Greene County Conservation District
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This Rivers Conservation Plan is the result of nearly four years of study and data compilation. A special thanks goes out to various agencies including the Natural Resources Conservation Service, Department of Environmental Protection, Pennsylvania Game Commission, and Pennsylvania Fish and Boat Commission for their efforts in collecting and analyzing data within the watershed.

This data as well as the photos were compiled and incorporated into this study by W. Steven Hegedis, Erosion & Sedimentation Control Technician with the Greene County Conservation District.

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Executive Summary

Early in 1996, the Greene County Conservation District received a grant funded through the Keystone Recreation, Park and Conservation Fund Act. This grant authorizes the Pennsylvania Department of Environmental Protection (PADEP) to provide technical and financial assistance to the Greene County Conservation District for developing a rivers conservation plan for the Dunkard Creek Watershed. This plan will ultimately put Dunkard Creek on the Pennsylvania Rivers Conservation Registry which recognizes local efforts for rivers conservation planning and encourages consistent staff action with these plans.

Public participation and assistance is an essential aspect of rivers conservation planning. At the beginning of this study, several public meetings were held throughout the watershed to get a sense of what the public was concerned about in the watershed. From these meetings we came up with seven top issues of concern in the watershed. They are as follows from most important to least important: Acid mine drainage, trash dumps, erosion and sedimentation, promote awareness of stream, raw sewage, water quality and promote heritage and recreation.

We began collecting data on the land resources, water resources, biological resources and cultural resources of Dunkard Creek with these issues in mind. The PADEP began water sampling in Pennsylvania in April of 1996 and finished sampling in April of 1997. West Virginia contracted the services of Sturm Environmental Services to sample the West Virginia portion of the watershed. They began sampling in July of 1996 and finished sampling in July 1997. To supplement this data, 8 acid mine drainage sites located around the Taylortown-Bobtown area and 3 sites along Interstate 79 were located in the lower section of the watershed. Waynesburg College's Department of Chemistry took on the task of sampling these sites. To further supplement our sampling, Americorp began sampling the upstream and downstream sections of the acid mine discharges.

On October 6 and November 16 of 1998, the PADEP did a study to assess the biological health of Dunkard Creek according to its macroinvertebrate population. Seven sections along the main stem of Dunkard Creek were studied from the Pennsylvania Fork downstream to the last wadeable section of the creek, midway between Bobtown and Poland Mines.

Dunkard Creek historically has suffered from abandoned mine drainage (AMD) and nutrient enrichment from malfunctioning or nonexistent on-lot systems and agricultural runoff. Upon review of the water sample data provided by the PADEP, the lower 6.2 miles of Dunkard (downstream of Taylortown) is severely impaired by acid mine drainage. An estimated 530 tons of acidity emanates from several acid mine discharges in this section of the creek. The highly alkaline (buffered) water in Dunkard Creek neutralizes the acid causing the pH of the mine water to rise. This increase in pH allows the iron (94 tons/year) and aluminum (55 tons/year) to precipitate on the stream bottom. It is this precipitation of iron and aluminum on the stream bottom that makes Dunkard Creek a nearly sterile stream, devoid of all life, from Taylortown to its mouth on the Monongahela River. In September of 1998, the Pennsylvania Fish and Boat Commission reported a large fish kill on Dunkard Creek at the Taylortown bridge. A large acid mine drainage site just upstream of the kill was the cause of this kill. The site discharged a high concentration of aluminum. This high concentration was more than the stream could assimilate thus the large fish kill.

According to a 1994 report by the PADEP (1994 DEP 305(b) Report), an estimated $66,690 in recreational use of Dunkard Creek is lost per year due to the degradation of acid mine drainage. The eight discharges sampled by Waynesburg College showed pH's in the 2 to 5 range as well as high iron and acidity. It is for these reasons that we have chosen to focus on these discharges. Nearly all of the discharges are located on steep slopes and very close to Dunkard Creek. We are looking at possibly piping the discharges to areas where a passive treatment facility can be implemented. The passive facilities being considered are aerobic wetlands, successive alkalinity-producing systems (SAPS) and anoxic limestone drains (ALDS). The preliminary cost estimate will be nearly 2 million dollars. Engineers from the Natural Resources Conservation Service (NRCS), Somerset office will be designing treatment facilities for each discharge site as well as coming up with the cost estimates.

For the issue of trash dumps, we are focusing on three very large illegal roadside dumps in the lower section of the watershed. They are located in the Bobtown area. All three dumps are located on very steep slopes near the creek. These steep slopes will make clean up of these dumps challenging as well as costly. We are looking into the possibility of using draglines to get the garbage off the steep slopes as well as old fashioned physical labor. Preliminary cost estimates have been determined by engineers from the NRCS Somerset office at approximately $200,000. Before these dumps are actually cleaned up, a plan must be implemented within the municipalities to begin a clean up day. These clean up days would give the public the opportunity to get rid of large bulky items once or twice a year.

Erosion and sedimentation appears to be more of an issue in the upper watershed, where a majority of the livestock farming operations exists. Dirt and gravel roads located in the watershed also contributes to the sedimentation in the watershed. The option for this issue would be to assist landowners in implementing Best Management Practices such as streambank fencing, agricultural crossings and riparian buffers. Another would be to increase participation and thus implementation of the Dirt and Gravel Roads program to eliminate sedimentation from dirt and gravel roads.

The Dunkard Creek Watershed Association (DCWA) was formed on November 14, 1995 at the Mason-Dixon Park. The Watershed Associations purpose is to recognize and solve problems common to communities in the Dunkard Creek Watershed. The DCWA will be taking on the issues of promoting the awareness of Dunkard Creek as well as the issue of promoting the heritage and recreation of the creek. They have already begun this task by sponsoring float trips and fish stockings and will also serve as a clearinghouse for information on the Dunkard Creek Watershed. There were four signs installed along highway bridges by the WV Department of Highways at the request of DCWA, identifying Dunkard Creek below.

Raw sewage has become less of an issue throughout the Dunkard Creek Watershed due to the recent upgrade or installation of sewage treatment facilities in populated areas such as Bobtown, Mount Morris, Blacksville and Brave. There is obviously still the issue of malfunctioning private septic systems throughout the watershed. These areas have not been pinpointed as of yet. The sample data to date is not really showing such problems in the watershed. We will be trying to investigate and identify these areas to determine their impact on the stream.

After reviewing the water quality sample data, the PADEP has determined that water quality in the Dunkard Creek Watershed in general is good. Physical characteristics such as limestone geology and a forested stream corridor lessen the overall impacts of the acid mine drainage on the water quality. However, close examination of several past studies of the benthic community reflect the stressed environment as the majority of the macroinvertebrates are facultative in their response to pollution. Although the buffering capacity of Dunkard Creek keeps the water column near neutral, the quantity and quality of the acid mine drainage is more than the stream can assimilate. The substrate is covered and cemented by iron and aluminum precipitate making it devoid of all aquatic life.

Introduction

The Dunkard Creek Watershed drains 234.65 square miles in Greene County, Pennsylvania and Monongalia County, West Virginia. The Chapter 93 Water Use Protection Category for Dunkard Creek is Warm Water Fishes. The purpose of this study is to look at several issues and concerns that the public has brought to our attention via public meetings concerning the watershed. Once these issues are identified, recommended policies and actions will be undertaken to conserve, restore and/or enhance the river resources and values. This process will ultimately include Dunkard Creek on the Pennsylvania Rivers Conservation Registry. The purpose of the Rivers Conservation Registry is to promote the conservation of rivers and river values, officially recognize community plans for conserving rivers and river values, and facilitate consistent state action with local river conservation plans.

This study was funded through the Keystone Recreation, Park and Conservation Fund Act, Act 50 of July 2, 1993, P.L. 359 authorized by the Department of Environmental Protection (DEP). Procedures for implementation of the legislatively authorized grants program as well as the parameters for a rivers conservation planning process and a rivers conservation registry including technical assistance have been developed by the department and incorporated into an initiative referred to as the Pennsylvania Rivers Conservation Program.

The planning process for this watershed study was organized in a nine-step sequence for carrying out planning activities that are required to secure registry status. The first step was to conduct informational public meetings. Several meetings were held at various locations within the watershed. It was from these meetings that we got a list of issues and concerns from the public.

The second step was to identify and collect resource data from the watershed. The purpose of this step is to identify and inventory the physical, natural, institutional and cultural resources that are located within the watershed that are directly related to the problems and concerns. Various individuals from federal, state, and local government as well as private citizens were split into three committees, the Physical Resources Committee, the Natural Resources Committee, and the Cultural Resources Committee.

Step three involved the analysis and evaluation of resource data as it relates to issues and concerns identified in the planning process. The fourth step was to prepare a preliminary findings report and management options plan. The preliminary findings report and management options plan was presented to the public at workshops for their review and comment.

Step number five was to prepare and present a draft Rivers Conservation Plan. This contained the preliminary findings report, modified and revised to reflect the recommendations and comments received at the previous workshops. This draft plan was also presented at workshops to gain support from the public and affected municipalities. Step six was to finalize the River Conservation Plan.

Step seven will be to present the final River Conservation Plan at a public hearing in at least one of the affected municipalities. Step eight will be to submit the final Rivers Conservation Plan and transcript of the public hearing to affected municipalities for supporting resolutions. The ninth and final step will be to submit the River Conservation Plan to DEP for approval and for inclusion in the Pennsylvania Rivers Conservation Registry.

W. Steven Hegedis, an Erosion and Sedimentation Control Technician working with the Greene County Conservation District coordinated this watershed study. Special recognition is due to the following individuals who are members of the steering committee:

Susan Funka-Petery, Supervisor District Conservationist, PA NRCS
Dan Rush, District Manager, Greene County Conservation District
Joel Folman, Mining Inspector, PA DEP
Vince Yantko, Water Quality Specialist, PA DEP
Tim Hamilton, Mining Inspector, PA DEP
Maggie Hall, PA DEP Bureau of District Mining Operations
Dan Seibert, PA NRCS, Somerset Office
Isaac Wolford, District Conservationist, WV NRCS
Pat Bowen, WV NRCS
Valerie Cole, Greene County Planning Commission Director
Peggy Pings, WVU, Department of Forestry
Andrew Price, President, Dunkard Creek Watershed Association
Kevin Mountz, WCO, PA Game Commission
Russ Connelly, Waynesburg College Contact

Summary of Data Collected

Various governmental agencies collected data on the Dunkard Creek watershed for this study. This data can be sorted into the following categories:

1. Land Resources - Topography, land use, soil characteristics, ownership, critical areas and hazard areas.

2. Water Resources - Major tributaries, wetlands, floodplain, water quality and water supply.

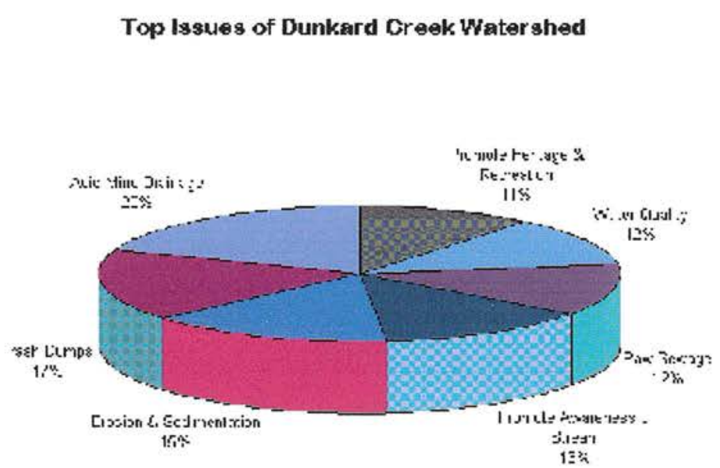
3. Biological Resources - Wildlife, vegetation and PNDI species

4. Cultural Resources - Recreation, archaeological and historical.

Top Issues of Concern

Public participation and assistance is an essential aspect of rivers conservation planning. At the beginning of this study, public meetings were held at various locations within the watershed. The purpose of these meetings was to gain public input concerning the watershed. A survey was distributed at these meetings. The survey asked the public to list the top five issues they would like to see addressed by this study. They were also asked to rank these issues from 1 to 5, 1 being most important and 5 being less important. Figure 1 shows the top issues listed by the degree of interest.

FIGURE 1.



Other issues that are lower in priority include: poor fishing, bi-state coordination, low water problems, improve boating access, natural debris backs up water at bridges, and natural gas leaks.

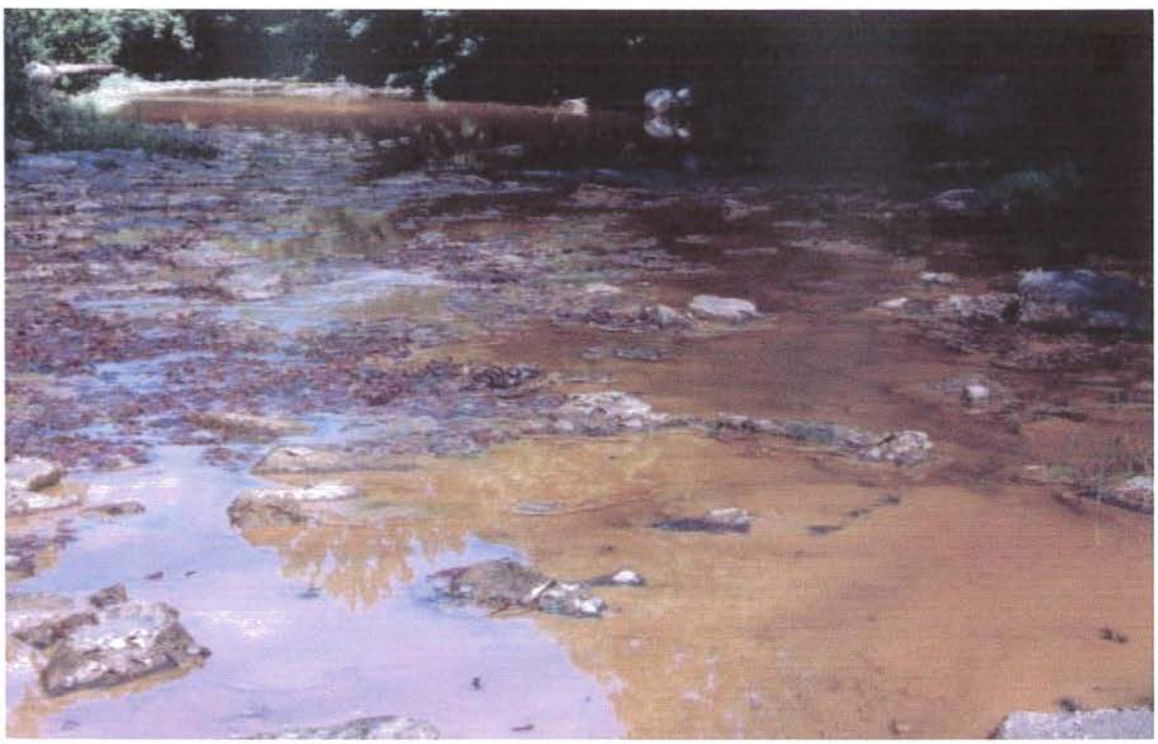
Overview of Management Options

The following is a brief overview of the management options that will be considered to deal with the issues of concern brought about by the public. For a more detailed look at these options, see the management options section toward the end of this report.

Acid Mine Drainage

Coal mining and processing is a major industry in the watershed. Most of the coal is extracted through deep mining of the Pittsburgh and Sewickley seams. Surface mining is also present, but is much less prevalent due to the depths of the coal seams.

Dunkard Creek has a history of acid mine drainage pollution, most of it occurring from the vicinity of Taylortown, PA downstream. Most of the problems are caused by drainage from several abandoned deep mines and barrier breaching along the valley walls from Taylortown to the mouth.



Several large acid mine discharges located along Dunkard Creek from Taylortown, PA downstream have contributed to the severe degradation of the stream.

Eight large acid mine discharges were located along Dunkard Creek from Taylortown downstream. See Figure 8 on page 36 for exact locations of these discharges. Each discharge was sampled by Waynesburg College to determine the severity of each discharge. Due to the steep slopes and the proximity of the discharge to the stream, treatment of these discharges will be difficult. The possible options we are looking into for treating these sites include piping these discharges to areas where treatment facilities can be implemented. The treatment facilities that will be considered are aerobic wetlands, Successive Alkalinity-

Producing Systems (SAPS) and Anoxic Drains. Please refer to the management options section for more detail of these facilities.

Trash Dumps

Trash appears to be a large problem in the lower section of the watershed. Three large dumps are located along Dunkard Creek near Bobtown, PA. The biggest problem in the area is, there are no landfills located nearby. People have no place to take their large trash items such as refrigerators, couches, etc. so they dump it along the creek.

Management options for this issue include encouraging municipalities to have a spring and fall clean up day. Once this has been established, we will try to clean up the large existing illegal dumps. This will prove to be a difficult task due to the very steep slopes that these dumps are located on. One option being considered is the use of a dragline to remove the large trash items from the steep slopes. The trash will then be trucked to a garbage dump.

