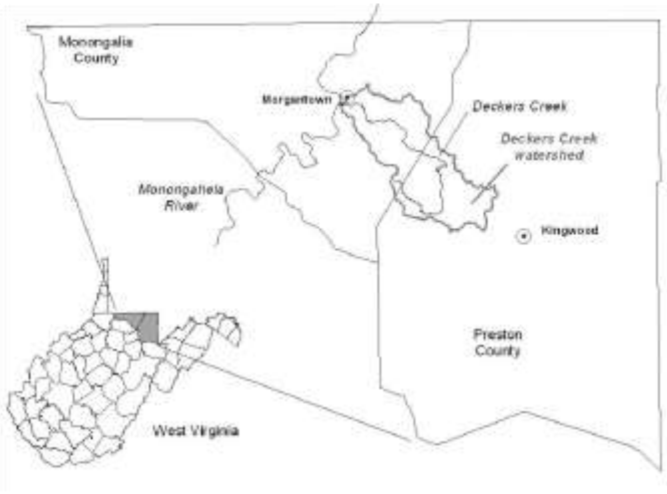


Figure 1: Location of the Deckers Creek watershed.

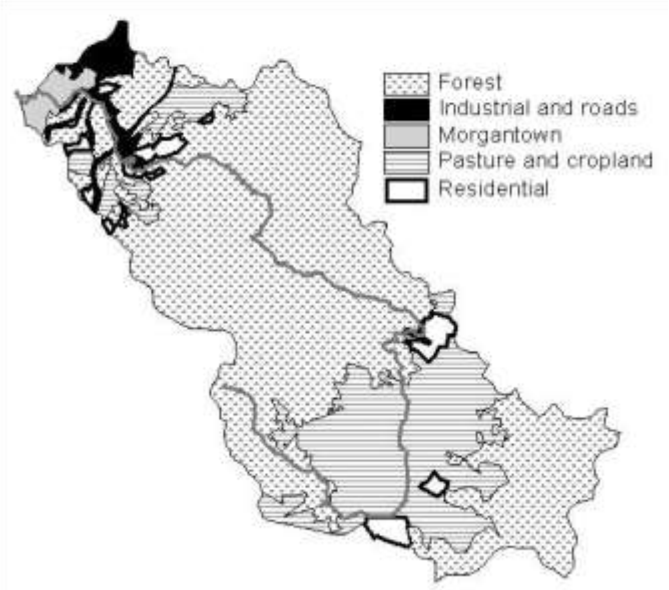


Figure 2: Land-use in the Deckers Creek watershed.

Monongalia County, including the unincorporated areas of Sturgisson, Brookhaven, Dellslow, Richard, Sabraton, and a substantial part of the City of Morgantown.

Geology

An orientation to the geology of Deckers Creek is useful for understanding both its scenic beauty and its challenges. The bedrock layers of the Deckers Creek watershed generally slope down from the southeast to the northwest, but there is one large fold, or anticline, in the rocks (Figure 3). In the center of this fold, older bedrock is pushed up through younger bedrock. The oldest bedrock appears where Deckers Creek has cut a gorge through this fold. Younger bedrock lies on the ridge formed by the fold, and even younger bedrock appears at either end of the gorge. The youngest bedrock is found at the western end of the watershed, on the Mileground in Morgantown.

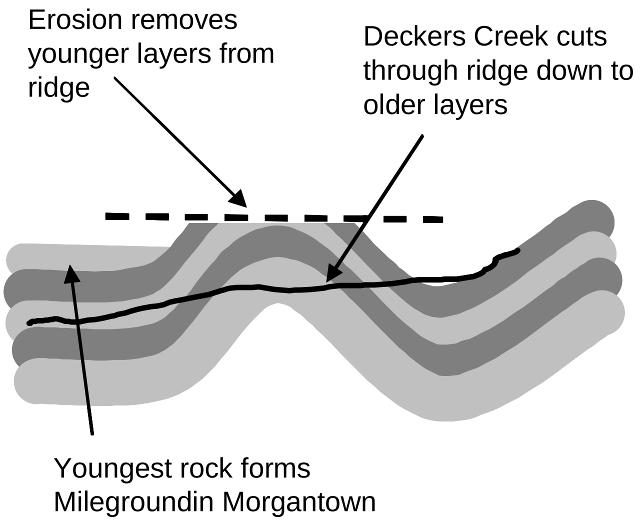


Figure 3: General geological profile of the Deckers Creek watershed (looking towards NNE).

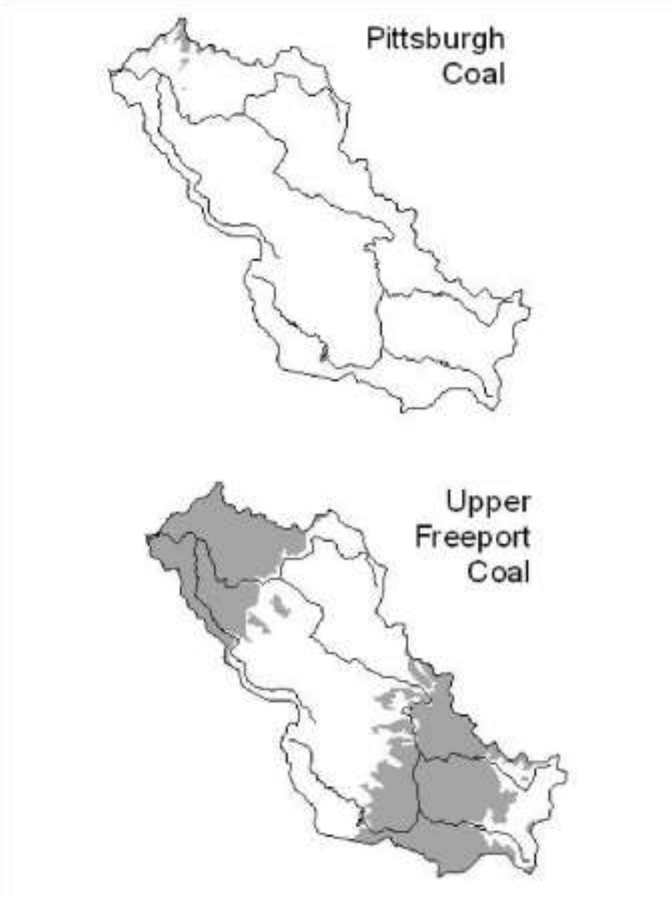


Figure 4: Distribution of major coal seams in the Deckers Creek watershed.

These rocks are important. In the Deckers Creek watershed, the coal seams are in the younger bedrock. The Upper Freeport Coal covers the entire watershed except where the anticline has pushed up into it, and where a few of the major tributaries have eroded it away. The Pittsburgh seam occurs only near Morgantown (Figure 4). The oldest rock with substantial exposure is the Greenbrier Limestone, which is found and mined where the creek cuts through the center of the anticline at Greer. The Bakerstown Coal is found between the Upper Freeport and Pittsburgh seams, but a map of its extent has not been compiled.

The coal and pyrite, a mineral in the coal, are responsible for the most devastating pollution in Deckers Creek: acid mine drainage (AMD). Mining coal exposes pyrite to oxygen and water. Pyrite consists of iron and sulfur. Oxygen reacts with the sulfur to form sulfuric acid, and also reacts with the iron to form iron hydroxide, or yellowboy, releasing additional acidity. AMD is destructive because of both the acidity (Box 1) and the dissolved metals in solution. The many forms of solid and dissolved metals and acidity make the task of solving AMD problems complicated (Box 2).

Past water quality information

A number of long-time residents have stories about anglers catching trout from Deckers Creek. Many more people, however, remember Deckers Creek being much more polluted than it is today. Although there is little historic data with which to construct a complete picture of the history of the creek, the more recent data confirm that the creek has improved.

With regard to sewage, the creek improved drastically after the construction of a sewer main along the creek. There has also been improvement with regard to AMD. A WVU Master's thesis (Henson, 1950) records pH values close to 4 at several sites as high up in the watershed as Masontown. Such low values indicate severe impact from AMD and make the creek uninhabitable for fish. Another student performed a similar investigation of Deckers Creek approximately 25 years later (Teti, 1975). Jason Stewart conducted a third study in 1999 and 2000 and compared it with earlier results (Stewart, 2001). The trajectories illustrate general improvement in the pH levels of the creek, although low pH values continue to occur in many locations (Figure 5).

Long-term water-quality changes stem from the changes in coal mining in north-central West Virginia. Mining in the Upper Freeport seam, which contributes the most acidity to Deckers Creek, has become rare because permits for mining this high-sulfur seam are difficult to obtain. In addition, the high sulfur level in the coal lowers the quality and the profitability of the coal by causing higher pollution control costs to those who burn it.

Shorter-term trends in water quality may reflect reclamation projects, mine management and weather patterns. The Office of Abandoned Mine Lands and Reclamation (OAMLR) within the West Virginia Department of Environmental Protection (WVDEP) has conducted reclamation on several sites, including Upper Deckers Creek Impoundment #5, Kanes Creek South, Elkins Coal and Coke, Dillan Creek, Tibbs Run Portals, Masontown Refuse and many others. AMD still flows from many of these sites, especially from the portals of deep mines. Nevertheless, isolation of acid-forming materials from water percolating through the soil may have eliminated substantial AMD loads to the creek. OAMLR has also added limestone fines to the creek in a number of locations to determine whether the water in the upper part of the gorge could

Box 1: Water and acid.

Water, H_2O, naturally splits up to form two ions, which are pieces with opposite electrical charges. H^+ has a positive charge and OH^- has a negative charge:

$$H_2O \qquad\qquad H^+ + OH^-$$

In a solution that is neither acidic nor basic, the numbers of H^+ and OH^- are equal. Such a solution would have a pH value of 7. In an acidic solution, the H^+ ions far outnumber the OH^- ions. pH values for these solutions are lower than 7. A solution at a pH of 4 has one million H^+ ions for every OH^- ion. The imbalance is greater at lower pH values.

As the pH in a solution changes, many of the chemical reactions that take place in it change as well. Materials that are solid at one pH may dissolve at another. Other materials may be dissolved in water at one pH, and bubble out of solution as a gas at other pH values. Fish in water and cells inside organisms exist in solutions, and changes in pH affect them. A change in pH may cause toxic chemicals to dissolve into a solution, or lifesustaining chemicals to become unavailable. Such changes may also slow down or stop many of the chemical reactions that are part of living, growing and reproducing.

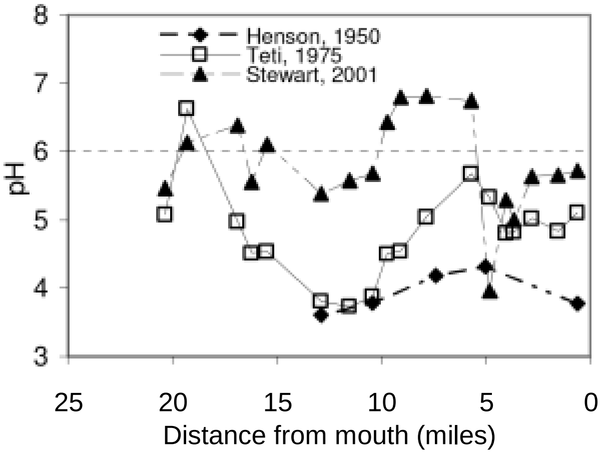


Figure 5: Comparison of pH profiles along Deckers Creek at roughly quarter-century intervals. See the "Sampling sites" section to relate distance from mouth to well-known landmarks.

be kept neutral and habitable by fish. Changes in water levels prevented before-and-after measurements from showing the effects of these efforts precisely. In no case is there a consistent regime of measurements that proves or disproves the efficacy of any particular measure. This lack of consistent monitoring at regular intervals is an important motivation for FODC's Clean Creek Program. Further, additional AMD remediation projects completed in 2007 by the Natural Resources Conservation Service (NRCS) and FODC may improve water quality even more (see Plans for Remediation below).

Box 2: The chemistry of acid mine drainage.

In the first step of AMD production, the sulfur in pyrite is oxidized to form iron sulfate and sulfuric acid.

$$FeS_2 + (7/2)\ O_2 + H_2O = FeSO_4 + 2H^+ + SO_4^{2-}$$

Both the iron sulfate and the acid are soluble, and both add acidity to the solution. To understand how the iron sulfate makes acid, it is important to understand the forms that acidity takes. The first form is the excess of H^+ ions. H_2SO_4 makes acidity by dividing into H^+ and SO_4^{2-}. The second form is dissolved metals, especially aluminum and iron, which contribute H^+ to solution as they become insoluble:

$$Al^{3+} + 3H_2O \qquad Al(OH)_3 + 3H^+ \text{ and}$$
$$Fe^{3+} + 3H_2O \qquad Fe(OH)_3 + 3H^+$$

where Al^{3+} and Fe^{3+} are dissolved forms of aluminum and iron, respectively, and $Al(OH)_3$ and $Fe(OH)_3$ are solids that precipitate out of solution. Therefore, in a solution with a pH value of 4 and a high concentration of aluminum, adding OH^- to fix the million-fold imbalance will not completely eliminate the acidity, because some of the neutralized acidity will be immediately replaced by the dissolved aluminum.

AMD often contains yet more acidity in a different form of dissolved iron, and in dissolved manganese. Ferrous iron (Fe^{2+}) does not immediately release H^+ into solution in the same way as ferric iron (Fe^{3+}). But in the presence of oxygen, it will turn into ferric iron, and release H^+.

$$Fe^{2+} + ¼O_2 + 2.5H_2O \qquad Fe(OH)_3 + 2H^+$$

Manganese undergoes similar reactions as it changes from Mn^{2+} to Mn^{4+} and then to $Mn(OH)_4$.

Deckers Creek benefits from several mining or former mining operations that carefully treat mine runoff. International Coal Group treats acid water in two large mines by adding quicklime and then allowing the water to run through several settling ponds before releasing it to Kanes Creek. CoalTrain Corporation has used alkaline shale from a bedrock layer adjacent to the Bakerstown coal seam to treat runoff. Decondor Coal Company treats mine drainage with anhydrous ammonia before discharging it.

In some cases, the chemistry data do not align with human observations. For example, a graph of pH values taken at the United States Geological Survey (USGS) gauging station at the base of Kingwood Street in Morgantown indicates that Deckers Creek is no longer acidic in the Morgantown area (Figure 6). Nevertheless, anyone driving through Sabraton or past Marilla Park can see that the creek is still polluted and stained orange/red from iron deposits in Morgantown.

This report also provides information on fish and benthic macroinvertebrate communities in the creek and its tributaries. Communities of benthic macroinvertebrates can be used to assess water quality in streams. Like the chemical measurements, these communities indicate that streams in the Deckers Creek watershed have improved since the Clean Creek Program began, but remain impaired.

About Friends of Deckers Creek

Deckers Creek has long attracted groups who have wanted to improve the environment and benefit the human communities nearby. Residents in Richard and Dellslow celebrated annual "Deckers Creek Valley Days" from 1968 to 1979. A clean-up in 1993, before FODC started, was coordinated by the Monongalia

Friends Meeting, the Unitarian Fellowship, the Baha'i Community, Sigma Gamma Epsilon, National Small Flows Clearinghouse, National Drinking Water Clearinghouse, Monongahela Chapter of the Sierra Club, and Morgantown's Board of Parks and Recreation (BOPARC).

FODC was started in 1995 by outdoor enthusiasts, especially rock climbers and kayakers. People from these groups agreed that Deckers Creek was worth restoring, and that it would only happen through grassroots efforts. The mission of the Friends of Deckers Creek is to improve the natural qualities of, increase public concern for, and promote the enjoyment of the Deckers Creek Watershed.

Friends of Deckers Creek carries out its mission through a wide variety of activities (Box 3).

About the Clean Creek Program

FODC identified water-quality monitoring in the creek as one of its core goals. Dependable water quality data allow FODC and its partners to target the most important sites for remediation, and to track improvements over time. There is a lack of long-term data measured with consistent methods in the same places. FODC therefore developed a program in which local businesses can collaborate on long-term monitoring. The key features of the program include:

- *Monitoring water chemistry at 13 sites quarterly*
- *Monitoring fish and benthic macroinvertebrate communities once a year*
- *Inviting businesses to sponsor monitoring sites*
- *Presenting results to watershed residents and community leaders*
- *Involving volunteers*
- *Publishing annual "State of the Creek" reports*

The desire to improve Deckers Creek is widespread among Morgantown area and Valley District residents. All those who wish to work on the creek should have clear information about the conditions of the creek at all its locations and in all its seasons.

