EFFECTS OF COAL-MINE DISCHARGES ON THE QUALITY OF THE STONYCREEK RIVER AND ITS TRIBUTARIES, SOMERSET AND CAMBRIA COUNTIES, PENNSYLVANIA

by Donald R. Williams, James I. Sams III, and Mary E. Mulkerrin

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U.S. DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
foot per mile (ft/mi)	0.1894	meter per kilometer
	Area	
square mile (mi^2)	2.590	square kimometer
	Volume	
gallon per minute (gal/min)	0.06309	liter per second
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
	Mass	
pound (lb)	454	grams
ton	0.9072	megagrams
	Temperature	
degree Fahrenheit (°F)	°C=5/9 (°F-32)	degree Celsius

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality units used in report:

micrograms per liter (µg/L)
milligrams per liter (mg/L)

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ABSTRACT

This report describes the results of a study by the U.S. Geological Survey, done in cooperation with the Somerset Conservation District, to locate and sample abandoned coal-mine discharges in the Stonycreek River Basin, to prioritize the mine discharges for remediation, and to determine the effects of the mine discharges on water quality of the Stonycreek River and its major tributaries. From October 1991 through November 1994, 270 abandoned coal-mine discharges were located and sampled. Discharges from 193 mines exceeded U.S. Environmental Protection Agency effluent standards for pH, discharges from 122 mines exceeded effluent standards for total-iron concentration, and discharges from 141 mines exceeded effluent standards for total-manganese concentration. Discharges from 94 mines exceeded effluent standards for all three constituents. Only 40 mine discharges met effluent standards for pH and concentrations of total iron and total manganese.

A prioritization index (PI) was developed to rank the mine discharges with respect to their loading capacity on the receiving stream. The PI lists the most severe mine discharges in a descending order for the Stonycreek River Basin and for subbasins that include the Shade Creek, Paint Creek, Wells Creek, Quemahoning Creek, Oven Run, and Pokeytown Run Basins.

Passive-treatment systems that include aerobic wetlands, compost wetlands, and anoxic limestone drains (ALD's) are planned to remediate the abandoned mine discharges. The successive alkalinity-producing-system treatment combines ALD technology with the sulfate reduction mechanism of the compost wetland to effectively remediate mine discharge. The water quality and flow of each mine discharge will determine which treatment system or combination of treatment systems would be necessary for remediation.

A network of 37 surface-water sampling sites was established to determine stream-water quality during base flow. A series of illustrations show how water quality in the mainstem deteriorates downstream because of inflows from tributaries affected by acidic mine discharges. From the upstream mainstem site (site 801) to the outflow mainstem site (site 805), pH decreased from 6.8 to 4.2, alkalinity was completely depleted by inflow acidities, and total-iron discharges increased from 30 to 684 pounds per day. Total-manganese and total-sulfate discharges increased because neither constituent precipitates readily. Also, discharges of manganese and sulfate entering the mainstem from tributary streams have a cumulative effect.

Oven Run and Pokeytown Run are two small tributary streams significantly affected by acidic mine drainage (AMD) that flow into the Stonycreek River near the town of Hooversville. The Pokeytown Run inflow is about 0.5 mile downstream from the Oven Run inflow. These two streams are the first major source of AMD flowing into the Stonycreek River. Data collected on the Stonycreek River above the Oven Run inflow and below the Pokeytown Run inflow show a decrease in pH from 7.6 to 5.1, a decrease in alkalinity concentration from 42 to 2 milligrams per liter, an increase in total sulfate discharge from 18 to 41 tons per day, and an increase in total iron discharge from 29 to 1,770 pounds per day. Data collected at three mainstem sites on the Stonycreek River below Oven Run and Pokeytown Run show a progressive deterioration in river water quality from AMD.

Shade Creek and Paint Creek are other tributary streams to the Stonycreek River that have a significant negative effect on water quality of the Stonycreek River. One third the abandoned-mine discharges sampled were in the Shade Creek and Paint Creek Basins.

INTRODUCTION

Coal is Pennsylvania's most important mineral resource. In 1993, coal production in Pennsylvania was more than 63 million tons and Somerset and Cambria Counties ranked second (5.6 million tons) and fifth (4.6 million tons), respectively, in the state for total coal produced (Pennsylvania Coal Association, 1994). Much of the Stonycreek River Basin, which is primarily in Somerset County and part in Cambria County, is underlain by low-volatile bituminous coal deposits that are an important economic mineral resource. With the onset of the Industrial Revolution in the late 1800's, extensive commercial mining of these coal resources began with almost no concern for the protection of the land surface and water resources. Consequently, the water quality in the Stonycreek River and its tributaries has been severely degraded for many decades by acid mine drainage (AMD) from abandoned coal mines and coal-refuse piles. The AMD problem has been recognized as one of the most serious and persistent water-quality problems not only in Pennsylvania, but in all of Appalachia, extending from New York to Alabama (Biesecker and George, 1966). Thousands of stream and river miles in Appalachia are currently affected by the input of mine drainage from sites mined and abandoned before strict effluent regulations were implemented (Kleinmann and others, 1988).

Part of the Stonycreek River Basin received an AMD evaluation in the early 1970's in the Operation Scarlift studies (Carson Engineers, 1974). The evaluation indicated the cleanup cost (based on conventional treatment technologies) in that part of the basin would amount to several hundred million dollars, and annual operating costs also would be in the millions of dollars. However, new passive-treatment technologies pioneered by the U.S. Bureau of Mines in the late 1970's and first applied by the mining industry in the 1980's, offer effective, low-cost, low-maintenance remediation.

The Stonycreek-Conemaugh River Improvement Project (SCRIP) association is a coalition of grass-roots groups and local resource agencies seeking to restore water quality in the Upper Conemaugh River Basin. This will be accomplished by the combined efforts of government, industry, and the private sectors and by use of new passive-treatment technologies. SCRIP was formed at the request of U.S Congressman John P. Murtha. Its goal is to develop and implement solutions to the AMD problem in the Conemaugh River Basin. SCRIP was instrumental in initiating the cooperative study of the Stonycreek River Basin between the U. S. Geological Survey (USGS) and the Somerset Conservation District.

Purpose and Scope

This report presents the results of a coal-mine-drainage study in the Stonycreek River Basin in Somerset and Cambria Counties, Pa., from 1992 to 1995. The report describes the locations and instantaneous contaminant loads of 270 mine discharges sampled during low flow throughout the basin and shows the effect that the discharges had on the water quality of the Stonycreek River and its major tributary streams. The report also describes the method used to prioritize the mine discharges for remediation and gives methods for remediation by use of passive-treatment systems. Base-flow samples were collected at 5 mainstem sites and 32 tributary sites in September 1992, July 1993, and May 1994. All 37 sites were sampled each year. To show the specific effect of mine discharges on the receiving streams, five mine discharges were sampled at their point of discharge into the receiving streams, and the receiving streams were sampled above and below these discharges. Also, two streams significantly affected by AMD, Oven Run and Pokeytown Run, were sampled at their point of discharge into the Stonycreek River, and the Stonycreek River was sampled above and below these tributary-stream inflows.

Description of Study Area

The Stonycreek River Basin is almost entirely in northern Somerset County in southwestern Pennsylvania with only a small part of the basin in Cambria County (fig. 1). Stonycreek River drains an area of 468 mi^2. Stonycreek River Basin is in the Allegheny Mountain Section of the Appalachian Plateaus Physiographic Province (Berg and others, 1989). The eastern basin boundary is the Allegheny Front, which is a crest forming the western edge of the Appalachian Mountains of the Ridge and Valley Physiographic Province. The western border of the Stonycreek River Basin is Laurel Ridge. The headwaters of the Stonycreek River rise near the town of Berlin in central Somerset County and flow generally north to Johnstown in Cambria County where it joins the Little Conemaugh River to form the Conemaugh River. The Stonycreek River has a length of 43.4 mi and an average slope of 38 ft/mi (U.S. Army Corps of Engineers, 1994). Elevations in the basin range from more than 2,900 ft above sea level on both the Allegheny Front and the Laurel Ridge to about 1,150 ft above sea level in the city of Johnstown. Relief throughout the basin is moderate to high. A wide, low flood plain exists at the headwaters of the Stonycreek River. As the river meanders northward, it enters an area of steep flanking hills with relief of 400 to 500 ft near the town of Hooversville; relief increases to a maximum of about 600 ft in Johnstown.

The Stonycreek River Basin contains a large resource of low-volatile bituminous coal. About 14 coal beds of mineable thickness are in the basin. However, the Lower and Upper Kittanning and the Upper Freeport coals have been the most extensively mined. The earliest mining activity in the basin was during the middle to late 1800's and was limited almost entirely to the Pittsburgh Coal bed in the southeastern most part of the basin and the Lower Kittanning Coal bed in the central and northern part of the basin. In the early 1900's, extensive mining of the Upper Kittanning Coal bed began. Surface-mining activities began between 1940 and 1950 and continue to be a major industry throughout the basin.

Rock in the Stonycreek River Basin is sedimentary in origin, and the rock types are primarily sandstone, siltstone, and shale with thin beds of limestone and coal. Folding along the Allegheny Front on the east and Laurel Hill on the west exposes a considerable part of the geologic column, from the Mississippian-Devonian age Rockwell Formation to the Pennsylvania age Monongahela Group. A generalized stratigraphic column showing the units present in the basin is shown in figure 2.

The rocks are divided into eight stratigraphic units: the Rockwell Formation of the Mississippian-Devonian System; the Burgoon sandstone, Loyalhanna Formation, and Mauch Chunk Formation of the Mississippian System; and the Pottsville Group, Allegheny Group, Conemaugh Group, and Monongahela Group of the Pennsylvanian System. The distribution of stratigraphic units in the basin is shown in figure 3. The Rockwell Formation consists of sandstone, shale, and some red beds. The Burgoon sandstone consists of buff-nonmarine sandstone and conglomerate. The Loyalhanna Formation is a highly cross-bedded siliceous limestone. The Mauch Chunk Formation consists of red shale with subordinate sandstone and limestone. The Pottsville Group is composed of the Homewood, Mercer, and Connoquenessing Formations and consists predominantly of sandstone, conglomerate, and thin beds of shale.

The Allegheny and Conemaugh Groups are the two most areally extensive stratigraphic units in the basin. The Allegheny Group is composed of the Freeport, Kittanning, and Clarion Formations. The group consists of sandstone, shale, and discontinuous limestone and coal beds. The Conemaugh Group is composed of the Casselman and Glenshaw Formations and consists primarily of sandstone and shale and lesser amounts of limestone and coal. The Allegheny Group is the major coal-bearing unit in the Stonycreek River Basin, containing the thick Freeport and Kittanning coal beds. In the basin, the Monongahela Group is composed only of the Pittsburgh Formation, which consists of sandstone, limestone, shale, and coal. The Monongahela Group is confined to the hilltops just north of Berlin. This Group contains three workable coal beds—the Pittsburgh coal, the Blue Lick coal (local name), and the Redstone coal. However, in the Stonycreek River Basin, this Group is sparsely represented.

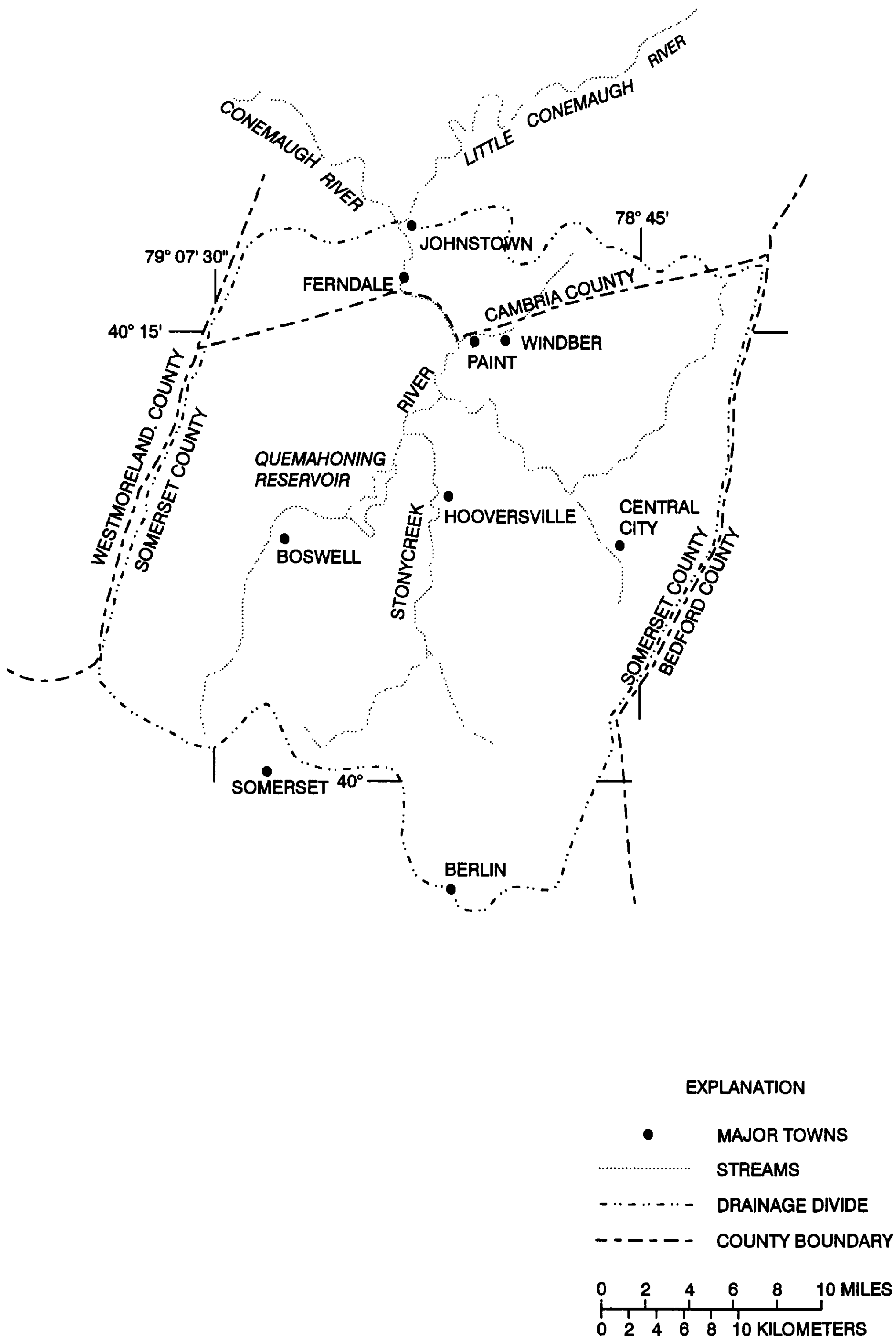

Figure 1. Location of the Stonycreek River Basin.

GENERALIZED STRATIGRAPHIC COLUMN
STONYCREEK RIVER BASIN

System	Group / Formation	Description
PENNSYLVANIAN SYSTEM	MONONGAHELA GROUP	Sandstones, limestones, shales, and thin coal beds
	CONEMAUGH GROUP	Pittsburgh Coal Gray and red shales and sandstones, thin coal beds, and thin units of limestone
	ALLEGHENY GROUP	Freeport coal Kittanning coals Sandstones, shales, limestones, and coals
	POTTSVILLE GROUP	Sandstone with shale and coal beds
MISSISSIPPIAN SYSTEM	MAUCH CHUNK FORMATION	Red shale with sandstone and limestone
	LOYALHANNA FORMATION	Siliceous limestone
	BURGOON SANDSTONE	Cross-bedded sandstone with some basal conglomerate
DEVONIAN SYSTEM	ROCKWELL FORMATION	Sandstone and carbonaceous shale

Figure 2. A generalized stratigraphic column of the geologic formations in the Stonycreek River Basin.