Erosion and Sedimentation

This is mainly a problem in the upper watershed where most of the livestock farming operations are located. Dirt and gravel roads that are located in the watershed also contribute to the sedimentation. Options include assisting landowners in implementing Best Management Practices such as streambank fencing, agricultural crossings and riparian buffers. Another would be to increase participation and implementation of the dirt and gravel roads program to eliminate sedimentation from dirt and gravel roads.

Promote Awareness of the Dunkard Creek

This is going to be taken on by the Dunkard Creek Watershed Association. Some of the things that they have discussed to promote the stream are setting up a page on the Internet for Dunkard Creek, holding wildflower walks, and 3-4 day field trips. They will also serve as a clearinghouse for information on the Dunkard Creek Watershed.

Raw Sewage

This issue is becoming less of a problem in the watershed due to populated areas recently installing or upgrading public sewage facilities. Although there are pollution contributions from malfunctioning on-lot sewage systems, the water quality data is not pinpointing such problems. The management option would be to investigate and identify such areas in the watershed and determine their impacts on the stream.

Water Quality

The results from the water sample data show water quality in the Dunkard Creek Watershed to be surprisingly good. Dunkard Creek has been documented in past studies as having a tremendous buffering capacity due to its limestone geology. It is this buffering that causes the pH of the mine water to rise, which in turn allows iron and aluminum to precipitate on the bottom. Acid mine drainage, erosion and sedimentation, and raw sewage are all issues of water quality, therefore, the management option for those issues will take care of the water quality issue.

Promote Heritage and Recreation

The Dunkard Creek Watershed Association will take on this issue. They have already begun by stocking a section of Dunkard Creek near the Mason-Dixon Park with trout. Local fisherman are invited to fish the area for the trout. There is also a need to help locate and record undocumented archaeological sites in the watershed.

Dunkard Creek Watershed Characteristics

Dunkard Creek is formed by the confluence of the Pennsylvania and West Virginia Forks of Dunkard Creek at the village of Shamrock on the Pennsylvania-West Virginia border. From there it flows from west-to-east, crossing the Mason-Dixon Survey Line several times to the town of Mount Morris, then continuing in an easterly direction to its mouth on the Monongahela River at River Mile (RM) 87.20, near the village of Poland Mines.

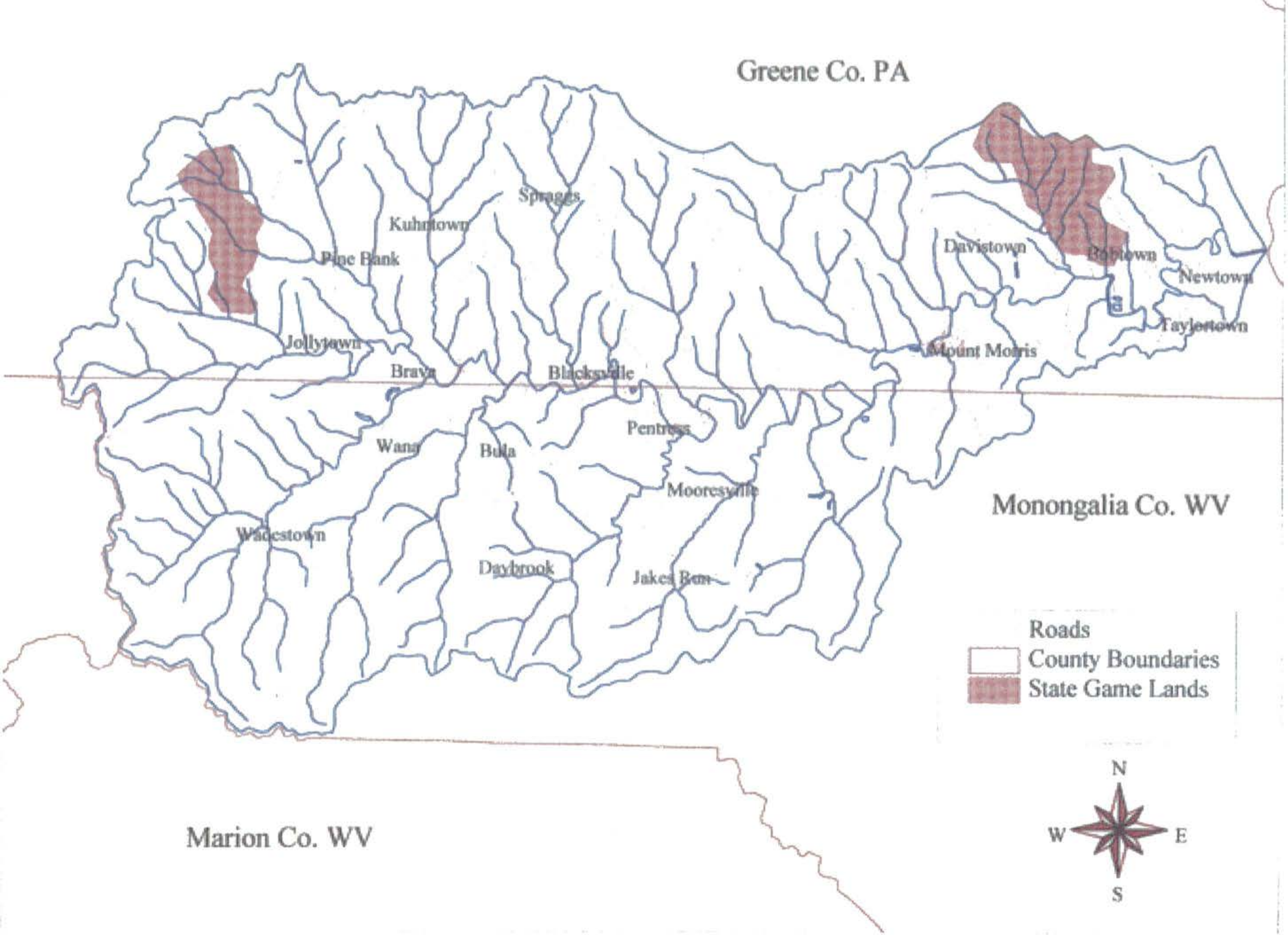
Steep forested hills and precipitous valleys characterize the watershed. This topography provides numerous scenic overlooks such as this one located upstream of Taylortown.

Dunkard Creek is part of the Monongahela River subbasin which drains into the Ohio River. It is identified as Hydrologic Unit Code 05020005010. The creek flows for 36 miles and drains 150,177 acres. 78,827 acres of the watershed drains 9 townships in Greene County, Pennsylvania while 71,350 acres drains 3 districts in Monongalia County, West Virginia.

MAP OF WATERSHED

Steep ridges form the western, southern, and eastern boundaries. The northern boundary of the watershed follows along the Warrior Trail. The hydrologic boundary to the west runs along the boundary line between Monongalia County, WV and Wetzel County, WV and on the south with the Marion County, WV boundary. The elevations along these ridgetops range from around 1500 ft. to over 1600 ft. above mean sea level. The highest recorded elevation in the watershed is 1686 ft., which is the U.S.G.S. Jackson Triangulation Station located on Bake Oven Knob (on the Monongalia-Marion County line in West Virginia) near the headwaters of Miracle Run. Dunkard Ridge forms the eastern boundary of the watershed.

Dunkard Creek Watershed



Flows are augmented by numerous tributaries that drain the short hollows that characterize the terrain of the watershed. The largest of these found in Pennsylvania are Pennsylvania Fork, 24,098 acres; Toms Run, 11,258.55 acres; Roberts Run near Blacksville, 7,766.17 acres; Hoovers Run at Brave, 7213.76 acres; Rudolph Run, 6,453.42 acres, Shannon Run near Mt. Morris, 6,258.55 acres and Meadow Run near Davistown, 4,895.85 acres. The major tributaries found in West Virginia are West Virginia Fork, 16,232.57 acres; Miracle Run, 14,854.24 acres; Days Run, 9,237.49 acres; Jakes Run, 8,203.83 acres and Dolls Run, 6,966.92 acres.

TABLE 1. Land Use Distribution of the Dunkard Creek Watershed

Land Use	Percentage
Forest	63%
Pasture	18%
Urban	3%
Cropland	2%
Other	14%

Social/Economic Profile

Population

Population in the Dunkard Creek Watershed is estimated at 11,000. The estimated population in 1998 for Greene County is 40,742 and 77,505 for Monongalia County. The 1990 Census indicated that there were 39,550 in Greene County and 75,509 in Monongalia County. If the estimate is correct it shows a 3% increase in Greene County and 2.6% increase in Monongalia County in 8 years.

The largest population centers in the watershed are Bobtown, Mount Morris and Blacksville. Other small communities include Brave, Taylortown, Poland Mines, Pentress, Core, Wadestown, Wana and Jakes Run.

Employment

Coal mining has been the dominant employer in this watershed, employing several thousand miners during boom periods in the coal industry. From 1980 to 1996, underground coal mining jobs declined dramatically. The resulting impact on the Dunkard Creek Watershed has been a decline in population and changes in the employment from high paying coal mining jobs to lower paying service occupations.

Remnants of the once booming coal industry can be found throughout the watershed. The dramatic decline in coal mining jobs has led to a decline in population in the watershed.

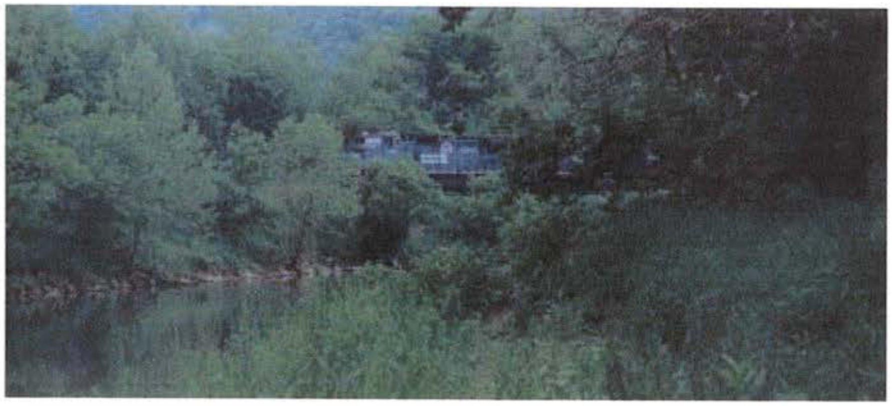
The primary employers in the watershed include Consolidation Coal Company, Eastern Associated Coal Company, Accurate Forging Corporation, Monongalia and Greene County schools and small service industries such as banks, convenience stores, small groceries and other small business. A few active logging and sawmill operations are located in the watershed. Morgantown, West Virginia and Waynesburg, Pennsylvania are both located approximately 7 miles outside of the watershed and serve as the major employment centers for most of the watershed residents.

The unemployment rate for Monongalia County is 3% compared to 5.9% for West Virginia. The unemployment rate for Greene County stands at 7.4%, which is the second highest rate in Pennsylvania. The Pennsylvania State rate is 4.5%. The rate for the United States as a whole is 4.9%.

Income

Income levels in the Dunkard Creek Watershed are relatively good due to the influence of high paying mining jobs. Although these jobs are declining, the average weekly wage for miners remains the highest of all industries, resulting in high overall income levels for this watershed. There is a wide disparity among income levels of miners and non-miners, resulting in an upward bias of all income statistics for the Dunkard Creek Watershed. The 1996 per capita income in Monongalia County is $20,111 compared to $18,225 for West Virginia. The 1995 per capita income in Greene County is $14,269 compared to $20,996 for Pennsylvania. The 1996 per capita income for the nation is $24,436.

Railroads



Consolidated Rail Corporation (Conrail) has lines that traverse the western end of the Dunkard Creek Watershed, running in a north-south direction. This rail line services four mines in northern West Virginia as follows: Blacksville One and Two, Federal One and Loveredge. The branch that services these mines is known as the Waynesburg Southern.

Highways

The major interstate that traverses the watershed is Interstate 79. Its location is mid-eastern within the watershed area. There is one interchange located in the watershed at Mount Morris, being Exit Number One.

The primary State Routes (SR) are Pennsylvania Traffic Route 218, which begins in Waynesburg and runs south through the village of Spraggs and Blacksville, on the Pennsylvania and West Virginia border; United States Traffic Route 19, which passes through Waynesburg and Mt. Morris; and Pennsylvania Traffic Route 88 which is located on the very eastern terminus of the watershed. Pennsylvania State Route 18 runs along the northwestern border of the watershed.

Route 7 runs west to east through the West Virginia portion of the watershed. It follows along most of the West Virginia Fork of Dunkard Creek through the town of Wadestown and continues along the main stem of Dunkard Creek through Blacksville until it reaches Dolls Run. It follows along Dolls Run and exits the watershed toward Morgantown, WV.

Unique Features

During July, 1993 a survey was conducted to study the unionid fauna in the Monongahela River Basin and the direct tributaries to the Ohio River in southwest Pennsylvania (Bogan, 1993). It was reported that the unionid fauna inhabiting Dunkard Creek represents the most diverse unionid fauna existing in the Monongahela River Basin and is second in diversity to that found in French Creek in the Allegheny River Basin. Bogan suggests this fauna is potentially sheltered from the possible direct impact of the zebra mussel because the lower end of Dunkard Creek is blocked by the combined effects of pollution and acid mine drainage effectively sealing off the upper portion of Dunkard Creek from invasion of the creek from the Monongahela River. Dunkard Creek above the impacted area is a refuge for a large portion of the unionid diversity in the upper Ohio River Basin in western Pennsylvania. There were 20 species identified as having been present in the basin. This was the greatest unionid species diversity found in any of the tributaries in the Allegheny, Monongahela or Ohio River basins in western Pennsylvania. In his report Bogan states that Dunkard Creek should be the focus of a combined effort to preserve this fauna on the part of both the states of West Virginia and Pennsylvania.

A portion of Dunkard Creek was designated as Pennsylvania's first catch and release bass fishery during 1995 through 1998. A 4.2 mile stretch from the mouth of Shannon Run at the T-339 ford downstream to the SR 2009 bridge. Under the proposed regulations, only "no-kill" angling was permitted for all bass species in this section of water. This section of Dunkard Creek was considered suited to a special regulation because of good access, habitat, forage, and smallmouth bass abundance. Data is presently being collected and analyzed. The results will be published in a report in the year 2000.

Land Resources

Dominant rock types found in the watershed include shales, siltstones, and shaly limestone.

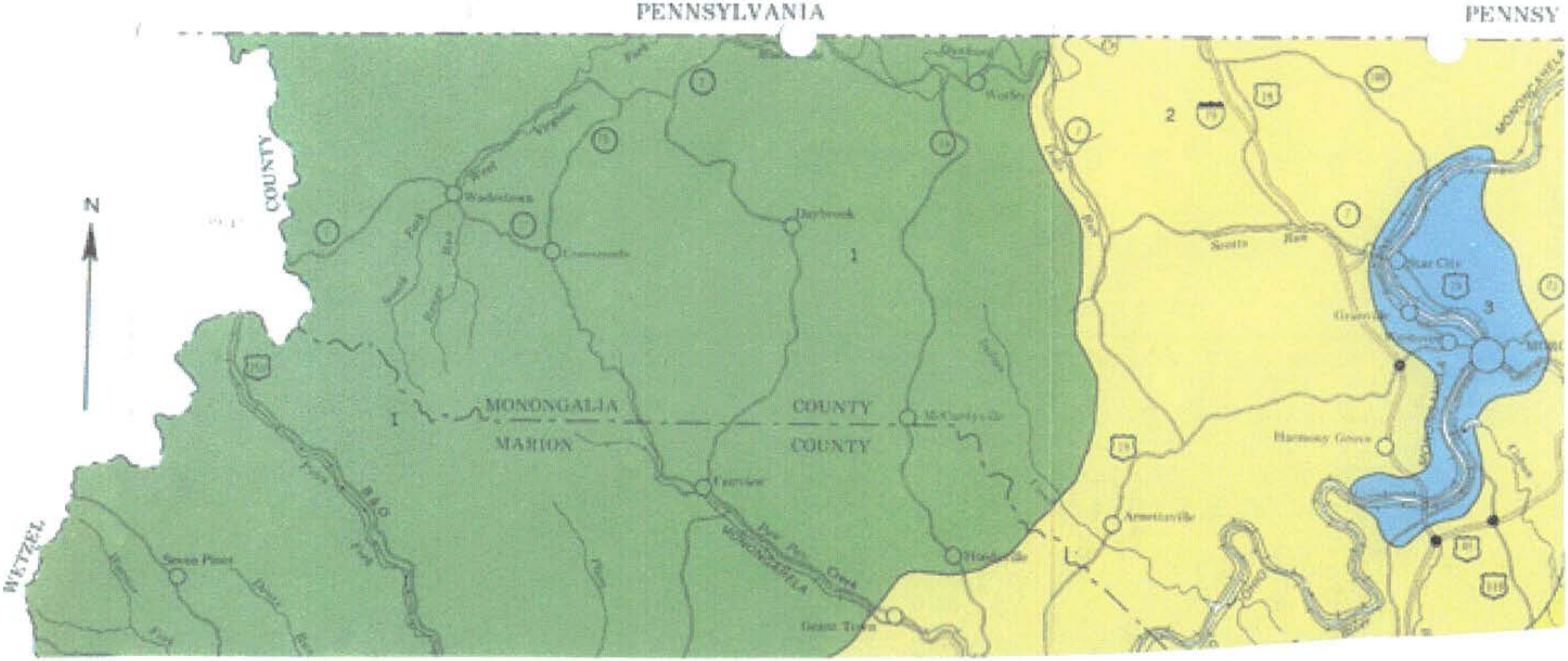
Soils and Geology

Dunkard Creek is in the Kanawha section of the Central Allegheny Plateau Province and originates at the confluence of the West Virginia Fork of Dunkard Creek and the Pennsylvania Fork of Dunkard Creek, west of Brave, PA. The topography of the watershed has rugged features. The ridgetops and valleys are narrow, and hillsides typically have slopes ranging from 15% to 65%. The sharp features are occasionally interrupted by long, narrow benches following the contours of the hillsides.