Those wishing to sponsor a sampling site in the Clean Creek Program should contact FODC using the information on Page iii.

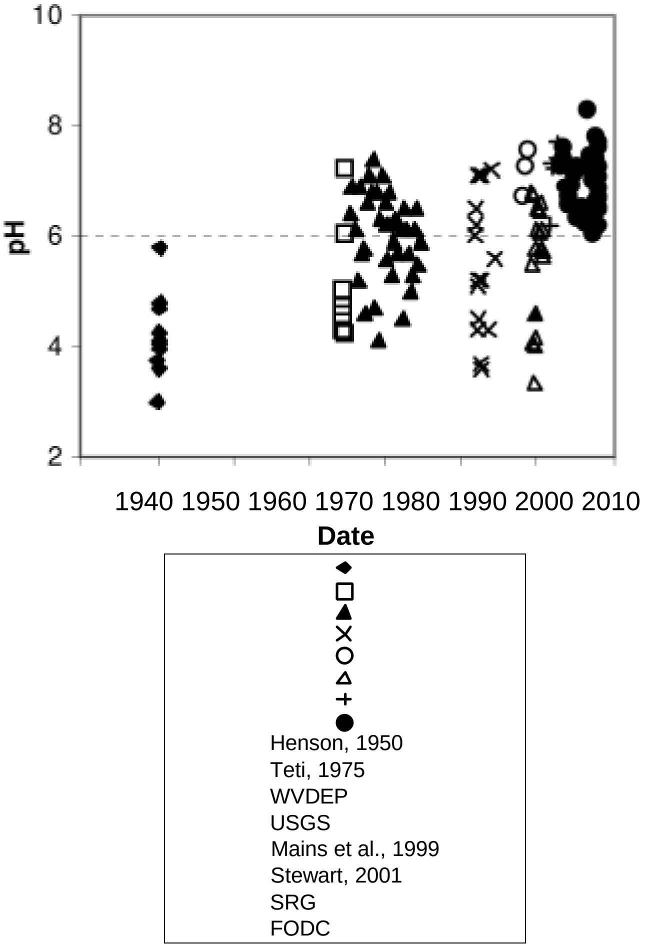


Figure 6: pH readings in Deckers Creek near the Valley Crossing site. The dashed line at a pH value of 6 is the minimum pH of unimpaired waters, according to WVDEP.

Box 3: Activities of Friends of Deckers Creek

Improving natural qualities:

- Coordinating state and federal efforts to clean up Deckers Creek, its tributaries and wetlands
- Raising funds for building and maintaining remediation projects
- Picking up litter
- Monitoring to identify pollution problems
- Devising solutions

Increasing public concern:

- Leading a campaign to address stormwater pollution in the watershed
- Publishing reports and newsletters
- Maintaining a website
- Making public presentations
- Hands-on watershed education initiatives for over 200 local youth
- Communicating with community leaders about Deckers Creek's potential and its problems
- Holding outreach meetings across the watershed

Promoting enjoyment:

- Deckers Creek Adventure Day! An annual adventure race and community festival celebrating Deckers Creek and the people working to improve it.
- Supporting rail-trail events, such as the Deckers Creek Half Marathon

Box 4: Internet resource for the Deckers Creek watershed.

FODC's website contains information about clean-ups and meetings, PDF files of many of our reports, and links to additional watershed information: **www.DeckersCreek.org**

USGS reports height and stream flow measured at the bottom of Kingwood Street in Morgantown: **waterdata.usgs.gov/nwis/nwisman/?site_no=03062500**

EPA allows you to find information on watersheds, such as that of the upper Monongahela River: **cfpub.epa.gov/surf/huc.cfm?huc_code=05020003**

The Monongahela River Trails Conservancy has information on the Deckers Creek and Caperton Trails: **www.MonTrails.org**

Arthurdale Heritage maintains a site about the first New Deal community. It is in the Deckers Creek watershed: **www.ArthurdaleHeritage.org**

Digital images of USGS topo maps are available from WVDEP. The Deckers Creek watershed is on the Kingwood, Lake Lynn, Masontown, Morgantown North, Morgantown South, Newburg and Valley Point quadrangles: **gis.wvdep.org/data/drgs.php**

Color-infrared aerial photos for the same quadrangles are also available from WVDEP: **gis.wvdep.org/data/doqq.php**

The inventory of abandoned mine lands can be found through an interactive server at OSM. The system does not have the resolution to query sites for the Deckers Creek watershed, but a query of Monongalia and Preston Counties is informative: **ismhdqa02.osmre.gov/OSM.HTM**

Water pollution discharge permits can be searched by USGS quad, county, permit number or permittee: **www.wvdep.org/WebApp/_dep/search/Permits/OWR/OWRPmtsearchpage.cfm?office=OWR**

There are also search tools for coal mining permits: **www.wvdep.org/WebApp/_dep/search/Permits/Omr/Permitsearchpage.cfm?office=OMR**

The TMDL document for the Upper Monongahela, watershed outlines pollutant reductions needed in Deckers Creek: **www.wvdep.org/alt.cfm?asid=46**

WVDEP lists impaired waters, including several in the Deckers Creek watershed: **www.wvdep.org/item.cfm?ssid=11&ss1id=720**

Jason Stewart and Jeff Skousen published a peerreviewed article on long-term changes in Deckers Creek: **www.wvu.edu/~agexten/landrec/decker25.pdf**

Sampling sites

The 13 Clean Creek Program sites were chosen according to several criteria. The sites document the changes in the creek up- and downstream from sources with major effects on the water quality. For example, a comparison of the results from Dellslow and Sabraton illustrate the effect of the Richard mine. Second, sites where people encounter the creek, especially on the Deckers Creek Rail-Trail, were given higher priority. Finally, major tributary sites were chosen based on their potential for holding fish at times when water quality drops in the mainstem, as well as for their effects on the mainstem. Because creeks are not often enjoyed or explored during winter, photos in this addition of our State of the Creek report highlight our CCP monitoring sites during the snowy and icy months.

Deckers Creek at Valley Crossing (Photo 1). This site is representative of the lower reaches of Deckers Creek, where its waters are not far from the Monongahela River. Users of the Deckers Creek RailTrail frequently mention seeing large fish in this segment of the creek. A USGS gauging station at this site records water height and posts it to the Web at half-hour intervals (Box 4). When it rains, a combined sewer overflow discharges to Deckers Creek in this stretch, and provides a demonstration of bacterial sources in the creek's lowest three miles.

Aarons Creek at the mouth (Photo 2): Aarons Creek generally has water with low pollutant concentrations, and benthic macroinvertebrate and fish communities indicating good water quality. There is some evidence of sediment problems at this site, however. Streambed pebbles and cobbles are embedded in silt and sand, eliminating interstitial spaces for invertebrate communities. Poorly controlled construction practices or collapsing banks upstream are adding the silt and sand to Aarons Creek. This site is an index of the care with which the land along the northern part of Greenbag Road is being developed.

Deckers Creek in Sabraton (Photo 3): This site is a long reach of the creek degraded by the abandoned Richard mine. This site is often red, sometimes green, and almost always turbid. Metals coming out of a dissolved form and turning into solid particles account

Photo 1: Deckers Creek at Valley Crossing. Photo taken from just below the Deckers Creek Rail-Trail.

Photo 2: Aarons Creek next to Greenbag Road looking downstream toward the confluence with Deckers Creek.

Photo 3: Deckers Creek in Sabraton, just upstream from the Deckers Creek Rail-Trail Bridge. Ice backed up here in February 2007.

Photo 4: Deckers Creek just above the Dellslow Bridge. This area below the steep terrain of the gorge but above the Richard mine holds the richest fish community in the mainstem, including a good number of large smallmouth bass and a few sauger.

Photo 5: Tibbs Run just downstream from the lower bridge on Tyrone Road.

Photo 6: A large boulder in the gorge section of Deckers Creek.

Photo 7: Deckers Creek at the County Line as it flows out of Preston and into Monongalia County.

Photo 8: Volunteer Rob Stenger tries to break up the ice to measure flow in Deckers Creek in Masontown.

for much of this turbidity. The stream bottom of this section of Deckers Creek is covered with iron armoring and algae. FODC hopes that people crossing the creek on the Deckers Creek Rail-Trail at this site will witness improvement in the creek rapidly, once the Richard mine discharge is treated.

Deckers Creek at the Dellslow Bridge (Photo 4): This site is usually one of the best sites for fish in the watershed. The creek at this point is large enough to hold a productive community of sizable fish. It is cool and aerated after passing through the long, steep, rocky gorge. Its water is also well buffered after passing an area with limestone bedrock, limestone mines, and no AMD. Large boulders and exposed bedrock make pools and riffles, providing important habitat structure for fish.

Tibbs Run at the crossing of Tyrone Road (Photo 5): Tibbs Run flows into Deckers Creek just upstream from Dellslow. It is one of the four largest tributaries of Deckers, but it is also important as a possible fish refuge when occasional surges of acidic water come down Deckers Creek past Pioneer Rocks. It is not a spacious refuge, however. It is steep and rocky, and there are a number of small falls in its first quarter mile. It sometimes carries large loads of bacteria from residential areas and its rocks are very slippery from algae.

The Deckers Creek Gorge (Photo 6): This site was chosen as the hallmark site of Deckers Creek at its wildest. The segment is of special interest to anglers because it physically resembles a trout stream, even though the creek gets too warm in the summer to sustain reproducing trout populations. The gorge section has a gradient of 200 feet in 0.7 mile. The creek itself winds past and pours over car- to house-sized boulders and bedrock ledges. Extreme kayakers know this section of Deckers as the steepest boatable creek on the east coast.

Deckers Creek at the Monongalia/Preston County Line (Photo 7): This site shares many of the physical characteristics of the gorge site. However, it differs in water quality as the creek has not yet passed the Greer limestone mines. This area is thus more likely to experience episodes of acidic or metal-laden water. The streambed is dominated by softball- to car-sized rocks rather than the larger boulders in the lower gorge and the gradient is not as steep. The habitat here is however promising for a productive fishery.

Deckers Creek at Masontown (Photo 8): This segment is at the downstream end of a calm, three-mile wooded segment. It is also located near a parking area for the Deckers Creek Rail-Trail. The field at this site is a large reclaimed area. A layer of coal spoil is visible where Deckers Creek has eroded the bank over the last few years. Sediment in the water just upstream from Masontown makes a reddish cloudiness when disturbed, suggesting decades of metal deposition. In Masontown, the slope and current of Deckers Creek pick up, and gravel and pebbles cover the streambed.

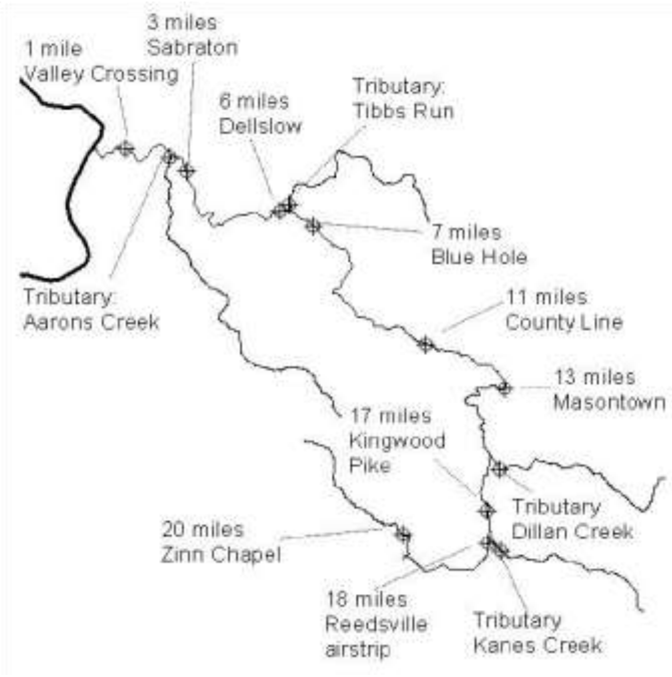


Figure 7: Deckers Creek and major tributaries with distance to mouth noted for monitoring locations. Distances are used in x-axis of many of the following water quality graphs.

Dillan Creek at Burke Road (Photo 9): Dillan Creek is a large tributary with severe AMD in its upper reaches. Its acidity is neutralized, however, before it reaches Deckers Creek. We monitor in a channelized section next to Burke Road. Dillan Creek may also be impacted by excessive nutrient loads as this section is overwhelmed with severe algal blooms in the summer.

Deckers Creek at Kingwood Pike (Photo 10): This site represents the channelized, low-gradient portions of Deckers Creek after it has received input from Kanes Creek. The streambed there is mostly sandy, but there is usually soft mud at the edge of the stream. There is also a large amount of submerged aquatic vegetation at this site.

Kanes Creek at Route 92 (Photo 11): The Kanes Creek watershed contains a large number of AMD sources. It is the watershed with the most remediation targets in the Deckers Creek watershed. This stream extends the Deckers Creek watershed to within about three miles of Kingwood. The ridges where it rises also hold the origins of Greens Run and Morgan Run of the Cheat River, and Squires Creek of Threeforks Creek, all of which are polluted by AMD.

Deckers Creek at the airstrip (Photo): Although it is marked on the USGS 7.5 minute topographical map, there is no airstrip at this site now. The stream at this site is physically similar to Deckers Creek at Kingwood Pike. It is channelized and has a sandy/silty bottom. Water quality is usually better at this site than at the Kingwood Pike because it is upstream from Kanes Creek, a source of AMD. Much like the Kingwood Pike site, this section of Deckers supports a large amount of aquatic vegetation.

Deckers Creek near Zinn Chapel (Photo): This site represents the headwaters of Deckers Creek and its tributaries, which rise on sandstone ridges and carry water from soils with little buffering capacity for either AMD or acid rain. The water in this stream indicates mild acidification. There is one abandoned mine land site upstream where drainage has been documented. The streambed here is comprised of bedrock, cobble, and sand with riffle/pool complexes and banks filled with rhododendron.

In many of the graphs that follow, the mainstem sites have been arranged according to distance from the mouth of Deckers Creek (Figure 7). Graphs show the change in the water quality from the highest elevation site, Deckers near Zinn Chapel (20 miles from the mouth), to Valley Crossing (one mile from the mouth).

Sampling periods

This report summarizes the Clean Creek Program dataset according to calendar years. In 2007, our physical and chemical sampling occurred in February, May, August, and November. We sampled macroinvertebrates in early June and fish communities in September.

Photo 9: Volunteer Lora Tenant measures flow in Dillan Creek, just downstream from Burke Road.

Photo 10: Sarah Veselka samples water chemistry in Deckers Creek at the Kingwood Pike.

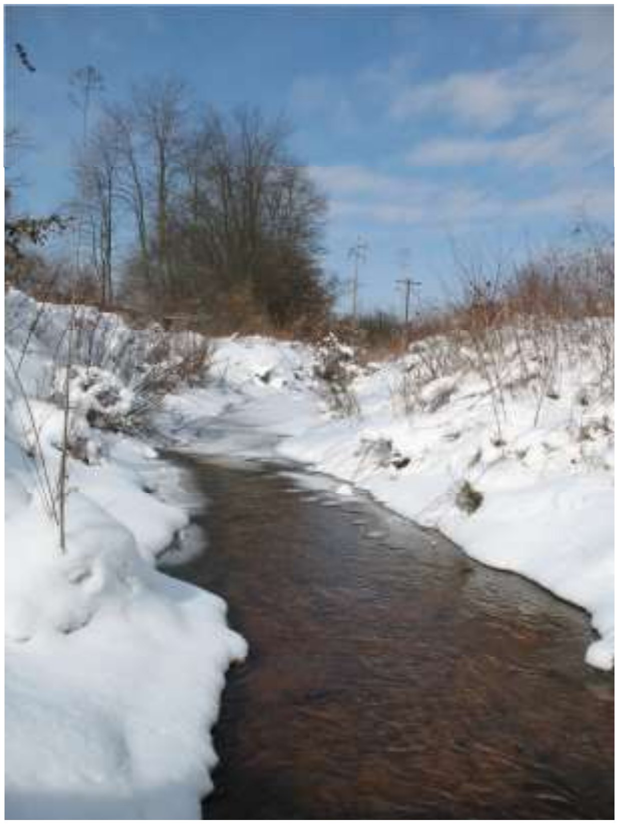


Photo 11: Kanes Creek just downstream from Route 92.