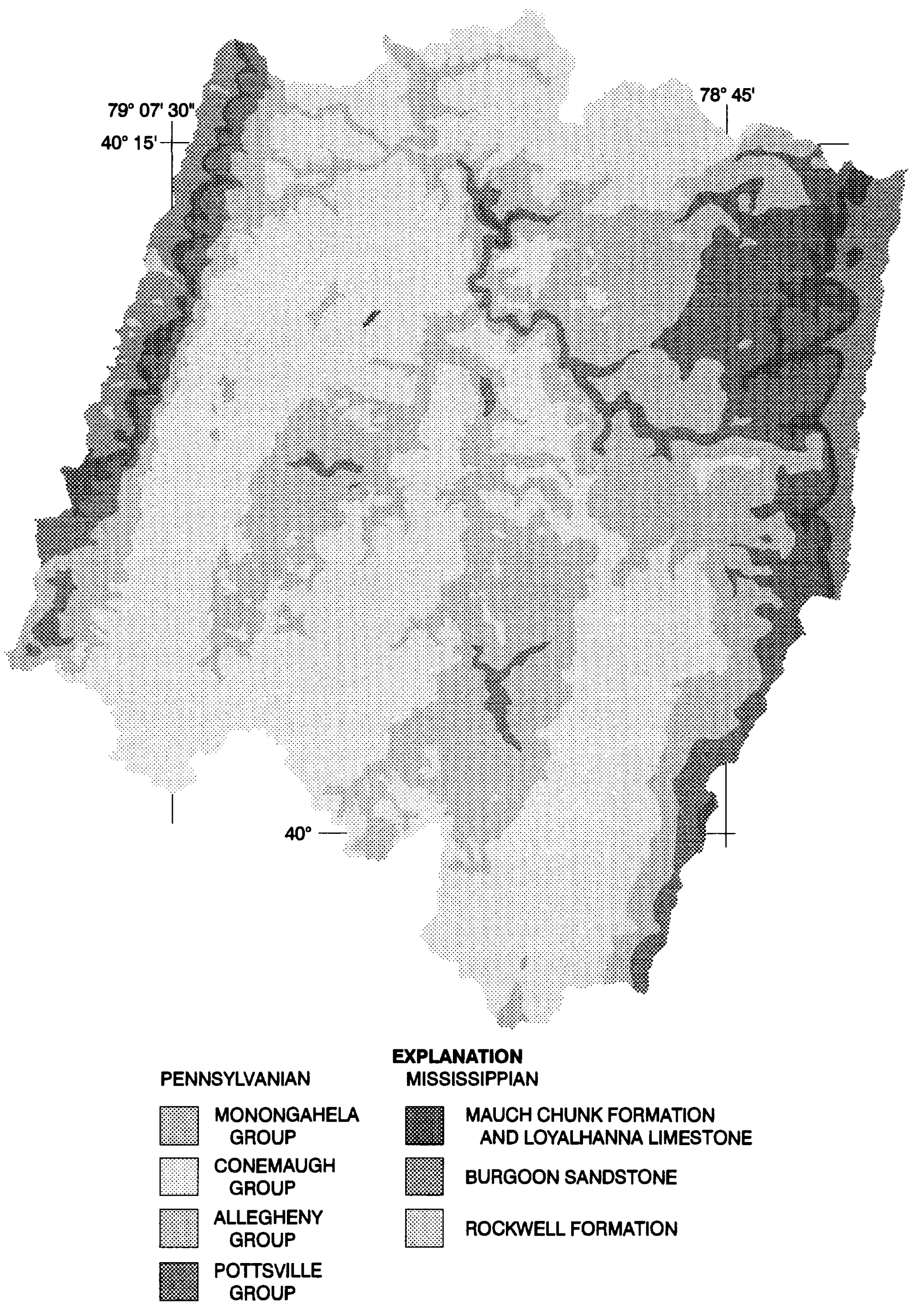

Figure 3. Geologic map of the Stonycreek River Basin (Geology compiled by Berg and others, 1980)

The climate in the Stonycreek River Basin is humid continental, characterized by warm summers and cold winters. Prevailing winds are from the west and bring most major weather systems that affect the basin. Air currents are mainly from the polar region, but during the summer, air currents from the Gulf of Mexico are frequent and result in warm, humid weather. Annual precipitation from 1926 to 1992 averaged 45.5 in. at Johnstown and from 1960 to 1991 averaged 40.7 in. at Boswell (U.S. Army Corps of Engineers, 1994). Snowfall and resulting snow on the ground throughout the basin tend to be much greater in areas of higher elevation. Average-annual snowfall at Johnstown (elevation approximately 1,200 ft) is 49.9 in. and at Boswell (elevation approximately 1,900 ft) is 64.9 in. The mean annual temperature at Johnstown during the period 1926-92 was 51.7°F. The average monthly temperature at Johnstown varies from a low of 27.9°F in January to a high of 72.9°F in July. The last frost of the season at Johnstown usually occurs in mid-April to early May; in higher elevations in the basin it could be from mid to late May. The first frost at Johnstown can be expected about mid-September until mid-October, but at higher elevations it has occurred as early as late August.

Agricultural land and forest land collectively account for 90 percent of the total land use throughout the basin (Anderson, 1967). The eastern (Allegheny Front) and western (Laurel Ridge) parts of the basin are the most heavily forested. Surface-mining operations, which affect both agricultural and forest land, are major activities in the basin and account for 4.4 percent of the land use. Residential development, commercial areas, urban areas, light industrial areas, and community parks account for the remaining 5.4 percent. The Stonycreek River Basin is sparsely populated and predominantly rural except near the mouth of the river at Johnstown, where most of the population is concentrated. The largest communities in the basin other than Johnstown and its suburbs include Windber, Berlin, Boswell, Paint, and Central City.

Methods of Study

One of the most significant challenges of the study was to physically locate the abandoned mine discharges throughout the basin. The mine-discharge locations were determined by four principal methods: (1) from previously published reports and from abandoned mine land (AML) maps supplied by the Bureau of Abandoned Mine Reclamation of the Pennsylvania Department of Environmental Protection (PaDEP); (2) from information obtained from Mine Conservation Inspectors of the PaDEP and River Keepers of the SCRIP organization (River Keepers are local residents who volunteered periodically to walk a section of the banks of the Stonycreek River or its tributaries and provide written reports on the condition of the selected stream segment and locations of mine discharges, sewage outflows, or any other unnatural inflows to the stream); (3) from talking to local residents and farmers familiar with the area and aware of discharges on their property or adjacent properties, (4) and by physically walking along the stream banks of tributary streams and the mainstem in remote areas where mining was known to have occurred. When a mine discharge was found, its location was determined by use of a Global Positioning System (GPS) receiver to record the latitude and longitude of the site to the nearest one tenth of a second. Each mine discharge was sampled where it first came from the ground. At the end of each sampling year, all mine discharges were prioritized and ranked with respect to their loading of selected constituents to the receiving stream. In the following year, the top 30 ranked discharges were resampled.

An initial field reconnaissance of the Stonycreek River Basin was conducted in October and November 1991 to determine the sampling locations of all stream sites. Five mainstem sites were selected on the Stonycreek River and 32 additional sites were selected on tributary streams. All 37 stream sites were sampled during low base flow on September 1 and 2, 1991, and July 27 and 28, 1993, and during high base flow on May 24 and 25, 1994.

The effect of mine discharges on receiving streams was determined by sampling five discharges at their point of inflow to the receiving streams and sampling the receiving streams above and below the mine discharges. The effect of Oven Run and Pokeytown Run on the Stonycreek River was determined by sampling the streams at their point of discharge into the river and sampling the river above and below the stream inflows.

In 1983-86, the USGS collected data on five headwater streams in the Laurel Hill area, three of which were in the Stonycreek River Basin, to determine the effect of acid precipitation on stream water quality (Barker and Witt III, 1990). Sulfate was the dominant precursor for acid formation in precipitation and streamflow. Nitrate was more abundant in snowfalls and contributed to streamflow acidification only during snowmelt.

Water-resources data, climatological data, and quality-assurance data were collected by the USGS in the North Fork Bens Creek Basin, a small subbasin in the Stonycreek River Basin, from 1983 through 1988 (Witt III, 1991).

In 1993, the U.S. Army Corps of Engineers, Pittsburgh District, completed a reconnaissance survey on the lower 4-mi section of the flood-reduction channel on the Stonycreek River (U.S. Army Corps of Engineers, 1993). The survey was conducted to examine the water quality, the channel sediments that might be removed or disturbed, and aquatic-life resources that might be affected by proposed rehabilitation in that section of the flood channel.

A Conemaugh River Basin Reconnaissance Study was published in 1994 by the U.S. Army Corps of Engineers, Pittsburgh District. This study considered a broad array of basin problems, one of which was water-quality degradation with respect to AMD. The study also recommended solutions for identified problem conditions.

The PaDEP publishes a water-quality assessment for Pennsylvania waters on a biennial basis in response to Section 305(b) of the Federal Clean Water Act. The PaDEP 1994 Water-Quality Assessment report for subbasin 18, which includes the Conemaugh River Basin, indicates that the single biggest source of water degradation in the subbasin is coal mining and is responsible for more than 81 percent of the degradation (Pennsylvania Department of Environmental Resources, 1994b).

Acknowledgments

The authors gratefully acknowledge the many individuals residing in the Stonycreek River Basin who took an earnest interest in this project and provided information and assistance in finding many abandoned-mine discharges. A special thanks goes to the Mine Conservation Inspectors of the PaDEP and to the River Keepers of SCRIP who provided information on the location of many mine discharges and assisted field personnel in physically locating the discharges. The authors also acknowledge the interest and cooperation of the many individual landowners, companies, and municipalities throughout the Stonycreek River Basin who provided access to private and public property for the field data collection, and commonly, provided personal escorts for locating secluded mine discharges.

COAL-MINE DISCHARGES

Coal mining can result in drainages that have a low pH and are contaminated with elevated concentrations of iron, manganese, aluminum, sulfate, and acidity. At sites mined since May 4, 1984, drainage chemistry must meet strict effluent quality criteria (Code of Federal Regulations, 1994) (table 1). In an effort to meet these criteria, mining companies commonly treat contaminated drainage by use of chemical methods. In most chemical-treatment systems, metal contaminants are removed through the addition of alkaline chemicals (e.g., sodium hydroxide, calcium hydroxide, calcium oxide, sodium carbonate or ammonia). The chemicals used in these treatment systems can be expensive, especially when required in large quantities. In addition, operation and maintenance costs are associated with aeration and mixing devices, and additional costs are associated with the disposal of metal-laden sludges that accumulate in settling ponds. Water-treatment costs can exceed $10,000 per year at sites that are otherwise successfully reclaimed (Hedin and others, 1994). The high costs of chemical water treatment place a serious financial burden on active mining companies and have contributed to bankruptcies of many others.

Table 1. *Federal effluent limitations for coal-mine drainage*

[Code of Federal Regulations, 1994, Title 40, Part 434, Section 22; concentrations are in micrograms per liter]

Element or property	Maximum for any 1 day	Average of daily values for 30 consecutive days
Iron, total	7,000	3,500
Manganese, total	4,000	2,000
pH	Within the range of 6.0 and 9.0 at all times	

Although the mining industry throughout the United States spends more than $1 million every day to treat effluent waters from active coal mines (Kleinmann, 1989), mine drainage continues to affect stream water quality because of the adverse effects of discharges from abandoned mines, many of which have been inactive for over a century.

The rate and direction of water movement through abandoned mines can be influenced by factors that include precipitation, the structure of the mined coal beds, overburden structure, mine tunnels, air shafts, boreholes, and local collapses. When an underground mine is abandoned, water levels rise until the water eventually overflows to another mine or at the land surface creating an abandoned mine discharge. Mine drainage from abandoned mines and coal refuse piles is the major source of water-quality degradation in the Stonycreek River. Most of the Stonycreek River and particularly the lower half of the river and many of its major tributaries are currently affected by mine drainage from both underground and surface sites. Many sites were mined and abandoned before passage of the Surface Mining Control and Reclamation Act of 1977 (Office of Surface Mining Reclamation and Enforcement, 1993). This Act sets strict compliance standards for surface coal-mining operations and for the surface effects of underground mining.

All mine discharges that were located and sampled for this study were abandoned mine discharges. Mine discharges from active mines are monitored regularly by the PaDEP to determine if the discharges comply with the current Federal and State effluent limitations.

Locations

Locations of the 270 coal-mine discharges sampled during the study are shown in figure 4 and listed in appendix 2. Methods used to physically locate most of the mine discharges are defined in the Methods of Study section on page 7. After reviewing the information from two previously published reports (U.S. Environmental Protection Agency, 1972; Carson Engineers, 1974) and the AML maps from PaDEP with mine-discharge locations, it was determined that a much more precise method than was used in previous studies was needed to locate mine discharges. A Trimble Navigation GPS Pathfinder system was used to achieve a horizontal accuracy of 3 to 10 ft. The exact location coordinates of all 270 mine-discharge locations are given in appendix 2.

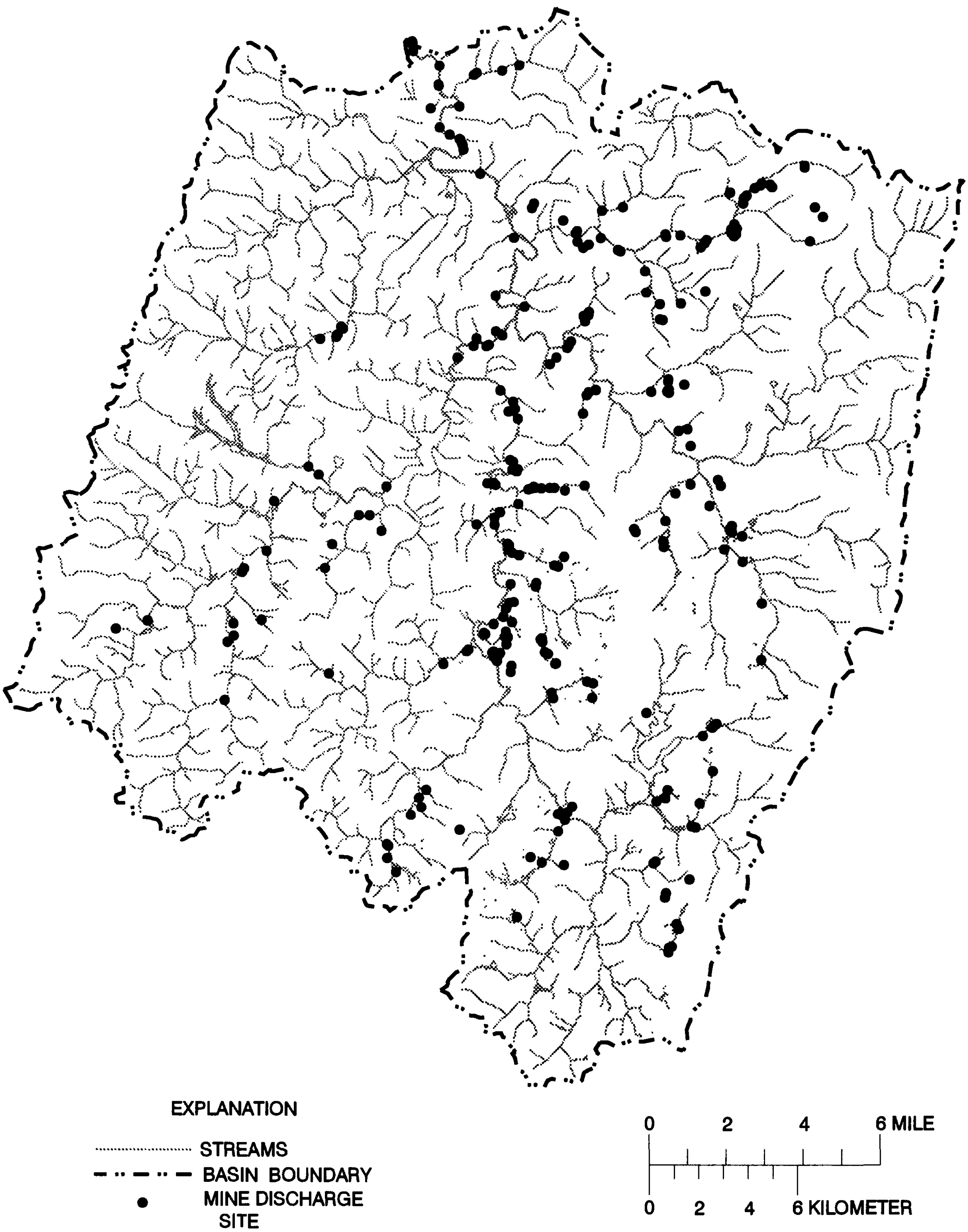

Figure 4. Locations of coal-mine-discharge sites in the Stonycreek River Basin.

Water Quality and Contaminant Discharges

Surface and underground coal mining exposes many earth materials to weathering. The physical-chemical breakdown of some materials is accelerated by this weathering process. Pyrite, or iron sulfide (FeS_2), is commonly present in coal and the adjacent rock strata and is the compound most associated with AMD. Water is also a principal component of the AMD problem, functioning as a reactant in pyrite oxidation, as a reaction medium, and as a transport medium for oxidation products. Pyrite oxidation is described by the following reaction in which pyrite, oxygen, and water form sulfuric acid and ferrous sulfate:

$$2FeS_2 + 7O_2 + 2H_2O = 4H^+ + 2Fe^{2+} + 4SO_4^{2-} . \quad (1)$$

Oxidation of ferrous iron (Fe^{2+}) produces ferric ions (Fe^{3+}) according to the following reaction:

$$2Fe^{2+} + 1/2\ O_2 + 2H^+ = 2Fe^{3+} + H_2O. \quad (2)$$

When the ferric ions react with water, an insoluble ferric hydroxide [$Fe(OH)_3$], also called "yellow boy," and more acid are produced:

$$Fe^{3+} + 3H_2O = Fe(OH)_3 + 3H^+. \quad (3)$$

The above reactions produce elevated concentrations of the precipitate insoluble ferric hydroxide [$Fe(OH)_3$], dissolved sulfate (SO_4^{2-}), and acid (H^+). Secondary reactions of the acidic water dissolve many other constituents associated with coal deposits, including manganese, aluminum, zinc, and trace metals such as arsenic, cadmium, and mercury (Tolar, 1982).