Dominant rock types, which outcrop in the watershed, are shales, siltstones, and shaly limestone of the Dunkard, Monongahela, and Conemaugh Groups. The Monogahela Group yields much of the commercial coal in the area. Within the three groups, aquifers occur in the sandstone, limestone, and coal.

The upland soils in the watershed are mostly Dormont-Culleoka and Gilpin-Culleoka-Upshur associations. These soils form the ridges, hillsides and benches. Floodplain soils in the narrow valleys of tributaries are typically Library-Newark or a Lobdell-Holly association. These soils are prone to flash flooding as a result of heavy rainfall in any season, or severe thunderstorms in summer. The soils in floodplains are suited for cultivated crops, pasture, or hay. They also have high productivity potential for trees, but very few acres are wooded.

Areas of Glenford and Monongahela soils are found on terraces along Dunkard Creek. They are deep, moderately well drained with a seasonal high water table. A variety of Udorthents are scattered throughout the watershed. These young soils forming in disturbed areas are classified by base status and type of soil surface disturbance or materials covering the



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WEST VIRGINIA UNIVERSITY AGRICULTURE EXPERIMENT STATION

GENERAL SOIL MAP

MARION AND MONONGALIA COUNTIES, WEST VIRGINIA

Scale 1: 190,080

FIGURE 4

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SOIL ASSOCIATIONS

1 Gilpin-Culleoka-Upshur association: Moderately steep to very steep well drained, acid and lime-influenced soils; on uplands

2 Westmoreland-Culleoka-Clarksburg association: Gently sloping to very steep, well drained and moderately well drained, lime-influenced soils on uplands and foot slopes

3 Monongahela-Zoar-Allegheny association: Gently sloping and strongly sloping, moderately well drained and well drained, acid soils; on terraces

4 Gilpin-Ernest-Lily association: Gently sloping to very steep, drained and moderately well drained, acid soils; on upland foot slopes

5 Dekalb-Buchanan-Ernest association: Strongly sloping to v well drained and moderately well drained, acid soils; on uplands and foot slopes

Compiled 1979

FIGURE 3

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

THE PENNSYLVANIA STATE UNIVERSITY, COLLEGE OF AGRICULTURE
AND THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
STATE CONSERVATION COMMISSION

GENERAL SOIL MAP

GREENE AND WASHINGTON COUNTIES, PENNSYLVANIA

Scale 1:253,440

LEGEND

1 — Dormont-Culleoka association: Moderately well drained and well drained, deep and moderately deep, gently sloping to very steep soils; on hilltops, ridges, benches, and hillsides

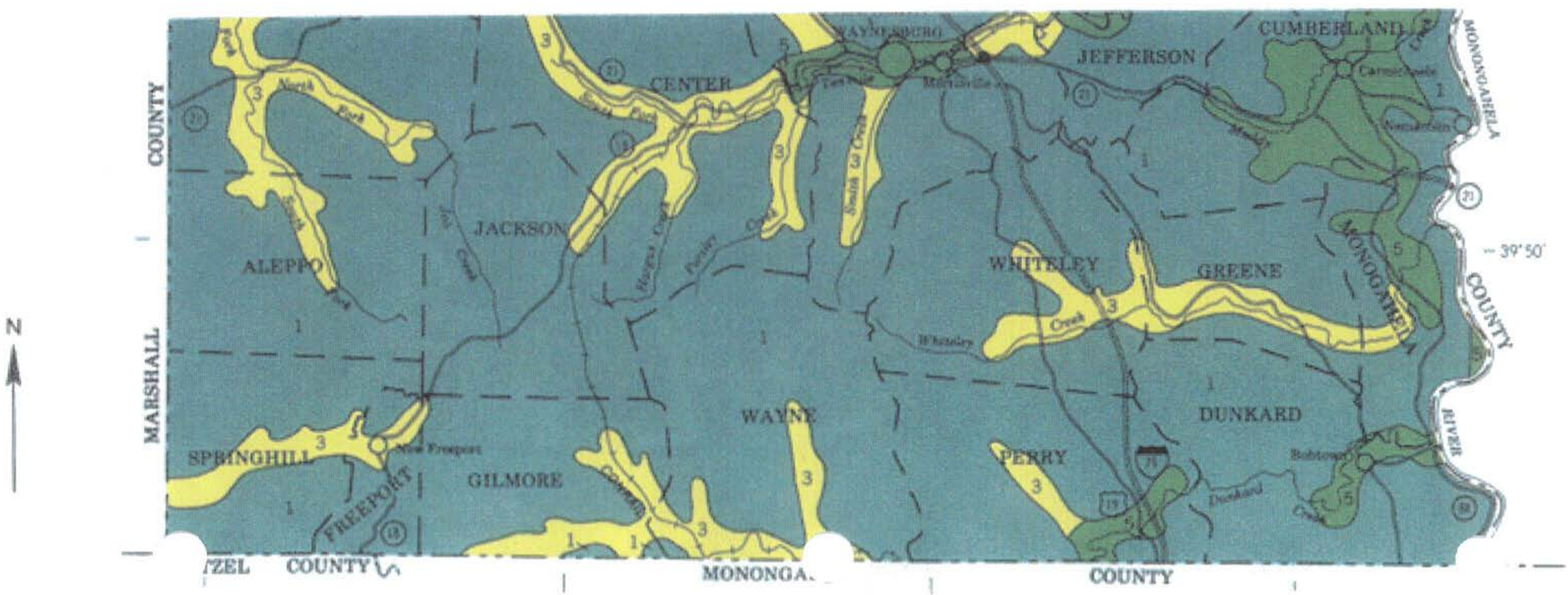
2 — Guernsey-Dormont-Culleoka association: Moderately well drained and well drained, deep and moderately deep, gently sloping to moderately steep soils, on hilltops, ridges, benches, and hillsides

3 — Dormont-Culleoka-Newark association: Well drained to somewhat poorly drained, deep and moderately deep, nearly level to very steep soils; on hilltops, ridges, benches, hillsides, and flood plains

4 — Udorthents-Culleoka-Dormont association: Well drained to somewhat poorly drained, very shallow to deep, gently sloping to very steep soils; on hilltops, ridges, benches, and hillsides

5 — Glenford-Dormont-Library association: Moderately well drained and somewhat poorly drained, deep, nearly level to sloping soils; on terraces and surrounding uplands

Compiled 1980



former soil surface. Briefly, the classes are either high-base or low-base variants of the following types: dumps, mudstone and sandstone, sandstone, and sandstone and shale. Udorthents are not assigned to a soil capability subclass.

Many of the soils in the Dunkard Creek Watershed are slip-prone. Particularly vulnerable are areas of Dormont and Upshur soils on steep hillsides. These soils have a high shrink-swell capacity and slips often occur when they are saturated. Furthermore, any of the soils on slopes greater than 15% and without vegetative cover are subject to slips as well as surface disturbances, which accelerate erosion. Generally, soils on 3-8% slopes are in soil capability subclass IIe. Soils sloping 8-15%, 15-25%, 25-35%, and >35% are in subclass IIIe, IVe, VIe, and VIIe, respectively. The "e" indicates soils vulnerable to erosive forces. Cultivated crops may be grown on soils in subclasses IIe and IIIe, and with limitations, on soils in subclass IVe. Soils in subclass IVe are better suited for pasture and hayland. Pastures are suitable for soils in subclass VIe, while woodland is the only recommended use for soils in subclass VIIe.

General Soil Map 1 General Soil Map 2

Ownership

Of the 150,177 acres in the Dunkard Creek Watershed, 5,735.699 acres are public land whereas 144,441.31 of the acreage are privately owned. This works out to 96.2% of the total acreage is privately owned and 3.8% is publicly owned.

Approximately 95% of the public land in the watershed is comprised of land owned by the Commonwealth of Pennsylvania, Pa Game Commission. Mason-Dixon Historical Park makes up the other 5% of public land. It is owned jointly by Greene County, Pennsylvania and Monongalia County, West Virginia. The property consists of 270 acres most of which is precipitous and wooded. The Pennsylvania-West Virginia state line bisects the acreage. Table 2 breaks down the public land found in the watershed by municipality.

TABLE 2. Ownership by Municipality

Township	Acres of Public Land
Dunkard	2,490.681
Gilmore	1,791.575
Jackson	914.500
Perry	249.630
Greene	154.313
Clay, WV	135.00
Freeport	--0--
Wayne	--0--
Whiteley	--0--
Monongahela	--0--

TOTAL	5,735.699 acres

Hazard Areas

A suspected petroleum hydrocarbon (PHC) release was discovered by the Pennsylvania Department of Environmental Protection (PADEP) along the bank of Dunkard Creek during a routine inspection of Accurate Forging's sewage treatment discharge on July 19, 1994. Accurate Forging is located at the intersection of SR 3009 and SR 3013 in Brave, Greene County, Pennsylvania, approximately 1/2 mile north of the West Virginia and Pennsylvania border.

According to a recent document by Peoples Natural Gas (PNG), the facility was owned and operated by PNG from 1906 through 1959 and once contained a natural gas compressor station, a natural gasoline plant, and water treatment and distribution facilities. The facility also reportedly contained, at one time, as many as 80 to 100 above ground storage tanks (3,000 to 4,000 gallons each) used to store natural gasoline prior to reported rail shipment. Demolition of the process facilities was conducted from 1959 through 1961. Currently, there are no visible signs of the former storage tanks or the process equipment in the area. The property was sold in 1961 to Bell's Warehouse and in 1963 to Accurate Forging Company.

The origin of the site PHCs have not been established; however, the former natural gasoline plant (e.g., typical operations) may have been a source of the PHCs. A containment type boom is currently being used along the stream bank at Accurate Forging. These control measures will be investigated, evaluated, and if warranted and necessary subsequently employed. Currently, Peoples Natural Gas and Accurate Forging Corporation are cooperating with the PA DEP to further investigate and mitigate the situation.

Waste Sites

A spring drive through the numerous back roads that follow along Dunkard Creek can be an aesthetically pleasing experience. Especially in the eastern portion of the watershed where the steep forested hills and narrow valleys give a very scenic view of the creek. Unfortunately, these scenic views are being degraded by several roadside dumps and wastes entering the creek due to flooding events.

Ironically, the three largest illegal roadside dumps are located where scenic views of the creek exist. Removal of these wastes (household garbage, junk vehicles, construction/demolition wastes, and white goods) would be very difficult due to the very steep topography. The area between Bobtown, PA and Taylortown, PA is most highly impacted by these illegal dumping activities (along S.R. 2025). See Figure 5 for exact locations of these illegal dumps.

Figure 5. Large Illegal Dump Sites in the Dunkard Creek Watershed

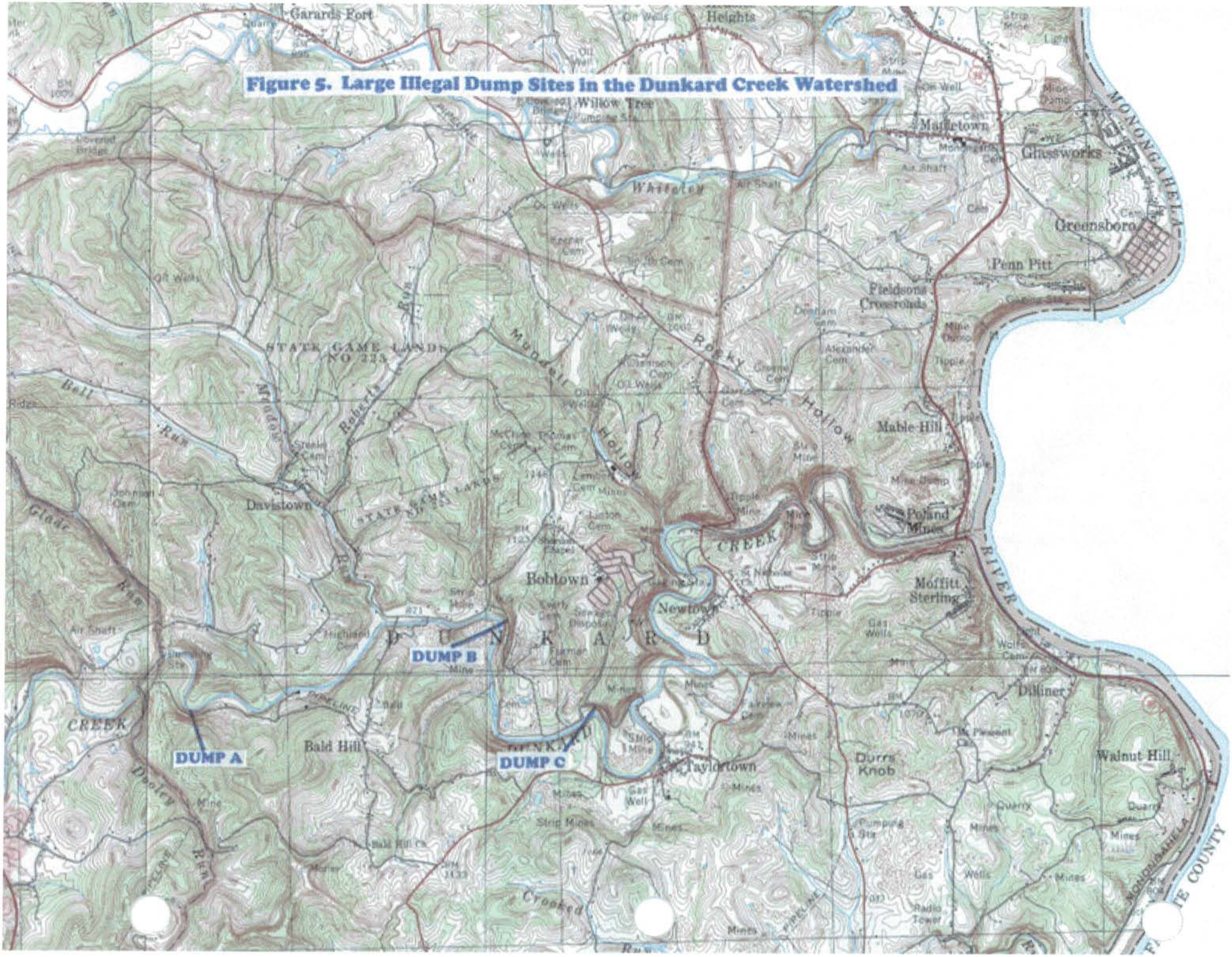


Figure 5. Large Illegal Dump Sites in the Dunkard Creek Watershed

Large illegal roadside dumps such as this one located near Bobtown, PA can be found on the very steep banks of Dunkard Creek.

Water Resources

Major Tributaries

According to the U.S. Geological Survey 7 1/2 minute quadrangle maps, Dunkard Creek has 80 named tributaries. The following table lists the major tributaries and the respective drainage areas.

TABLE 3. Major Tributaries

Tributary Name	Drainage Area	State Located
Pennsylvania Fork	24,098 acres	PA
West Virginia Fork	16,233 acres	WV
Miracle Run	14,854 acres	WV
Toms Run	11,259 acres	PA
Days Run	9,237 acres	WV
Jakes Run	8,204 acres	WV
Roberts Run	7,766 acres	PA
Hoovers Run	7,214 acres	PA
Dolls Run	6,967 acres	WV
Rudolph Run	6,453 acres	PA
Shannon Run	6,259 acres	PA
Meadow Run	4,896 acres	PA

According to the Pennsylvania Department of Environmental Protection's Chapter 93 Water Quality Standards, all tributaries to Dunkard Creek in Pennsylvania are designated as warm water fisheries with the exception of Little Shannon Run which is designated as a cold water fishery. There are no streams designated as high quality or exceptional value in this watershed.

Wetlands

The National Wetlands Inventory (NWI) has documented 203 wetlands in the Dunkard Creek watershed. They range in area from less than 1 acre to about 20 acres. Over 90% are classified as Palustrine, and many of those are either persistent emergent or deciduous scrub-shrub, and they may be temporarily or seasonally flooded. A great number of the wetlands are classified as Palustrine-permanently flooded impoundments having an unknown bottom, and are associated with active or recent mining operations. Several of the larger wetlands, classified as Lacustrine-limnetic with unconsolidated bottom and permanently flooded, are actually coal waste impoundments. In the far western reaches of the watershed, several wetlands associated with beaver activity are located on an unnamed tributary of the Pennsylvania Fork of Dunkard Creek. The approximate range of total area covered by this wetland type is 300-500 acres. Other wetland types and regimes are located throughout this watershed area.