Photo 13: Deckers Creek near the old Reedsville airstrip.

Photo 14: Deckers Creek near Zinn Chapel Rd.

Specific methods

Quarterly physical and chemical sampling at the 13 sites included the measurements in Box 5.

FODC obtained a scientific collecting permit from the West Virginia Division of Natural Resources for benthic macroinvertebrate and fish community surveys. We sampled benthic invertebrates using two different methods. For the Save Our Streams (SOS) method, one person held a sampling net approximately one-square-yard in size perpendicular to the flow with one edge against the stream bottom and the opposite edge above the surface of the water. Another person rubbed larger rocks and kicked through smaller sediments in an approximately one-square-yard area upstream of the net. We then used forceps to find benthic macroinvertebrates and transfer them from the net to a preservative until approximately 200 organisms were found. We also used a modified EPA EMAP (Environmental Monitoring and Assessment Program) protocol to collect benthic macroinvertebrates. A square kick net was used to collect benthic macroinvertebrates in one square meter area in targeted riffles. Three kick net samples were collected and the entire sample was stored in alcohol. Rose Bengal, a dye used to help facilitate the sorting process, was then added to the sample. All benthic macroinvertebrates collected during the 2007 CCP were identified to order and Ephemeroptera, Plecoptera, and Tricoptera orders were identified to family. Both the WV Stream Condition Index (WVSCI) and SOS scores were calculated from the numbers and kinds of organisms found using spreadsheets provided by the WVDEP (WVDEP, 2005).

Fish communities were surveyed using a backpack electrofisher in a stream reach approximately 100 meters long. This device sends pulses of AC electrical current through the water. The pulses stun the fish, allowing them to be easily netted. Once they are collected, all fish are anesthetized using clove oil, identified, weighed, measured, and returned to their approximate point of capture in the stream. We also measured wetted width every 20 meters in the stream reach sampled. Stream area for fish surveys was calculated by multiplying the reach length by the average wetted width. Stream areas surveyed ranged from 342 to 1,343 meters squared in 2007.

Box 5: Field and laboratory methods used in the Clean Creek Program.

Field measurements

pH: Field pH was measured with a handheld pH meter with a glass combination electrode.

Conductivity: Field measurements of specific conductance were made with a handheld conductivity meter (Oakton Con 100).

Dissolved oxygen (DO): DO was measured using a Hach Sension 6 portable oxygen meter.

Flow: Measurements of flow were taken at 10 to 15 locations along a stream transect. At each location, water velocity was measured with a Marsh-McBirney flow meter.

Laboratory analyses

Total iron, aluminum and manganese: These metals were measured by atomic absorption spectrophotometry.

Alkalinity: Alkalinity was measured by adding acid (titrating) until the solution reached a certain, slightly acidic, endpoint.

Hot acidity: For samples starting with pH less than 4.9, iron and manganese were oxidized using hydrogen peroxide. The samples were then titrated with a base to determine how much alkalinity was present. In samples starting with pH values greater than 4.9, alkalinity was measured before the oxidation step, and the final acidity value was corrected for the initial alkalinity.

Sulfate: The water sample was mixed with chemicals that make sulfate come out of solution as a fine powder. Sulfate concentration was measured as the turbidity of that powder.

Fecal coliform bacteria: Bacteria were enumerated by diluting the sample many times, and determining which dilutions still contained enough bacteria to establish new colonies in new media.

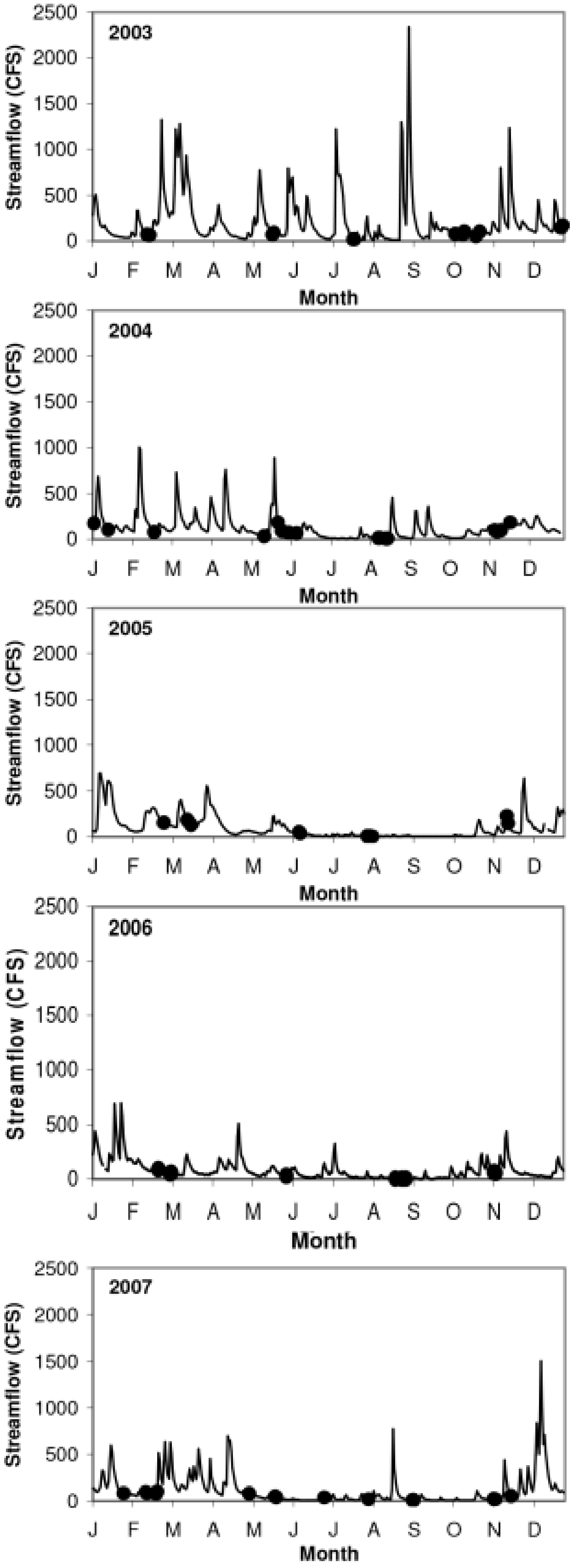


Figure 8: Daily flow for Deckers Creek measured near Valley Crossing. Black circles indicate flows at that site when sampling took place.

RESULTS

Hydrology

To understand the water quality in the creek, one must understand how much water is going by. Measurements of flow in conjunction with measurements of pollutant concentrations are necessary for calculating the amount of a pollutant passing a particular point in the stream during a period of time. This amount is known as the pollutant load. Pollutant loads are obtained by multiplying the concentration of a pollutant (usually measured in milligrams per liter) by the water flow (usually measured in gallons per minute, which can be converted to liters per second). If a pollution source contributes a load to a receiving stream that is similar to the load downstream, then eliminating that one source may solve the pollution problems in the receiving stream.

Flow measurements are made with most of the observations for the Clean Creek Program. These measurements require wading across the creek and making 10 to 15 water velocity measurements. At peak flows, this task becomes difficult or dangerous.

The USGS maintains a stream-height gauge on Deckers Creek at the bottom of Kingwood Street in Morgantown, near the Valley Crossing site. This gauge records stream height every half hour, and electronically conveys the value to USGS, which publishes it on their web site. Figure 8 compares streamflow during the five Clean Creek Program years. The y-axis represents the average flow measured at Valley Crossing on that day. CCP sampling occurred mostly at relatively low flows due to creek access concerns during high flows. Because some pollutants reach their highest concentrations when it rains, our load measurements may be biased.

The hydrological data can be used to understand longer term changes in streamflow. 2003 had extremely high streamflows. The transition from low to high flows probably affected water quality in Deckers and in other creeks. From 2004 - 2007 Deckers Creek had average flows closer to the longterm average.

Temperature

Water temperature is an extremely important measurement. It helps determine what fish communities might inhabit a stream if it were not polluted. Reproducing native trout populations, for example, are seldom found in waters where the temperature climbs above 18.3°C or 65°F (PFBC, 2006).

At various times FODC placed temperature loggers at Masontown at the top of the gorge, in Dellslow at the bottom, and at a place in the middle of the gorge. In every year and at all sites, temperatures exceeded 20ºC during the summer. During the warmer months, temperatures in Dellslow were slightly lower than those in Masontown (Figure 9).

Water quality in the mainstem

Chemical measurements confirm that AMD harms the life of the creek. Its signature, however, is complex. AMD has different effects on the water quality in Deckers Creek in different segments and at different times.

On average, Deckers Creek has a pH close to or greater than 6 through most of its length (Figure 10). At certain times, however, readings fall below 6. In the Clean Creek Program dataset, seven of the nine sampling sites on the mainstem have had at least one pH value below 6. These values indicate that the water during that time period is becoming too acidic to support rich aquatic life.

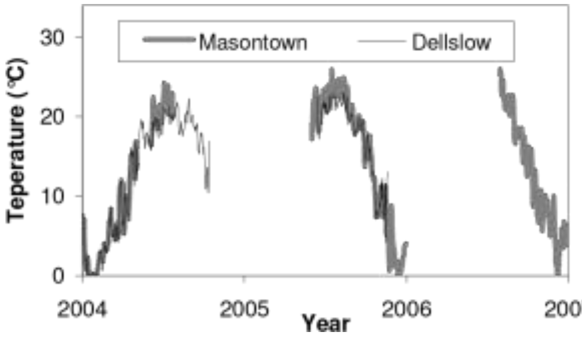


Figure 9: Temperature in Deckers Creek at the top (Masontown) and bottom (Dellslow) of the gorge. 2007 data for the Dellslow site are not available.

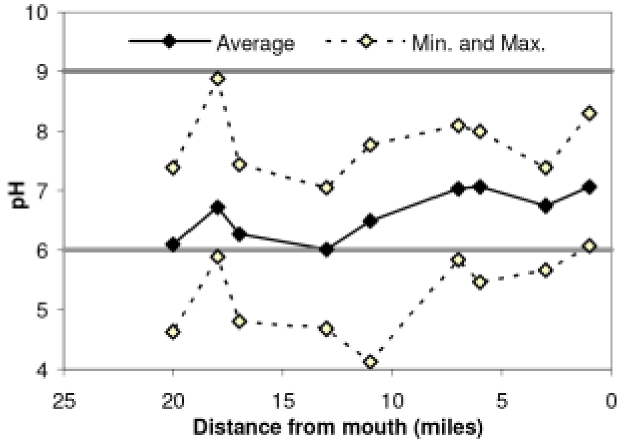


Figure 10: Average, minimum and maximum pH values measured at mainstem sampling sites from October 2002 to December 2007. Gray lines represent West Virginia's water quality standard for pH.

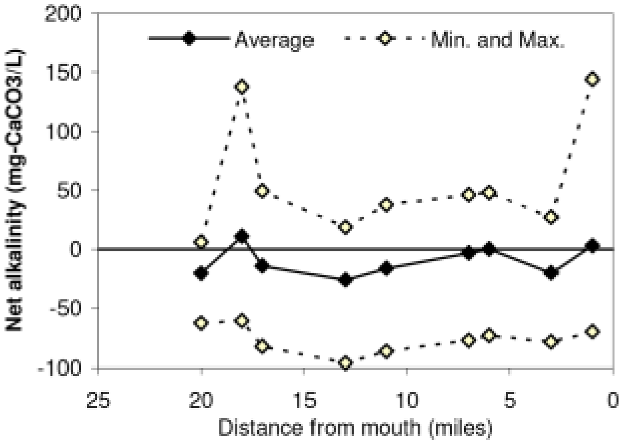


Figure 11: Average, minimum and maximum net alkalinity concentrations in the mainstem of Deckers Creek from October 2002 to December 2007.

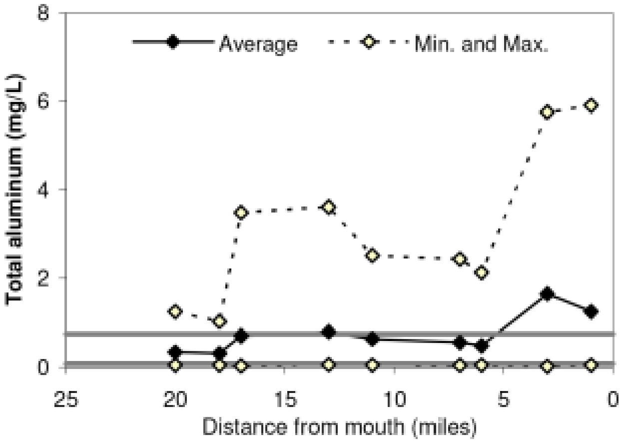


Figure 12: Average, minimum and maximum aluminum concentrations in the mainstem of Deckers Creek. Gray lines represent chronic (0.087 mg/L) and acute (0.75 mg/L) water quality standards for dissolved aluminum. Some of the

aluminum quantified in Deckers Creek may be suspended, rather than dissolved.

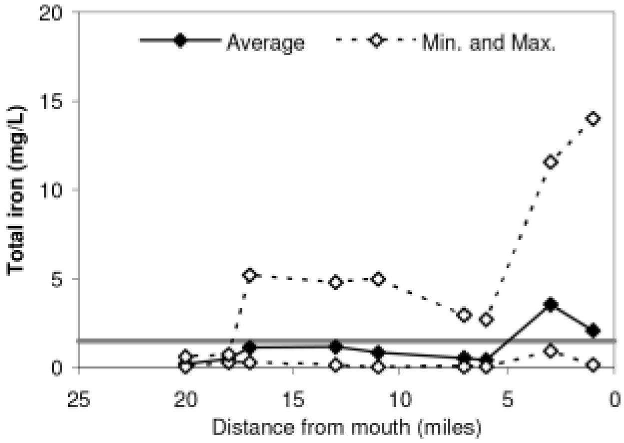


Figure 13: Average, minimum and maximum iron concentrations in the mainstem of Deckers Creek, compared to the water quality standard (gray line).

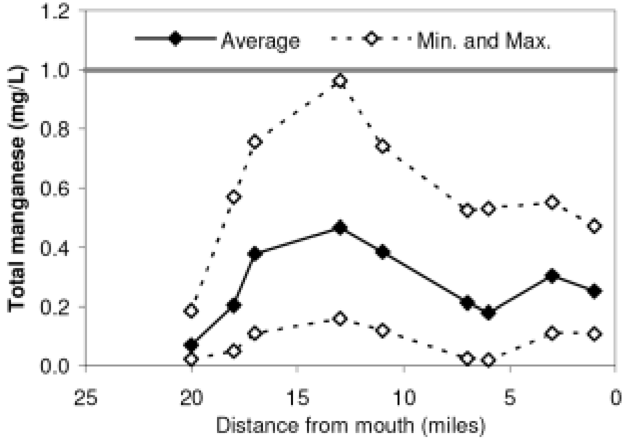


Figure 14: Average, minimum and maximum manganese concentrations in the mainstem of Deckers Creek, compared to the water quality standard (gray line).

The lowest pH values have been found at the County Line, downstream of all the AMD sources in Valley District, but upstream of the limestone mines. Although the Clean Creek Program sampling program has not detected it, pH in Sabraton and Morgantown may also fall below 6 at very low flows. Samples taken at previous years' CarpFest (late summer and early fall) have had pH values less than 5, which are the lowest values for the segment below Richard in any year.

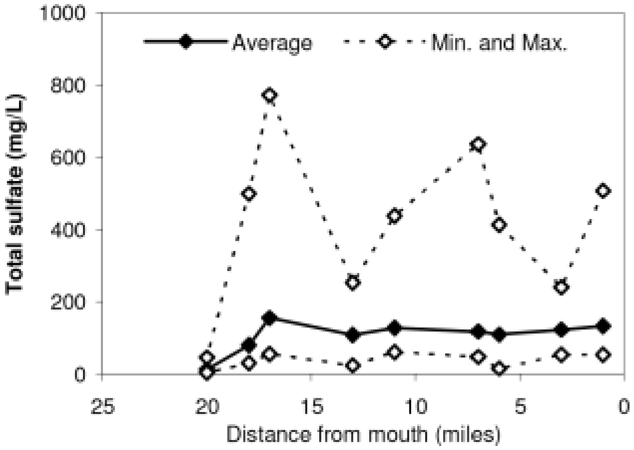
Although pH values are, on average, less than 7, the creek often maintains some alkalinity (Figure 11). However, on average, net alkalinity in the creek is very close to 0 mg/L as $CaCO_3$.