High acidities of many mine discharges also can be attributed to the action of the bacterium *Thiobacillus ferrooxidans* on the pyrite associated with the coal. At near-neutral pH, the oxidation rates of pyrite by air and by *T. ferrooxidans* are comparable. This stage is typical of freshly exposed coal or refuse, and despite the high concentration of pyrite, the oxidation rate either by oxygen or *T. ferrooxidans* is low. When a mine discharge is sufficiently alkaline, the acidic water may persist for only a short time before neutralization occurs. However, when the neutralization capacity of the discharge is exceeded, acid begins to accumulate and the pH decreases. As the pH decreases, the rate of iron oxidation by oxygen also decreases, but *T. ferrooxidans* catalyze the pyrite oxidation and accelerate acid production, which serves to further lower pH. As the pH near the pyrite falls to less than 3, the increased solubility of iron and the decreased rate of ferric hydroxide precipitation significantly increase the overall rate of acid production. Most sampled mine discharges throughout the Stonycreek River Basin that had a pH less than 3 also had very high acidities in addition to high concentrations of iron, manganese, aluminum, and sulfate. The field and laboratory analyses of all samples collected at the 270 mine discharge sites are listed in appendix 3. The number of sampled mine discharges that exceeded effluent limits for pH, total iron, and total manganese concentrations (Code of Federal Regulations, 1994) (table 1) and arbitrary limits for sulfate (U.S. Department of the Interior, 1968) and acidity are shown in figure 5. A pH less than 6.0 was measured in 193 mine discharges, and a pH greater than 9.0 was measured in 1 discharge. Concentrations of total iron greater than 7,000 μg/L were measured in 122 mine discharges, and 141 mine discharges contained concentrations of total manganese greater than 4,000 μg/L. Effluent limits for pH and for concentrations of total iron and total manganese were all exceeded in 94 mine discharges. Effluent standards for 1 or 2 of those constituents were exceeded in 140 mine discharges. Sulfate is an excellent indicator of mine drainage because neutralization processes generally do not change the sulfate concentration and the sulfate ion remains in solution. The U.S. Department of Interior (1968) reported that 75 mg/L of sulfate is an indicator of AMD in streams. Sulfate concentrations exceeded 75 mg/L in 263 mine discharges.

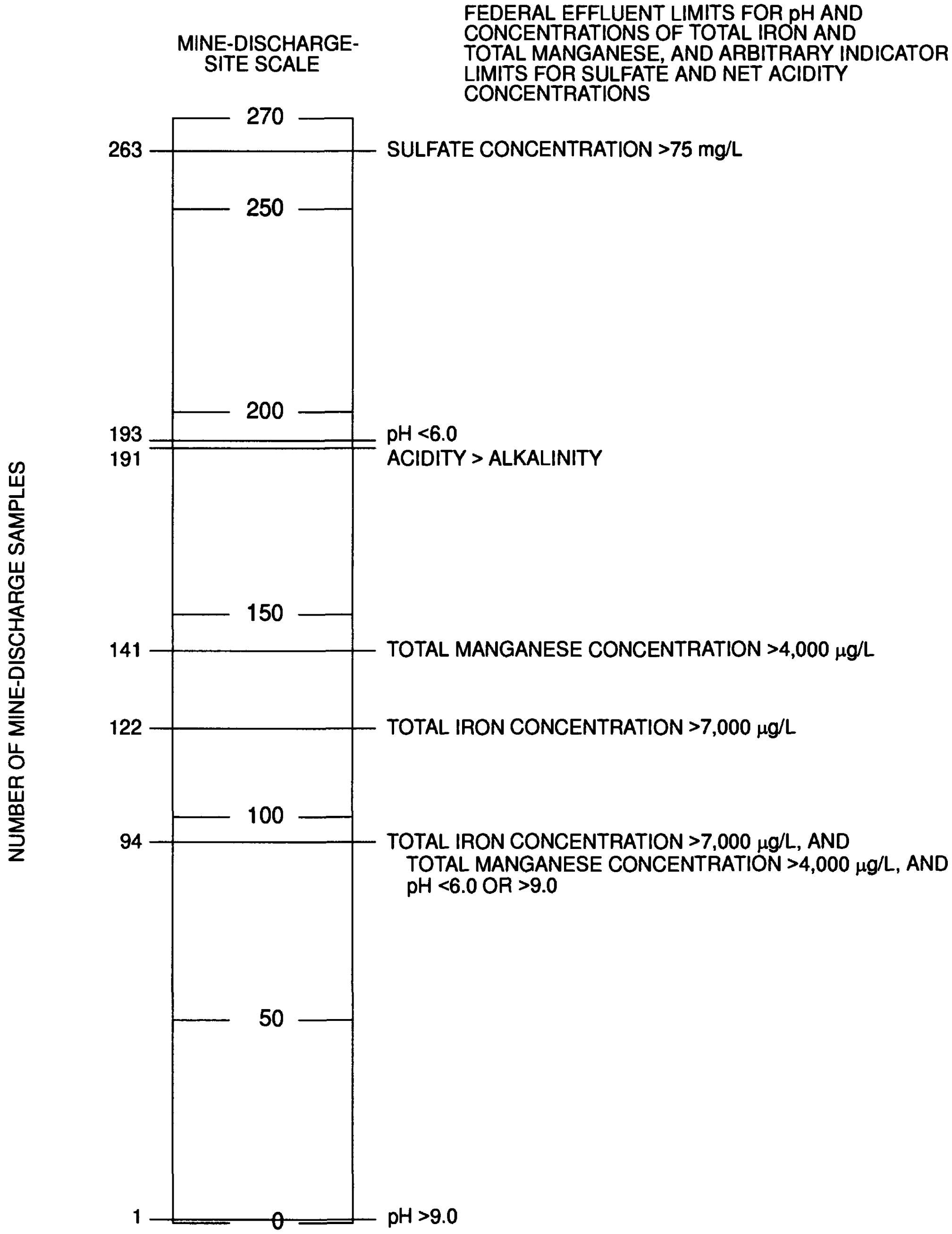

Figure 5. Coal-Mine discharges that exceeded Federal effluent limits for pH and concentrations of total iron and total manganese, and arbitrary indicator limits for sulfate and net acidity concentrations.

Acidity concentrations show the severity of a mine discharge. A discharge that is appreciably acidic will be highly aggressive—that is, it will dissolve many minerals in coal mines. The acidity of coal-mine drainage generally arises from free hydrogen ions (H^+) and mineral acidity from dissolved iron, manganese, and aluminum, which can undergo hydrolysis reactions that produce H^+. When a mine discharge contains both mineral acidity and alkalinity, the discharge is net acidic if acidity is greater than alkalinity or net alkaline if alkalinity is greater than acidity. Of the mine discharges sampled, 191 were classified as net acidic and the remaining 79 were classified as net alkaline.

Natural processes commonly ameliorate mine discharges and the toxic characteristics of the discharges can decrease because of chemical and biological reactions and by dilution with uncontaminated water. Many of these processes occur as the mine discharge flows on the land surface and is exposed to the air. The data in table 2 show the changes that occurred in water quality and quantity of two mine discharges sampled on the same day at their point of discharge from the ground and at a distance downstream just before the discharges flowed into the receiving stream. Water quality of mine-discharge at site 17 showed slight improvement about 400 ft downstream. The flow of mine discharge at site 17 was about the same at both sampling points. The quality of mine discharge at site 22 was considerably improved about 1,000 ft downstream, but dilution appears to have been a significant cause.

Natural processes that ameliorate the quality of mine discharges also can occur before the discharge flows from the ground. When mine water contacts oxygen in the mine voids, iron and manganese can precipitate as hydroxides or oxides, and pH can increase if the discharge comes in direct contact with carbonate rocks. Of the 270 abandoned-mine discharges sampled, 38 met effluent standards for pH and concentrations of iron and manganese (table 3). Five of the 38 discharges met secondary drinking-water standards established by USEPA (1994) for pH, iron, manganese, aluminum, and fluoride.

***Table 2.** Water-quality and quantity changes that occurred downstream of mine-discharge sites 17 and 22 on May 12, 1994*

[mg/L, milligram per liter; µg/L, microgram per liter]

Site	Discharge (cubic feet per second)	pH (units)	Iron, total (µg/L as Fe)	Manganese, total (µg/L as Mn)	Acidity, total heated (µg/L as $CaCO_3$)	Sulfate, total (mg/L as SO_4)
Site 17 at point of discharge from the ground	2.5	3.6	990	800	32	200
Location approximately 400 feet downstream of site 17	2.3	3.7	900	760	30	230
Site 22 at point of discharge from the ground	1.2	3.6	21,300	7,100	172	730
Location approximately 1,000 feet downstream of site 22	2.5	3.4	9,300	3,700	82	400

Table 3. *Mine discharges that met Federal effluent standards for pH and concentrations of total iron and total manganese*

[U.S. Environmental Protection Agency, 1994; µg/L, microgram per liter; mg/L, milligrams per liter, <, less than]

Site number	pH (units)	Manganese, total (µg/L)	Iron, total (µg/L)	Aluminum, total (µg/L)	Fluoride (mg/L)
50	7.1	330	24		
61	6.7	2,000	150		
64	6.4	2,900	1,700		
66	6.8	500	260		
68	6.7	130	1,400		
86	6.6	610	500		
88	6.5	10	60		
91	6.8	120	88		
96	6.3	610	460		
121	6.0	760	940		
123	6.4	170	50		
135	6.6	1,200	140		
136	6.6	1,800	170		
145	6.2	70	280		
146	6.7	1,600	120		
151	6.5	3,000	260		
152	6.5	40	100		
153	6.3	230	320		
171	6.6	950	510		
193	6.9	1,400	130		
[1]195	7.1	100	10	<130	<0.2
[1]196	6.8	30	10	<130	<.2
197	7.2	1,900	79		
199	7.1	230	170		
202	6.1	150	86		
211	6.6	1,200	1,600		
224	6.4	830	3,900		
229	6.2	2,200	380		
230	6.1	4,000	2,000		
243	6.3	2,000	43		
244	6.3	220	17		
245	6.0	210	120		
[1]246	6.4	20	240	<130	<.2
[1]247	6.6	490	840	150	<.2
257	6.9	570	33		
259	6.3	180	190		
268	6.3	700	680		
[1]270	6.6	110	10	197	.2

[1] Discharges that met U.S. Environmental Protection Agency secondary drinking water standards for aluminum and fluoride.

The flow rate of a mine discharge is one of the most important factors when determining contaminant discharges. This is illustrated in table 4. The first set of data on the top left side of the table represents the top 10 percent (27 discharges) of the 270 mine discharges with respect to the largest total iron concentrations. The sites are sorted from highest concentration to lowest concentration of total iron. The "DISCHARGE RANK" column represents the rank of the corresponding discharge for each site from highest measured instantaneous discharge to lowest measured instantaneous discharge of all 270 mine discharges. For example, mine discharge at site 20 contained the highest measured total-iron concentration (4,750,000 µg/L) of all 270 mine discharges, but the iron discharge of 39.9 lb/d ranked 26th of all 270 mine discharges. Mine discharge at site 122 contained the fourth highest measured iron concentration (690,000 µg/L), but its discharge of only 1.66 lb/d ranked that mine discharge 107th of the 270 mine discharges.

On the top right side of table 4, the data are sorted with respect to total-iron discharges, with the highest measured discharge at the top of the data group in the column marked "Discharge, lb/d" and the lowest measured discharge at the bottom. In this data group, mine discharge at site 16 contained the largest total iron discharge (1,700 lb/d), but the concentration ranked only 41 of the 270 discharges. The reason for the highest measured total iron discharge was because of the very large flow (2,250 gal/min) in addition to a large concentration (63,000 µg/L). Mine discharges at sites 149 and 242 ranked very high in both iron discharge rank and iron concentration rank because both mine discharges contained high total-iron concentrations and high flows.

The bottom half of table 4 shows discharge ranks and concentration ranks for acidities that were sorted on the basis of acidity concentrations and acidity discharges. Site 242 ranked second of all 270 sites in acidity discharge rank and acidity concentration rank. The iron and acidity columns labeled "Discharge, lb/d" on the right side of table 4 gives the 27 mine discharges that are contributing most of the contaminant discharges of total iron and total acidity to the receiving streams.

The next section in this report integrates discharges of total iron, total manganese, dissolved aluminum, acidity, and sulfate to prioritize all sampled mine discharges for remediation.

Table 4. *Flows, concentrations of total iron and acidity, and iron and acidity discharges and discharge rank for mine discharge sites in the Stonycreek River Basin*

[gal/min, gallon per minute; µg/L, microgram per liter; lb/d, pound per day; mg/L, milligram perliter; <, less than]

Site	Flow (gal/min)	Iron (µg/L)	Discharge (lb/d)	Discharge rank
20	0.7	4,750,000	39.9	26
242	22	2,750,000	726	4
79	2.0	1,300,000	31.2	31
122	.2	690,000	1.66	107
165	18	320,000	69.1	17
149	310	300,000	1,120	2
228	.1	220,000	.26	164
141	48	210,000	121	12
24	3	210,000	7.56	68
158	.5	200,000	1.20	118
192	2.1	190,000	4.79	76
174	7.5	180,000	16.2	42
180	25	180,000	54.0	23
191	5	180,000	10.8	54
219	18	160,000	34.6	29
166	13	150,000	23.4	34
142	2.5	140,000	4.20	81
57	1.6	130,000	2.50	91
80	.4	130,000	.62	139
94	2.5	130,000	3.90	83
125	225	130,000	351	6
225	60	120,000	86.4	14
184	45	120,000	64.8	20
127	1.3	110,000	1.72	105
176	330	110,000	436	5
148	.2	100,000	.24	165
179	7.5	95,000	8.55	61

Site	Flow (gal/min)	Iron (µg/L)	Discharge (lb/d)	Concentration rank
16	2,250	63,000	1,700	41
149	310	300,000	1,120	6
19	1,780	41,000	876	57
242	22	2,750,000	726	2
176	330	110,000	435	25
125	225	130,000	351	21
178	1,620	17,000	330	93
173	470	34,000	192	68
110	449	30,000	162	75
3	155	75,000	140	32
4	348	30,000	125	76
141	48	210,000	121	8
81	1,400	6,900	116	124
225	60	120,000	86.4	22
109	180	39,000	84.2	60
22	224	30,000	80.6	74
165	18	320,000	69.1	5
15	96	60,000	69.1	45
97	197	28,000	66.2	80
184	45	120,000	64.8	23
38	78	66,000	61.8	40
180	25	180,000	54.0	13
205	75	52,000	46.8	49
95	981	3,500	41.2	155
248	114	30,000	41.0	77
20	<1	4,750,000	39.9	1
55	45	72,000	38.9	35

Site	Flow (gal/min)	Acidity (mg/L)	Discharge (lb/d)	Discharge rank
20	0.7	19,700	165	37
242	22	12,200	3,230	2
79	2.0	3,940	94.6	50
122	.2	3,620	8.69	121
165	18	1,600	345	24
141	48	1,300	751	6
125	225	1,180	3,180	3
142	2.5	1,120	33.6	79
219	18	940	203	32
227	7.5	940	84.6	55
117	21	934	235	30
124	18	866	187	35
158	.5	850	5.10	136
24	3	840	30.2	83
188	51	820	501	16
180	25	820	246	28
166	13	820	128	44
73	1.6	780	15.0	102
118	.3	734	2.64	161
60	6.4	720	55.3	63
94	2.5	714	21.4	94
80	.4	700	3.36	154
140	27	684	222	31
208	374	680	3,050	4
59	3.1	660	24.6	88
3	155	630	1,170	7
204	60	620	446	20

Site	Flow (gal/min)	Acidity (mg/L)	Discharge (lb/d)	Concentration rank
16	2,250	250	6,750	61
242	22	12,200	3,230	2
125	225	1,180	3,190	7
208	374	680	3,050	24
149	310	540	2,010	30
19	1,780	74	1,580	132
3	155	630	1,170	26
4	348	270	1,130	55
14	799	88	844	119
141	48	1,300	751	6
81	1,400	44	739	156
189	539	100	647	101
176	330	162	642	76
110	449	100	539	102
22	224	200	538	66
188	51	820	502	15
103	436	92	481	111
104	200	194	466	68
63	277	140	465	85
204	60	620	446	27
97	197	186	440	71
38	78	442	414	40
95	981	30	353	168
165	18	1,600	346	5
164	97	260	303	56
15	96	222	256	62
160	171	120	246	93

Remediation-Prioritization Index

A primary goal of the Stonycreek River Basin project was to prioritize individual mine discharges by a method that would show their relative severity with respect to all sampled discharges throughout the basin. If applicable, this method also could be used in other subbasins that are severely affected by mine drainage. A priority numbering system, or prioritization index (PI), was developed to identify the mine discharges that have the greatest effect on the receiving streams and that should be given a high priority for remediation. The remediation work would be designed to improve water quality in tributary streams and in the Stonycreek River. The PI was based on a site-to-site comparison of discharges of selected water-quality constituents. Discharges of the specific constituents were determined by multiplying the concentration in milligrams per liter or micrograms per liter times the flow rate in gallons per minute times a constant of 0.012 (for milligrams per liter) or 0.000012 (for micrograms per liter). The constant was used to convert concentration (in milligrams per liter or micrograms per liter) per flow rate (in gallons per minute) to pounds per day. Most mine discharge samples were collected during base-flow conditions. Because of funding limitations, sampling all 270 mine discharges at different flow conditions was not feasible. However, approximately 48 of the mine discharges were resampled 1 to 5 times and the data in appendix 3 show that the flow rate and constituent concentrations varied at the resampled sites. Data from the first sample collected at each mine discharge site were used for the PI calculations. When water-resource managers consider remediation at specific sites on the basis of these first-sample comparisons, they can take into consideration all data collected at each site and may want to consider collecting additional data at different flows and in different seasons to design treatment systems properly. The water-quality constituents used to calculate the PI included total iron, total manganese, dissolved aluminum, acidity, and total sulfate. The pH was indirectly used in the PI as a tie breaker for constituent discharges that were identical. These factors are related either directly or indirectly to the effects of coal-mine drainage on water quality. Low pH and high acidities are common to the most severe mine discharges. Total iron, total manganese, and pH in coal-mine drainage are limited by Federal regulations. The sulfate discharge is a reliable indicator of mine drainage because the neutralization processes that can occur in a mine discharge or stream do not greatly affect sulfate concentrations. Dissolved aluminum in waters having low pH affects fish and some other forms of aquatic life (Driscoll and others, 1980). Flow of a mine discharge is very significant because the flow and the concentration of a constituent determine the constituent discharge.