Flood Plain Characteristics

The floodplain characteristics of the watershed were identified in 1992 as part of the Statewide Flood Damage Assessment. The floodplain is approximately 1600 acres. An estimated 220 homes and 60 commercial properties are located in the floodplain. The following data was collected concerning land use of the 1600 acre floodplain:

TABLE 4. Floodplain Land Use

Land Use	**Percentage**	**Acres**
Grassland	45%	720
Woodland	19%	304
Urban/Residential	3%	48
Cropland	0%	0%
Other(mine land, roads)	33%	528

Water Quality

Point Source Discharges

Water pollution is either point or nonpoint. Point sources enter the environment at discrete, identifiable locations. Usually, they can be measured directly or otherwise quantified. Major point sources of pollution include effluent from industrial and sewage treatment plants and from farm buildings or solid waste disposal sites. West Virginia Department of Environmental Protection data indicates that there are approximately 30-35 NPDES permits active in the West Virginia portion of the watershed with 80% of those being mining related. According to the Pennsylvania Department of Environmental Protection, there are 10 NPDES point source discharges in the Pennsylvania portion of the Dunkard Creek Watershed. Of these discharges, all ten are sewage treatment discharges. There are no industrial plant discharges.

Permitees of the NPDES discharges are required to submit monthly discharge monitoring reports (DMRs) from sewage plant effluent monitoring. Typical permit parameters are carbonaceous biological demand (CBOD5), suspended solids, ammonia, nitrogen, pH, fecal coliform, total residual chlorine, dissolved oxygen, and flow. These reports are kept on file in the Pittsburgh Regional DEP Office and DEP McMurray Office. The DEP Bureau of Water Quality Protection conducts periodic inspections of sewage plants and monitors for compliance with permit conditions. Generally, sewage treatment plants in the Dunkard Creek watershed are well maintained and operated and are in compliance with permit conditions.

Nonpoint Source

Nonpoint pollution enters the environment from diffuse sources. These sources may be land-based or airborne; for example, storms washing fertilizers from croplands or automobiles emitting lead in exhausts. Pollution from nonpoint sources is relatively difficult to isolate and control.

The generation of nonpoint-source pollutants is intermittent, occurring largely during storm events. Nonpoint-source pollution episodes thus occur less frequently and for shorter periods of time than point discharges. The amounts of pollutants mobilized from nonpoint sources relate to flow conditions. During periods of high runoff, stream flow is high, leading one to expect that this might have a diluting effect on the concentration of pollutants. Usually, this is not the case because flow rates equate to the energy needed to dislodge and mobilize particulates. The nature of the source itself is also an integral part of this equation. Therefore, it is difficult to generalize about the loadings and concentrations of pollutants produced.

Significant nonpoint sources for the Dunkard Creek Watershed include failed septic systems, mining and logging areas, livestock farming areas, runoff from waste sites, and construction sites. From all sources of nonpoint pollution, sediment comprises the greatest volume by weight of materials transported. Other pollutants can be transported in association with sediment (absorbed pollutants) or in solution (soluble pollutants). Surface mining operations pose a significant erosion problem because large tracts of bare soil and rocks are exposed. In fact, erosion occurs in almost all abandoned coal mines. The soil losses, while local, can be high. Haul roads are an important source of sediment.

Pastures can be found in fair abundance in the western portion of the Dunkard Creek Watershed. Croplands, on the other hand, are sparsely scattered throughout the watershed. Although erosion rates on cropland are not a direct measure of the sediment reaching streams, they remain important values for pinpointing areas where sediment problems may occur. While soil losses from pastures generally fall within tolerable limits, nonpoint source pollution occurs where overgrazing is continuous. When properly managed, forest and pastures pose no imminent threat to surface water quality. But the rapid, unplanned conversion of this land to row crop agriculture has proven to be environmentally disastrous. Furthermore, the continued cropping of corn following corn, which is often necessary to keep a farmer financially viable, may greatly accelerate soil erosion.

Cropland and pastures contribute almost 7 million tons of nitrogen and 3 million tons of phosphorus annually to the nation's surface water-almost 70 percent of the total loads. Livestock farming in the United States produces about 2 billion tons of wet manure per year, which contains 7 million tons of nitrogen and 2 million tons of phosphorus. High concentrations of ammonium, bacteria, and organic matter in manure can contaminate surface waters when animals are allowed direct access to streams. Contamination can be delivered in shock loading to streams adjacent to and downhill from barnyards and feedlots.

The livestock pollution problem is extremely difficult to define and deal with because it is highly dispersed and involves farm units ranging from large feedlots to small dairy operations. It is safe to say that it constitutes an exceedingly important and active source of nonpoint pollution. One major concern is the potential for shock loading of streams with toxic ammonium when barnyard runoff directly enters a watercourse. Such shock loading may have greater impacts than point source loading over the same area.

Toxic metals, including lead, zinc, copper, chromium, cadmium, nickel, and mercury, are important water pollutants in populated areas. This source of pollution is of lesser importance due to the small number of populated areas throughout the watershed. Most metals arise from transportation activities, building materials, and some industries. The metals generated by transportation activity result from exhaust discharges, grinding of engine parts, rusting of metal body parts, and tire wear. These metals are easily transported to storm sewers, and the delivery ratio is high.

Dunkard Creek Water Monitoring

The Pennsylvania Department of Environmental Protection began water sampling in the Pennsylvania portion of the Dunkard Creek Watershed in April of 1996. Eight sample points were chosen on the main stem of Dunkard Creek, which were monitored on a monthly basis. Eight tributaries were sampled on a three-month rotation. The tributaries that were sampled are as follows: Garrison Fork, Toms Run, Hoovers Run, Roberts Run, Rudolph Run, Shannon Run, Calvin Run, and Meadow Run.

Figure 6: Monitoring Points on Dunkard Creek and It's Tributaries

Refer to Table 6 for Explanation of Sample Point Abbreviations

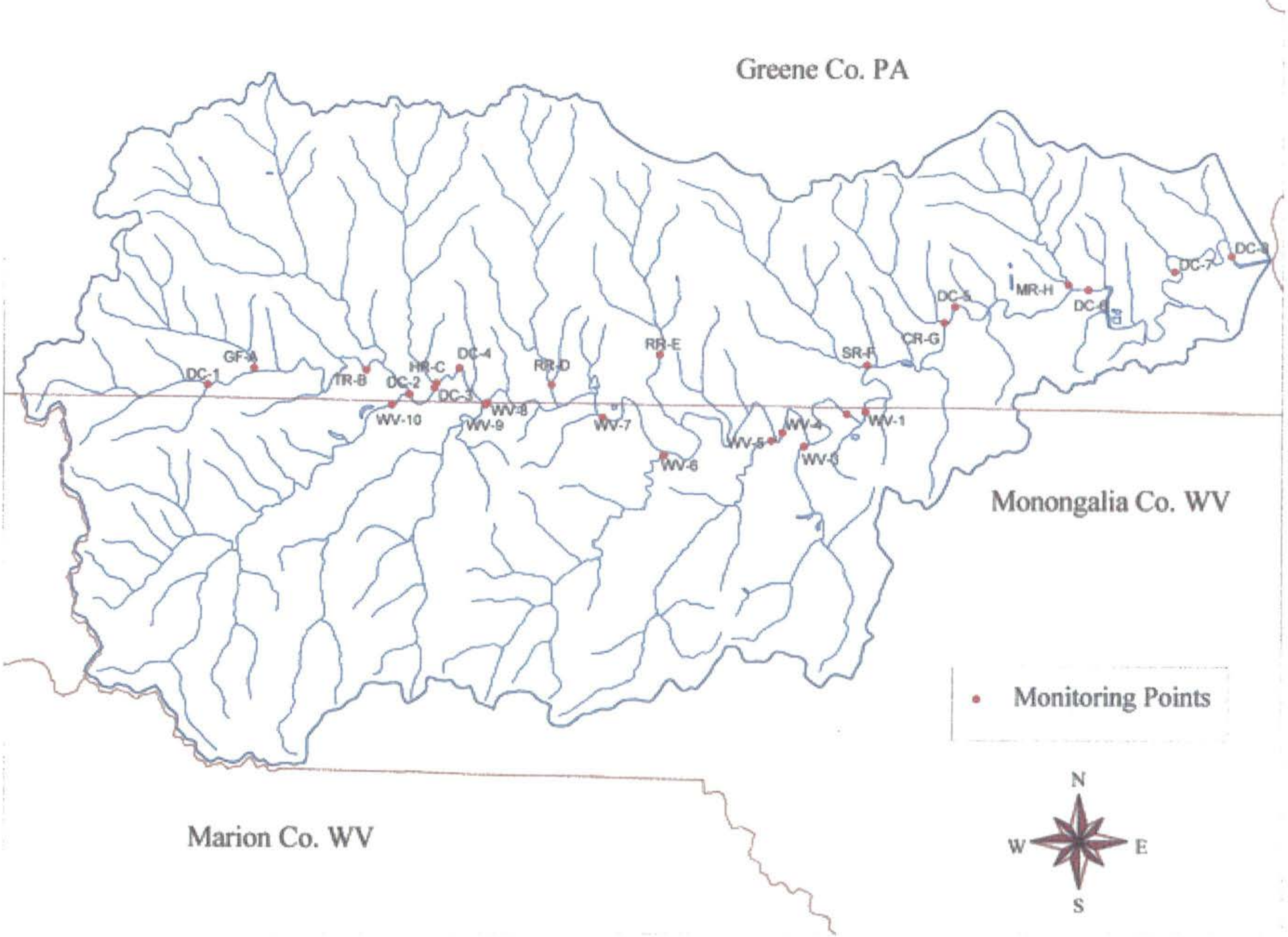


Figure ˜ Acid Mine Drainage Discharges Mor˙ ˋred by Waynesburg College & Amer˙ rps

Refer to Table 6 For Explanation of Sample Point Abbreviations

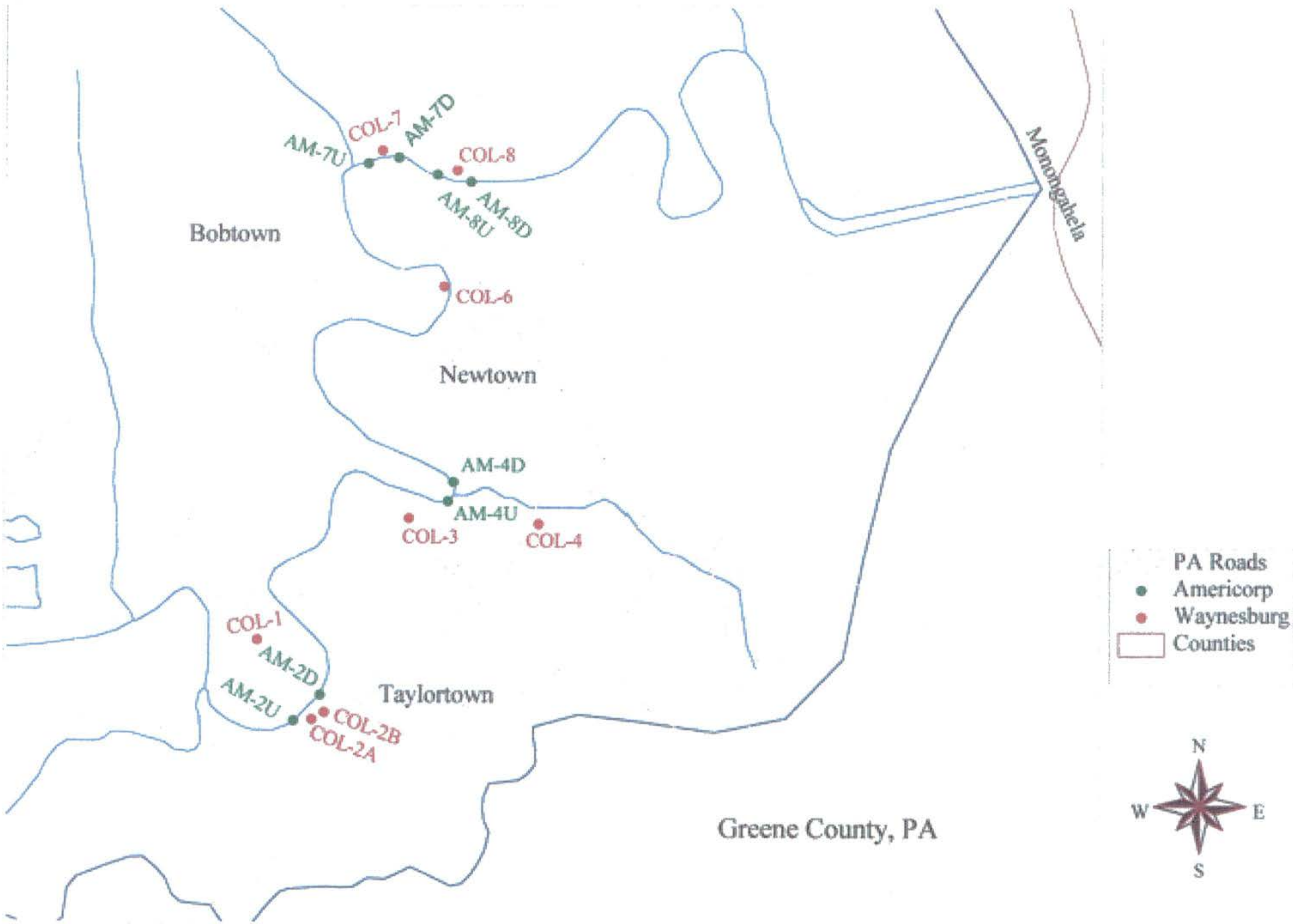


Figure 6	Figure 7

The West Virginia Division of Environmental Protection contracted the services of Sturm Environmental to do the water sampling in the West Virginia portion of the watershed. They began sampling five points on the main stem of Dunkard Creek and five tributaries on a monthly basis in July of 1996. The tributaries that were sampled are as follows: West Virginia Fork, Miracle Run, Days Run, Jakes Run, and Dolls Run. Table 6 lists the sample points for both states along with their locations. Refer to the map in Figure 6 & 7 for exact locations of sample point.

TABLE 5. Sample point locations

Sample	Description	Latitude/Longitude
DC-1	PA Fork Dunkard	394329 / 802108
DC-2	Dunkard Creek, PA	394326 / 801550
DC-3	Dunkard Creek, PA	394332 / 801542
DC-4	Dunkard Creek, PA	394358 / 801505
DC-5	Dunkard Creek, PA	394501 / 800335
DC-6	Dunkard Creek, PA	394521 / 800029
DC-7	Dunkard Creek, PA	394539 / 795832
DC-8	Dunkard Creek, PA	394535 / 795709
GF-A	Garrison Fork, PA	394350 / 802003
TR-B	Toms Run	394400 / 801655
HR-C	Hoovers Run	394338 / 801540
RR-D	Roberts Run	394343 / 801305
RR-E	Rudolph Run	394410 / 801029
SR-F	Shannon Run	394403 / 800539
CR-G	Calvin Run	394450 / 800351
WV-1	Dunkard Creek, WV	394315 / 800535
WV-2	Dunkard Creek, WV	394307 / 800559
WV-3	Dolls Run	394254 / 800659
WV-4	Dunkard, WV	394247 / 800728
WV-5	Jakes Run	394233 / 800742
WV-6	Days Run	394216 / 801014
WV-7	Dunkard Creek, WV	394258 / 801148
WV-8	Dunkard Creek, WV	394312 / 801424
WV-9	Miracle Run	394308 / 801428
WV-10	WV Fork Dunkard	394317 / 801618

The following table lists the sample parameters that were monitored during this study. Not all parameters were monitored by both states. The table lists the state monitoring each parameter.

TABLE 6. Parameters and Test Methods for Sample Data

Parameter	State	Test Method	Reference
pH	PA,WV	00403	STD METH-18 4500H-B
Alkalinity	PA,WV	00410	EPA 310.1
NH3-N, Total	PA,WV	00610A	EPA 350.1
NO2-N, Total	PA,WV	00615A	EPA 353.2
Residue, Total Filterable	PA,WV	00515	STD METH-13148B
Phosphorus, Total	PA	00665A	EPA 365.3
Hardness, Total as CACO3	PA,WV	00900A	EPA 130.1
Sulfate, Total	PA,WV	00945A	EPA 375.2
Copper, Total	PA	01042A	EPA 200.7
Manganese, Total	PA,WV	01055A	EPA 200.7
T Organic Carbon	PA,WV	00680	EPA 415.2
Specific Cond. UMHOs/CM	PA,WV	00095	EPA 120.1
Residue, Total Nonfilter	PA,WV	00530	EPA 160.2
Chloride	PA,WV	00940A	EPA 325.1
Iron, Total	PA,WV	01045A	EPA 200.7
Nickel, Total	PA	01067A	EPA 200.7
Zinc, Total	PA	01092A	EPA 200.7
Aluminum, Total	PA,WV	01105A	EPA 200.7
BOD 5-Day	PA,WV	00310	STD METH-185210B
Acidity, Total Hot	PA,WV	70508	EPA 305.1
Lead, Total	PA	01051H	EPA 200.8
Fecal Coliform	PA,WV		STD METH-18 9221

The following parameters were also monitored in the field: pH, temperature, dissolved oxygen, and specific conductivity.