Some areas of the creek with pH values consistently above 6 are still not free of AMD. Concentrations of aluminum and iron increase, on average, to levels higher than WV water quality standards in two regions of the creek: 1) just below Kanes Creek, and 2) just below the Richard mine (Figure 12 and 13).

Concentrations of manganese have remained below 1 mg/L during the Clean Creek Program sampling periods, even in the most AMD-impacted areas (Figure 14). The pattern in the concentration of this metal differs from that of other metals in that manganese reaches its highest concentration in the upper part of the watershed, rather than below the Richard mine.

Sulfate is another chemical that pollutes streams from AMD (Box 2). Sulfate concentrations also spike downstream from Kanes Creek and from the Richard mine (Figure 15).

Fecal coliform bacteria also occur in Deckers Creek.



In the five years of the Clean Creek Program, however, concentrations at sampling times have seldom exceeded 400 cfu/100 mL, which is the level that raises concern about a rarely-sampled body of water, according to the WVDEP (Figure 16). However, it is important to note that CCP sites are rarely sampled during extremely high flows when the levels of harmful bacteria are typically the highest in streams. Bacteria in Deckers Creek may come from homes and businesses with inadequate sewage treatment, from combined sewer overflows during rainy periods, or from wildlife or livestock.

Figure 15: Average, minimum and maximum sulfate concentrations in the mainstem of Deckers Creek.

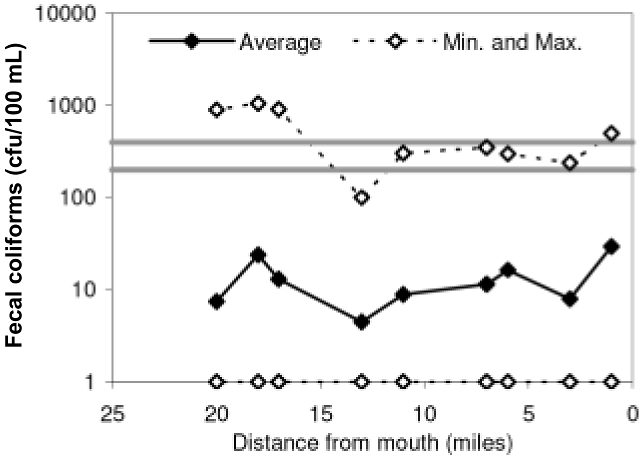


Figure 16: Geometric mean, minimum and maximum fecal coliform counts in the mainstem of Deckers Creek, compared with water quality standards (200 and 400 cfu/100 mL).

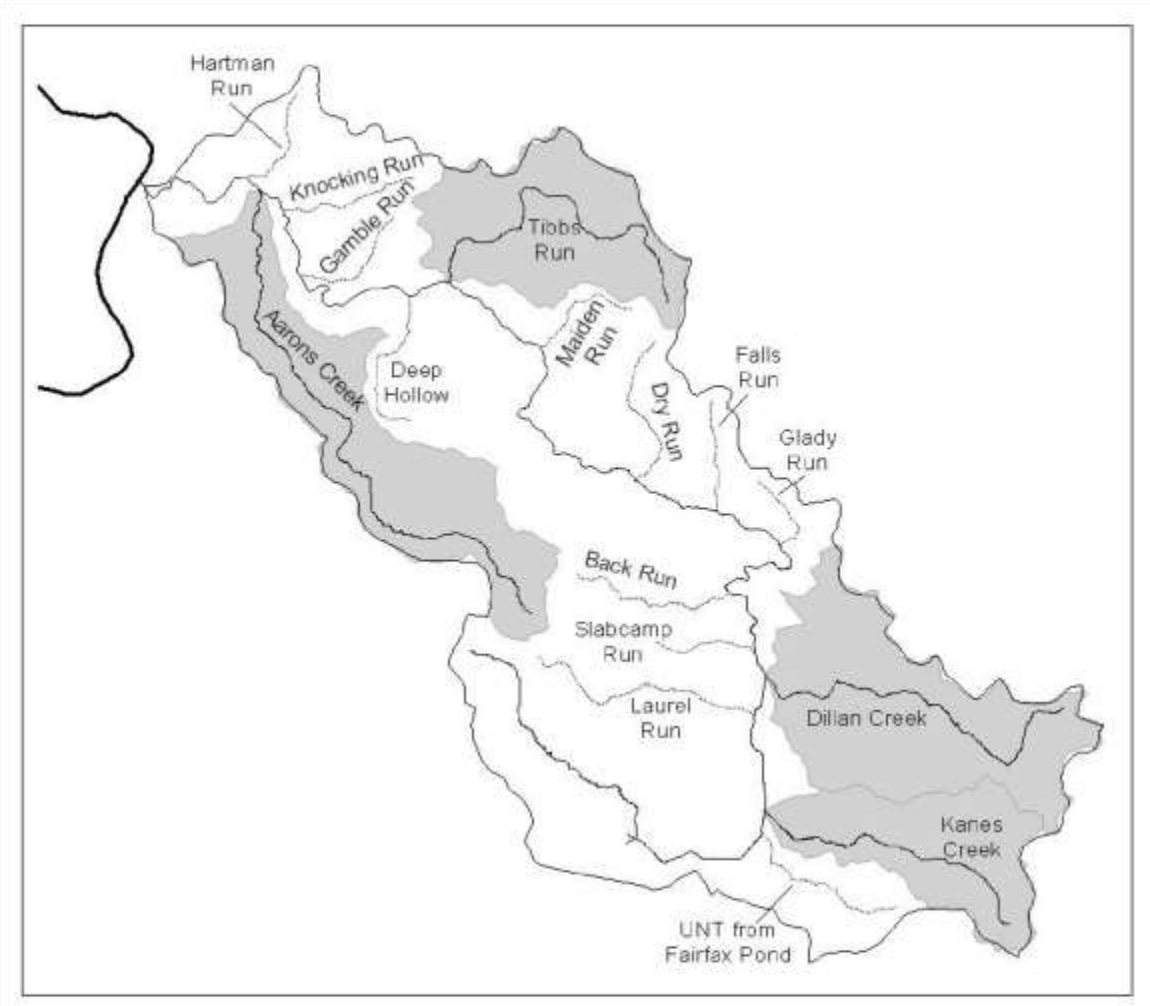


Figure 17: Tributaries of Deckers Creek. Gray watersheds represent those with CCP monitoring sites.

Box 6: Tributaries to Deckers Creek. Numbers in

Water quality in the tributaries

parentheses indicate the distance from the mouth of each tributary to the mouth of Deckers Creek.

Hartman Run (1.9) Often acidic from abandoned Pittsburgh mine seams

Aarons Creek **(**2.2) Large tributary with little AMD, some high bacteria counts and sediment issues

Knocking Run (2.7) Little AMD, some high bacteria counts

Gamble Run (3.6) Little AMD, some high bacteria counts

UNT from Deep Hollow (5.7) Carries AMD, but not enough to degrade Deckers Creek

Tibbs Run (6.3) Some AMD, some high bacteria counts

Maiden Run (7.8) Little data, probably mildly acidic from acid precipitation

Dry Run (11) Little data, usually good water quality

Falls Run (12.2) Not acidic but high conductivity. Greer maintains facilities in this watershed.

Glady Run (13.2) Acidic tributary from a heavily mined watershed

Back Run (14.9) Good water that feeds an impoundment supplying water to Masontown

Slabcamp Run (15.9) Small stream, severely polluted with AMD

Dillan Creek (16.3) Severely degraded by AMD in its headwaters, but more or less neutralized by its own tributaries

Laurel Run (16.8) Impaired by AMD at its mouth, and possibly a large source to Deckers. Upstream portions probably impaired by acid precipitation.

UNT from Zinn Chapel (17.3) Impaired by AMD in headwaters, but neutral at its mouth

Kanes Creek (18.2) Severely impaired by AMD, although water at mouth is sometimes neutral due to the Morgan Mine treatment plant

UNT from Fairfax Pond (18.5) Not acidic, although manganese loads may come from abandoned mines. Water contains lead from foundry waste used as fill in the watershed.

Some of Deckers Creek's tributaries are its worst problems, while others are the safest places for fish to reside when water quality in the mainstem is degraded (Box 6). The Clean Creek Program monitors the four largest tributaries to Deckers Creek, and may expand to more in the future.

Dillan Creek drains 11.8% of the Deckers Creek watershed, the largest fraction of any tributary. Aarons Creek, which drains 11.3% of the watershed, is only slightly smaller. Tibbs Run and Kanes Creek drain 8.5 and 6.8% of the Deckers Creek watershed, respectively (Figure 17).

Aarons Creek is similar to Deckers Creek in that it has eroded a gorge through the anticline in the middle of the watershed (Figure 3). It differs in that none of the low area to the southeast of the ridge drains to it. Deckers Creek is therefore much larger. Deckers Creek also encounters the Upper Freeport coal seam in its upper reaches, while Aarons Creek does not. The lowest reaches of Aarons Creek, however, are undergoing extensive development, which may harm the creek through changes in sediment loads and flow regimes due to increased stormwater runoff. The flat land in the lower reaches of Aarons Creek also supports a small amount of cattle farming.

Tibbs Run also has its origins on the Chestnut Ridge anticline. Unlike Aarons Creek, it joins the mainstem of Deckers on the edge of the ridge, and is steep and rocky for most of its length. A number of housing developments have been built in this sub-watershed.

Dillan Creek flows towards Deckers Creek from the ridge that separates the Cheat River and Deckers Creek watersheds. Much of its watershed is forested, but pastureland occupies its northernmost corner, and Reedsville is growing along its southwestern edge. Upper Freeport and Bakerstown coal have been mined from this watershed. A number of mine portals were established in the valley that Dillan Creek flows through.

Kanes Creek is dominated by woodland and abandoned mine sites, with some residential development along the major roads, especially Route 7. Like Dillan Creek, underground mines flank Kanes Creek, which eroded a valley through the Upper Freeport seam.

Water quality measurements are consistent with the settings of these tributaries. Aarons Creek has the highest pH and net alkalinity values, while Kanes Creek has the lowest (Figures 17and 18). Tibbs Run has higher pH values but lower net alkalinity than Dillan Creek. Ordinarily, water with a higher pH would be expected to carry more alkalinity, but these two creeks do not show the expected relationship. Dillan Creek contains substantial levels of sulfate, while Tibbs Run contains very little. The presence of higher concentrations of solutes, especially sulfate, in Dillan Creek is consistent with its impairment by AMD in its upper reaches: the AMD adds the sulfate, but the acidity is neutralized by tributaries. One of the tributaries, Swamp Run, contains carefully reclaimed mines of Bakersfield coal. This coal seam is overlain by a geologic layer containing abundant limestone, and the high alkalinity in Swamp Run probably comes from those reclaimed mines.

Among the metals, concentrations of aluminum and iron are much greater in Kanes Creek, as expected (Figures 19 and 20). Manganese concentrations do not exceed 1 mg/L at any site (Figure 21). Manganese concentrations are highest in Kanes Creek, the tributary most impaired by AMD. Patterns of sulfate concentrations also indicate that Kanes Creek is degraded by AMD (Figure)

During the time of this study, Tibbs Run, Aarons Creek, and Dillan Creek violated the 400 cfu/100 mL level, indicating impairment by fecal coliform bacteria (Figure 23). Aarons Creek and Tibbs Run have average geometric mean concentrations close to 100 cfu/100 mL. Because fecal coliform levels depend so much on the weather before and during the sampling period, the data collected are difficult to interpret. We can assume, however, that because we do not regularly sample during high flow events, we are not capturing the greatest concentrations of bacteria at these sites.

The AMD-impaired tributary, Kanes Creek, consistently has very low bacteria counts.

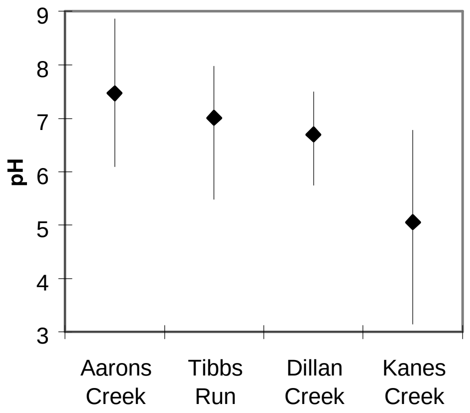


Figure 17: Average, minimum and maximum pH values in four tributaries from October, 2002 to November, 2007, for Aarons Creek and Tibbs Run, and from October 2003 to November 2007 for Dillan and Kanes Creeks.

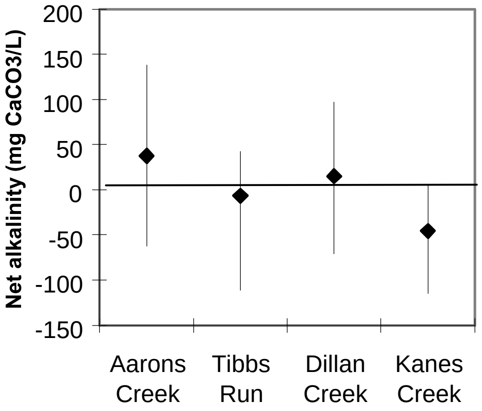


Figure 18: Average, minimum and maximum net alkalinity in tributaries.

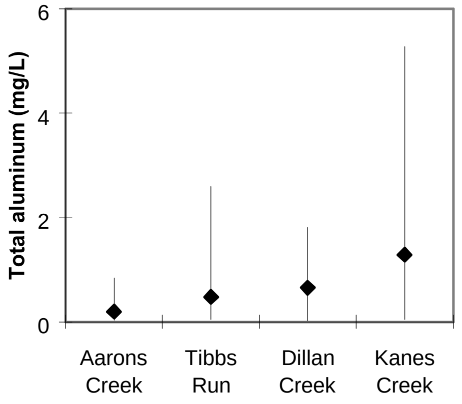


Figure 19: Average, minimum and maximum aluminum concentrations in tributaries.

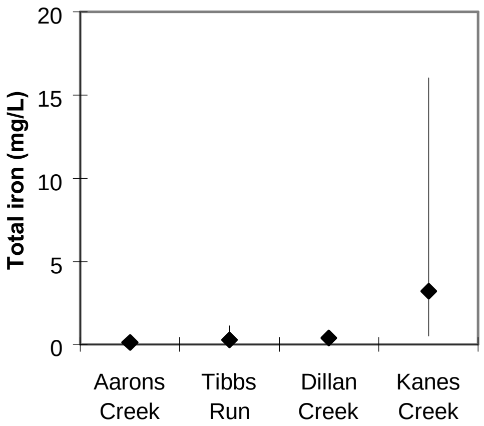
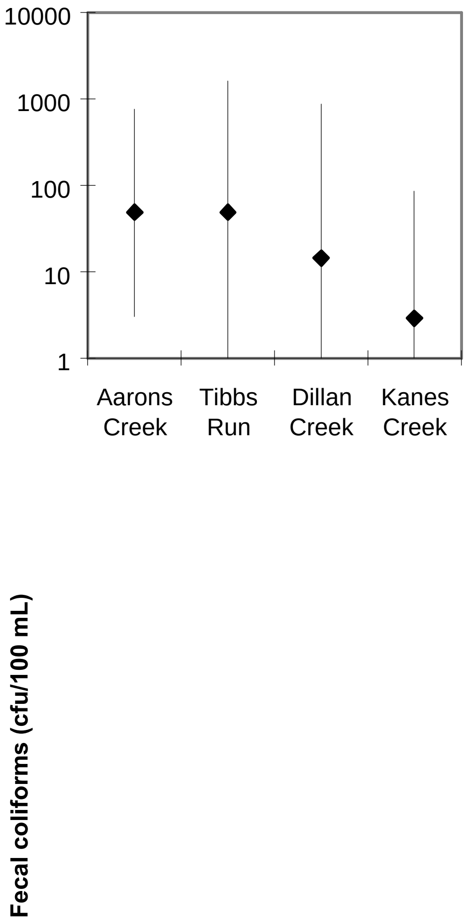
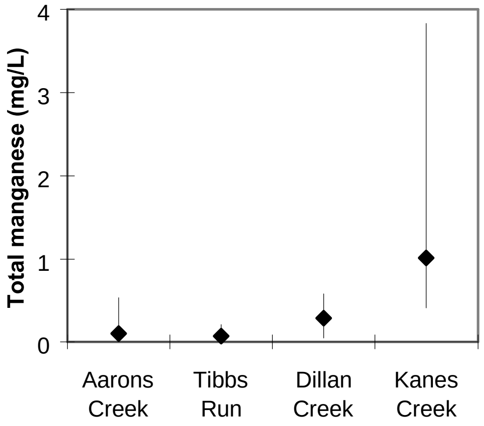


Figure 20: Average, minimum and maximum iron concentrations in tributaries.