A computerized spreadsheet of the water-quality data at all sites was used to simplify the PI calculations. The spreadsheet was used to complete a primary sort on the discharges of each constituent in order of ascending or improving water quality. Table 5 shows how total-iron discharges were sorted, ranked, and scored for the PI calculations. The left four columns of table 5 show the unsorted total-iron data for sites 1 through 56. The right six columns of table 5 show how the 56 sites of all 270 sites with the highest total-iron discharges were sorted, ranked, and scored. The text below refers to the sorted total-iron data in table 5. A rank number was assigned to each total-iron discharge in a descending order, with a rank 1 for the largest total-iron discharge (1,700 lb/d), and a rank 56 for the smallest total-iron discharge (10.2 lb/d). Each discharge was then given a score based on the rank. A score of 1 to 10 was assigned to each discharge by subdividing the 270 sites into 10 percent groups. The first 10 percent group (rank 1-27) received a score of 10. The next 10 percent group (rank 28-54) received a score of 9, and so on. If sites had identical discharges, a secondary sort was conducted on the discharges to break the tie, using pH as the tie breaker. The discharge with the lower pH received the lower rank number. Sites 165 and 15 both had total-iron discharges of 69.1 lb/d. The pH at site 165 was 2.7 and the pH at site 15 was 3.6, so site 165 received the lower rank number. Discharges for all five water-quality constituents were sorted, ranked, and scored by this method. The final score for each site was then calculated by adding the scores for the five water-quality constituents. The final rank or PI was determined by assigning the largest final score the number 1, the second largest score the number 2, and so forth through all 270 sites. Flow was used as a tie breaker for identical final scores. The site with the largest flow received the lower rank number. The final rank or PI shows which mine discharges have the greatest potential effect on the water quality of the receiving streams, in a descending order. The complete spreadsheet showing the individual ranks and scores for each water-quality constituent at all sampled discharges and the final PI for each mine discharge is given in appendix 4.

Table 5. *Unsorted total-iron data and sorted, ranked, and scored total-iron data used for the Prioritization Index (PI) calculations*

[gal/min, gallons per minute; µg/L, micrograms per liter; lb/d, pounds per day]

Unsorted total-iron data				Sorted, ranked, and scored total-iron data					
Site number	Flow (gal/min)	Total-iron concentration (µg/L)	Total-iron discharge (lb/d)	Site number	Flow (gal/min)	Total-iron concentration (µg/L)	Total-iron discharge (lb/d)	Rank	Score
1	16	46,000	8.83	16	2250	63,000	1,700	1	10
2	9.0	3,800	.410	149	310	300,000	1,120	2	10
3	155	75,000	140	19	1780	41,000	876	3	10
4	348	30,000	125	242	22	2,750,000	726	4	10
5	341	40	.164	176	330	110,000	436	5	10
6	306	9,900	36.4	125	225	130,000	351	6	10
7	91	11,000	12.0	178	1620	17,000	330	7	10
8	5.8	62,000	4.32	173	470	34,000	192	8	10
9	6.7	38,000	3.06	110	449	30,000	162	9	10
10	122	750	1.10	3	155	75,000	140	10	10
11	136	5,800	9.47	4	348	30,000	125	11	10
12	86	13,000	13.42	141	48	210,000	121	12	10
13	52	8,300	5.18	81	1400	6,900	116	13	10
14	799	880	8.44	225	60	120,000	86.4	14	10
15	96	60,000	69.1	109	180	39,000	84.2	15	10
16	2,250	63,000	1,700	22	224	30,000	80.6	16	10
17	284	3,400	11.6	165	18	320,000	69.1	17	10
18	11	6,600	.871	15	96	60,000	69.1	18	10
19	1,780	41,000	876	97	197	28,000	66.2	19	10
20	.7	4,760,000	40.0	184	45	120,000	64.8	20	10
21	46	6,900	3.81	38	78	66,000	61.8	21	10
22	224	30,000	80.6	180	25	180,000	54.0	22	10
23	12	300	.043	205	75	52,000	46.8	23	10
24	3.0	210,000	7.56	95	981	3,500	41.2	24	10
25	3.9	68,000	3.18	248	114	30,000	41.0	25	10
26	1.5	23,000	.414	20	.7	4,760,000	40.0	26	10
27	1.0	30,000	.360	55	45	72,000	38.9	27	10
28	84	1,200	1.21	6	306	9,900	36.4	28	9
29	19	30	.007	219	18	160,000	34.6	29	9
30	4.4	2,100	.111	204	60	48,000	34.6	30	9
31	155	2,000	3.72	79	2	1,300,000	31.2	31	9
32	18	1,100	.238	164	97	26,000	30.3	32	9
33	8.4	330	.033	144	185	13,000	28.9	33	9
34	42	32,000	16.1	166	13	150,000	23.4	34	9
35	48	5,200	3.00	140	27	70,000	22.7	35	9
36	43	13,000	6.71	58	35	47,000	19.7	36	9
37	6.8	1,100	.090	188	51	31,000	19.0	37	9
38	78	66,000	61.8	249	41	36,000	17.7	38	9
39	63	820	.620	208	374	3,700	16.6	39	9
40	75	4,800	4.32	170	142	9,700	16.5	40	9
41	9.0	78,000	8.42	104	200	6,800	16.3	41	9
42	36	5,400	2.33	174	7.5	180,000	16.2	42	9
43	.5	27,000	.162	34	42	32,000	16.1	43	9
44	133	140	.223	121	1510	760	13.8	44	9
45	.04	290	.000	63	277	4,100	13.6	45	9
46	20	7,500	1.80	12	86	13,000	13.4	46	9
47	1.6	38,000	0.730	169	15	74,000	13.32	47	9

Table 5. *Unsorted total-iron data and sorted, ranked, and scored total-iron data used for the Prioritization Index (PI) calculations—Continued*

[gal/min, gallons per minute; µg/L, micrograms per liter; lb/d, pounds per day]

Unsorted total-iron data				Sorted, ranked, and scored total-iron data					
Site number	Flow (gal/min)	Total-iron concentration (µg/L)	Total-iron discharge (lb/d)	Site number	Flow (gal/min)	Total-iron concentration (µg/L)	Total-iron discharge (lb/d)	Rank	Score
48	8.0	6,400	.614	190	60	18,000	12.96	48	9
49	3.4	4,800	.196	160	171	5,900	12.11	49	9
50	1.0	330	.004	7	91	11,000	12.01	50	9
51	18	300	.065	17	284	3,400	11.59	51	9
52	.2	9,500	.023	187	36	26,000	11.23	52	9
53	4.6	1,200	.066	207	221	4,200	11.14	53	9
54	111	7,900	10.523	191	5	180,000	10.80	54	9
55	45	72,000	38.880	54	111	7,900	10.52	55	8
56	20	240	.058	124	18	47,000	10.15	56	8

A PI also was established for all mine discharges in certain subbasins that were moderately to severely effected by mine drainage. This was done so that water-resource managers could work on a subbasin approach in designing remediation plans. The subbasins prioritized included Shade Creek, Paint Creek, Wells Creek, Quemahoning Creek, Oven Run, and Pokeytown Run. The subbasin data are listed in tables 6-11. Locations of the subbasin sites are shown in figures 6-11

The GIS data base containing the site locations and PI provides an effective means for viewing the spatial distribution and magnitude of each sampled mine discharge throughout the basin. The GIS was also useful in viewing spatial relations of mine discharges with high quality streams, population centers, existing wetlands, land use, and land slope.

Table 6. *Prioritization index (PI) for coal-mine discharges in the Shade Creek Basin*

[gal/min, gallon per minute; lb/d, pound per day; <, less than]

Site number	pH (units)	Iron, total (lb/d as Fe)	Acidity, total heated (lb/d as $CaCO_3$)	Sulfate, total (lb/d as SO_4)	Aluminum, dissolved (lb/d as Al)	Manganese, total (lb/d as Mn)	Discharge, instantaneous (gal/min)	Final score	PI
16	3.3	1,700	6,750	29,700	486	232	2250	50	1
19	5.1	876	1580	10,300	25.6	85.4	1780	50	2
15	3.6	69.1	256	1,130	18.4	19.6	96	50	3
14	3.6	8.44	844	7,000	93.0	64.2	799	49	4
38	3.0	61.8	414	796	38.4	6.08	78	49	5
42	3.1	2.33	86.4	562	6.05	11.2	36	45	6
40	3.1	4.32	148	378	12.6	4.86	75	44	7
76	3.4	7.14	52.9	239	4.12	1.34	35	44	8
221	3.2	2.09	47.5	612	3.31	1.73	60	43	9
231	3.4	.92	62.2	478	3.28	5.76	48	43	10
20	2.4	39.9	165	227	1.34	.50	.7	42	11
75	3.3	1.98	28.8	176	1.22	1.22	30	40	12
234	3.5	3.22	13.8	104	.10	1.14	7.9	38	13
236	5.4	.02	25.9	421	.39	.39	45	34	14
41	5.5	8.42	13.0	52.9	.01	.44	9	34	15
215	3.0	.35	9.46	53.4	.38	.58	7.3	34	16
214	3.1	.13	8.35	63.4	.85	.29	12	33	17
232	2.7	1.08	6.58	29.6	.02	.36	1.3	32	18
247	6.6	.39	<.01	675	.10	.68	67	31	19
235	3.7	.06	5.69	6.7	.18	.71	7.9	31	20
216	5.5	6.27	9.65	39.4	.01	.33	6.7	31	21
39	6.2	.62	<.01	159	.08	.46	63	30	22
233	2.7	.49	4.03	20.4	.05	.28	1	29	23
37	3.6	.09	2.94	21.2	.19	.25	6.8	28	24
27	3.0	.36	5.04	10.6	.50	.14	1	28	25
229	6.2	.63	<.01	97.9	.04	.11	24	27	26
230	6.1	.35	<.01	25.1	.01	.17	7.2	23	27
238	5.3	.01	4.03	119	.04	.01	14	22	28
43	3.5	.16	.83	2.16	.05	.06	.5	22	29
245	6.0	.03	<.01	67.7	.02	.02	12	21	30
200	4.6	.02	2.16	12.6	.05	.05	7.5	21	31
265	6.3	1.04	.46	6.91	<.01	.08	1.2	21	32
86	6.6	.07	<.01	15.1	.01	.05	9	17	33
243	6.3	.19	<.01	12.3	.01	<.01	7.9	17	34
85	4.6	.06	.33	8.40	<.01	.08	2.5	17	35
246	6.4	<.01	<.01	32.3	<.01	.01	3.9	14	36
201	4.2	<.01	.50	2.11	.01	.01	1.6	14	37
237	3.6	.12	.20	1.73	<.01	<.01	.2	13	38
244	6.3	.01	<.01	6.34	<.01	<.01	4.8	11	39
266	6.8	.06	<.01	4.61	<.01	<.01	.8	10	40
267	6.6	.07	<.01	.02	<.01	.01	.4	10	41
239	6.0	.05	.02	.11	<.01	<.01	.1	10	42
222	5.6	<.01	<.01	4.18	<.01	<.01	1.2	9	43
240	5.8	.01	.03	.98	<.01	<.01	.2	9	44

Table 7. _Prioritization index (PI) for coal-mine discharges in the Paint Creek Basin_

[gal/min, gallon per minute; lb/d, pounds per day; <, less than]

Site number	pH (units)	Iron, total (lb/d as Fe)	Acidity, total heated (lb/d as $CaCO_3$)	Sulfate, total (lb/d as SO_4)	Aluminum, dissolved (lb/d as Al)	Manganese, total (lb/d as Mn)	Discharge, instantaneous (gal/min)	Final score	PI
81	4.8	116	739	12,100	31.9	47.0	1400	50	1
125	2.4	351	3,180	8,640	232	178	225	50	2
141	2.7	121	751	864	42.6	63.4	48	49	3
188	2.6	19.0	502	1,470	61.2	25.7	51	48	4
103	3.2	7.85	481	5,760	34.0	25.6	436	47	5
104	3.0	16.3	466	3,840	31.2	33.6	200	47	6
184	2.8	64.8	242	1,240	13.0	2.27	45	43	7
140	2.5	22.7	222	648	10.4	15.6	27	43	8
117	3.1	8.32	235	605	27.7	17.1	21	43	9
124	2.6	10.2	187	648	19.2	11.4	18	42	10
31	3.2	3.72	182	670	16.9	10.6	155	41	11
219	2.4	34.6	203	518	2.59	6.70	18	40	12
101	3.2	2.39	132	1100	6.60	2.53	117	38	13
187	2.4	11.2	164	562	9.50	1.34	36	38	14
44	3.6	.22	99.0	1150	8.62	3.99	133	37	15
28	3.1	1.21	101	433	9.98	5.85	84	37	16
139	2.6	9.20	73.0	250	3.12	6.08	13	36	17
126	2.9	1.22	86.1	253	8.74	7.49	26	35	18
46	3.2	1.80	50.4	118	5.28	1.18	20	32	19
142	2.2	4.20	33.6	102	1.47	2.79	2.5	31	20
100	5.8	.21	5.07	1770	1.86	2.91	352	30	21
111	3.4	.19	29.5	216	3.06	2.34	30	30	22
79	2.2	31.2	94.6	149	2.38	.24	2	29	23
32	3.4	.24	13.8	207	1.32	.93	18	27	24
77	3.8	.10	24.3	100	3.10	2.69	3.8	27	25
78	4.5	.02	21.8	679	.63	.94	65	25	26
116	3.6	.16	13.7	178	1.15	1.19	15	25	27
112	3.5	.06	10.7	132	1.15	.75	12	23	28
185	2.7	1.39	13.2	54.7	.62	.09	1.9	21	29
29	4.1	<.01	11.9	141	1.62	.32	19	20	30
113	3.3	.04	8.72	94.8	.91	.58	7.9	20	31
96	6.3	.38	<.01	437	.08	.29	52	19	32
217	2.9	1.32	10.7	29.7	.54	.09	2.5	19	33
268	6.3	.34	<.01	326	.14	.33	40	18	34
127	2.6	1.72	7.58	25.0	.02	.50	1.3	18	35
33	3.9	.03	4.44	86.7	.50	.57	8.4	17	36
114	3.5	.04	5.94	79.2	.58	.48	5.5	17	37
30	3.1	.11	7.39	24.8	.74	.40	4.4	17	38
220	3.5	.03	5.57	54.7	.47	.59	8.6	16	39
115	3.6	.05	4.31	56.2	.37	.51	3.9	16	40
138	2.7	.33	4.11	16.7	.21	.44	1.6	15	41
218	5.6	.27	<.01	265	.06	.01	33	14	42
80	2.7	.62	3.36	6.24	.12	.03	.4	12	43
118	2.6	.22	2.64	6.84	.23	.12	.3	12	44
102	4.7	.01	2.16	14.6	.06	.08	15	6	45
45	9.7	<.01	<.01	.41	<.01	<.01	.04	5	46

Table 8. *Prioritization index (PI) for coal-mine discharges in the Wells Creek Basin*

[gal/min, gallon per minute; lb/d, pounds per day; <, less than]