To supplement our sample data, eight acid mine discharges located along Dunkard Creek as well as 3 sites located near Interstate 79 were chosen to be sampled. The sites located near I-79 were chosen to determine the effects of the interstate on Dunkard Creek (road salts, etc.). Waynesburg College's Chemistry department, under the direction of Carolyn T. Connelly, Ph.D., volunteered to sample these sites. They sampled in November, December, February, March and April of 1996. The following parameters were monitored for these eleven sites: Iron, manganese, alkalinity, acidity, pH, chloride and specific conductivity. Figure 7 shows the acid mine discharge points sampled by the college.

To further supplement this sample data, Americorp sampled in Dunkard Creek upstream and downstream of four of the acid mine drainage sites. They sampled eight different sites on Dunkard Creek for the same parameters that Waynesburg College sampled. Their findings coincide with the findings of Waynesburg College. Figure 7 shows the sample stations for both the college and Americorp.

The United States Geological Survey (USGS) is in the process of studying 60 large river basins throughout the United States under the National Water Quality Assessment Program. Ten sites have been chosen to be monitored by the USGS throughout the Monongahela River Basin. Of these ten sites, Dunkard Creek is one of them. The USGS has sampled Dunkard Creek at the SR 2008 bridge in Taylortown, PA from April of 1996 through 1998. The goal of this sampling is to determine the effects of acid mine drainage on Dunkard Creek. They are presently in the process of interpreting the data. The data interpretation will be in 2 or 3 separate reports that will be published some time in the year 2000. The data is available anytime upon request through the USGS.

On October 6 and November 16 of 1998, PADEP conducted a watershed study of Dunkard Creek. The object of the study was to assess the biological health of Dunkard Creek according to its macroinvertebrate population. Seven stations on the main stem of Dunkard Creek were studied beginning in the Pennsylvania Fork downstream to the last wadeable section of the creek, midway between Bobtown and Poland Mines. The first six stations coincide with the PADEP monitoring stations DC-1 thru DC-6 found on the map in Figure 6. The seventh station was located downstream of DC-7. The invertebrate sampling was performed using a 1.5-m X 1.0-m kick screen with 0.5-mm pores. Each kick disturbed one square meter of substrate. Every site was sampled until no new taxa were recovered.

Water Monitoring Analysis

Upon review of the water sample data, water quality in Dunkard Creek upstream of Taylortown can be characterized as good and is meeting its designated uses as a warm water fishery. Although there are pollution contributions from malfunctioning on-lot sewage systems and agricultural runoff (sediment) throughout the watershed, these contributions do not impact the stream to the point of impairment. Aquatic studies conducted by the PADEP along with studies and recommendations by the Pennsylvania Fish and Boat Commission (PAFBC) confirm the good water quality results, upstream of Taylortown.

The lower 6.2 miles of Dunkard Creek (downstream of Taylortown) is severely impacted by acid mine drainage according to PAFBC data provided by their regional office in Somerset, PA. The water quality data collected by the PADEP and Waynesburg College below Taylortown, at first glance, does not indicate a significant water quality problem due to acid mine drainage. Closer examination of the water quality data of the five worst deep mine discharges quickly defines the mine water pollution problem in the lower 6.2 miles of Dunkard Creek. Figure 8 on the following page shows the locations of the 8 major acid mine drainage discharges located in the watershed. According to the Pennsylvania Fish and Boat Commission, a large fish kill was suffered in September of 1998 at the Taylortown Bridge. Approximately 1,752 fish were found dead on a 2 mile stretch starting at the Taylortown bridge. It is suspected that a large acid mine drainage discharge located above this area is to blame.

The volume of iron, aluminum and acidity produced at these discharges are shown in tons per year in Table 7. The 530 tons of acidity that emanates from these discharges is assimilated by the highly alkaline water in Dunkard Creek. The neutralization of the acid causes the pH of the mine water to rise. This increase in pH allows the iron (94 tons/year) and aluminum (55 tons/year) to precipitate on the stream bottom. It is this precipitation of the iron and aluminum on the stream bottom that makes Dunkard Creek a nearly sterile stream from Taylortown to its mouth on the Monongahela River.

Water quality changes dramatically in the lower 6.2 miles of Dunkard Creek due to the impacts of acid mine drainage. The photo above is a popular fishing hole known as Pigeon Hole located approximately 3 miles upstream of Taylortown, PA. Below is a photo of Dunkard Creek located near Bobtown, PA.

Figure 8 AMD Map

Figure 8. Major Acid Mine Drainage Sites Located in Dunkard Creek Watershed

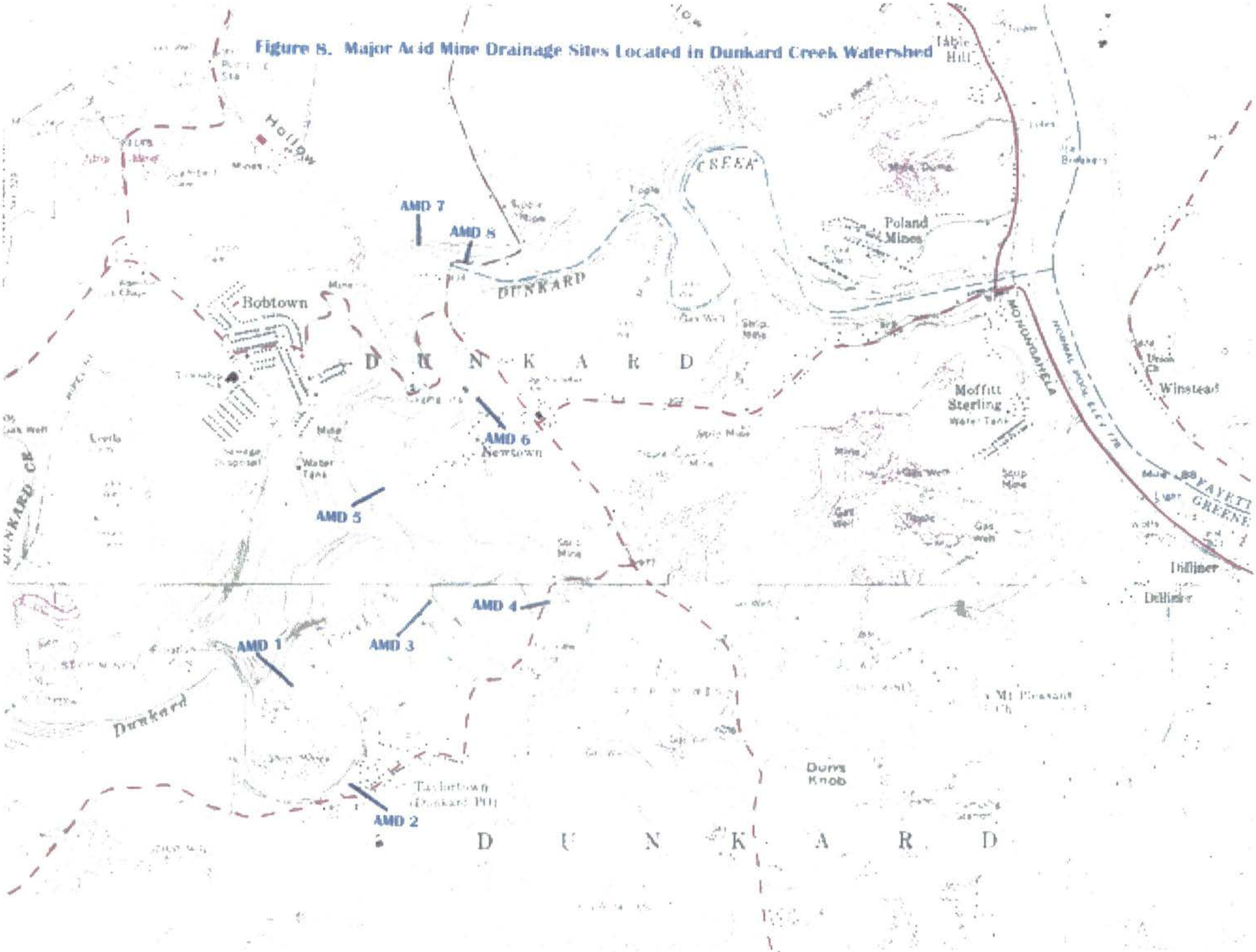


TABLE 7. Dunkard Creek mine drainage pollutant loading, Taylortown to Mouth.

Site	Flow GPM	Iron MG/L	Iron Load Tons/Yr	Alumin. MG/L	Alumin. Load Tons/Yr	Acidity MG/L	Acid Load Tons/Yr
2A-B	347	48	36.54	42	31.97	290	220.75
4	162	50	17.77	23	8.17	362	128.64
6	147	26	8.38	46	14.83	376	121.25
7	205	47	21.14	0.3	0.13	45	20.24
8	97	47	10.00	0.5	0.11	185	39.37
Totals	958		93.83		55.22		530.24

The aquatic study done by the PADEP in October and November of 1998 documents the impact of the precipitated metals on the aquatic population of this section of Dunkard Creek. The study indicates that station 7, which is located downstream of Taylortown between Bobtown and Poland Mines, is completely impaired by mine drainage. There were no aquatic invertebrates nor fish found alive at this station. With no ability to adhere to the rocks in the stream, caused by the coating of iron and aluminum, there would be no way for benthic organisms to survive. Consequently, very few fish would be able to survive with no insects on which to feed.

The following describes each parameter analyzed and gives a general analysis of the parameters effect on Dunkard Creek.

pH

The pH is a numerical measure of acidity, or hydrogen ion activity (an ion is an electrically charged chemical species) used to express acidity or alkalinity; neutral is pH 7.0, values below 7.0 are acid, and above 7.0 are alkaline. Table 8 shows the pH effects on aquatic life.

TABLE 8. pH impacts on aquatic life.

pH	Impact
6.5 - 7.0	Generally harmless, although may cause delayed spawning in some fish.
6.0 - 6.5	Interferes with spawning and hatching of eggs for some fish.
5.0 - 6.0	May be lethal to eggs and larvae of sensitive fish species, blue green algae may predominate.
4.5 - 5.0	Prohibits reproduction in salmonids; blackflies, mayflies, and stoneflies may be absent.
4.5	Fish usually not found although some hardy species may survive for short periods. Dense mats of algae and chlorophyll-containing flagellates may color stream beds green. Stream bed animals may be absent.

The Chapter 93 water quality standards for pH of streams is from 6.0 to 9.0 inclusive. All pH readings are within these standards. Despite several acid mine discharges with a pH as low as 2.7, the average pH for the main stem of Dunkard Creek ranges from 6.7 to 7.9. This shows the amazing buffer capacity of Dunkard Creek. The average range for the tributaries is from 6.8 to 8.4.

Alkalinity

The alkalinity of water is a measure of its acid neutralizing capacity. The primary importance of alkalinity is the buffer it imparts to water; that is, the ability of the water to resist changes in pH with the addition of acids or bases.

Alkalinity is due primarily to salts of weak acids such as carbonates, silicates and phosphates. A few naturally occurring organic acids (i.e. humic) may also contribute alkalinity to waters. In most natural waters and wastewaters, the bicarbonate-carbonate species, along with the hydroxyl ions, are the major components of alkalinity. Because the composition of natural waters reflects the mineralogy of surrounding soils, the type of minerals found in an area influence alkalinity. The alkalinity of natural waters varies widely with locality, being dependent on a number of factors such as the amount of carbonate-bearing minerals in the soil.

Alkalinity is usually expressed in mg/l as $CaCO_3$; that is, the equivalent concentration of $CaCO_3$ which will give the same alkalinity as the sample. The Chapter 93 water quality standards for alkalinity of streams is a minimum 20 mg/l as $CaCO_3$, except where natural conditions are less. The alkalinity has not been below this standard for any of the sampling points. The average alkalinity for the main stem ranges from 44 mg/l at DC-1 to 145 mg/l at WV-4. The average alkalinity for the tributaries ranges from 52.5 mg/l at Garrison Fork to 339.3 mg/l at Meadow Run.

Hardness

The hardness is a characteristic of water caused by various salts, calcium, magnesium and iron. It is a term used to describe the total amount of divalent cations in a water sample capable of reacting with soaps to form insoluble scums and also capable of forming scale by precipitation of inorganic salts (i.e. $CaCo_3$) inside water pipes. Waters can be broadly categorized as:

TABLE 9. Water hardness parameters

Degree of Hardness	**Hardness mg/l as $CaCO_3$**
Soft	0-75
Moderately Hard	75-150
Hard	150-300
Very Hard	>300

According to the data, most of Dunkard Creek and its tributaries are soft to moderately hard. It appears the water gets harder the further downstream on the main- stem of Dunkard Creek you go. The lower end of Dunkard from the state line to the mouth is hard to very hard.

Mostly all of the tributaries appear to fall within the soft to moderately hard category with the exception of Meadow Run which appears to be very hard and Miracle Run which appears to be hard.

Dissolved Solids, Total Suspended Solids

A large part of the pollutant load in streams may be in the solid form. Total suspended solids are small particles of solid pollutants in sewage that contribute to turbidity and that resist separation by conventional means.

Dissolved solids are the total amount of dissolved material organic or inorganic, contained in water or wastes. Excessive dissolved solids make water unpalatable for drinking and unsuitable for industrial uses. The Chapter 93 water quality standard for dissolved solids in a stream for aquatic life is a maximum of 1,500 mg/l. For water supply use it is 500 mg/l as a monthly average value; maximum 750 mg/l. All sample points fall within these parameters with the exception of Meadow Run which averages 277 mg/l.

Total solids are all matter that remains after evaporation at 103 - 105 degrees Celsius. This includes suspended plus dissolved solids.

TABLE 10. Typical Concentrations of Total Solids

Potable Water	20 - 1000 mg/l)typical 500 mg/l)
Wastewaters	350 - 3000 mg/l
Sludges	up to 100,000 mg/l and higher

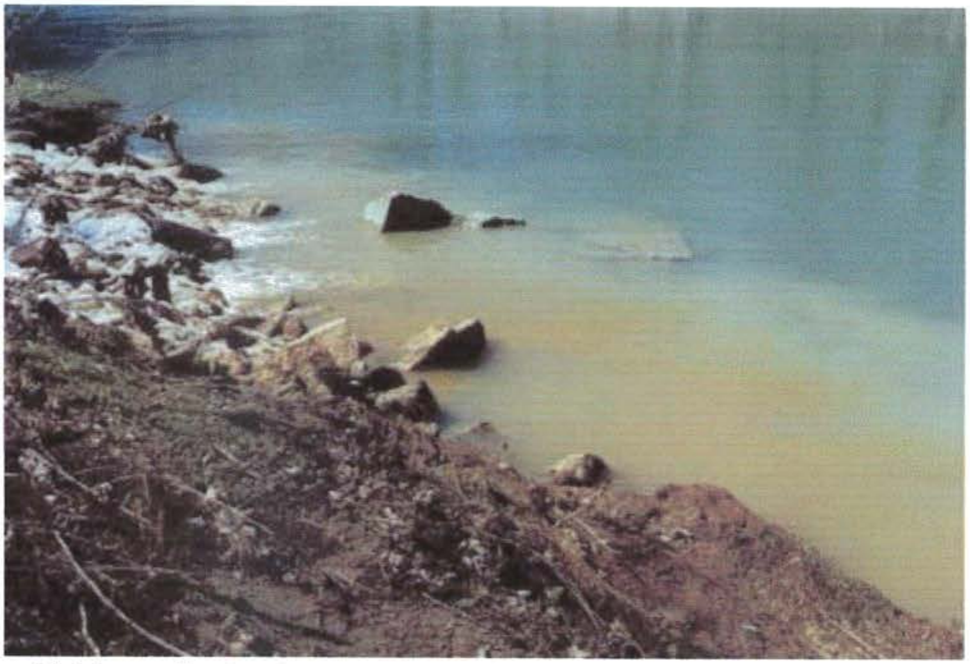
Specific Conductivity

Specific conductance is a measure of the ability of water to conduct an electrical current. It is expressed in micromhos per centimeter at 25 degrees Celsius. Specific conductance is related to the type and concentration of ions in solution and can be used for approximating the dissolved solids concentration of the water. Commonly, the concentration of dissolved solids (in milligrams per liter) is about 65 percent of the specific conductance (in micromhos). This relation is not constant from stream to stream, and it may vary in the same source with changes in the composition of the water.

According to the data, the average specific conductivity rises the further downstream you go. The highest average specific conductivity on the main stem of Dunkard Creek occurs at WV-1 which averages 1079 umhos. Meadow Run had the highest average specific conductivity of the tributaries at 3019 umhos.

Sulfates and Iron

Coal bearing minerals are typically high in iron sulfide ores, pyrite and marcasite (two different crystalline forms of $FeS2$). During mining, pyritic materials are exposed to air and water and are oxidized to ferric iron, sulfate and acidity. The net result is that ferric hydroxide is produced which causes a reddish-brown discoloration of the water and tends to smother the stream bottom with a blanket of precipitated iron.



Notice the reddish-brown discolored water emanating from an acid mine discharge near Taylortown, PA. This discoloration known as ferric hydroxide, smothers the stream bottom with precipitated iron.