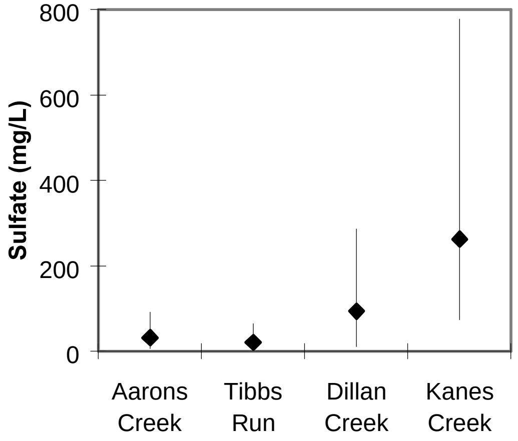


Figure 21: Average, minimum and maximum manganese concentrations in tributaries.

Figure 22: Average, minimum and maximum sulfate concentrations in tributaries.

Figure 23: Geometric mean, minimum and maximum fecal coliform counts in tributaries.

Changes from year to year

Water quality in Deckers Creek continues to improve year after year. Average pH values were greater than the state criterion minimum level of 6 at all sampling sites in 2007 (Figure 24). Net alkalinity in 2007 was higher than data gathered in 2006; however, the majority of the mainstem sites had net alkalinity levels lower in 2007 compared to 2204 and 2005 (Figure 25). It is important to note that FODC changed analytical laboratories in 2006 which may have contributed to the drastic reduction in net alkalinity seen in that year and lower than average levels measured in 2007 as well (Figure 25).

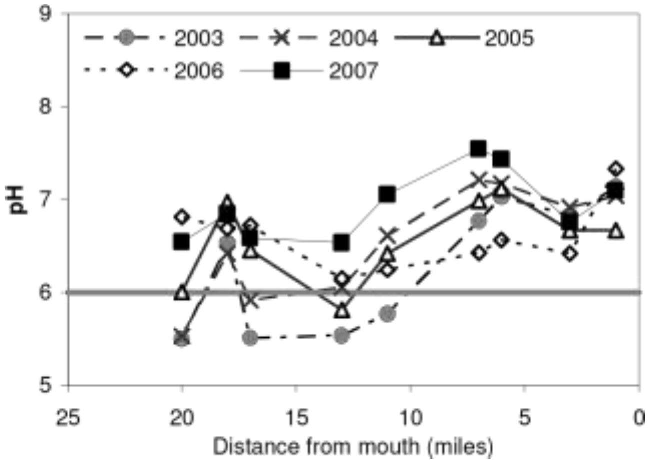


Figure 24: Comparison of average pH values in the mainstem for the five monitoring years.

On average, aluminum and iron concentrations in the upper portions of the Deckers Creek mainstem were lower in 2007 compared to previous years; however, they were a bit higher in 2007 compared to 2006 in the mainstem sites near Morgantown (Figures 26 and 27). In fact, in 2007, aluminum and iron concentrations exceeded the state standards in Deckers Creek at Valley Crossing and in Sabraton likely due to the discharge of AMD from the Richard mine (Figures 26 and 27). The patterns of sulfate concentrations, which has no water quality standard, indicate less pollution in the Preston County portion of Deckers Creek in 2005, but an unexplained increase in sulfate concentrations in Morgantown (Figure 28).

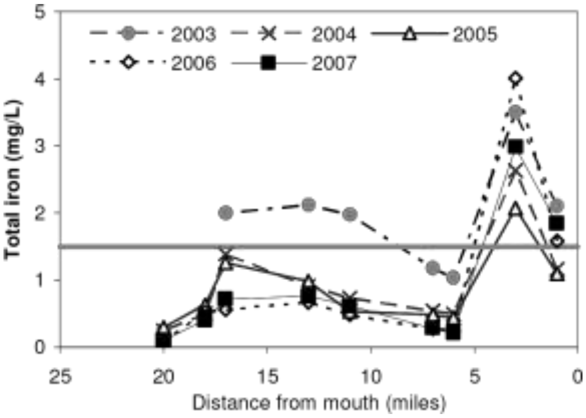


Figure 27:

Average iron concentrations in the mainstem in each monitoring year, compared to the water quality standard for total iron

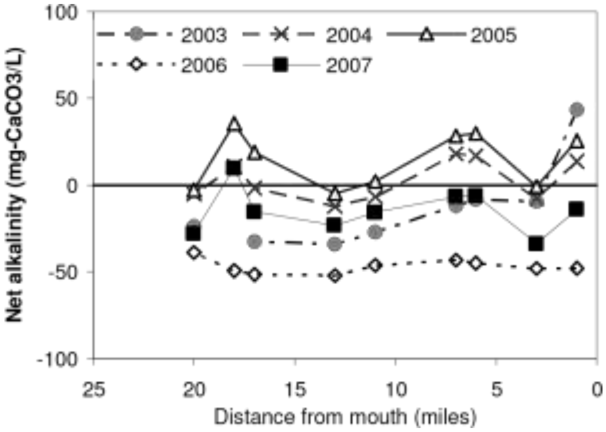


Figure 25: Average mainstem alkalinity concentrations in the five monitoring years.

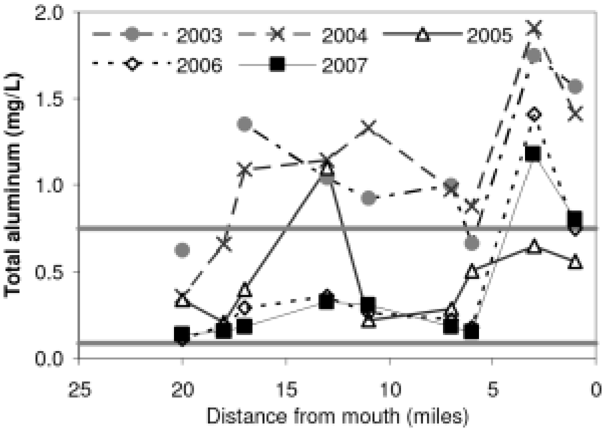


Figure 26: Average aluminum concentrations in the mainstem in each monitoring year compared to the water quality standard for acute and chronic aluminum concentrations.

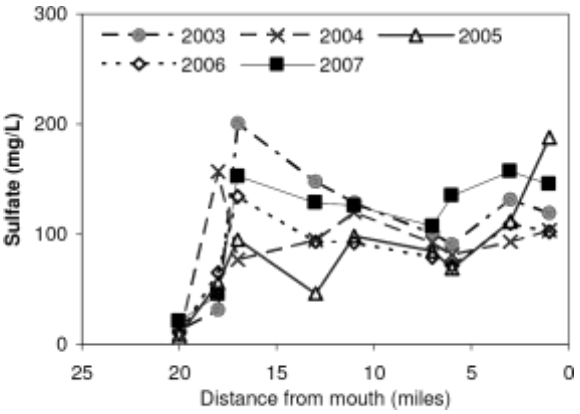


Figure 28: Average sulfate concentrations in the mainstem in each monitoring year

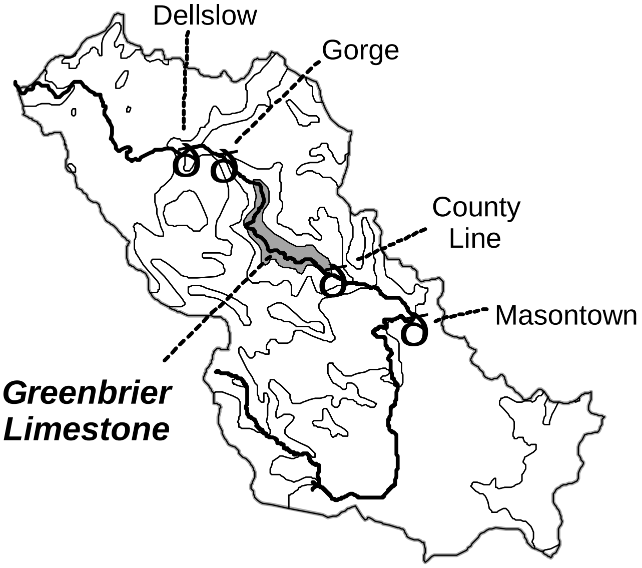


Figure 9: Geological formations, especially the Greenbrier Limestone formation in the Deckers Creek watershed, along with monitoring points just up- and downstream from the area with limestone bedrock.

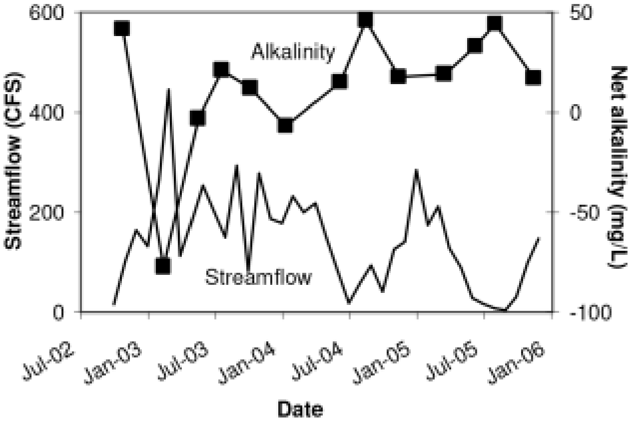


Figure 10: Streamflow (averaged by month) and alkalinity measured in the gorge segment throughout the study period.

Relating streamflow and chemistry

The Clean Creek Program started at the end of a few relatively dry years (Figure 30). The increase in flows that began in November 2002 took place at the same time as some dramatic changes in water quality. Those changes have some important implications for plans to neutralize acidity in the creek.

As Deckers Creek flows past the section of the gorge with limestone bedrock (Figure 9), including the limestone mines, it increases in alkalinity. According to the average values in our five-year dataset, the water changes from net acidic to net alkaline in this region (Figure 25). The limestone improves the water and protects the biological communities found downstream.

The behavior of the water following the increase in flow late in 2002, however, indicates that this protection is delicate. Figure 10 compares streamflow patterns over more than three years with measurements of net alkalinity in the gorge.

High flows in December 2002 through March 2003 occur at the same time as and probably caused a large drop in net alkalinity not only in the upper watershed, but through the gorge and even past the limestone bedrock area. In fact, there was a large decline in the fish population between fall 2002 and fall 2003 (see below).

The data confirm that the limestone in the Deckers Creek watershed improves the creek and offers some protection from AMD. The protection, however, is inadequate during the more powerful swings in water quality.

Benthic macroinvertebrates

Benthic invertebrates, creatures that live in the sediments at the bottom of the stream, are good indicators of stream water quality. The types of bugs and the relative numbers of each type provide information about the water quality in which they live. Clean streams have diverse bug communities while polluted streams have fewer types and only one or two of those types usually dominate the community. Further, there are certain families of bugs that are especially sensitive of pollution. As a rule of thumb, the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) are typically abundant in clean streams and absent in highly polluted streams.

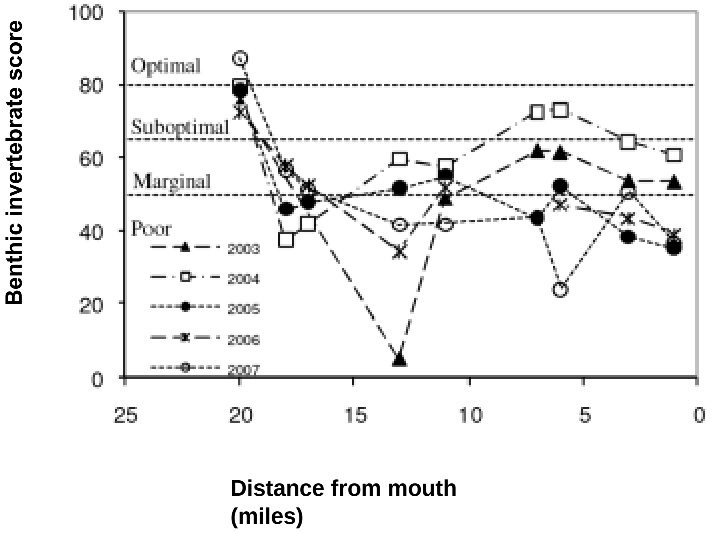


Figure 31: Benthic invertebrate community scores for the mainstem of Deckers Creek in each year.

WVDEP has provided watershed groups several ways of integrating the information about different organisms and their numbers into scores that reflect water quality. One of these scoring methods is the West Virginia Stream Condition Index (WVSCI). The accompanying graphs present WVSCI scores for each CCP site calculated using a WVDEP spreadsheet, which can be found at www.wvdep.org. In previous CCP reports if less than 100 organisms were found, we modified the score using a multiplier (number of organisms found divided by 100). For this report, if less than 100 organisms were found, we used the average of the total taxa, EPT taxa, and biotic index points for our WVSCI score according to new WVDEP guidelines.

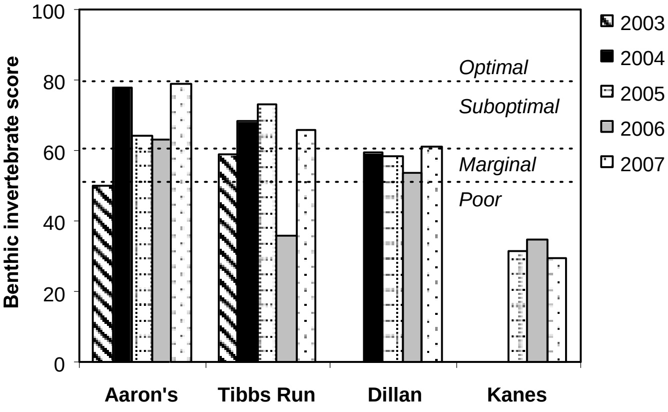


Figure 32: Benthic invertebrate scores in tributaries. Dillan and Kanes Creeks were not sampled in 2003.

In general, water quality in Deckers Creek has improved dramatically since 2003; however, WVSCI scores from 2007 indicate a recent decline. Based on calculated WSCI scores, water quality in the mainstem of Deckers Creek in 2007 was mostly marginal to poor (Figure 31). The Zinn Chapel site at mile 20 has good water, but the quality drops as Deckers passes Kanes Creek and flows to Masontown. Past Masontown, there is some improvement in the gorge, especially below the limestone mines at Greer (mile 10). The gains are lost as Deckers passes the Richard mine between Dellslow and Sabraton.

Benthic invertebrates scores in the tributaries also improved since 2003 (Figure 32). Aarons Creek and Tibbs Run are in the

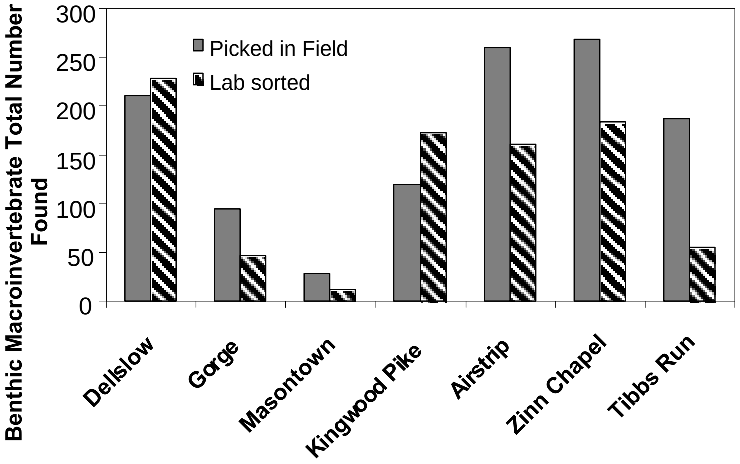


Figure 33: Total number of benthic invertebrates found in 2007 for select CCP sites using two different sampling and processing methods.