Site number	pH (units)	Iron, total (lb/d as Fe)	Acidity, total heated (lb/d as $CaCO_3$)	Sulfate, total (lb/d as SO_4)	Aluminum, dissolved (lb/d as Al)	Manganese, total (lb/d as Mn	Discharge, instantaneous (gal/min)	Final score	PI
22	3.0	80.6	538	2,020	25.5	20.2	224	49	1
17	3.3	11.6	198	1,260	17.0	6.48	284	44	2
10	3.5	1.10	35.1	571	2.78	133	122	38	3
11	4.4	9.47	32.6	588	1.31	2.61	136	35	4
210	5.8	9.43	<.01	524	.35	5.35	97	29	5
23	3.4	.04	14.4	51.8	1.58	1.30	12	24	6
223	5.6	.75	1.74	78.0	.06	.90	25	21	7
9	6.1	3.06	<.01	30.6	.01	.21	6.7	17	8
18	6.4	.87	<.01	31.7	.01	.11	11	13	9

Table 9. *Prioritization index (PI) for coal-mine discharges in the Quemahoning Creek Basin*

[gal/min, gallon per minute; lb/d, pounds per day; <, less than]

Site number	pH (units)	Iron, total (lb/d as Fe)	Acidity, total heated (lb/d as $CaCO_3$)	Sulfate, total (lb/d as SO_4)	Aluminum, dissolved (lb/d as Al)	Manganese, total (lb/d as Mn	Discharge, instantaneous (gal/min)	Final score	PI
208	6.2	16.6	3,050	5,830	539	58.3	374	49	1
176	5.9	436	642	1,780	.40	24.2	330	46	2
172	2.8	2.38	93.6	342	8.64	5.04	30	43	3
173	6.2	192	<.01	4,570	1.13	24.8	470	41	4
259	6.3	1.87	<.01	4,580	1.35	1.98	867	35	5
174	5.0	16.2	30.6	83.7	.07	1.17	7.5	35	6
175	3.2	2.22	7.20	28.8	.32	.66	5	33	7
209	3.5	6.68	<.01	230	.15	.92	64	31	8
48	4.5	.61	4.80	53.8	.27	.87	8	31	9
258	3.8	1.51	6.42	38.4	.21	.33	3.3	30	10
54	6.7	10.5	<.01	129	.19	.84	111	28	11
53	3.6	.07	3.97	28.2	.43	.04	4.6	25	12
171	6.6	.79	<.01	124	.11	.42	69	23	13
47	3.2	.73	3.69	14.8	.17	.27	1.6	23	14
183	4.2	.05	1.44	7.56	.14	.10	3	20	15
92	5.8	.02	.24	22.4	<.01	.02	1.7	16	16
182	5.2	.18	.20	1.44	<.01	.03	1	15	17
52	3.8	.02	.12	1.32	<.01	<.01	.2	11	18
256	5.8	<.01	.05	.30	<.01	<.01	.8	8	19
257	6.9	<.01	<.01	4.09	<.01	<.01	1.1	7	20

Table 10. *Prioritization index (PI) for coal-mine discharges in the Oven Run Basin*

[gal/min, gallon per minute; lb/d, pounds per day]

Site number	pH (units)	Iron, total (lb/d as Fe)	Acidity, total heated (lb/d as CaCO3)	Sulfate, total (lb/d as SO_4)	Aluminum, dissolved (lb/d as Al)	Manganese, total (lb/d as Mn)	Discharge, instantaneous (gal/min)	Final score	PI
3	2.8	140	1,170	2,980	100	42.8	155	50	1
60	2.9	.38	55.3	384	6.60	10.8	6.4	39	2
227	3.0	1.89	84.6	144	9.90	1.71	7.5	35	3
24	3.0	7.56	30.2	122	2.23	4.68	3.0	34	4
72	3.7	.08	45.4	144	5.78	4.54	8.6	30	5
59	2.9	2.72	24.6	100	2.05	2.90	3.1	28	6
71	3.8	.10	24.3	100	3.10	2.69	3.8	22	7
73	3.5	1.73	15.0	76.8	1.09	2.30	1.6	19	8
158	3.8	1.20	5.10	21.6	.44	.72	.5	12	9
159	4.6	.09	2.54	21.2	.36	.66	2.3	6	10

Table 11. *Prioritization index (PI) for coal-mine discharges in the Pokeytown Run Basin*

[gal/min, gallon per minute; lb/d, pounds per day; <, less than]

Site number	pH (units)	Iron, total (lb/d as Fe)	Acidity, total heated (lb/d as $CaCO_3$)	Sulfate, total (lb/d as SO_4)	Aluminum, dissolved (lb/d as Al)	Manganese, total (lb/d as Mn	Discharge, instantaneous (gal/min)	Final score	PI
242	2.3	726	3,230	5,280	259	7.39	22	49	1
4	2.8	125	1,130	4,010	83.5	21.7	348	46	2
34	2.7	16.1	156	605	10.6	7.06	42	40	3
1	2.8	8.83	73.0	288	6.14	5.76	16	35	4
94	3.0	3.90	21.4	51.0	.75	4.50	2.5	28	5
35	6.0	3.00	<.01	173	.12	1.84	48	24	6
2	3.1	.41	9.94	107	.56	.95	9	23	7
87	6.4	.24	<.01	12.7	<.01	.09	1.8	15	8

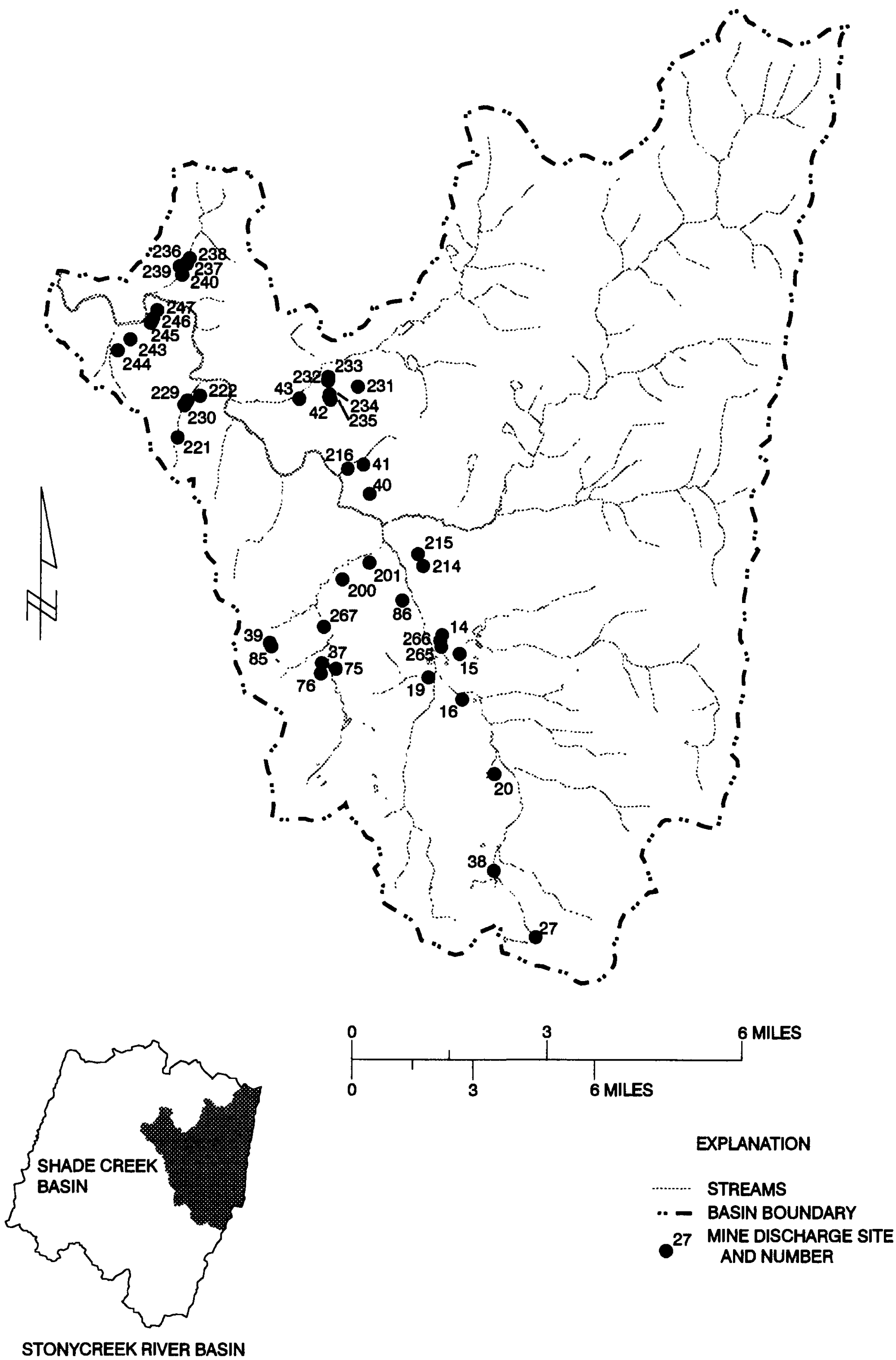

Figure 6. Location of the coal-mine-discharge sites in the Shade Creek Basin.

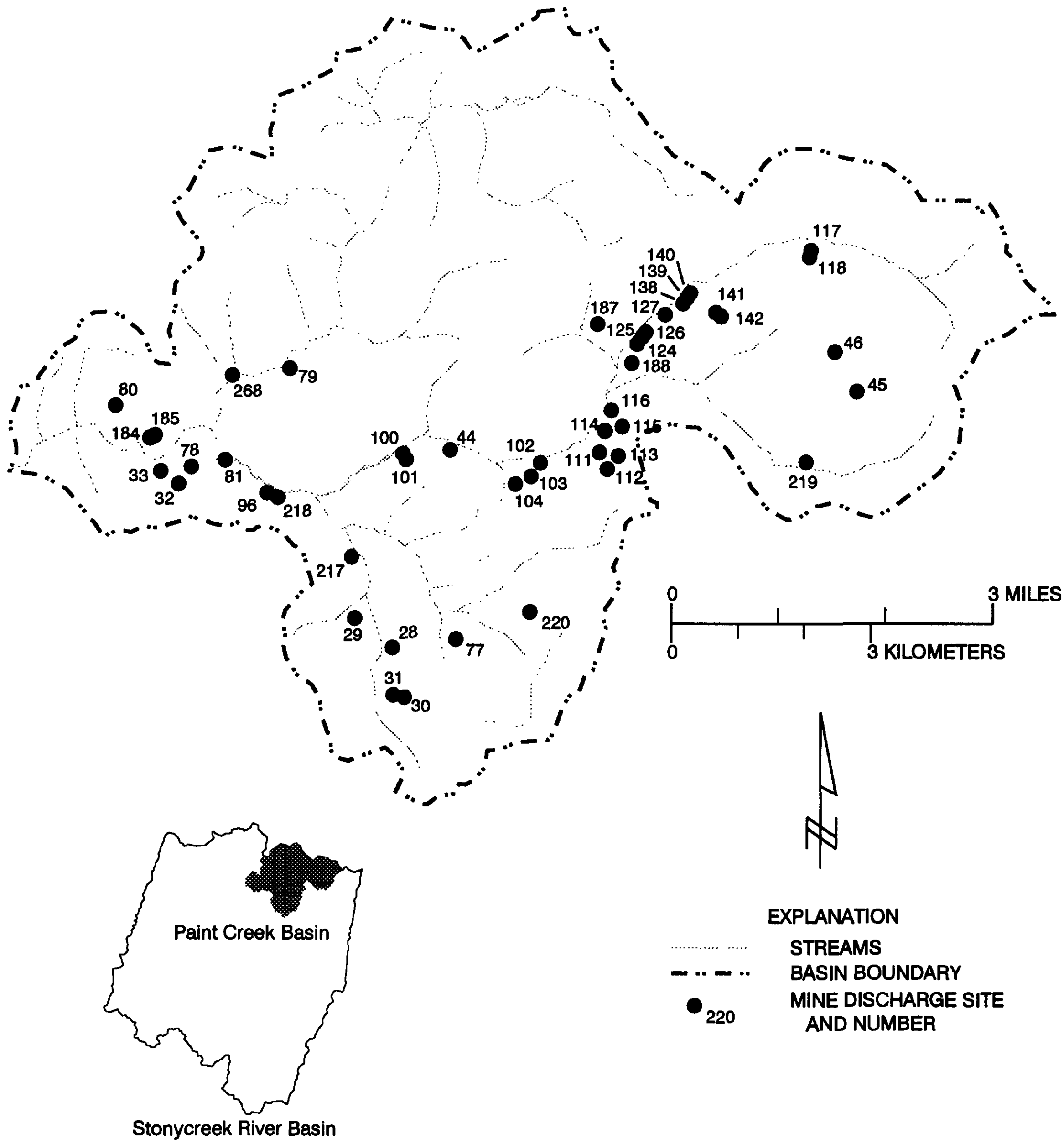

Figure 7. Location of the coal-mine-discharge sites in the Paint Creek Basin.

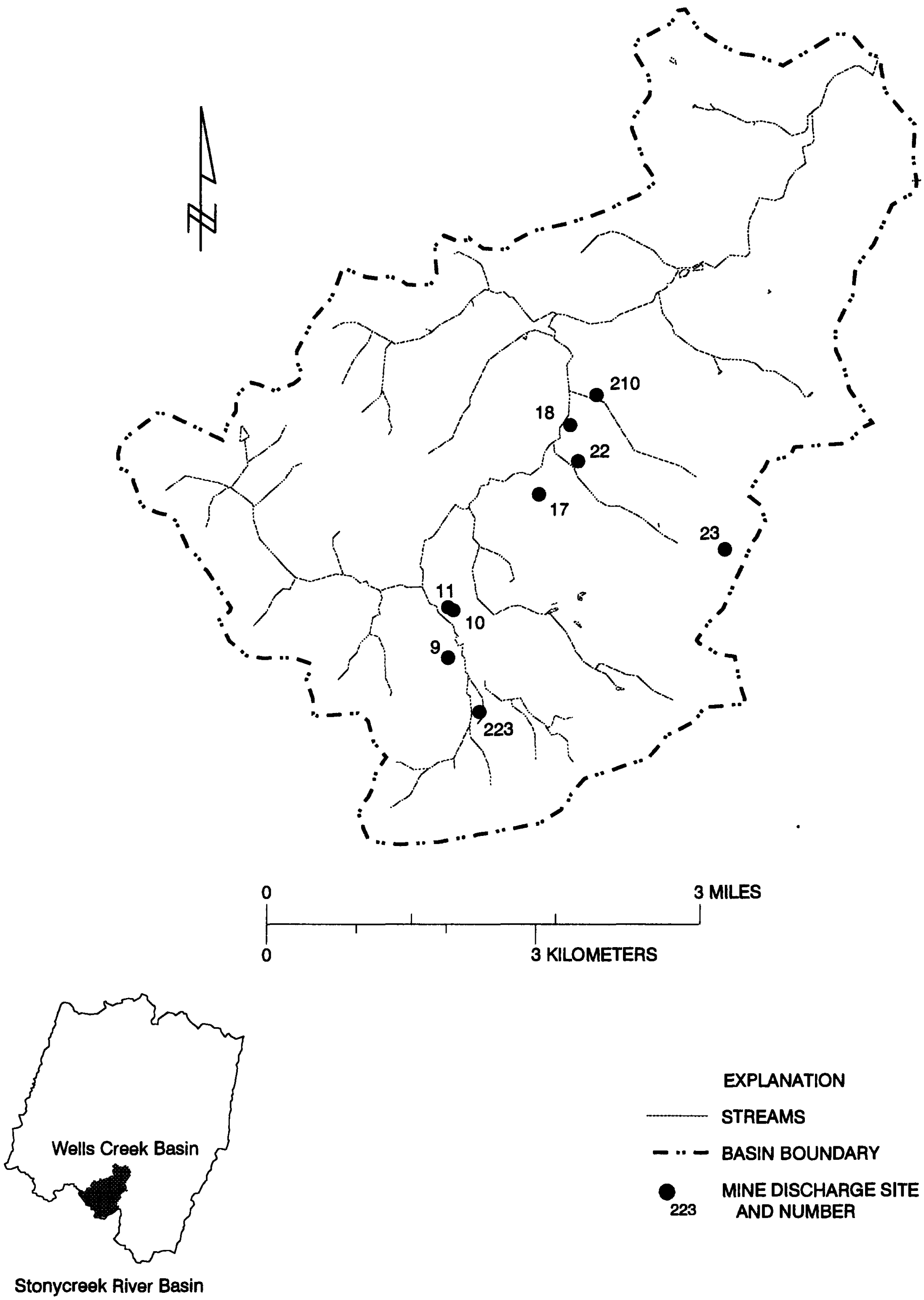

Figure 8. Location of the coal-mine-discharge sites in the Wells Creek Basin.