The Chapter 93 water quality standards for sulfates in streams is a maximum of 250 mg/l for water supply purposes. There is no standard for aquatic life listed. Sulfates appear to increase as you go further downstream of the main stem of Dunkard Creek. Most of Dunkard Creek falls under the 250 mg/l maximum until you hit WV-1. From this point to the mouth, the average sulfates range from 268 mg/l to 362 mg/l. This is probably due to the extensive mining in this section of the watershed. All the tributaries fall under the 250 mg/l maximum with the exception of Meadow Run which averages 991 mg/l. This tributary has a history of mining also.

For iron, the daily average is 1.5 mg/l as total iron; maximum 0.3 mg/l as dissolved iron. These numbers are for both aquatic life and water supply. All points were sampled for total iron. All points on the main stem as well as the tributaries fall below the 1.5 mg/l. It is important to note that we have monthly averages, not daily averages. May was the only month that showed nearly all samples on the main stem as well as Roberts Run between 1.97 mg/l and 3.04 mg/l.

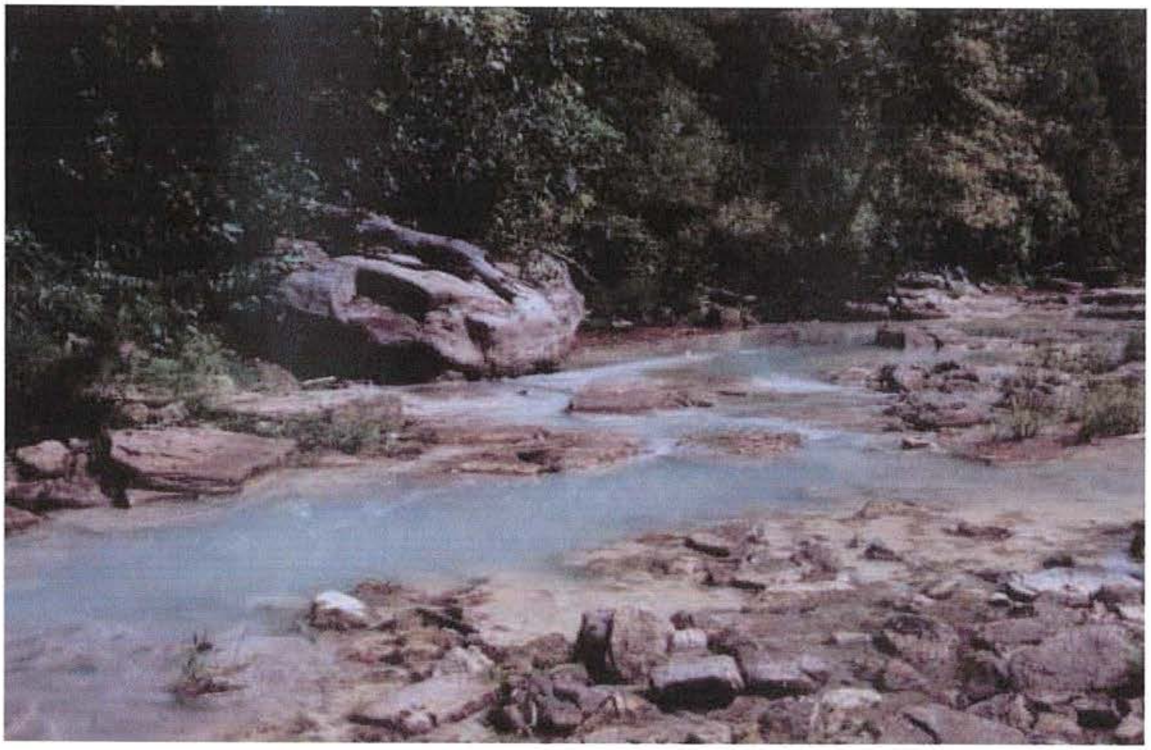
Heavy Metals- Manganese, Copper, Lead, Nickel, Zinc, Aluminum

For many heavy metals such as lead, there is no known biological need. In fact they can be quite toxic. Even excessive levels of nutritionally necessary metals such as copper and zinc can be harmful.

To be biologically active, a metallic element must, in general, be in a soluble form. Thus, processes which govern the partitioning of the metal between the solid and solution phases are extremely important in determining adverse environmental effects. Three extremely important processes governing the toxicity and fate of heavy metals are precipitation, adsorption, and reactions with organic matter.

Precipitation is of utmost importance in determining the toxicity of metals to aquatic biota. Fortunately, most metals are maintained at low levels in aquatic systems by the formation of insoluble oxides, hydroxides, carbonates, and the like. Metal solubility increases with decreasing pH for most metals of significance in aquatic systems. Zinc, Copper and Aluminum are usually found at lethal or near-lethal levels in streams affected by acid mine drainage.

Adsorption with solid particles also reduces soluble metal levels. The pH dependent behavior of adsorption is similar to participates: increasing adsorption, as the system becomes more alkaline.



This photo shows the white, milky aluminum being discharged from an acid mine discharge located near Bobtown, PA.

Reactions with organic matter can both increase and decrease metal availability. If the organic matter is water insoluble like humic materials, complexation will tend to immobilize the metals. On the other hand, formation of soluble metal complexes may increase the mobility and bioaccumulation potential of the heavy metals.

Chapter 93 only lists water quality standards for aluminum and manganese. The maximum for aluminum is 0.1 of the 96 hour LC50 for representative important species as determined through substantial available literature data or bioassay tests tailored to the ambient quality of the receiving waters. LC50 is the concentration of a toxicant in water that kills half of a test population in a specified time period (usually 48 or 96 hours). It is used as an index of acute toxicity; common test organisms include bluegill, fathead minnows, and daphnia. The average aluminum concentration for the main stem ranges from 0.22 mg/l to 0.98 mg/l, the highest occurring in the lower watershed. The tributaries ranged from 0.14 mg/l to 1.2 mg/l found on Shannon Run.

The water quality standard for manganese is a maximum of 1.0 mg/l for water supply uses. The average for the main stem of Dunkard Creek ranges from 0.04 mg/l to 0.25 mg/l. The highest averages appear to be in the lower end of the watershed. The tributaries range anywhere from 0.02 mg/l to 0.14 mg/l.

Ammonia, Phosphorus, Nitrate, Nitrite, and Carbon

Carbon, nitrogen and phosphorus are the three chief nutrients present in natural water. Large amounts of these nutrients are produced by sewage, certain industrial wastes, and drainage from fertilized lands. Biological waste treatment processes do not remove the phosphorus and nitrogen to any substantial extent. In fact, they convert the organic forms of these substances into mineral form, making them more usable by plant life. The problem starts when an excess of these nutrients over-stimulates the growth of water plants which cause unsightly conditions, interfere with treatment processes, and cause unpleasant and disagreeable tastes and odors in water.

Nitrate is an important plant nutrient and type of inorganic fertilizer. It is the most highly oxidized phase in the nitrogen cycle. In water the major sources of nitrates are septic systems, animal feed lots, agricultural fertilizers, manured fields, industrial waste waters, sanitary landfills, and garbage dumps.

Nitrate is the primary source of nitrogen for plants; it is a nutrient they cannot live without. Extensive farming can rob the soil of its natural nitrogen sources, so farmers often add nitrate fertilizers. Properly managed, nitrogen does not endanger health and can increase crop production. However, when more nitrogen is added to the soil than the plants can use, excess nitrate can leach into groundwater supplies and contaminate wells. Because nitrate is converted to a very toxic substance (nitrite) in the digestive systems of human infants and some livestock, nitrate-contaminated water is a serious problem.

The Chapter 93 water quality standards for nitrite plus nitrate is a maximum of 10 mg/l as nitrogen for water supply uses. It appears the nitrate and nitrite levels rose sharply as Dunkard dipped down into West Virginia and then dropped as it entered back into Pennsylvania. The ammonia levels appear to do the same thing but the sharp rise appears earlier at DC-4. The Nitrite levels in the West Virginia tributaries tower over the Pennsylvania tributaries. Days Run has a considerable high Ammonia level at 2.63 mg/l as compared to the other tributaries.

Chloride

The Chapter 93 water quality standards for chloride in streams is a maximum of 250 mg/l for water supply uses. All sample points on the main stem as well as the tributaries falls below these standards. Meadow Run comes the closest with an average of 198 mg/l.

Biochemical Oxygen Demand (BOD)

BOD is a measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. Large amounts of organic waste use up large amounts of dissolved oxygen, thus the greater the degree of pollution the greater the BOD.

TABLE 11. Typical Values of BOD

System	BOD (mg/l)
Streams Draining Virgin Territory	
---dry season	0.5 - 1.0
---During high runoff	1.0 - 3.0
Untreated Domestic Wastewater	100-400 (200 typical)
Domestic Wastewater Effluents	10-30
Septage	1500-20,000
Landfill Leachate	100-15,000
Whole Milk	100,000

The average BOD for the main stem of Dunkard Creek averages from 0.98 mg/l to 1.88 mg/l, the highest being DC-8. The average BOD for the tributaries ranges from 0.63 mg/l to 2.55 mg/l on Jakes Run.

Fecal Coliform

Fecal coliform bacteria is a group of organisms common to the intestinal tracts of man and of animals. The presence of fecal coliform bacteria in water is an indicator of potentially dangerous bacterial contamination. Fecal coliform is the standard test organism used in many laboratories testing treated sewage, untreated public water supplies, and such primary contact waters as swimming areas.

During the swimming season (May 1 through September 30), according to the Chapter 93 water quality standards, the maximum fecal coliform level shall be a geometric mean of 200 coliform per 100 milliliters (ml) based on five consecutive samples, each sample collected on different days. For the remainder of the year, the maximum fecal coliform level shall be a geometric mean of 2,000 coliform per 100 milliliters (ml) based on five consecutive samples collected on different days.

For water supply uses there should not be more than 5,000 coliform per 100 milliliters as a monthly geometric mean. The average fecal coliform for the main stem ranges from 20/100 ml to 1873/100 ml at WV-8. The numbers appear to drop in the lower portion of the watershed. The average for the tributaries ranges from 290/100 ml to a high of 13,663/100 ml on Miracle Run.

Water Supply

Aquifers occur in the sandstone, limestone, and coal in the watershed. The groundwater is used as a domestic drinking water supply as well as for watering livestock and other farm activities. In hilltop and hillside areas, the aquifers are unconfined and commonly have insufficient yield. Valley areas have partly confined and confined aquifers. The range of depth typical for water wells in the watershed is 50-300 feet. Yields are usually 1-30 gallons per minute (gpm), but may exceed 200 gpm. The groundwater is hard to very hard, alkaline, and has large iron concentrations locally.

Wildlife

Terrestrial

The following list identifies the different types of wildlife that occur or are likely to occur throughout the Dunkard Creek Watershed. Their occurrence may depend on season, habitat type, and individual movements or migration patterns. The Pennsylvania Game Commission has compiled this data.

GAME ANIMALS

black bear:	The habitat types in the watershed are not those which traditionally support a resident population of black bear; however, several sightings of migrants have been documented during the mating season this past summer.
white-tailed deer:	The deer population is very strong in the watershed. The average deer density for Greene County is 50 deer per forested square mile. I would rate the watershed area to be slightly above average.
cottontail rabbit:	The rabbit population in this area is fair to moderate due to good ground cover.
squirrels:	The entire watershed hosts a good population of gray and fox squirrels. The number of red squirrels is much lower.
woodchuck:	There are a number of farms in the area which produce good habitat for groundhogs. There is no lack of these critters.

GAME BIRDS:

bobwhite quail:	Quail sightings are few and far between but have been documented. I would rate their numbers as extremely low.
geese:	There are several flocks of resident geese located near Pine Bank, near State Gameland #179, and next to Jollytown. The watershed is a temporary home to Southern James Bay migrants during late fall and early spring.
grouse:	This area supports a good population of grouse and, from all indications, numbers are on the increase.
otter:	As a direct result of the Pennsylvania Game Commission's otter reintroduction program several have been documented over the past few years in the Dunkard Creek area.
raccoon:	Raccoon numbers are very high. Nuisance complaints have been increasing in every area of the county.
red and gray fox:	Despite the fact that there is not a great number of agricultural farm lands, the red fox numbers are good. The gray fox, who uses the deeper woods for cover, are present but in lesser numbers.
skunk:	Striped skunk occur in fair numbers throughout the watershed. If the study area had a greater human population, skunk numbers would probably increase.

weasel:	Of the three types of weasels in the watershed, the long tailed weasel uses the study area for it's home. This is a very secretive furbearer that is seldom noticed but is here.

According to Ralph Bell, who is an active bird watcher in the area, there are 89 nesting bird species in the area and 15 species that possibly nest in the watershed.

Table 12, compiled by the PA Game Commission, identifies endangered, threatened, and special concern species which may potentially occur within a designated area. This list includes species, which may exist in the Dunkard Creek Watershed, as well as migrating and accidental species. This information is based on records of these animals inhabiting specific habitat types within Greene County.

TABLE 12. Threatened, endangered and special concern species.

Common Name	Status
Eagle, Bald	PA/Fed Endangered
Falcon, Peregrine	PA/Fed Endangered
Osprey	PA Endangered
Owl, Short-eared	PA Endangered
Tern, Black	PA Endangered
Shrew, Least	PA Endangered
Snake, Rough Green	PA Threatened
Bittern, American	PA Threatened
Flycatcher, Yellow-bellied	PA Threatened
Heron, Yellow-crowned Night	PA Threatened
Sandpiper, Upland	PA Threatened
Harrier, Northern	Candidate-At Risk
Owl, Common Barn	Candidate-At Risk
Snipe, Common	Candidate-At Risk
Sparrow, Henslow's	Candidate-At Risk
Bobcat	Candidate-At Risk
Coot, American	Candidate-Rare
Goshawk, Northern	Candidate-Rare
Grebe, Pied-billed	Candidate-Rare
Grosbeak, Blue	Candidate-Rare
Tanager, Summer	Candidate-Rare
Teal, Swainson's	Candidate-Rare
Bat, Evening	Candidate-Rare
Bat, Silver-haired	Candidate-Rare

Bobwhite, Northern	Candidate-Undetermined
Crossbill, Red	Candidate-Undetermined
Dickcissel	Candidate-Undetermined
Duck, Ruddy	Candidate-Undetermined
Egret, Cattle	Candidate-Undetermined
Gadwall	Candidate-Undetermined
Nighthawk, Common	Candidate-Undetermined
Owl, Northern Saw-whet	Candidate-Undetermined
Whip-poor-will	Candidate-Undetermined
Wigeon, American	Candidate-Undetermined
Weasel, Least	Candidate-Undetermined
Madtom, Brindled	Candidate Species
Sucker, Spotted	Candidate Species
Warmouth	Candidate Species

Aquatic

Four Dunkard Creek stream surveys were obtained from the Pennsylvania Fish and Boat Commission and the Pennsylvania Department of Environmental Protection for this aquatic information. R. Hesser, B. Weirich, R. Snyder, and D. Hyatt did the first survey in 1972 for the PA Fish and Boat Commission. Three sample points were surveyed on Dunkard Creek. Two points near the confluence of Glades Run and one point near the confluence of Meadow Run.

Tom Proch did the second survey in 1978 for the Commonwealth of Pennsylvania. Six sample points were surveyed, 2 of which were on tributaries of Dunkard Creek. The two tributaries were Roberts Run and Sharp Run. The main stem sample points were located at Jollytown, Mount Morris, downstream of Taylortown, and downstream of Bobtown.

Glenn Rider did the third survey in 1985 for the PA Department of Environmental Protection. Four sample points were surveyed, all of which were located on Dunkard Creek. The points were located upstream of Mount Morris, downstream of Mount Morris, at the confluence of Meadow Run, and downstream of Bobtown.

The fourth survey was prepared in 1992 for the Pennsylvania Fish and Boat Commission by Rick Lorson, Tom Shervinskie, and Chuck Eisel. Fish species were collected in a section from the stateline 3.1 km upstream of the T-339 ford downstream to 1.0 km upstream from the SR 2008 bridge during 1986 and 1992.

Table 13 lists the species of fish found as well as the year they were found in.

TABLE 13. Fish Species found in Dunkard Creek

Fish Species	1972	1977	1984	1986	1992
Smallmouth Bass	X	X	X	X	X
Rock Bass	X	X	X	X	X
umpkinseed	X	X	X	X	X
N. Hogsucker	X	X	X	X	X
Golden Redhorse	X	X	X	X	X
Stoneroller	X	X	X	X	X
Common Shiner	X	X	X	X	X
Bluntnose Minnow	X	X	X	X	X
Fantail Darter	X	X	X		X
Rainbow Darter	X	X	X	X	X
Greenside Darter	X	X	X	X	X
River Chub	X		X	X	X
Silver Shiner	X				
Johnny Darter	X	X			X
White Sucker		X	X		
Creek Chub		X		X	
Rosyface Shiner		X	X	X	X
Spotfin Shiner		X	X	X	X
Spottail Shiner		X			
Silverjaw Minnow		X			
Silvery Minnow		X			
lver Redhorse		X	X	X	
Yellow Bullhead		X	X	X	
Largemouth Bass		X	X	X	
Bluegill		X	X	X	
Green Sunfish		X	X		
Redbreast Sunfish		X			
Banded Darter		X	X		
Log Perch		X	X	X	X
Carp			X	X	X
Sand Shiner			X		X
Striped Shiner			X		
Blacknose Dace			X		
Stonecat			X		
Hybrid Sunfish			X		X
Varigated Darter			X	X	X
Blackside Darter			X		
Brown Bullhead				X	X
Spotted Bass					X
Tiger Muskellunge					X
auger					X
Channel Catfish					X
Freshwater Drum					X

Aquatic History of Dunkard Creek

In 1931 the Pennsylvania Department of Health surveyed Dunkard Creek and described it as a stream mildly polluted by acid mine drainage. It contained fishable populations of bluegills, yellow perch, catfish, and bass (Anon. 1931). In 1938 J.H. Banning found the stream to contain smallmouth bass, rock bass, crappies, bluegill and other sunfish, carp, bullheads, suckers, and minnows.