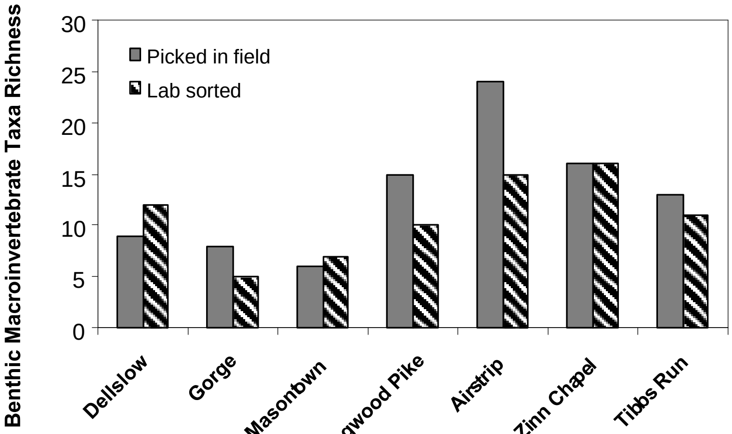


Figure 34: Benthic invertebrate taxa richness found in 2007 for select CCP sites using two different sampling and processing methods.

suboptimal range, while Dillan Creek and Kanes Creek scores indicate marginal and poor conditions, respectively.

In 2007, we sampled and processed benthic invertebrate samples using two different sampling methods for a methods comparison. Both methods require kicking and turning over rocks upstream of a net in a riffle area to collect the invertebrates. In previous years, FODC has collected stream bugs using only the Save Our Streams (SOS) method. For the SOS method, FODC uses a seine (large flat net) to sample riffle habitat. FODC staff and volunteers then bring the seine to the shore and use tweezers to pick the bugs out of the sediments on the seine. The process is repeated until approximately 200 bugs are found or six net samples are collected. The bugs are then taken back to the office for identification. The latter is a more qualitative sampling technique.

In 2007 we also sampled bugs at seven out of the 13 CCP sites using a second method, a quantitative technique. In addition to the seine collection, we also took samples using smaller kick-nets in a known area. The kick nets are square-shaped nets mounted on a wooden handle. The sediment collected in three kicknet samples per stream was placed directly into jars with alcohol as a preservative and brought back to the office. A small amount of Rose Bengal, a pink dye used to facilitate the sorting process, was then added to the samples. The invertebrates were then sorted out from the sediment using a magnifying lens and identified.

Both sampling techniques are well known among watershed workers. While watershed groups all over the country participate in the SOS method, most government agencies concerned with water quality rely on methods where sediments are examined in the lab. We conducted the methods comparison for several reasons. First, we need hands on experience with the quantitative method (sorting in the lab) to make sure we can satisfy the government agencies who require that method. Second, we need to know which method retrieves the most organisms. In previous years, our qualitative sampling method has yielded very small numbers of organisms in places that we think should have more invertebrates.

Results from the 2007 methods comparison indicate that in general, the qualitative sampling method generates more organisms, more taxa, and higher WVSCI scores than the quantitative method (Figures 33-35). We found more organisms at five out of the seven sites, more taxa at four of the seven sites, and higher WVSCI scores at six of the seven sites using the qualitative method. It is also important to note that based on the WVSCI scores, some streams were classified differently when comparing the two different methods used (Figure 35).

Possible explanations for these results are as

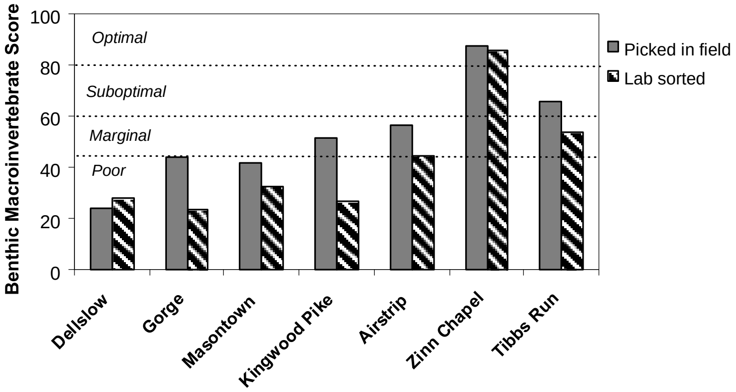


Figure 35: Benthic invertebrate WVSCI scores in 2007 for select CCP sites using two different sampling and processing methods.

follows. The quantitative sampling method is limited to a smaller area (only three kick nets one square meter each), while the SOS method can possibly lead to much larger areas sampled (up to six kick nets > one square meter each as the net is much larger). In order to determine if the area sampled impacted the results shown, FODC could have calculated the area sampled for both methods and examined the data based on area. Further, FODC volunteers may not be efficient enough at sorting through the collected sediment in the office to generate accurate data. FODC will continue to improve their methods for sorting sediment using the quantitative sampling method.

Photo 14: A net spinning caddisfly collected in the Gorge.

In general, the quantitative sampling method requires less field time and personnel; however, it does require more equipment in the form of jars and alcohol and more time for processing in the office. The qualitative sampling method is excellent for educational purposes out in the field and will continue to be used to show volunteers the different types of invertebrates living in our watershed's streams. FODC will also continue using the quantitative method to sample benthic invertebrates in order to satisfy government agency requirements; however, we will also use the SOS method for educational purposes and conduct future studies to examine the impact of area sampled on our results.

Photo 15: Martin Christ and Sarah Veselka use a square kick net to sample benthic invertebrates in the Gorge.

Photo 16: Preston High School Health Science and Technology students pick invertebrates off of a seine using the SOS methods.

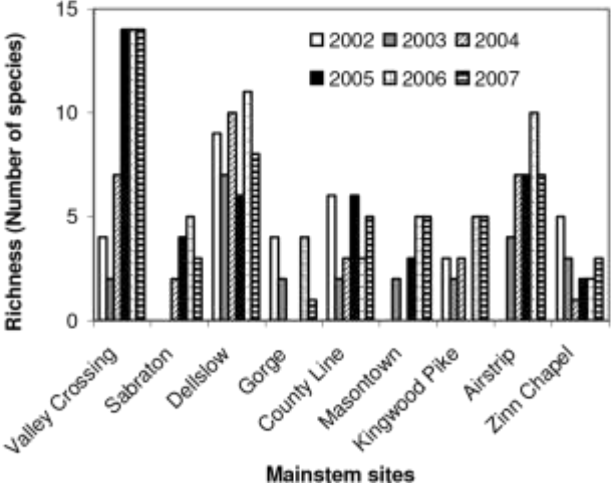


Figure 36: Numbers of fish species found at mainstem sites during annual surveys.

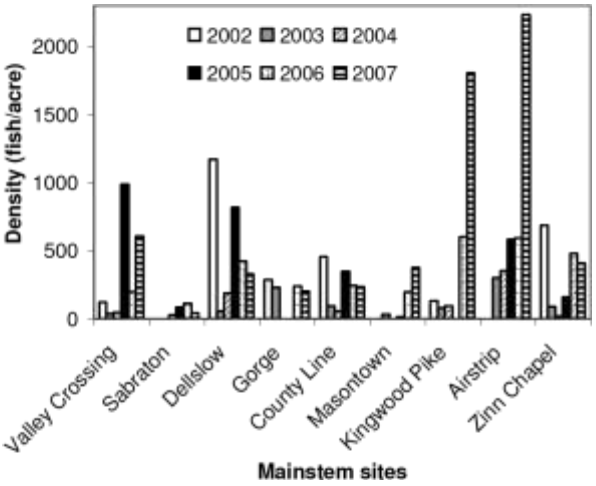


Figure 37: Numbers of individual fish found during annual surveys

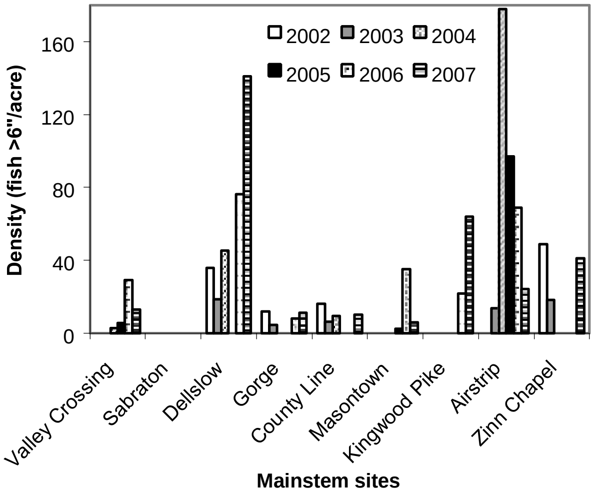


Figure 38: Numbers of large fish collected per acre during annual surveys

Fish

Fish communities in Deckers Creek are highly variable from site to site and year to year. This holds true for the numbers of species present (richness), the number of fish collected per acre sampled (density) and for the total weight of all fish collected per acre sampled (biomass). However, overall, fish communities in Deckers Creek have improved from 2002 to 2007 particularly in some of the more degraded sections such as Deckers Creek in Sabraton, Masontown, and at the Kingwood Pike.

Fish species richness at the majority of the sites remained relatively stable from 2006 to 2007 (Figure 36). Fish species tend to disappear as conditions worsen; however, re-colonization of fish species can be rapid following water quality improvements. For example, the Valley Crossing site has been extremely polluted in the past with iron precipitate coating every creek surface, but pollution has become more moderate in recent years. With improvements to water quality, fish now readily swim up Deckers Creek from the Monongahela River which has its own diverse array of fish due to improving water quality. Many of the species that appear and disappear from the Valley Crossing site are small minnow species or larger pelagic species common to larger rivers (Table 1). In fact, these larger river fish have been found as far upstream as Dellslow (i.e., sauger).

The Sabraton, Masontown, and Kingwood sites have consistently had the most degraded fish communities. However, fish species richness (Figure 36), density (Figure 37), and biomass (Figure 38) are increasing in each of these sites indicating improved water quality in these sections of Deckers Creek. In fact, the number of fish caught per acre at the Kingwood Pike site almost tripled from 2006 to 2007 (Figure 37). This year, we also saw a large increase in the total numbers of fish caught per acre in Deckers Creek at the Airstrip (Figure 37); however there was also a large reduction in the number of large fish caught at this site indicating an abundance of small fish such as the prevalent white sucker.

We did not find improvements to the fish population in Deckers Creek in Sabraton. Compared to 2006, we saw a reduction in the number of fish collected from 48 to 14 and in the number of species collected from five to three in 2007 (Figures 36 and 37). Similar to previous samples, we did not collect any big fish at this site in 2007 (Figure 38). All in all, this section of Deckers Creek remains quite devoid of resident fish populations of any significant size. This is likely due to the large amount of iron oxide found on the stream bottom and variable water chemistry at this site resulting from the discharge at the abandoned Richard Mine.

The number of large fish collected during our sampling efforts can indicate how well each site may support recreational fishing. Figure 38 depicts the numbers of fish longer than 6" collected per acre at each of the mainstem sites. Dellslow, Kingwood Pike, and Zinn Chapel were the most fishable sites in 2006. Game fish to be landed at these sites include sunfish (pumpkinseed, green, and bluegill), sauger, bass (rock, smallmouth, and spotted) and catfish (yellow bullhead) (Table 1).

Fish communities may also be assessed using biomass, or the total weight of all the fish in a given area. Biomass numbers indicate that the Dellslow and Airstrip sites are consistently the two most productive sites in Deckers Creek and now followed up by the Kingwood Pike (Figure 39).

Fish communities in four major tributaries to Deckers Creek in 2007 were quite similar to previous years with the exception of Kanes Creek (Figures 40 and 41). In 2006, we collected fish from Kanes Creek for the first time in the history of the Clean Creek Program. Even then, we only collected three species and a total of 19 fish. In 2007, we collected 74 fish total and eight different species (Figure 40), a dramatic improvement. Three of the eight species found were sunfish including green, bluegill and pumpkinseed sunfish (Table 1).

As in previous years, Aarons Creek continues to support a productive and diverse fish community (Figures 40 and 41). In 2007, we found 227 fish and 11 species. Species collected here include bass, bullhead, suckers, darters, minnows, sunfish, stonerollers, and creek chubs. Surprisingly, we did not collect any lamprey out of Aarons Creek in 2007 as they were found here in previous samples (Table 1).

Two new fish species were collected in the Deckers Creek watershed this year, the greenside darter and the bigeye chub (Table 1). Both of these species were collected at the Valley Crossing site. Table 1 shows all fish species collected at each of the 13 sites in the Clean Creek Program during annual sampling events.

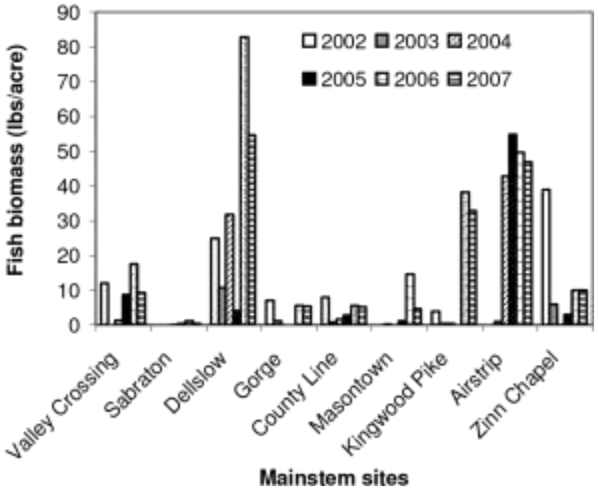
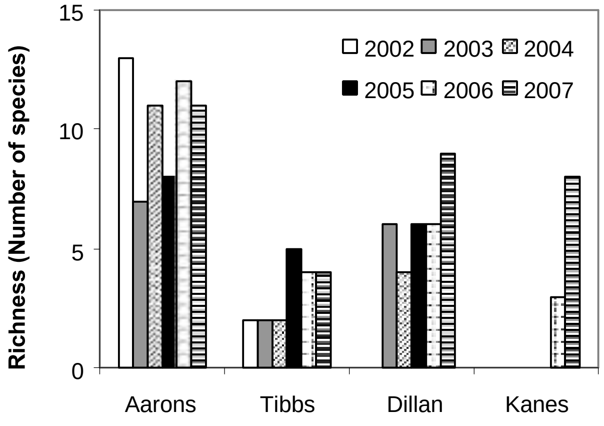


Figure 39: Total weights of fish caught per acre during annual surveys.



Tributary sites

Figure 40: Number of fish species collected in four major tributaries to Deckers during annual samples.

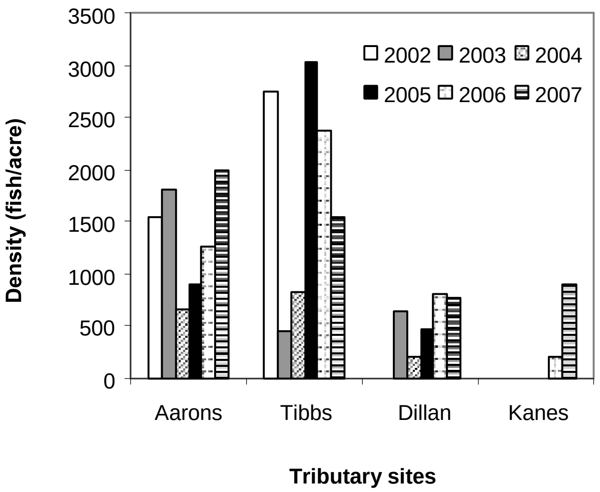


Figure 41: Numbers of individual fish collected in four major tributaries to Deckers during annual samples.

Tributary sites

Figure 42: Numbers of individual fish >6" long collected in four major tributaries to Deckers

during annual samples.