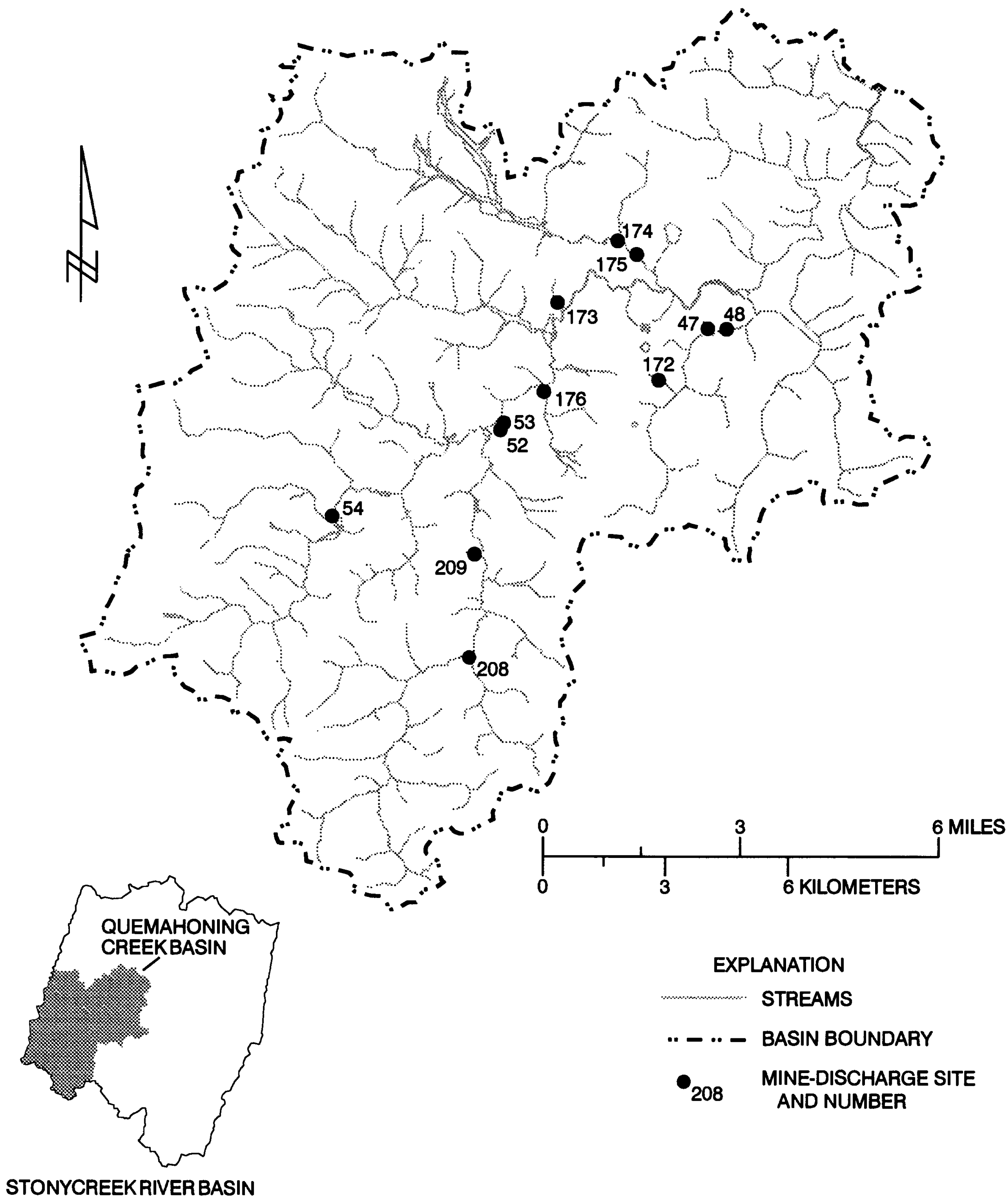

Figure 9. Location of the coal-mine-discharge sites in the Quemahoning Creek Basin.

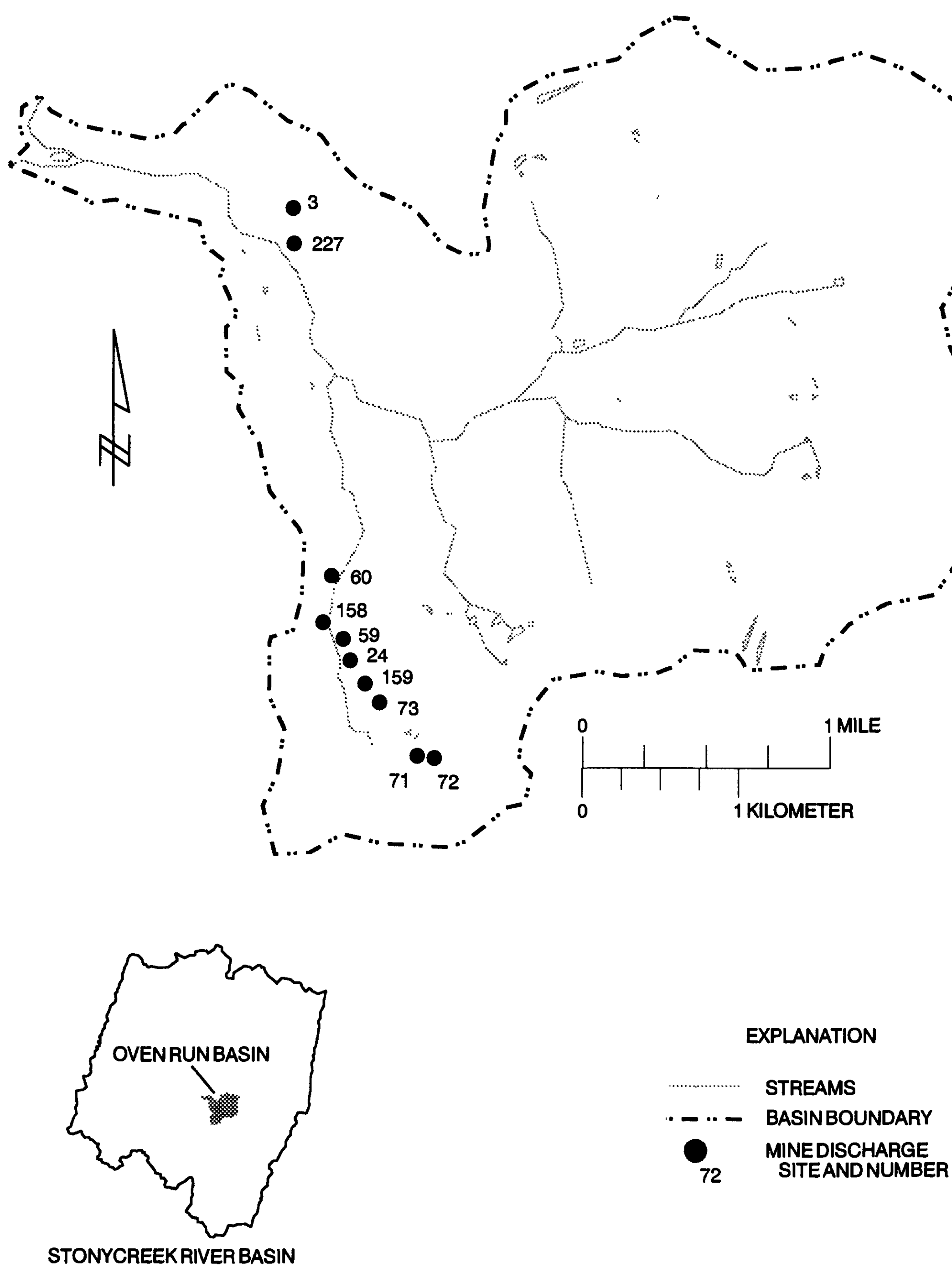

Figure 10. Location of the coal-mine-discharge sites in the Oven Run Basin.

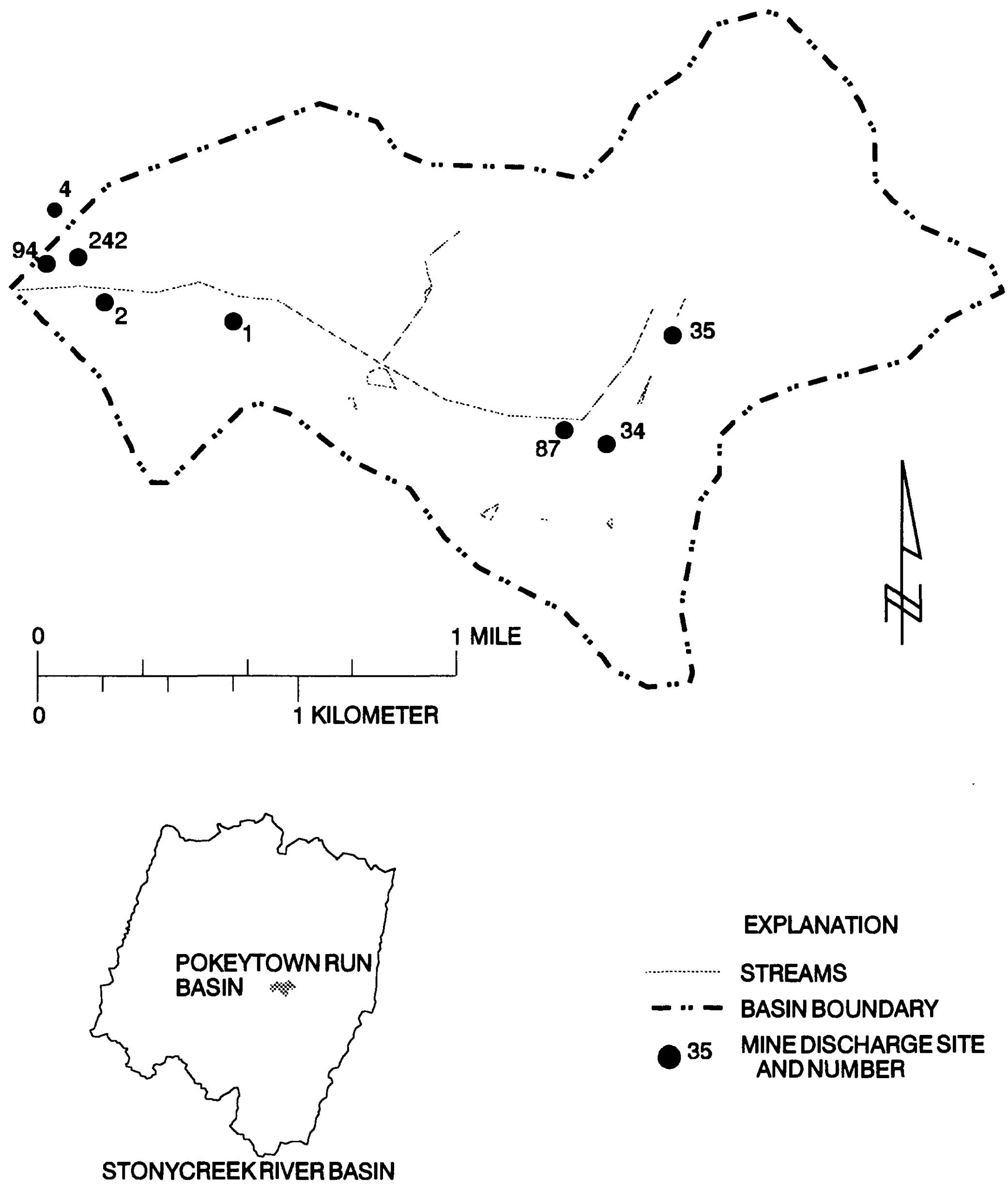

Figure 11. Location of the coal-mine-discharge sites in the Pokeytown Run Basin.

Remediation by Passive-Treatment Systems

Within the last decade, passive-treatment systems have developed from an experimental concept to full-scale field implementation at hundreds of sites (Hedin and others, 1994). Passive technologies take advantage of natural chemical and biological processes that improve the quality of contaminated water. Passive-treatment systems use contaminant removal processes that are slower than conventional treatment systems. Passive-treatment systems must retain contaminated mine water long enough to decrease contaminant concentrations to acceptable levels. The retention time for a particular mine discharge is limited by available land area, and therefore, the sizing of passive-treatment systems is a crucial design aspect. Baseline water quality and flow must be known to design AMD-treatment systems properly.

Three principal types of passive technologies are currently in use for the treatment of coal-mine drainage: aerobic wetland systems, wetlands that contain an organic substrate (compost wetlands), and ALD's. In aerobic wetland systems, oxidation reactions occur and metals precipitate primarily as oxides and hydroxides. Most aerobic wetlands contain cattails (*Typha latifolia*) growing in clay or spoil substrate. Plantless systems also have been constructed and function similarly to those containing plants if the influent water is alkaline. However, it is recommended that plants be included because they may help filter particulates, prevent flow channelization, and benefit wildlife. The water depth in a typical aerobic system is approximately 6 to 18 in.

Compost wetlands are similar to aerobic wetlands in form but also contain a thick layer of organic substrate. This substrate promotes chemical and microbial processes that generate alkalinity and neutralize acidic components of mine drainage. Typical substrates used in compost wetlands include spent mushroom compost, Sphagnum peat, hay bales, and manure.

ALD's are commonly used to treat AMD before it flows into a constructed wetland. The ALD raises the pH of the water to circumneutral levels (pH 6 to 7) and introduces bicarbonate alkalinity that neutralizes the acidity. When water exits the ALD, the circumneutral pH level promotes metal precipitation (Hedin and Narin, 1993). The limestone and mine water in an ALD are kept anoxic by sealing the drain to atmospheric oxygen to avoid armoring of the limestone with ferric hydroxide.

Each of the three passive technologies is most appropriate for a particular type of mine-water problem, but commonly, they are most effectively used in combination with each other. Examples are shown in figures 12 and 13. A passive-treatment system in which three ALD's, a constructed wetland, and two limestone cells are used in series to treat mine drainage from reclaimed surface mine spoils that were approximately 10 years old is shown in figure 12. This passive-treatment system is at an experimental site of the U.S. Bureau of Mines in the Shade Creek Basin, a subbasin of the Stonycreek River Basin. Kepler and McCleary (1994) have conducted research on a system called a successive alkalinity-producing system (SAPS) that combines ALD technology with the sulfate reduction mechanism of the compost wetland. A typical cross-sectional view of a SAPS treatment component is shown in figure 13. This system can be used to treat mine drainage that is extremely acidic (acidity concentration greater than 300 mg/L as $CaCO_3$) and has high concentrations of ferric iron (concentrations greater than 1.0 mg/L). A series of SAPS is commonly utilized until the AMD either meets effluent criteria or the quality of the AMD improves to the degree proportional to the area available for treatment. Passive treatment technology is still evolving and developing as researchers continue to work on perfecting these treatment systems. Although the effluent from these treatment systems at abandoned mine sites may not meet compliance standards, passive treatment may provide the only practical means of improving the quality of the mine discharge. Hedin and Narin (1992) provide an extensive listing of passive-treatment literature for water-resource managers who may be involved in the passive treatment of contaminated mine discharges.

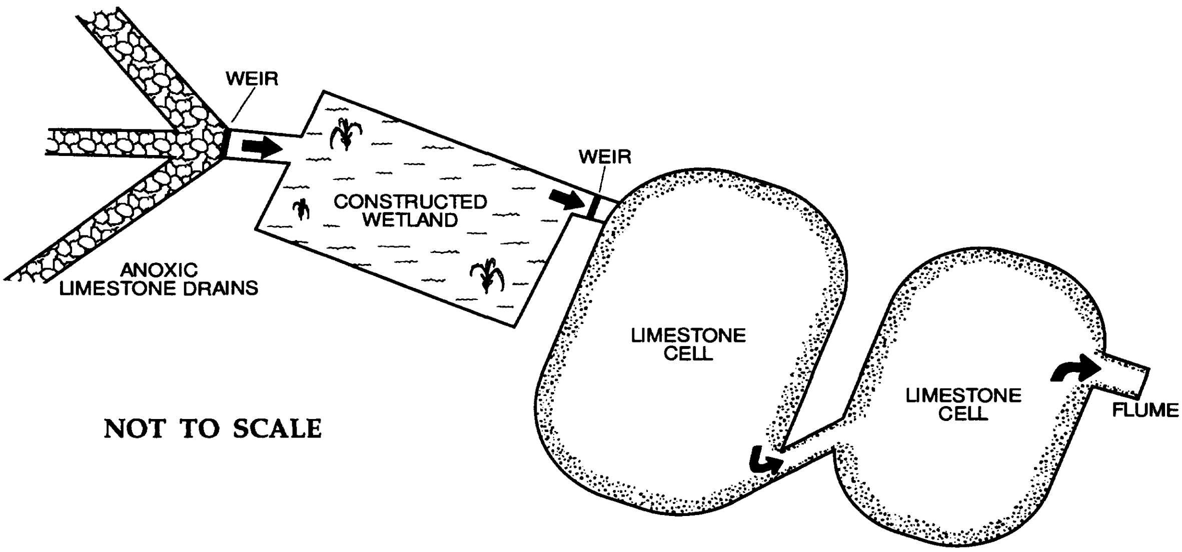

Figure 12. Layout of the Shade passive-treatment system in the Stonycreek River Basin (Modification from Narin and others, 1991).