In 1941 a West Virginia Mine located along Dolls Run discharged acid mine drainage into Dolls Run, a tributary to Dunkard Creek. No legal action was taken against the mining company because "the pollution laws of Pennsylvania exempt mine drainage pollution" (French 1941). As a result a fish kill was suffered on Dolls Run. The Shannopin Mine located near Bobtown, PA had some adverse affects on Dunkard Creek downstream of Mount Morris, PA during low flow periods. A chemical sampling in 1951 showed Dunkard Creek at Mount Morris had a pH of 7.5 and an alkalinity of 15 mg/l, but a pH of 2.9 and a total acidity of 282 mg/l at a point 12.8 km (8.0 miles) downstream from Mount Morris.

Robbins (1953) found Dunkard Creek suitable for stocking with warmwater fish from Mount Morris downstream to the SR 2021 bridge, a distance of 8.0km (5.0 miles). Sines (1956) reported good water quality at Mount Morris and at a point below Davistown and noted its high buffering capacity at these two points. From 1958 to 1961, Dunkard Creek was stocked with smallmouth bass, white crappies, bullheads, yellow perch, white bass, and carp. In 1971 smallmouth bass and brown bullheads were stocked (Pennsylvania Fish and Boat Commission (PFBC) stocking records). In July 1972 Dunkard Creek was surveyed to determine the feasibility of stocking muskellunge in the stretch between the T-339 ford and the SR 2021 bridge (Hesser et al. 1972a). The stream was stocked with tiger muskellunge fingerlings in 1973, 1974, and 1977, and purebred muskellunge fingerlings in 1975. According to The PA Fish and Boat Commission, 150 tiger muskellunge fingerlings were stocked in 1982, 400 fingerlings in 1989, and 250 fingerlings each in 1991 and 1993. The muskellunge stocking program was discontinued in 1995.

A second survey was done in August 1972 to determine the effects of a pollution from the Shannopin Mine on Glade Run and Dunkard Creek (Hesser et al. 1972b). A heavy precipitate covering the stream bottom was noted at the confluence with Glade Run and downstream along the left bank for approximately 300 feet. The stream bottom of Glade Run downstream from the discharge, besides being stained, contained masses of algae characteristic of mine acid drainage discharges. The survey determined that acid mine drainage from Glade Run substantially reduced the invertebrate populations immediately downstream. Because of the high buffering capacity of this stream, the invertebrate population approximately 3 miles downstream at the L.R. 30074 bridge appeared to have been unaffected by the discharge.

A survey done in June of 1977 reported that Dunkard Creek appears to sustain good water quality for most of its length (Proch 1978). Proch determined that mine drainage accounted for the loss of water quality in the lower reaches of the creek. Two point sources accounted for only a small portion. Most resulted from barrier breeching along the valley wall starting at Bobtown and continuing for almost a kilometer. Proch found tremendously high levels of freshwater mussels and highly colored Centrarchids. The mussels comprised of several species ranging from the small fingernail clam Pisidium to the large species of the genus Elliptio. The density of mussels peaked near Blacksville, West Virginia, where mounds of empty shells were everywhere, the remains of Racoon Bacchanalias. The Centrarchids were the commonest and principle gamefish in the basin. Their size was remarkable for stream bred populations. Proch reported the angling potential was apparently under utilized.

Annual sampling for smallmouth bass took place from 1984 through 1992 (PFBC data base). This stream has maintained a viable smallmouth bass and rock bass fishery during these years. Occasional catches of and recent sampling efforts show that sauger, channel catfish and tiger muskellunge also are available (Lorson, Shervinskie, and Eisel 1995). Sauger and channel catfish have moved upstream out of the Monongahela River whereas the tiger muskies have been stocked as fingerlings. According to the Pennsylvania Fish and Boat Commission, Sauger have been migrating upstream to the second dam downstream of the Accurate Brass Plant located in Brave, PA each of the last three spawning seasons (1994-95-96).

The Department of Environmental Protection (DEP) conducted a Priority Water Body Survey in 1984 (Rider 1985). The report investigated the Chapter 93 Water Use Designation of Warm Water Fishes. The survey data indicated this use was attained from Mount Morris to Taylortown and could be attained from Taylortown to the mouth in the absence of acid mine drainage. The recommendation was to retain the Warm Water Fishes Use Designation (Lorson, Shervinskie and Eisel 1995).

In 1995 the PFBC designated a 4.2 mile stretch from the mouth of Shannon Run at the T-339 ford downstream to the SR 2009 bridge as a smallmouth catch and release area. Smallmouth bass sampling took place from 1995 through 1998 in this area. An angler opinion survey took place during 1998. Data from this study will be evaluated in 1999 and regulation changes, if necessary will occur in 2000. The PFBC will be publishing a report in the year 2000 concerning the findings of this study.

In September of 1998, The Pennsylvania Fish and Boat Commission reported a large fish kill at the Taylortown bridge. Approximately 1,752 fish were found dead on a 2 mile stretch starting at the Taylortown bridge. It is suspected that a large acid mine drainage discharge located above this area is to blame.

Vegetation

Approximately 50% of the watershed area is covered with forest. Individual forested area ranges in size from less than 50 acres to more than several hundred acres. They are interspersed throughout the area with pasture, hay, and crop fields. This forest land is composed of trees varying in size from small seedlings to large mature sawtimber. Forest land is defined as land that is at least 10% stocked with trees of any size.

Table 14 lists native and exotic tree species that are present in the watershed as compiled by the Pennsylvania Bureau of Forestry:

TABLE 14. Native Tree Species of the Dunkard Creek Watershed

1	Oak Species (Red, White, Black, Chestnut, Scarlet, Shingle, Post)
2	Hickory Species (Shogbark, Bitternut, Mockernut, Red)
3	Maple Species (Sugar, Red, Black, Silver, Boxelder)
4	American Beech
5	Blackgum
6	White Ash Species (White, Green)
7	Big-Tooth Aspen
8	American Basswood
9	Tulip-Poplar
10	Black Walnut
11	Butternut

12 Black Cherry
13 Black Locust
14 Honey Locust
15 Elm Species (American, Slippery)
16 Ohio Buckeye
17 Yellow Buckeye
18 Pawpaw
19 Dogwood Species
20 Willow Species
21 Cottonwood Species
22 Cucumber Magnolia
23 Hackberry
24 Persimmon
25 Sycamore
26 Sawwood
27 Ironwood
28 Musslewood
29 Eastern Redbud
30 Serviceberry
31 Eastern Hemlock
32 Eastern White Pine
33 Sassafras

Native Shrubs	**Plantation Species**	**Exotic Species**
1 Viburnum Species	1 Pine Species	1. Tree-of-Heaven
2 Spicibrish	2 Spruce Species	2. Horse Chestnut
3 Witch Hazel	3 Fir Species	3. Kentucky Coffeetree
4 Hazelnut	4 Larch	4. Norway Maple
5 Sumac Species		5. Catalpa

According to the Pennsylvania Bureau of Forestry, the Gypsy Moth insect first caused noticeable tree defoliation in the watershed in June of 1995, mostly in the Mount Morris area. In 1996 the effects of the insect could be seen in the western most reaches of the watershed. Many of the oak stands along the ridge tops and on the southwest facing slopes were heavily defoliated in June of 1996.

It is uncertain just how this insect will ultimately affect the vegetation of the watershed. Parasitic insects and a fungus have been introduced into the gypsy moth population in an effort to keep it at tolerable levels. In 1996 the gypsy moth fungus disease was very effective in keeping numbers of the insect in check in some areas of the watershed.

PNDI Species

A Pennsylvania Natural Diversity Inventory (PNDI) search was done for the Dunkard Creek Watershed. The search revealed five plant species and eleven aquatic species located in the watershed that are rare and endangered. The following table lists the common name and scientific name of the species listed:

TABLE 15. PNDI Species in the Dunkard Creek Watershed.

Common Name	Scientific Name
Pigeon Grape	Vitis Cinerea Var Baileyana
Blue Monkshood	Aconitum Uncinatum
Clubshell	Pleurobbema Clava
Crested Dwarf Iris	Iris Cristata
Pink Heelsplitter	Potamilus Alatus
Pistolgrip Mussel	Tritogonia Verrucosa
Purple Wartyback	Cyclonaias Tuberclata
Rainbow Mussel	Villosa Iris
Regal Fritillary	Speyeria Idalia
Salamander Mussel	Simpsonaias Ambigua
Small-Flowered Crowfoot	Ranunculus Micranthus
Snuffbox	Epioblasma Triquetra
Sourwood	Oxydendrum Arboreum
Three-Ridge	Amblema Plicata
Wabash Pigtoe	Fusconaia Flava
Warmouth	Lepomis Gulosus

Recreation Data

The following is a list of township parks or community centers found in the Dunkard Creek Watershed.

1. Dunkard Township, PA 724-839-7273

Supervisors Chairman - Michael Chory

Bobtown Municipal Park

--Baseball Field

--Playground Area

--2 pavilions with kitchen rented out in summer only Private community building in Bobtown, for bingo etc.

2. Perry Township, PA 724-324-2861 Robert Pyles, Secretary

Perry Park & Community Center in the old Mt. Morris elementary school, Mt. Morris, PA.

--Playground

--Basketball Court

--Tennis Court

Boating access in Perry Township to Dunkard at the mouth of Shannon Run.

3. Wayne Township, PA 724-435-7316

Supervisors Chairman - Tim Chapman

There are no existing recreational facilities in Wayne Township. People can get access to Dunkard Creek anywhere along it. Lots of fishing and a little canoeing. Popular spot is where Hoover's Run meets Dunkard Creek near Brave.

Major Recreational Facilities

1. The Warrior Trail - A path used for 5,000 years by Native Americans from the east going to Flint Ridge, Ohio to obtain supplies of flint and to conduct commerce. The eastern terminus of the trail is on the Monongahela River, the trail runs about five to six miles north of the Mason Dixon line following the northern divide of the Dunkard Creek Watershed along the ridgelines.

Contact: Warrior Trail Association

RR 1 Box 35

Spraggs, PA 15362

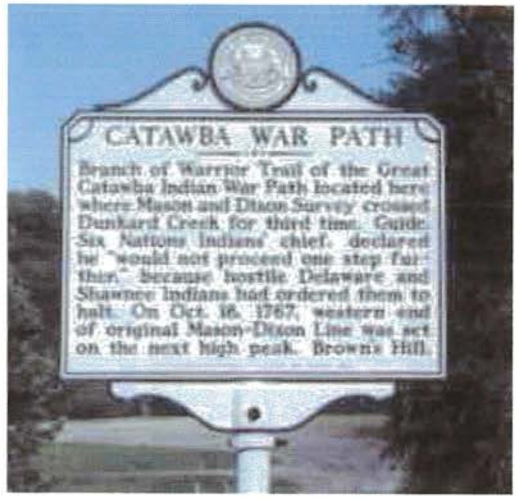
2. The Catawba Trail - A prehistoric Indian trail that was the route from New England to the Carolinas that was said to make Warriors out of the young men of each tribe. Unlike the Warrior Trail, which stays on one ridge between watersheds, the Catawba Trail does cross Dunkard, Whiteley and other streams of necessity.

Contact: Bob & Connie Ammons

Route #1, Box 18-A

Core, WV 26529

(304) 879-5500



3. Mason and Dixon Historical Park - A monument at the point where the Indians insisted that Charles Mason and Jeremiah Dixon end their famous Mason-Dixon survey line in 1767. The line settled a boundary dispute between the Penn family of Pennsylvania and Lord Calvert of Maryland. The line started in Brunswick, New Jersey and proceeded west to the monument. A swath was cut 24 feet wide to mark the line over rough, often wooded, terrain and unbridged streams. To complete the survey required over two years and the labor of a crew of from 40 to 100 men. Park is 270 acres (half in PA and half in WV) it is owned jointly by Greene County, Pennsylvania and Monogalia County, West Virginia.

Annual events at the park include:

--Ramp Fest, third Saturday of April

--Annual picnic and business meeting, second Sunday in June

--Dunkard Valley Frontier Festival, fourth weekend in August

--Buckwheat Cakes and Sausage Feast, second Saturday in October

--Fall Covered Dish Social, second Saturday in November

--Combat Mountain Road Race, 52 mile USCF Road Race, 32 mile citizens

Amenities

Park shelters, 2 activity or social rooms, ballfields available by reservation. Basketball courts, hiking trails throughout 270 acres of park. Amphitheater, museum and courses available

Contact: County Administrator
County Court House
Morgantown, WV 26505
(304) 291-7257
Jim Shepherd 304-292-7557
Richard Little 304-291-9026

For Reservations:
Bob & Connie Ammons
Route #1, Box 18-A
Core, WV 26529
(304) 879-5500

4. High Point Raceway, Perry Township, PA Motocross racetrack

Archaeological Sites

Eighteen Archaeology Sites have been previously recorded within the watershed in both Pennsylvania and West Virginia. The majority of the 18 known sites fall within the Monongahela Culture--this is a Native American culture that dates from 1000-1700 AD. Other prehistoric sites date as far back as the Archaic Period, as early as 5000 BC.

There are hundreds of undocumented archeological sites in the Dunkard Creek Watershed. Below are the sites registered with the WV Department of Culture and History:

Osage USGS Quadrangle

1. 46Mg15, Pyle Farm, Late Prehistoric Village Site
2. 46Mg18, LaPoe, Stone Burial Mound
3. 46Mg20, LaPoe, Prehistoric Monongahela Village Site
4. 46Mg21, LaPoe, Village Complex
5. 46Mg55, Vannoy Farm, pictograph "turkey track" carved on a large stone
6. 46Mg57, (Location?), possible camp or village site
7. 46Mg69, Vannoy Farm, village site containing components dating from the Early Archaic/Middle Woodland

Blacksville USGS Quadrangle

1. 46Mg23, Worley, village complex ca. AD 900 that was thoroughly excavated (and is now the location of a large housing development)
2. 46Mg56, (Location?), village site containing some projectile points
3. (No Number), Wana, large village site located by infrared photography, not yet studied; field test confirmed pottery, shell, flint present

There are also a large number of Early Historic log homes, many of which have not been properly recorded. An effort can be made to locate and record these homes. With some guidance this can be done by interested volunteers.

Management Options Report

Acid Mine Drainage

Coal mining and processing is a major industry in the watershed. Most of the coal is extracted through deep mining of the Pittsburgh and Sewickley seams. Figure 8 shows the distribution of mined and unmined Pittsburgh coal located in the watershed area.