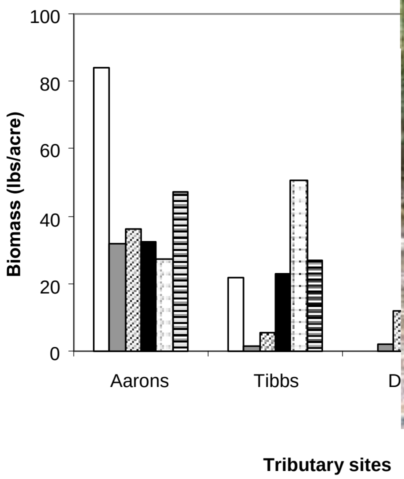
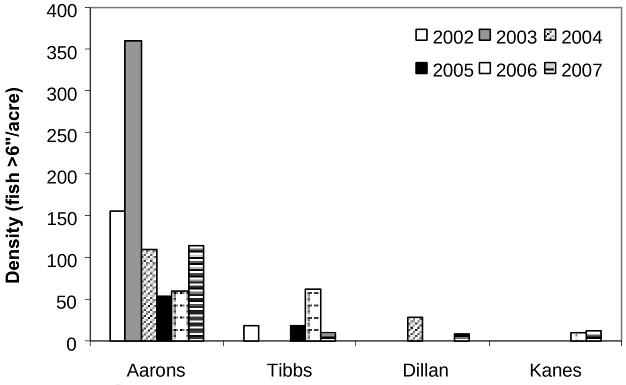


Photo 17: James Nutaitis and volunteers sample fish communities in Deckers Creek along Route 92 at the airstrip.

Figure 43: Total weights of fish caught per acre during annual surveys in the CCP tributary sites.

Photo 18: A yellow bullhead caught in Dellslow gets weighed, measured, and recorded.

Photo 19: Students in Dr. George Merovich's WVU Fisheries Management class sample fish communities in Deckers Creek at Valley Crossing.



The most abundant fish species collected in 2007 in descending order included creek chubs, green sunfish, yellow bullhead, white suckers, and central stonerollers. These fish were found at twelve, nine, ten, seven, and four out of the 13 sites sampled in that same order. There was a large increase in the number of both yellow bullheads and white suckers found in 2007 compared to 2006. We also found bass (smallmouth and spotted) at eight of the 13 sites sampled; however, they were less numerous than the species listed above.

Common name	*Scientific name*	Valley Crossing						Sabraton						Dellslow						Gorge				County Line					
		02	*03*	*04*	*05*	*06*	*07*	*02*	*03*	*04*	*05*	*06*	*07*	*02*	*03*	*04*	*05*	*06*	*07*	*02*	*03*	*06*	*07*	*02*	*03*	*04*	*05*	*06*	*07*
Bigeye chub	*Hybopsis amblops*						X																						
Blacknose dace	*Rhinichthys atratulus*			X			X			X	X	X	X	X	X	X	X	X	X										
Black bullhead	*Ameiurus melas*																									X			
Black crappie	*Pomoxis nigromaculatus*																										X		
Bluegill	*Lepomis macrochirus*						X							X	X	X		X	X		X			X					
Bluntnose minnow	*Pimephales notatus*			X	X	X	X																						
Brown bullhead catfish	*Ameiurus nebulosus*				X																								
Central stoneroller	*Campostoma anomalum*			X	X	X	X				X	X		X			X	X									X		X
Common carp	*Cyprinus carpio*														X														
Creek chub	*Semotilus atromaculatus*		X		X	X				X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X
Emerald shiner	*Notropis atherinoides*					X																							
Fantail darter	*Etheostoma flabellare*											X																	
Golden redhorse	*Moxostoma erythrum*						X																						
Golden shiner	*Notemigonus crysoleucas*																							X					
Greenside darter	*Etheostoma blennioides*						X																						
Green sunfish	*Lepomis cyanellus*	X											X	X	X	X	X	X	X			X					X		X
Johny darter	*Etheostoma nigrum*																												

Largemouth bass	*Micropterus salmoides*	X		X X		
Least brook lamprey	*Lampetra aepyptera*					X
Logperch	*Percina caprodes*	X X X				
Margined madtom	*Noturus insignis*					
Northern hog sucker	*Hypentelium nigricans*	X X X		X X		
Pumpkinseed	*Lepomis gibbosus*	X		X X X X	X	X X
Rainbow darter	*Etheostoma caeruleum*	X X X				
Redbreast sunfish	*Lepomis auritus*				X	
River chub	*Nocomis micropogon*					
Rock bass	*Ambloplites rupestris*	X		X		
Rosyface shiner	*Notropis rubellus*	X X				
Sand shiner	*Notropis ludibundus*	X				
Sauger	*Sander canadense*	X X X X		X		
Silver shiner	*Notropis photogenis*	X				
Silverstrip shiner	*Notropis stilbius*	X				
Smallmouth bass	*Micropterus dolomieu*	X X X X	X	X X X X		
Spotfin shiner	*Cyprinella spiloptera*	X X X X X		X		
Spotted bass	*Micropterus punctulatus*		X	X	X	X X X

White sucker	*Catostomus commersoni*	X		X X X X X X		
Yellow bullhead catfish	*Ameiurus natalis*					

Table 1. Fish species found at each of the 13 sites in the Deckers Creek Clean Creek Program during annual sampling events (2002-2007). The gorge section of Deckers Creek was not sampled in 2004 or 2005.

X X X X X X X X X X X X

Table 1. Continued. Gray columns indicate years in which fish communities were not sampled.

Common name	*Scientific name*	Masontown						Kingwood Pike						Reedsville Airstrip						Zinn Chapel					
		02	*03*	*04*	*05*	*06*	*07*	*02*	*03*	*04*	*05*	*06*	*07*	*02*	*03*	*04*	*05*	*06*	*07*	*02*	*03*	*04*	*05*	*06*	*07*
Bigeye chub	*Hybopsis amblops*													▨											
Blacknose dace	*Rhinichthys atratulus*													▨											
Black bullhead	*Ameiurus melas*													▨											
Black crappie	*Pomoxis nigromaculatus*													▨											
Bluegill	*Lepomis macrochirus*					X				X		X	X	▨		X	X	X	X	X	X		X		X
Bluntnose minnow	*Pimephales notatus*													▨											
Brown bullhead catfish	*Ameiurus nebulosus*		X			X								▨		X				X					
Central stoneroller	*Campostoma anomalum*													▨			X	X							
Common carp	*Cyprinus carpio*													▨											
Creek chub	*Semotilus atromaculatus*				X	X	X					X	X	▨	X	X	X	X	X	X		X	X	X	X
Emerald shiner	*Notropis atherinoides*													▨											
Fantail darter	*Etheostoma flabellare*													▨											
Golden redhorse	*Moxostoma erythrum*													▨											
Golden shiner	*Notemigonus crysoleucas*													▨					X						
Greenside darter	*Etheostoma blennioides*													▨											
Green sunfish	*Lepomis cyanellus*						X	X		X		X	X	▨			X	X	X						
Johny darter	*Etheostoma nigrum*													▨											

Largemouth bass	*Micropterus salmoides*	X X	X X	X X	X
Least brook lamprey	*Lampetra aepyptera*				
Logperch	*Percina caprodes*				
Margined madtom	*Noturus insignis*				
Northern hog sucker	*Hypentelium nigricans*				
Pumpkinseed	*Lepomis gibbosus*	X X		X X X	X
Rainbow darter	*Etheostoma caeruleum*				
Redbreast sunfish	*Lepomis auritus*				
River chub	*Nocomis micropogon*				
Rock bass	*Ambloplites rupestris*				
Rosyface shiner	*Notropis rubellus*				
Sand shiner	*Notropis ludibundus*				
Sauger	*Sander canadense*				
Silver shiner	*Notropis photogenis*				
Silverstrip shiner	*Notropis stilbius*				
Smallmouth bass	*Micropterus dolomieu*			X	
Spotfin shiner	*Cyprinella spiloptera*	X			
Spotted bass	*Micropterus punctulatus*	X	X	X X X	

White sucker	*Catostomus commersoni*						X		X				X	▨	X	X			X						
Yellow bullhead catfish	*Ameiurus natalis*					X	X	X	X			X	X	▨	X	X	X	X	X	X	X			X	X

Table 1. Continued. Gray columns indicate years in which fish communities were not sampled.

Common name	*Scientific name*	Aarons Creek						Tibbs Run						Dillan Creek						Kanes Creek					
		02	*03*	*04*	*05*	*06*	*07*	*02*	*03*	*04*	*05*	*06*	*07*	*02*	*03*	*04*	*05*	*06*	*07*	*02*	*03*	*04*	*05*	*06*	*07*
Bigeye chub	*Hybopsis amblops*													▨											
Blacknose dace	*Rhinichthys atratulus*			X		X	X	X	X		X	X	X	▨						▨					
Black bullhead	*Ameiurus melas*													▨		X				▨					
Black crappie	*Pomoxis nigromaculatus*													▨						▨					
Bluegill	*Lepomis macrochirus*	X	X	X						X	X		X	▨	X	X		X	X	▨					X
Bluntnose minnow	*Pimephales notatus*			X	X	X	X							▨					X	▨					
Brown bullhead catfish	*Ameiurus nebulosus*													▨			X		X	▨					
Central stoneroller	*Campostoma anomalum*	X	X	X	X	X	X							▨						▨					X
Common carp	*Cyprinus carpio*													▨						▨					
Creek chub	*Semotilus atromaculatus*	X	X		X	X	X	X	X	X	X	X	X	▨	X		X	X	X	▨				X	X
Fantail darter	*Etheostoma flabellare*	X	X	X	X	X	X							▨						▨					
Golden Redhorse	*Moxostoma erythrum*			X										▨						▨					
Golden shiner	*Notemigonus crysoleucas*													▨			X	X		▨					
Greenside darter	*Etheostoma blennioides*													▨						▨					
Green sunfish	*Lepomis cyanellus*	X				X					X		X	▨		X	X	X	X	▨				X	X

Johny darter	*Etheostoma nigrum*	X		X			X																		
Largemouth bass	*Micropterus salmoides*											X		X											
Least brook lamprey	*Lampetra aepyptera*	X		X		X																			
Logperch	*Percina caprodes*																								
Margined madtom	*Noturus insignis*		X																						
Northern hog sucker	*Hypentelium nigricans*	X	X	X	X	X	X																		
Pumpkinseed	*Lepomis gibbosus*	X					X				X	X		X		X		X						X	X
Rainbow darter	*Etheostoma caeruleum*																								
Redbreast sunfish	*Lepomis auritus*																								
River chub	*Nocomis micropogon*																								
Rock bass	*Ambloplites rupestris*																								
Rosyface shiner	*Notropis rubellus*																								
Sand shiner	*Notropis ludibundus*																								
Sauger	*Sander canadense*																								
Silver shiner	*Notropis photogenis*																								
Silverstrip shiner	*Notropis stilbius*																								
Smallmouth bass	*Micropterus dolomieu*	X	X	X	X	X	X								X										
Spotfin shiner	*Cyprinella spiloptera*																								

Spotted bass	*Micropterus punctulatus*	X X X		X X X	X
White sucker	*Catostomus commersoni*	X X X X		X X	X
Yellow bullhead catfish	*Ameiurus natalis*	X X X		X X X	X

PLANS FOR REMEDIATION

The first part of FODC's mission is to improve the natural qualities of the Deckers Creek watershed. FODC's strategic plan envisions a creek that is fishable by 2010 and swimmable by 2015. While the Deckers Creek watershed is now polluted by AMD, bacteria, heavy metals, sediment and trash, FODC and the Deckers Creek Restoration Team have made the most progress toward addressing AMD. A plan is presented below. This section summarizes FODC's watershed-based plan (Christ and Pavlick, 2006).

Box 7: Reclamation funding sources.

Section 319 funds – Provided by the USEPA to the WVDEP for addressing nonpoint source pollution. 319 funds are available for constructing passive AMD treatment systems on abandoned mine lands (AMLs). These funds are named after section 319 of the Clean Water Act.

AML Trust Fund – Funding made available by SMCRA. Monies are generated from a tax placed on every ton of coal mined in the U.S., and are distributed to the coal mining states to address problems on AMLs, including safety issues as well as water pollution.

Set-Aside Fund - Program allows states to reserve up to 30% of their annual AML Trust Fund as an endowment for use on water quality projects. Monies can be spent on operations and maintenance costs associated with AMD treatment systems on AML sites.

Watershed Cooperative Agreement Program – Program sponsored by OSM that provides grants to watershed groups to treat AMD from AMLs.

Natural Resources Conservation Service Public Law 566 funds – Program that supports projects addressing watersheds. It requires a 50% match from a state agency.

AMD sources to Deckers Creek will be eliminated using both passive and active methods. This section describes the team that will bring the projects about, the funding resources to be used, and the most promising technologies.

Deckers Creek Restoration Team

In 2002, organizations and government agencies that were already planning AMD remediation projects declared the existence of the Deckers Creek Restoration Team (DCRT). This new group, which is roughly modeled on the Cheat River group "River of Promise," is a forum to discuss, plan and coordinate remediation projects for Deckers Creek. Each of the organizations involved brings a number of strengths and resources to the table. All groups take part in identifying projects, developing designs, securing funding and constructing solutions. Each organization has a number of particular strengths and many have access to funding resources (Box 7).

<u>FODC</u>: convenes the group and takes the lead in outreach to watershed residents about Deckers Creek and its journey toward remediation. FODC also secures Watershed Cooperative Agreement Program (WCAP) and 319 funds.

<u>OAMLR</u>: is the state agency responsible for solving AML problems in the state. They have access to annual disbursements from the

Abandoned Mine Lands Trust Fund, and approximately 25 years of experience in planning and executing projects.

The WVDEP Division of Water and Waste Management (DWWM): administers a program to eliminate nonpoint source pollution. They provide personnel with technical and project management expertise, as well as access to funding through the United States Environmental Protection Agency (USEPA), through Section 319 of the Clean Water Act.

The Natural Resources Conservation Service (NRCS): addresses a number of water pollution problems at a watershed scale. They work in the Deckers Creek watershed through the Public Law 566 program. This program requires a state sponsor with a 50% financial match. WVDEP, through OAMLR, has agreed to be that sponsor. The combination of OAMLR and NRCS is a crucial tool for remediation of Deckers Creek. NRCS is part of the United States Department of Agriculture.

The Office of Surface Mining (OSM): is charged with overseeing state programs related to reclaiming abandoned mine lands and bond forfeiture sites as well as regulating permitted mines. They also provide expertise in a number of important fields. The WCAP is a crucial tool for giving watershed groups power to initiate projects by matching other sources of funding. OSM is part of the United States Department of the Interior.

Local governments: The Monongalia and Preston County Commissions, the City Council of Morgantown, and the Town Councils of Masontown and Reedsville all have designated correspondents for the DCRT. Their participation is crucial for linking the efforts of other groups with local citizens and landowners.

Businesses: Greer Industries is also a correspondent on the DCRT, and may participate in restoring Deckers Creek as an owner of former mine lands, an owner of stream bank, and as a supplier of limestone.

DCRT meetings are open to the public. FODC and DCRT invite all interested parties to attend its meetings.

The regulatory context for stream remediation

The power of watershed groups to clean up creeks stems not only from widespread public concern for natural areas and resources, but also from the law of the land. The Clean Water Act (CWA) of 1972 dedicated the country to eliminating discharges of pollutants to surface waters by 1985. The CWA and USEPA established a number of rules and procedures to make sure that states protect clean streams and clean up polluted streams.

Table 3: Summary of load estimates and allocations for sub-watersheds of the Deckers Creek watershed.

Sub-watershed	Metal	Loads (lbs/year)	
		Estimated	*Target*
Kanes Creek	Al	12,000	2,400
	Fe	53,000	7,500
	Mn	2,600	2,600
Laurel Run	Al	42,000	3,200
	Fe	198,000	11,000
	Mn	6,900	4,200
Dillan Creek	Al	8,000	1,650
	Fe	41,000	8,600
	Mn	2,000	1,600
Slabcamp Run	Al	42,000	42,000
	Fe	200,000	7,000
	Mn	7,000	2,200
Deckers Creek,	Al	400	400
Slabcamp to Back Run	Fe	1,600	1500
	Mn	500	500
Deckers Creek	Al	5,000	5,000
Back Run to Glady Run	Fe	190,000	4.500
	Mn	3,300	3,300
Glady Run	Al	3,400	600
	Fe	15,000	2,700
	Mn	1,000	700
Deep Hollow	Al	9,000	1,600
	Fe	66,000	6,400
	Mn	2,700	2,300
Deckers Creek, Deep Hollow	Al Fe	19,000	3,000
to Aarons		70,000	7,500
(including Richard mine)	Mn	3,300	3,300
Hartman Run	Al	9,900	1,800
	Fe	46,000	5,800
	Mn	3,700	1,900

Source: USEPA, 2002.