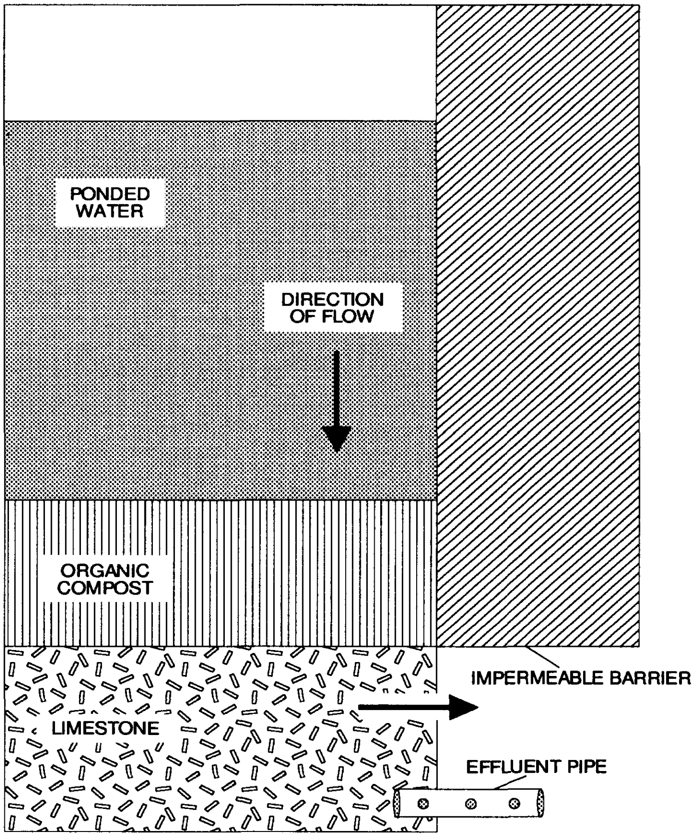

Figure 13. A typical cross-sectional view of a successive alkalinity-producing system treatment component (Kepler and McCleary, 1994, p. 198).

SURFACE-WATER-QUALITY SAMPLING SITES

Locations

The 37 surface-water-quality sampling sites selected for this study are listed in table 12, and their locations are shown in figure 14. The sites were selected to include a variety of stream-quality conditions. The sites consisted of mainstem sites, tributary sites, sites affected by varying degrees of mine drainage, sites designated as high quality or exceptional value streams by the PaDEP, inflows to reservoirs, reservoir outflows, and sites where historical data are available. Five sites were established on the Stonycreek River (sites 801-805) and 32 sites were on tributary streams (sites 806-837). Sites 805 and 833 are streamflow-gaging stations where continuous streamflow data and periodic water-quality data are collected. Site 805 (Stonycreek River at Ferndale, Pa.) is 5.2 mi upstream from the confluence with the Little Conemaugh River and has been a streamflow-gaging station since 1913. This site was established as the outflow site for the Stonycreek River Basin because of its proximity to the river mouth and the availability of long-term streamflow data and periodic water-quality data. Ninety-seven percent of the Stonycreek River Basin is monitored at site 805. Site 833 (North Fork Bens Creek at North Fork Reservoir) is the main inflow to the North Fork Reservoir, a water-supply reservoir serving the greater Johnstown area. Data were collected at this site from 1984 to 1993 as part of a nationwide network to determine long-term effects of acid precipitation on base-flow stream quality (Aulenbach and others, 1996). Data collection was continued at this site in 1994 for this investigation. Site 801 is a mainstem site in the headwaters of the Stonycreek River and is, for the most part, unaffected by mine drainage. Sites 802-804 are mainstem sites at the towns of Kantner, Blough, and near Windber, respectively, and are affected by varying degrees of mine drainage. Eight tributary sites (sites 813, 814, 818, 824, 826, 829, 832 and 834) were previously sampled by the USGS during 1979-81 (Herb and others, 1981) as part of a monitoring network to collect hydrologic data in coal-bearing areas. Site 831 was previously sampled by the USGS from 1983 to 1986 to determine the effect of acid precipitation on stream-water quality (Barker and Witt III, 1990). Site 808 is a discontinued streamflow-gaging station on Clear Run operated by the USGS from 1961 to 1978. The remaining sites were near the mouth of tributary streams in the Stonycreek River Basin and at inflows to the Quemahoning Reservoir (sites 818-823), Indian Lake (sites 808 and 809), and Lake Stonycreek (site 807). Site 817 was at the outflow of the Quemahoning Reservoir and site 810 was at the outflow of Lake Stonycreek and Indian Lake.

Table 12. *Surface-water-quality sampling sites in the Stonycreek River Basin*

[°, degrees; ', minutes; ", seconds; --, no drainage area available]

Site number	Station number[1]	Location		Station name	Drainage area
		Latitude	Longitude		
801		40°00'14"	078°54'02"	Stonycreek River at Shanksville	
802		40°06'11"	078°55'58"	Stonycreek River at Kantner	--
803		40°10'18"	078°54'29"	Stonycreek River at Blough	--
804		40°14'37"	078°53'02"	Stonycreek River near Windber	--
805	03040000	40°17'08"	078°55'15"	Stonycreek River at Ferndale	451
806		39°58'36"	078°55'49"	Glades Creek near Shanksville	--
807		40°00'33"	078°51'16"	Boone Run near Shanksville	--
808	03039200	40°02'50"	078°49'58"	Clear Run near Buckstown	3.68
809		40°03'37"	078°51'37"	Calendars Run at Bucktown	--
810		40°00'56"	078°54'05"	Rhoads Creek at Shanksville	26.1
811		40°00'58"	078°55'23"	Shrock Run near Shanksville	--
812		40°04'14"	078°54'51"	Lamberts Run at Lambertsville	--
813	03039300	40°04'11"	078°56'45"	Wells Creek at Mostoller	16.8
814	03039340	40°05'35"	078°57'16"	Beaverdam Creek at Stoystown	18.5
815		40°07'06"	078°55'28"	Oven Run at Rowena	--
816		40°08'41"	078°54'49"	Fallen Timber Run at Hooversville	2.48
817		40°11'21"	078°56'28"	Quemahoning Creek at Quemahoning Reservoir Outflow	98.2
818	03039440	40°09'54"	079°01'51"	Quemahoning Creek at Boswell	58.5
819		40°09'54"	079°04'05"	Beaverdam Creek at Jennerstown	--
820		40°08'22"	079°03'59"	N Br Quemahoning Ck near Coal Junction	--
821		40°10'17"	079°00'53"	Roaring Run at Pilltown	--
822		40°09'08"	078°58'57"	Twomile Run near Boswell	5.52
823		40°08'26"	078°58'04"	Higgins Run near Boswell	5.81
824	03039700	40°06'18"	078°47'55"	Dark Shade Creek at Central City	8.51
825		40°07'01"	078°48'16"	Laurel Run at Central City	10.0
826	03039750	40°08'03"	078°48'53"	Dark Shade Creek at Reitz	35.8
827		40°08'54"	078°49'02"	Clear Shade Creek at Reitz	31.4
828		40°10'59"	078°49'52"	Roaring Fork near Hillsboro	--
829	03039930	49 14'46"	078°50'49"	Little Paint Creek at Scalp Level	12.4
830		40°14'41"	078°53'02"	Paint Creek near Windber	36.8
831	03039930	40°23'41"	079°02'49"	South Fork Bens Creek near Thomasdale	3.28
832	03039950	40°15'02"	078°58'20"	South Fork Bens Creek near Ferndale	18.1
833	03039925	40°15'58"	079°01'01"	North Fork Bens Creek at North Fork Res	3.45
834	03039957	40°16'58"	078°56'10"	Bens Creek at Ferndale	41.6
835		40°18'21"	078°54'36"	Solomon Run at Johnstown	8.47
836		40°12'43"	078°53'55"	Shade Creek at Seanor	96.7
837		40°07'38"	078°55'28"	Pokeytown Run at Wilbur	--

[1] For sites that have no station number listed, the station number is the 15 digit number that includes the latitude, longitude, and a 01 identifier at the end. For example, the station number for site 801 would be 400014078540201.

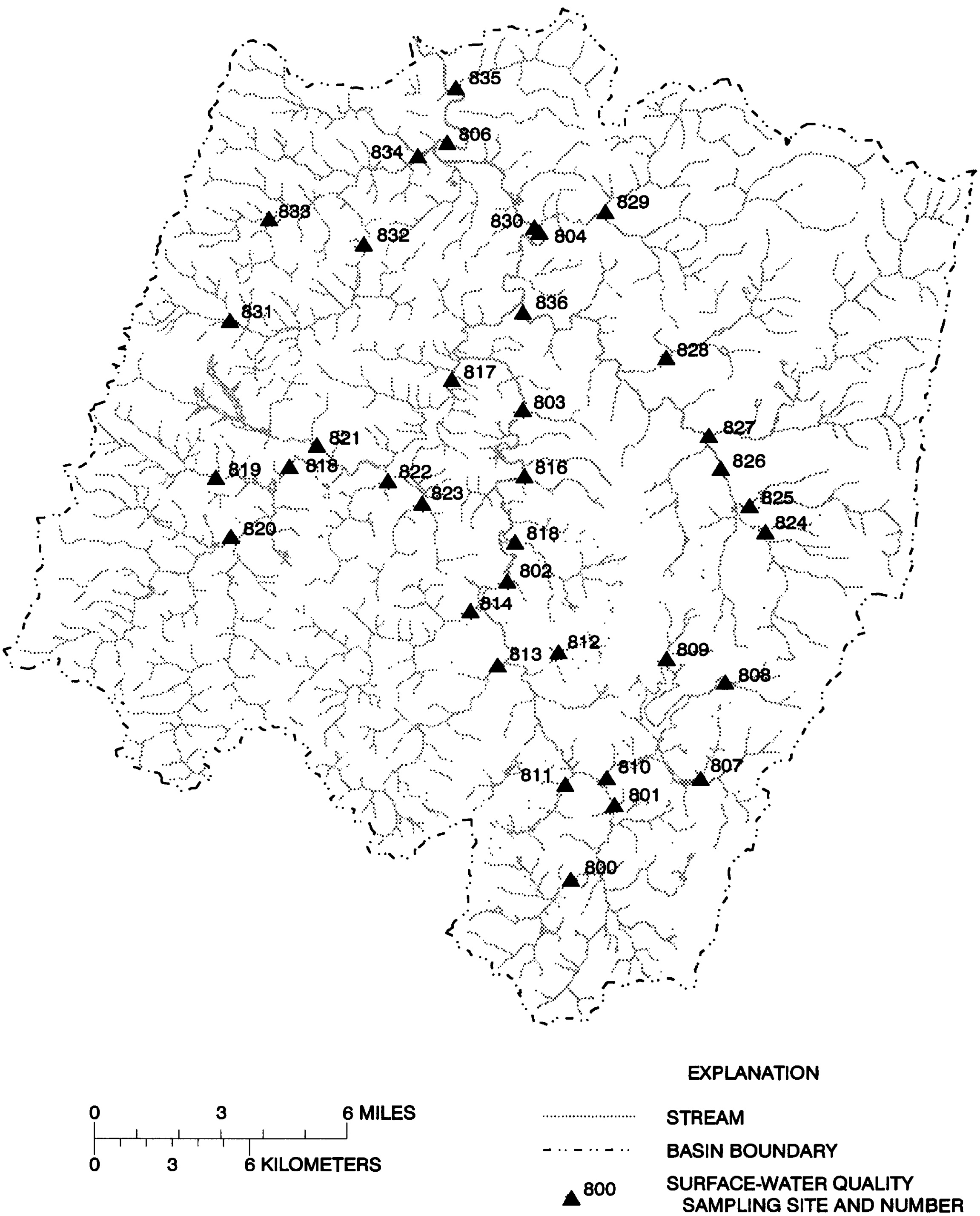

Figure 14. Surface-water-quality sampling sites in the Stonycreek River Basin.

Water Quality and Contaminant Discharges

In order to determine base-flow stream quality and contaminant discharges, synoptic-sampling was conducted each year from 1992 through 1994 at the surface-water sites. Because no precipitation occurred within 5 days of each sampling period, any effects of direct surface runoff to the streams were eliminated. Consequently, the data provide a basinwide coverage of base-flow water quality. Low-base-flow samples were collected on September 1 and 2, 1992, and July 27 and 28, 1993, at the 63- and 76-percent flow durations at the Stonycreek River at Ferndale, Pa., respectively. High-base-flow samples were collected on May 23 and 24, 1994, at the 35-percent flow duration. Surface-water-quality analyses are presented in appendix 5. Samples collected on July 27 and 28, 1993, were during the lowest base-flow conditions of the three synoptic runs and are used to describe base-flow water quality throughout the basin. Specific conductance, pH, and concentrations and discharges of dissolved solids, alkalinity, acidity, total iron, total manganese, and sulfate in the mainstem and tributary streams in the Stonycreek River Basin are shown on figures 15-18.

The pH at mainstem sites 801 and 802 was near neutral, but at mainstem sites 803-805, the pH was 4.2 or less (fig. 15). The pH from the mainstem corresponds with changes in the alkalinity and acidity on the mainstem (fig. 16). As the pH decreased, the alkalinity decreased and the acidity increased. Alkalinity at mainstem site 801 and tributary streams between 801 and 802 effectively neutralizes most acidity in the mainstem at site 802. However, the extremely high acidities at tributary sites 815 and 837 eliminate the neutralizing capability in the mainstem, and the mainstem remains acidic from site 803 to outflow site 805. Tributary sites 836 and 830 also contribute significant acid discharges to the mainstem. Specific conductance and dissolved-solids concentrations do not significantly change from mainstem site 801 to mainstem site 805 because of dilution from tributary streams (fig. 15). However, specific conductance and dissolved-solids concentrations vary in the tributary streams. Dissolved-solids discharges gradually increase from mainstem sites 801 to 803 and then increase significantly at mainstem sites 804 and 805. The large increases at sites 804 and 805 are the result of large dissolved-solids discharges entering the mainstem from tributary sites 830 and 836 and the increase in streamflow from site 804 to 805.

Total-iron concentrations vary considerably spacially in both the mainstem and in the tributary streams (fig. 17). Chemical reactions occurring within the stream, which promote the oxidation and precipitation of iron, contribute to the variation in concentrations of iron. The discharge of total iron increased from 30 lb/d at mainstem site 801 to 684 lb/d at mainstem site 805. The slight decrease in total-iron discharge from mainstem site 803 to site 804 was probably because of the precipitation of iron. Concentrations of total manganese also varied considerably in the mainstem and in the tributary streams (fig. 17). However, the discharge of total manganese increased considerably from mainstem site 802 to site 805. Very large discharges of manganese entered the mainstem from tributary sites 836 and 830. Manganese oxidation reactions and precipitation are strongly affected by pH and are very slow below pH 8.5. Therefore, the manganese entering the mainstem from the tributary streams did not precipitate and had an additive affect on mainstem discharges.

Sulfate concentrations are particularly high at tributary sites 812, 815, 830, and 837 (fig. 18). Mainstem sulfate concentrations gradually increase from sites 801 to 803 and then gradually decrease from sites 803 to 805. Neutralization reactions occurring in a stream generally do not change sulfate concentrations. The attenuation of the sulfate concentrations from mainstem sites 803 to 805 is probably because of dilution. Sulfate discharges gradually increase from mainstem sites 801 to 803 and significantly increase from sites 803 to 805 (fig. 18). The streamflow at sites 804 and 805 exceeded the streamflow at site 803 by 3.4 and 5.5 times, respectively, accounting for the large increase in sulfate discharges.