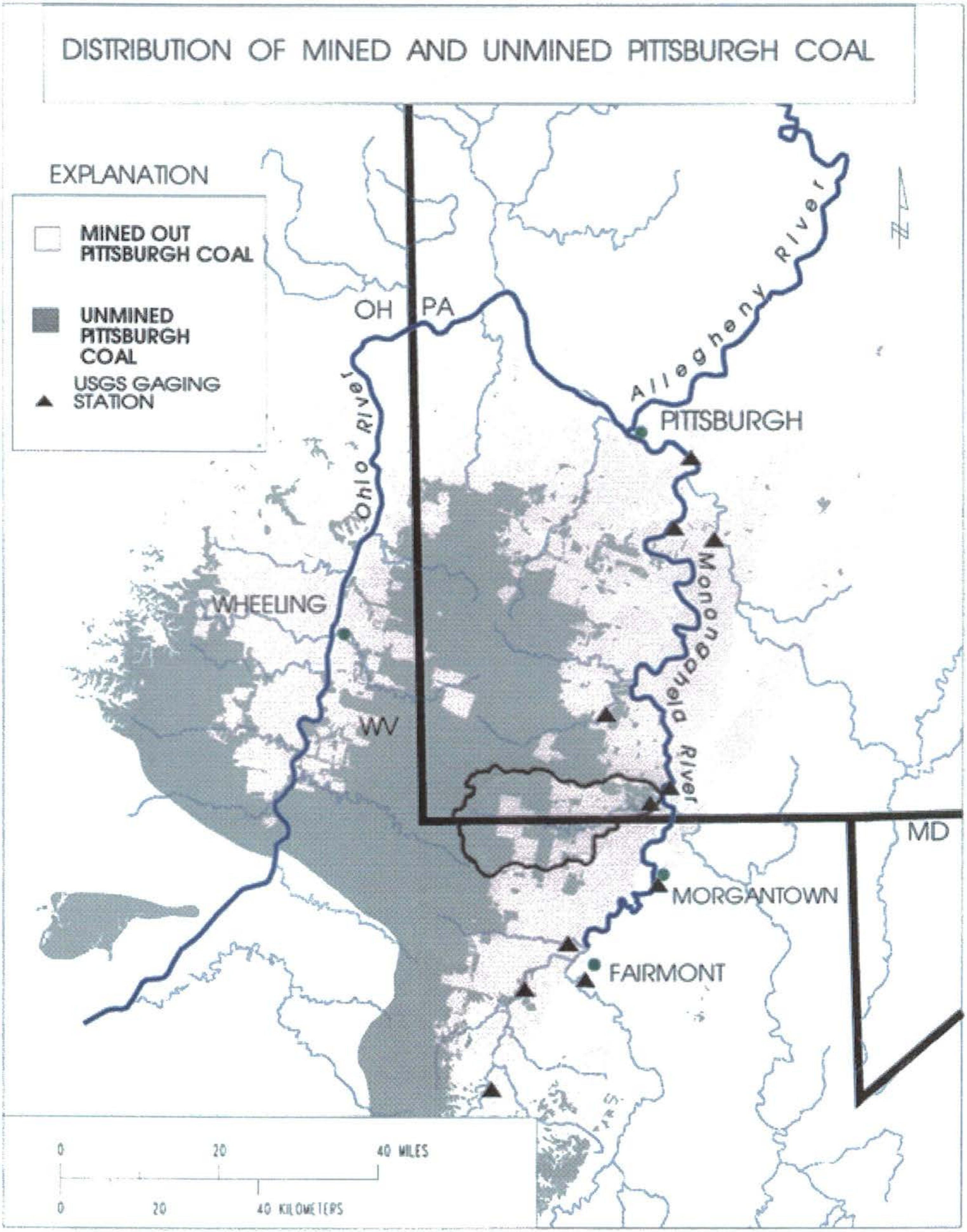
The Pennsylvania Fish and Boat Commission has designated most of Dunkard Creek as a Smallmouth Bass/Sunfish stream. However, a 10.8 km (6.8 mi.) portion of Dunkard Creek located from 1.0 km upstream of the SR 2008 bridge in Taylortown, PA, downstream to the mouth has been designated as polluted. Physical characteristics of this section of the creek such as limestone geology and a forested stream corridor lessen the overall impacts of acid mine drainage. Although this buffering capacity of Dunkard Creek keeps the water column near neutral, the quantity and quality of acid mine drainage is greater than the stream can assimilate. The substrate near the acid mine discharges is covered and cemented by iron precipitate and is practically devoid of aquatic life. In September of 1998, 1,752 fish were found dead on a 2 mile stretch of Dunkard Creek below the Taylortown Bridge. A large acid mine drainage discharge is suspected to be the cause of the large fish kill.

The PA Department of Environmental Protection (PADEP) conducted a Priority Water Body Survey in 1984 (Rider 1985). The report investigated the Chapter 93 Water Use Designation of Warm Water Fishes. The survey data indicated this use was attained from Mt. Morris to Taylortown and could be attained from Taylortown to the mouth in the absence of acid mine drainage (AMD).

PADEP estimated in 1994 that $66,690 in recreational use of Dunkard Creek is lost per year due to the degradation of acid mine drainage (1994 DEP 305(b) Report). It is for these reasons that we chose to focus on the lower section of the watershed for the management options of this issue.

Eight large acid mine discharges were located around the Taylortown-Bobtown area of the watershed. These discharges were sampled by Waynesburg College's Chemistry Department. The points on Figure 7 with the "COL" prefix are the AMD discharges.

Distribution of Mined and Unmined Pittsburgh Coal



DISTRIBUTION OF MINED AND UNMINED PITTSBURGH COAL
EXPLANATION
MINED OUT PITTSBURGH COAL
UNMINED PITTSBURGH COAL
USGS GAGING STATION
OH
PA
WV
MD
Ohio River
Allegheny River
Monongahela River
PITTSBURGH
WHEELING
MORGANTOWN
FAIRMONT
N
0
20
40 MILES
0
20
40 KILOMETERS

Acid mine drainage site 2 is probably the largest of discharges in the watershed. It begins at two large mine openings located on each side of a small valley located in Taylortown, PA. These photos show both mine openings.

From the two mine openings shown on the previous page, the discharge travels approximately 100 feet to the waterfall shown above and then directly into Dunkard Creek. The photo below shows Dunkard Creek ABOVE the discharge.

The photo above shows the downstream portion of Dunkard Creek below site 2. Compare this photo to the upstream photo on the previous page. There is a very distinct change in water quality due to this discharge. The photo below shows site 6 located near Bobtown, PA. This discharge contains high concentrations of aluminum.

The photo above shows site 7 located above the SR 2011 bridge near Newtown, PA. Below is a downstream shot of this discharge. Notice the milky, white aluminum.

Site 8 originates at this mine opening located just downstream of site 7 along SR2011. The discharge flows through a culvert under SR2011 and continues into Dunkard Creek as shown in the photo below.

Because of the steep slopes and the proximity of the discharges to the stream, these discharges will be very challenging to treat. An option we are in the process of looking at will be to pipe the discharge to an area where a passive treatment system can be implemented. Passive treatment of coal mine drainage has been shown to be an effective, low-cost, low-maintenance alternative to active treatment at abandoned mine land sites. These passive systems are designed to treat the mine drainage for a long period of time, usually 20 to 40 years.

Three passive systems are being considered for these discharges. They are aerobic wetlands, anoxic limestone drains (ALDs), and SAPS (successive alkaline producing systems).

Aerobic Wetlands

Aerobic wetlands can only fully treat water that is net alkaline. These wetlands can effectively remove iron from net acidic mine drainage if the water would be net alkaline in the absence of manganese.

Aerobic wetlands are designed to promote oxidation, precipitation, and settling of iron and manganese oxyhydroxides. To promote oxidation, small waterfalls or rip-rap channels may be constructed to increase the oxygen transfer rate. The depth of water in most of these systems is only 10-15 cm. This promotes additional oxygen transfer and allows plants, such as cattails, to flourish. One of the major functions of the plants is to slow the flow of water, which promotes settling of the metal precipitates, and to discourage channelization.

Anoxic Limestone Drains (ALDs)

Anoxic limestone drains solely function to add alkalinity to the mine drainage, changing net acidic water to net alkaline water. Concentrations of dissolved ferrous iron and manganese pass through ALDs unchanged. These metals must be removed in an aerobic wetland constructed to treat the net alkaline ALD effluent. ALDs are limited to waters that contain no aluminum or ferric iron. Aluminum has been shown to precipitate within the drain, significantly reducing permeability. Ferric iron will precipitate on the limestone surface, reducing its dissolution rate.

At many of the sites where ALDs are effective, the raw mine water contains some alkalinity but is still net acidic due to high levels of ferrous iron and/or manganese. This type of water is ideal for ALD treatment. In order for water to contain alkalinity, the pH must be greater than 4.5. This pH precludes the presence of significant concentrations of dissolved aluminum or ferric iron. However, in order for the ALD to be effective, it must add enough alkalinity to the mine drainage to subsequently neutralize the acidity that will be generated by iron and manganese precipitation in the aerobic wetland.

Successive Alkalinity-Producing Systems (SAPS)

These systems consist of three layers: limestone, compost, and standing water. A perforated pipe network is placed within a limestone layer. Above the limestone is a 0.5 m layer of compost and 1 - 2 m of free standing water. The mine water is forced down through the compost and limestone. Sulfate reduction reactions occur in this compost layer. Compost removes dissolved oxygen and reduces ferric iron to ferrous iron in the mine water making the water appropriate for contact with limestone. As with an ALD, an oxidation/settling pond or aerobic wetland is required after the mine water flows through one of these systems. Unlike an ALD, these systems can be used in succession to the degree necessary to develop net alkaline conditions.

Trash Dumps

Three large illegal roadside trash dumps are present along Dunkard Creek around the Bobtown, PA area. Refer to Figure 5 for exact location. Unfortunately, these dumps are located on very steep hillsides along the creek. These hillsides provide a very scenic overlook of the creek.

Probably the main reason these roadside dumps have developed is due to the lack of a landfill nearby. People have no place to take their large household garbage such as old refrigerators, furniture, etc. The municipalities in the area do not sponsor any type of annual clean up days. A management option for this issue would be to convince municipalities to sponsor a clean up day in the spring and fall.

Once this has been established, we can begin to try and clean up the three large roadside dumps. This is going to prove to be difficult and costly due to the steep slopes the dumps are found on. One option would be to use a drag line to pull the garbage up the hillsides. Physical labor could also put a dent in the dumps but this could prove to be dangerous.

The photo above shows Dump A located along TR341 between Bald Hill and Mt. Morris. Dump B located along SR2025 near Bobtown is shown below.

Dump C located along SR2008 near Bobtown, PA.

Erosion and Sedimentation

It is the nature of streams to change their course. Erosion of streambanks is a natural part of this process. It is the nature of people living near streams to attempt ways of stopping this process, because they enjoy the recreational and aesthetic benefits of their association with the waterway, but wish to minimize the hazards. This natural streambank erosion process can be accelerated through human interaction and land uses in the watershed.

Livestock operations within the watershed impacts streambank erosion and thus causes sedimentation. Most of these operations are located in the upper watershed. Much of this degradation that occurs can be corrected by the implementation of best management practices such as streambank fencing, agricultural crossings and riparian buffers. Various partners like The Natural Resources Conservation Service, Conservation Districts, California University and the landowners will be offering these programs. The management option would be to assist landowners (both agricultural and non-agricultural) in implementing Best Management Practices and heighten awareness via education.

Streambank erosion such as this located near Blacksville, WV is much more common in the upper portion of the watershed.

Erosion and sedimentation runoff from dirt and gravel roads is a major contributing factor to sedimentation in the watershed. Approximately 130 miles of these road types lie within the watershed winding through the steep ridges and valleys. Pennsylvania has a program available to eliminate sedimentation into streams from dirt and gravel roads. Working with the Conservation District, municipalities can receive grant money to stabilize problem areas. The management option would be to increase participation and thus implementation of this program.

Promote Awareness of Stream

On November 14, 1995, the Dunkard Creek Watershed Association was formed. It is made up of citizens from the bi-state region determined to improve the quality of water within Dunkard Creek, improve its recreational opportunities, enhance its economical potential, and increase the quality of life the citizens desire. The Watershed Association is headquartered at the Mason-Dixon Historical Park located on the Pennsylvania-West Virginia line.

The Dunkard Creek Watershed Association will take on promoting the awareness of Dunkard Creek. The Watershed Association has already started promoting the stream by holding events such as float trips on Dunkard Creek. One option that was discussed was to put information concerning the stream on the internet. The Watershed Association will also be a clearinghouse for the historical data on the watershed. Other future activities may include wildflower walks as well as 3 to 4 day field trips.

Raw Sewage

Raw sewage has become less of a problem recently in the watershed due to the upgrade or addition of sewage treatment facilities in populated areas such as Mt. Morris, Blacksville, Brave and Bobtown. Generally, the sewage treatment plants in the Dunkard Creek Watershed are well maintained and operated and are in compliance with permit conditions. Faulty on-lot septic systems are present throughout the watershed but have not really been pinpointed by the sample data. The management option for this issue will be to investigate and identify areas within the watershed that have malfunctioning on-lot sewage systems and determine their impacts on the stream.

Water Quality

For the most part, water quality in Dunkard Creek upstream of Taylortown can be characterized as good. Although there are pollution contributions from malfunctioning on-lot sewage systems and agricultural runoff, these contributions do not appear to alter the stream to the point of impairment. However, in the lower 6.2 miles of Dunkard Creek, acid mine drainage is degrading the water quality so severely it is devoid of all aquatic life. Acid mine drainage, raw sewage and erosion and sedimentation are all issues of water quality. Therefore the management option for those issues would take care of the water quality issue.

Promote Heritage and Recreation

This issue is similar to promoting the awareness of Dunkard Creek. Again, the Dunkard Creek Watershed Association will be taking on the task of this issue. They have already begun by stocking the creek with trout near the Mason-Dixon Park and allowing anglers to fish them out. They also will be promoting float trips. There is a need to locate and record undocumented archaeological sites located within the watershed. This can be taken on by volunteers or through the Dunkard Creek Watershed Association.

Dunkard Creek provides anglers with excellent fishing holes like Pigeon Hole (shown above) located near Bald Hill, PA.

Another option would be to establish trails and greenways along the creek. This could be taken on by the Conservation Districts.

<u>Time Frame for Management Option</u>

The Dunkard Creek Watershed Association is presently taking care of the issues of promoting awareness of Dunkard Creek and promoting heritage and recreation. They have been stocking a section of Dunkard Creek with trout to get the fisherman interested in fishing Dunkard Creek. They have been holding float trips on the creek as well. They are in the process of constructing boat access areas along Dunkard Creek. They will continue to address these two issues on a regular basis year round.

The first step in dealing with the issue of trash dumps is to encourage municipalities to start a spring and fall cleanup day in each township located in the watershed. We should begin talking to the municipalities as soon as possible. A clean up day should be scheduled annually in the spring and fall.

Once these cleanup days are scheduled, we can begin tackling the large dump sites shown in Figure 5. The first dump that should probably be addressed would be dump C. This dump is chosen as first because of it's proximity to Bobtown. The public will become aware of our intent to clean up the watershed. This work should begin as soon as the first clean up days have taken place. We will be taking on the task of cleaning these dumps on a yearly basis starting with Dump C then continuing with Dump B the following year and Dump A the year after that.

The treatment of acid mine drainage discharges will probably begin as soon as money becomes available to begin dealing with these sites. The discharge sites will be prioritized by acid loading tons per year. Table 16 lists the acid loadings per site.

We will be looking at treating site 4 first because it will be much easier to access and treat. We will then be looking at the following sites in this order: site 2A-2B, site 7 & 8, site 6, site 3, site 5, and site 1. Sites 7 and 8 will be done together because they are located close together. Site 1 has been recently been backfilled and is not presently discharging into Dunkard Creek. This site will be closely monitored by PADEP to determine whether it will begin discharging into Dunkard Creek again. It will depend on the availability of funds as well as land rights as to when these sites will begin and the actual order that the sites will be treated. These sites will probably be taken on a yearly basis. Table 16 lists the management option for each issue as well as the approximate date the option will be implemented and the approximate cost for each option.

Table 16. Matrix of Management Options.

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ISSUE	MANAGEMENT OPTIONS	TIMEFRAME	COST	FUNDING	ORGANIZATION
d .ie Drainage	**Site 2A-2B**-Pipe discharge across Dunkard to area where a passive treatment system will be installed. **Site 4**-Pipe discharge to area where a passive treatment system will be installed. **Site 6**-Pipe discharge along Dunkard and across SR 2012 to area where a passive treatment system will be installed. **Site 1**-Pipe discharge to area where a passive treatment system will be installed. **Site 7-8**-Pipe discharges along Dunkard and across SR 2011 to area where a passive treatment system will be installed.	We will take these on annually as funds become available.	$870,500 $604,000 $294,000 $ 80,000 $491,000	EPA 319 Grants OSM 10% Set Aside Funding	Natural Resources Conservation Services, Department of Environmental Protection, Conservation Districts, Sportsman's Clubs
Trash Dumps	Encourage municipalities to begin a clean-up day. **DUMP C**-Use draglines to remove approx. 500 truckloads of garbage. **DUMP B**-Construct access road to access approx. 200 truckloads of garbage. **DUMP A**-Construct access road to access approx. 600 truckloads of garbage.	We will take these on annually as funds become available.	---------- $ 70,000 $ 45,000 $ 85,000	PA Cleanways WV Stream Relief Program	Department of Environmental Protection, Department of Natural Resources
Erosion and Sediment	Assist landowners (Ag & Non-Ag) in implementing Best Management Practices such as streambank fencing, agricultural crossings and riparian forested buffers and heighten awareness via education. Increase participation and thus implementation of the Dirt and Gravel Roads program to eliminate sedimentation from dirt and gravel roads.	These programs will be ongoing.	----------- -----------	Federal USDA Programs such as EQIP, WHIP, WRP, CRP. Dirt and Gravel Roads Program.	Fish and Wildlife Service Partners for Wildlife Program, Natural Resources Conservation Service, Conservation Districts, California University, Landowners, PA Game Comm., PA Fish & Boat Comm., Municipalities.
Promote Aware-ness of the stream	The Dunkard Creek Watershed Association sponsors float trips, wildflower walks, field trips and fish stocking. Establish a clearinghouse for stream information. Develop a site on the internet.	Annually Ongoing	----------- ----------- -----------	State and Federal Mini Grants	The Dunkard Creek Watershed Association
Raw Sewage	Investigate and identify sewage discharge sites from malfunctioning on-lot sewage systems.	1 Year	-----------	State and Federal Mini Grants	Department of Environmental Protection, Conservation Districts.
Promote Heritage and Rec.	The Dunkard Creek Watershed Association sponsors "Put and Take" trout stockings and development of boat access areas. Help locate and record undocumented archaeological sites in the watershed. Establish trails & greenways.	Annually Ongoing	----------- -----------	State and Federal Mini Grants	The Dunkard Creek Watershed Association. Volunteers. Conservation Districts.

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