First, the state must establish water quality standards for a variety of pollutants. If the streams do not meet the standards, they are considered impaired.

Next the state must report to the USEPA a list of all the impaired water bodies in the state. The list is called the 303(d) list. AMD impairs a number of Deckers Creek watershed streams according to the list, including Hartman Run, the unnamed tributary from Deep Hollow, Glady Run, Slabcamp Run, Dillan Creek, Laurel Run and Kanes Creek, as well as Deckers Creek itself. The unnamed tributary from Fairfax Pond in Arthurdale is on the list for impairment by lead.

For waters that are impaired, the state must prepare a clean-up plan. These plans are known as “total maximum daily loads” (TMDLs). The TMDL for the Monongahela River encompasses its tributaries, including Deckers Creek (USEPA, 2002). TMDLs break larger watersheds down into sub-watersheds, estimate the total amount of a particular kind of pollution (e.g., iron) that is discharged into it, and then calculates a target: the maximum amount that could be discharged without impairing that sub-watershed’s streams. Table 3 shows these target values for the Deckers Creek watershed.

If the TMDL determines that pollution must be reduced, the state must find a way to achieve those reductions. If the pollution is from a point source, such as an active coal mine, and more importantly if some party has a permit to discharge the pollution, then the state can reduce pollutant loads by adjusting the amounts that the point source is allowed to discharge. If, on the other hand, the pollution is from a nonpoint source, which includes sources such as farming and forestry as well as abandoned mines, then the state must find other ways to solve the problem.

Fortunately, the USEPA provides funds to states that must clean up nonpoint source pollution. These are known as “319” funds because they are described in Section 319 of the CWA. In order to use these funds, a watershed based plan (WBP) must be approved, which demonstrates that projects supported by the funds will:

- Achieve the load reductions described in the TMDL
- Improve water so that water quality standards are met
- Remove the stream from the list of impaired water bodies.

Box 8: Types of coal mines in the Deckers Creek watershed.

Permitted mines – Mine sites that began operation post-1977, after SMCRA was put into law. Operators are required to post bonds for each mine as an incentive to reclaim the site to preexisting conditions. Bonds are held by the state if a mine is abandoned, and are used to fund reclamation projects on these sites.

Bond forfeiture sites (BFS) – Permitted mines that have been abandoned before all bonds were released. Bonds are forfeited when post-mining reclamation standards required by SMCRA are not met by the operator. AMD is often found at these sites.

Abandoned mine lands (AMLs) – Sites mined and abandoned pre-1977. These mines are not subject to SMCRA. Funding to reclaim these sites is generated from a tax placed on mined coal and from other state and federal grant programs.

A two-pronged plan

FODC completed a WBP for the entire watershed in 2005 (Christ, 2005). The plan, which has been accepted by both WVDEP and USEPA, provides information on nonpoint source pollution entering Deckers Creek. This baseline information will help track the improvements in the creek's water quality as projects are designed and executed.

Eliminating AMD from Deckers Creek will require both active and passive treatment. AMD from abandoned mine lands is usually treated using passive methods, whereas mines that release water during current mining operations treat it actively (Box 8). In active treatment, an alkaline material is mixed with AMD, which is then conveyed to a settling pond where metal oxides come out of solution and settle to the bottom of the pond as sludge. This kind of treatment needs ongoing inputs of money, materials and energy. In passive treatment, on the other hand, water is conveyed through one or more structures that treat the water. These structures usually include limestone to neutralize acidity, and some means to exclude or consume oxygen (Box 9). When AMD is treated in the presence of oxygen, limestone gets covered with an iron oxide "armor" that slows down acid neutralization. Until recently, it was assumed that after installation, passive treatment measures would need little monitoring or upkeep. Current practitioners are now researching how long the various treatment techniques will remain effective, and what sort of maintenance plans can keep the acid neutralization rate high.

In the Deckers Creek watershed, most of the AMD sources can be treated using passive methods. The most important exception is the Richard mine. The drainage from the Richard mine is too voluminous and too concentrated to be treated passively in the small area where it comes out of the mine and travels to Deckers Creek.

The two kinds of AMD sources — those that can be treated passively and those that cannot—are the two paths in the plan to solve the AMD problems in Deckers Creek.

Passive treatment projects

The DCRT will carry out passive treatment projects starting at the headwaters of Kanes Creek and moving downstream to the confluence with Deckers Creek, and then downstream on Deckers. Sources in other tributaries will be addressed as confluences are encountered. Passive treatment projects are split into high and low priority groups to give flexibility in planning. If small amounts of funding are available, smaller projects may be executed out of order. The major sources are mapped in Figure 44.

Drainage from Upper Freeport mines usually contains acidic water with substantial concentrations of iron, aluminum, and dissolved oxygen. Reviews of AMD treatment methods generally suggest reducing and alkalinity producing systems (RAPS) for this kind of AMD (e.g., Watzlaf et al., 2004). The sulfate-reducing bioreactor (SRB) is a recent modification of RAPS.

A computer program, “AMDTreat,” can be used to calculate the size of the installation that will be needed to treat the water (OSM, 2005). If a RAPS (called a “Vertical Flow Pond” in AMDTreat) is sized according to the amount of acidity from the Valley Point #12 site, for example, it would take up an area 270’ by 147’, or about 0.9 acres.

Constraints related to the layout of sites and the desires of landowners frequently affect the exact size and nature of the treatment measures. Designers continue to innovate to devise better and more predictable systems.

The first project on the list is Valley Point #12. FODC secured 319 funds from WVDEP and WCAP funds from OSM, hired Skelly & Loy, an engineering firm to design a system to treat this water, and Charles E. Bolyard and Son to build it. This project was completed in 2008.

The next two projects are Kanes Creek South Site #1 and Valley Highwall #3. We have secured 319 funds from WVDEP and WCAP for these sites and hired an engineering firm to design the system, but we have not yet moved into the construction phase for these projects. After these three sites are addressed, there will be no large AMD sources to Kanes Creek above mile 2.6, where Sandy Run contributes AMD from an impaired watershed. FODC has also secured 319 funds from WVDEP and WCAP for Sandy Run, Kanes Creek South Site 3, and Morgan Mine Road. We will be seeking

Box 9: Common methods for passive treatment of AMD.

Aerobic Wetland: A shallow wide area, usually with plants, spreads water out and slows it down. Oxygen diffuses into the water and oxidizes iron and manganese and metal oxides settle out of solution. These require neutral or net-alkaline water.

Anoxic Limestone Drain: Anoxic water is kept anoxic as it flows through a limestone passage. Neutralization takes place without oxidized iron coating the limestone.

Compost Wetland: This is a shallow area where water movement slows. This form of wetland is loaded with compost and usually limestone. The compost prevents iron oxidation and sometimes turns oxidized iron back to the reduced form. It may also neutralize AMD with the alkalinity formed by sulfate reduction.

Grouting: Mine voids are occasionally filled back up, often with some kind of combustion ash that sets up like concrete. Grouting can divert water from acid-forming material.

Manganese Reduction Bed: Leading AMD through limestone beds after aluminum and iron have been removed can cause manganese to precipitate out of solution.

Open limestone channel: Simple v-shaped channels with limestone are frequently used to convey water from one place to another on reclamation sites. These channels neutralize some acidity, but are equally important for keeping water from eroding away the soil that covers acid-forming material.

Reducing and alkalinity producing system: These systems are similar to compost wetlands, but they force the water to drain through the compost and then allow it to interact with limestone.

Sulfate-reducing bioreactor: These pass water through an organic layer similar to the one in RAPS. The layer is deeper, and the oxygen demand should be stronger, so that sulfate is reduced (Photo 15).

Wet seals: Portals where water drains from a deep mine must be sealed so that the path the water takes is controlled, and so that no one can get into the mine.

conceptual designs from engineering firms for these remediation projects in the fall of 2008.

NRCS has also completed two projects. The Dillan Diversion project consists mainly of an OLC that prevents unpolluted water from entering unconsolidated mining spoil, where it would become acidic. The Goat #2 project consists of OLCs and a limestone-lined settling pond. NRCS expects to construct the Goat #1 site, which will be similar to the Goat #2 site, in 2009.

Figure 44. AMD projects in the Deckers Creek watershed.

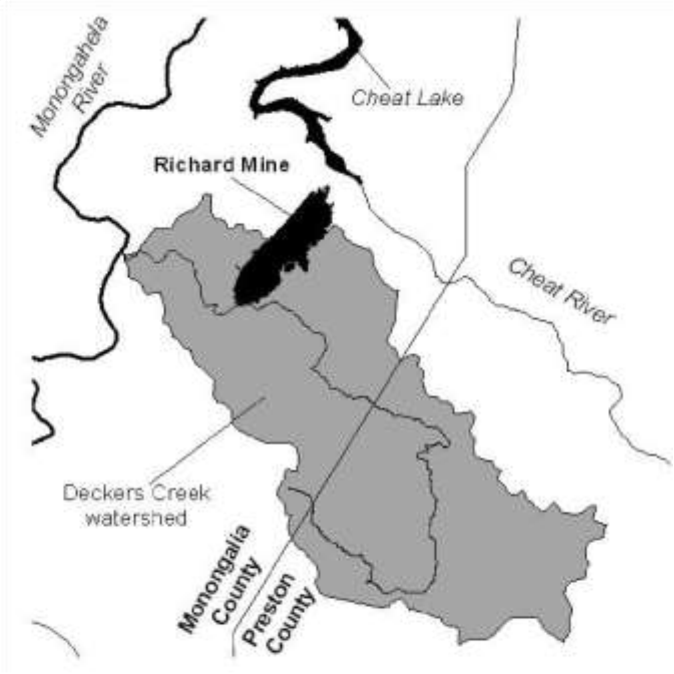


Figure 45: Location of the Richard mine relative to Deckers Creek and Cheat Lake.

Active treatment: the Richard mine

The drainage from the Richard mine will require a bigger, more complex project. This mine occupies approximately three square miles underneath Brookhaven, and reaches nine tenths of the distance from Deckers Creek to Cheat Lake (Figure 45). NRCS is taking the lead on this project. They conducted a review of all the possible methods for addressing AMD at this site, and determined that an active treatment facility would be the most dependable method. NRCS has funding to construct a treatment plan and is developing agreements with other agencies, especially WVDEP and the West Virginia Conservation Agency, to identify who will operate and maintain it.

The Richard Mine discharges approximately 200 gpm of water carrying roughly 1000 mg/L acidity, enough acid to dissolve 760,000 pounds of limestone each year. It discharges approximately 800 lbs. of metals into Deckers Creek daily.

The annual cost of an active treatment system for the Richard mine is difficult to determine. According to preliminary calculations by WVDEP, treatment might cost as much as $160,000 per year. The largest proportion of that cost is the chemical agent, either pebble quick lime or hydrated lime, for neutralizing the AMD. That amount also includes electricity for mixing the AMD and the chemicals and for pumping sludge out of the settling ponds, maintenance, monitoring and other labor costs. Community, business and government support will be necessary to maintain such a project.

REFERENCES

Christ, M., and M.J. Pavlick. 2005. Watershed based plan for the Deckers Creek watershed, Preston and Monongalia Counties, West Virginia. Morgantown, WV: Friends of Deckers Creek. March.

Henson, E.B. 1950. Bottom fauna in relation to the hydrogen-ion concentration of lower Deckers Creek basin. Masters Thesis, West Virginia University.

Lathrop, J. M., H. C. Penny and W. R. Proctor. 1886. An Atlas of Marion and Monongalia Counties. D.J. Lake & Co. Philadelphia, PA.

Mains, C., B. Williams and C.-W. Wang. 1999. Deckers Creek Stream Quality Inventory. Friends of Deckers Creek, Dellslow, WV.

NRCS (United States Department of Agriculture Natural Resources Conservation Service). 2000. Supplemental watershed plan no. 1 and environmental assessment for the upper Deckers Creek watershed, Preston and Monongalia Counties, West Virginia. Morgantown, WV.

Office of Surface Mining, Reclamation, and Enforcement (OSMRE). 2005. AMDTreat, version 3.2. http://amd.osmre.gov/amdtreat.asp. Accessed March 2005.

PFBC (Pennsylvania Fish and Boat Commission). 2006. Pennsylvania Fishes website, Chapter 16: Trout and Salmon. http://sites.state.pa.us/PA_Exec/Fish_Boat/pafish/fishhtms/chap16.htm.

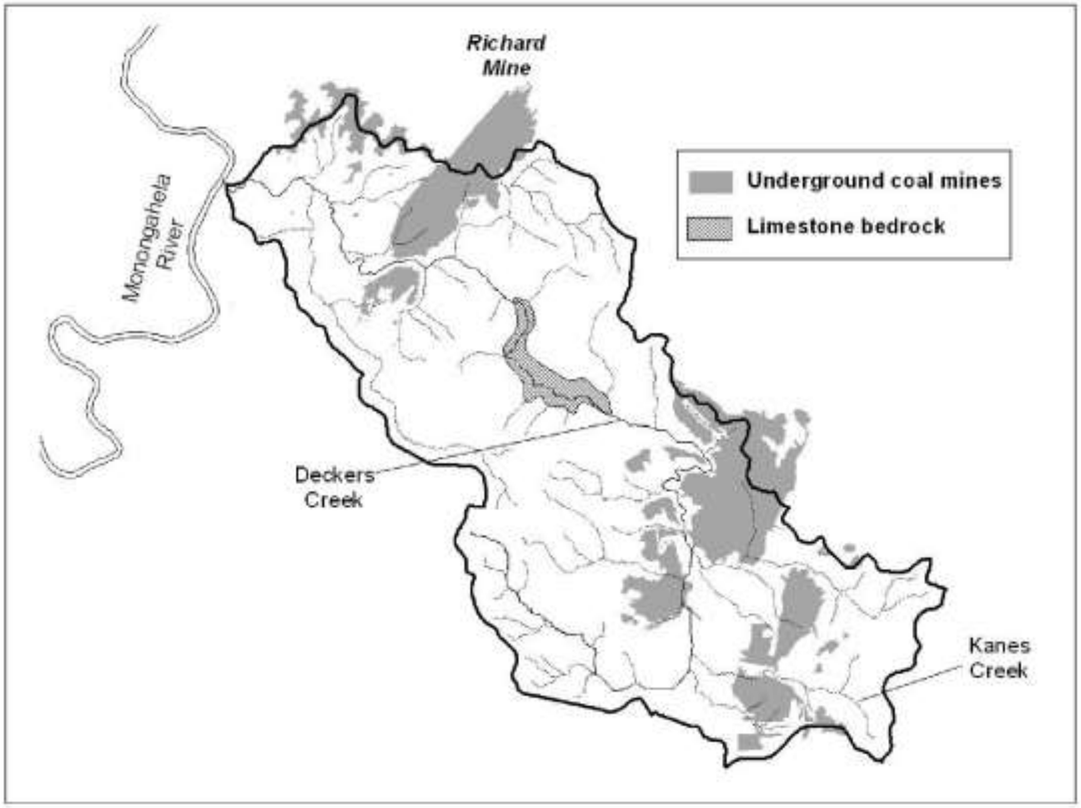
Stewart, J. 2001. Changes in water quality in Deckers Creek from 1974 to 2000. Masters Thesis, West Virginia University.

Teti, M.J. 1975. The surface water geochemistry of Deckers Creek drainage basin, West Virginia. Masters Thesis, West Virginia University.

USEPA (United States Environmental Protection Agency). 2002. Metals and pH TMDLs for the Monongahela River watershed, West Virginia. USEPA, Philadelphia, PA. September.

Watzlaf, G. R., K. T. Schroeder, R. L. P. Kleinmann, C. L. Kairies, and R. W. Nairn. 2004. The passive treatment of coal mine drainage. U. S. Department of Energy National Energy Technology Laboratory report DOE/NETL-2004/1202.

WVDEP (West Virginia Department of Environmental Protection). 2005. WV Save Our Streams website. Division of Water and Waste Management. www.wvdep.org/item.cfm?ssid=11&ss1id=202. Accessed March 4.



Deep mines in the Deckers Creek watershed.

Photo 20: Rebecca Rhodes, Ben Brinkman and Martin Christ show off the newly built and installed weir placed in an unnamed tributary to Sandy Run in the Kanes Creek sub-watershed.

Photo 21: Construction of an AMD remediation project at VP12 in the upper portion of the Deckers Creek watershed.

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