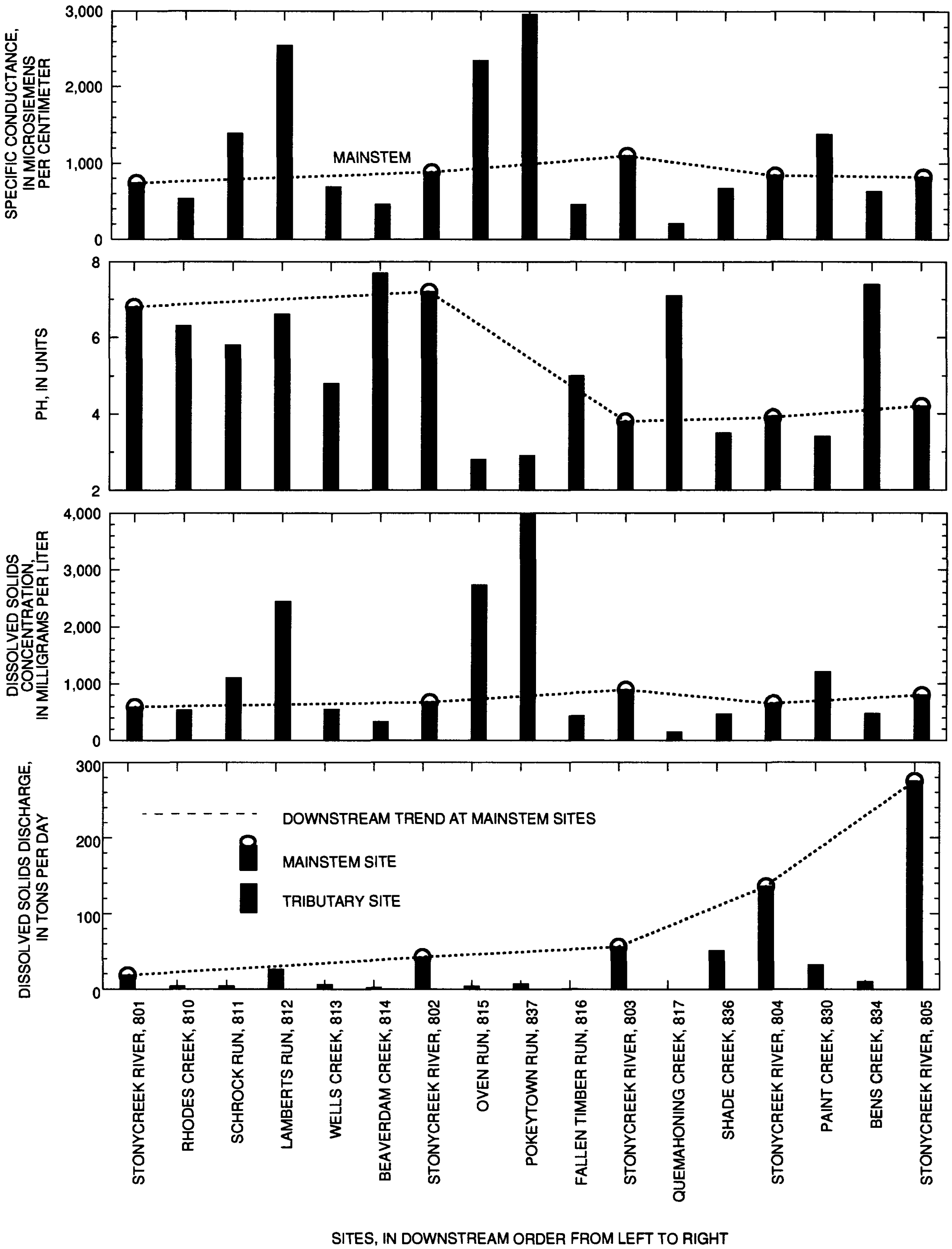

Figure 15. Specific conductance, pH, and concentrations and discharges of dissolved solids measured in the mainstem and in tributary streams in the Stonycreek River Basin on July 27 and 28, 1993.

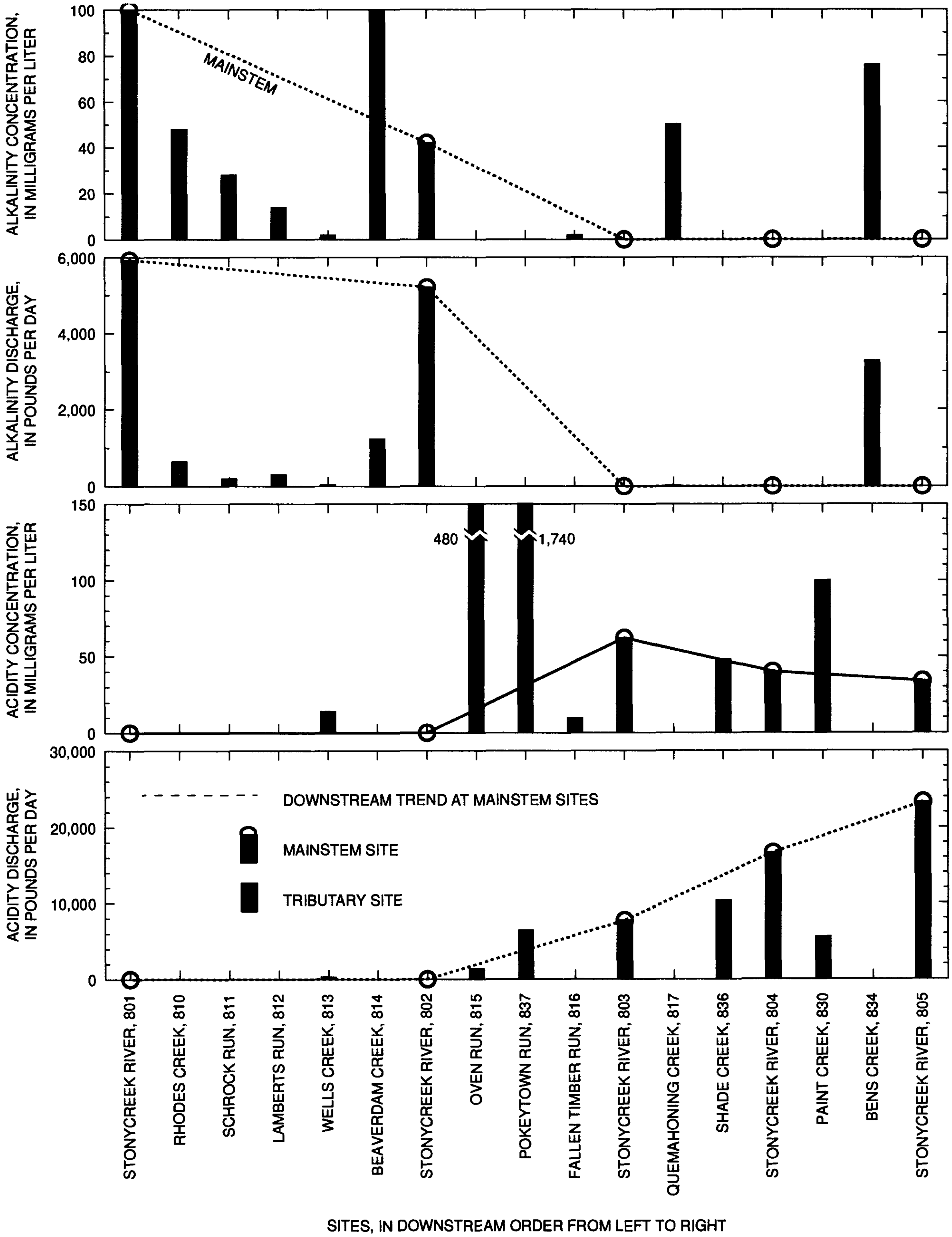

Figure 16. Concentrations and discharges of alkalinity and acidity measured in the mainstem and in tributary streams in the Stonycreek River Basin on July 27 and 28, 1993.

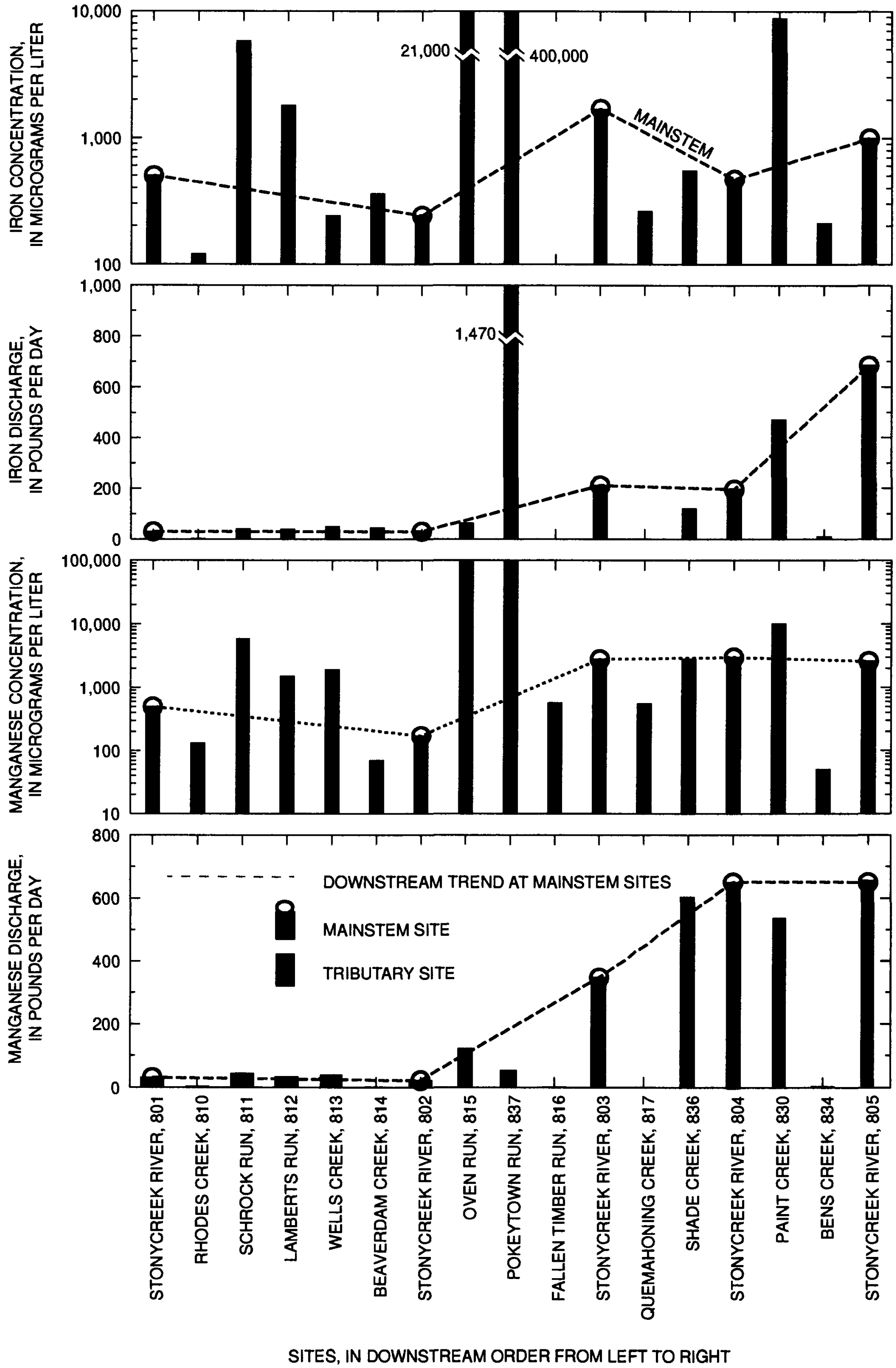

Figure 17. Concentrations and discharges of total iron and total manganese measured in the mainstem and in tributary streams in the Stonycreek River Basin on July 27 and 28, 1993.

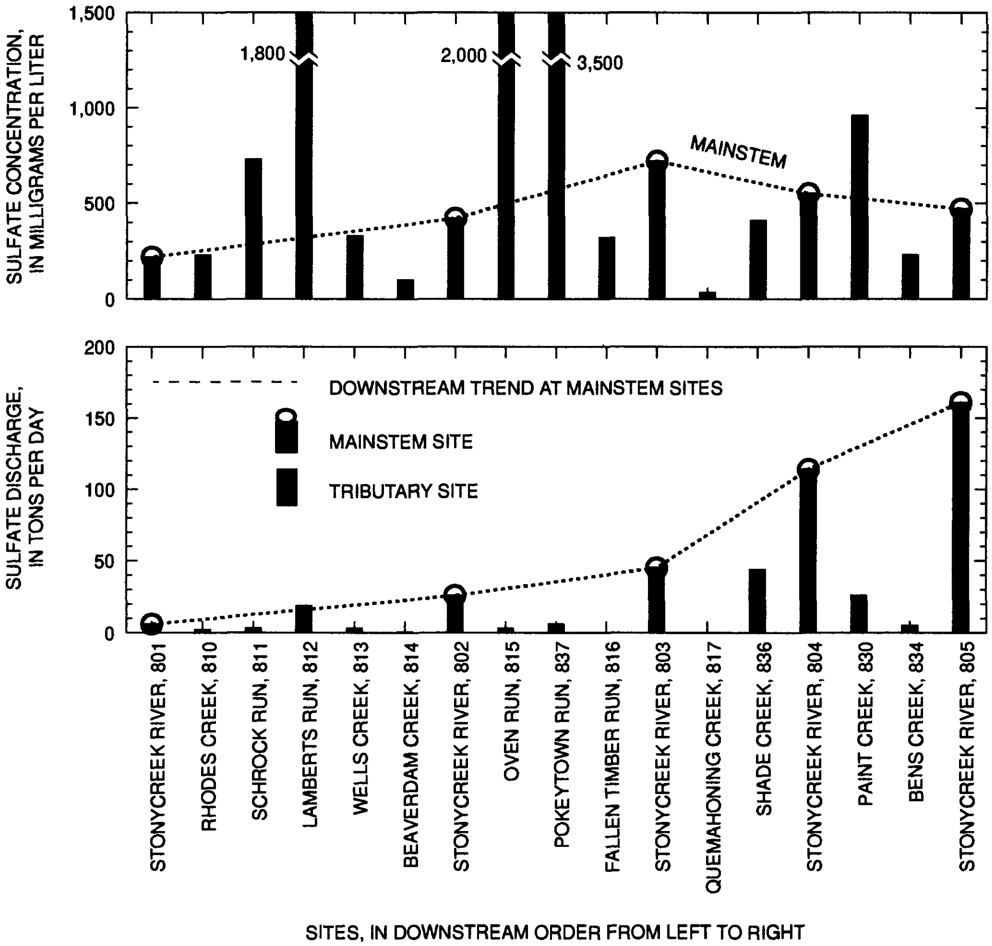

Figure 18. Concentrations and discharges of total sulfate measured in the mainstem and in tributary streams in the Stonycreek River Basin on July 27 and 28, 1993.

EFFECTS OF COAL-MINE DISCHARGE ON THE QUALITY OF STONYCREEK RIVER AND ITS TRIBUTARIES

Coal-mine discharges affected surface-water quality throughout all of Appalachia. AMD continues to flow from some underground mines and coal refuse piles that are already a century old. In 1967, the Federal Water Pollution Control Administration (U. S. Department of the Interior, 1967) estimated that 78 percent of Appalachia's mine-drainage problems were from inactive and abandoned mines and coal refuse piles. However, with the enactment of the Surface Mining Control and Reclamation Act of 1977 and the establishment of effluent limitations for coal mining (Code of Federal Regulations, 1994), the total stream miles affected by mine drainage have decreased and inactive and abandoned mine sites now account for 99 percent of AMD problems in streams (Kleinman and others, 1988). This assessment is probably accurate for streams in the Stonycreek River Basin because effluents from all active mining operations must meet current effluent limitations (table 1).

When mine spoils containing sulfides are exposed to air and water, the sulfide minerals are oxidized by a series of microbial and chemical processes. The products of these reactions are carried into surface waters where they degrade water quality via acidification, metal contamination, and sedimentation. AMD waters are characterized by high metal and sulfate concentrations, high conductivity, and low pH (Mills, 1985).

Physical properties and chemical constituents varied during low-base flow on tributary streams and mainstem sites in the Stonycreek River Basin (figs. 15-18). Mine drainage flowing into a stream will affect most of those constituents. However, because of various physical and chemical processes such as precipitation, neutralization, and adsorption, changes in concentrations of stream constituents can occur that are not related to mine drainage. Sulfate is not affected by neutralization and precipitation processes and therefore, sulfate concentrations and discharges can be used as a reliable indicator of mine drainage in streams (Tolar, 1982, p.8). Bencala and others (1987) found that sulfate was an excellent conservative tracer of AMD in a stream system in Colorado. Very few processes act to remove sulfate from solution in stream water. The concentration of sulfate in streams depends on the amount produced at the source (a mine discharge) and the subsequent dilution in the stream. Dilution depends on streamflow, which can vary with factors such as precipitation and drainage area. Because of the dilution factor, sulfate concentrations cannot be compared from stream to stream as a reliable index of mine drainage. However, the resultant sulfate discharges can be compared from stream to stream or within a stream as a reliable indicator of mine drainage. The measured sulfate discharges of tributary streams and the measured and calculated sulfate discharges of the mainstem sites are shown in figure 19. The calculated mainstem discharges were determined by adding the upstream mainstem discharge with the measured downstream tributary discharges to determine the next mainstem discharge. For example, the sulfate discharge measured at mainstem site 801 (6 ton/d) was added to the discharges from tributary site 810 (2 ton/d), tributary site 811 (3 ton/d), tributary site 812 (19 ton/d), tributary site 813 (3 ton/d), and tributary site 814 (1 ton/d) to arrive at a calculated sulfate discharge of 34 ton/d at mainstem site 802. The measured sulfate discharge at mainstem site 802 was 26 ton/d. A good correlation between the measured mainstem sulfate discharges and the calculated sulfate discharges is shown in figure 19. The calculated sulfate discharges at mainstem sites 803-805 were less than the measured discharges because sulfate discharges from some mine discharges that flow directly into the Stonycreek River were not measured. Sulfate discharges from Shade Creek (site 836) (44 ton/d) and Paint Creek (site 830) (26 ton/d) had the largest effect on sulfate discharges in the Stonycreek River.

Water-quality analyses from five mine discharges and the receiving streams above and below the mine discharges are presented in table 13. The water quality at mine-discharge site 14 did not affect Dark Shade Creek, primarily because that section of Dark Shade Creek was already severely affected by mine drainage.

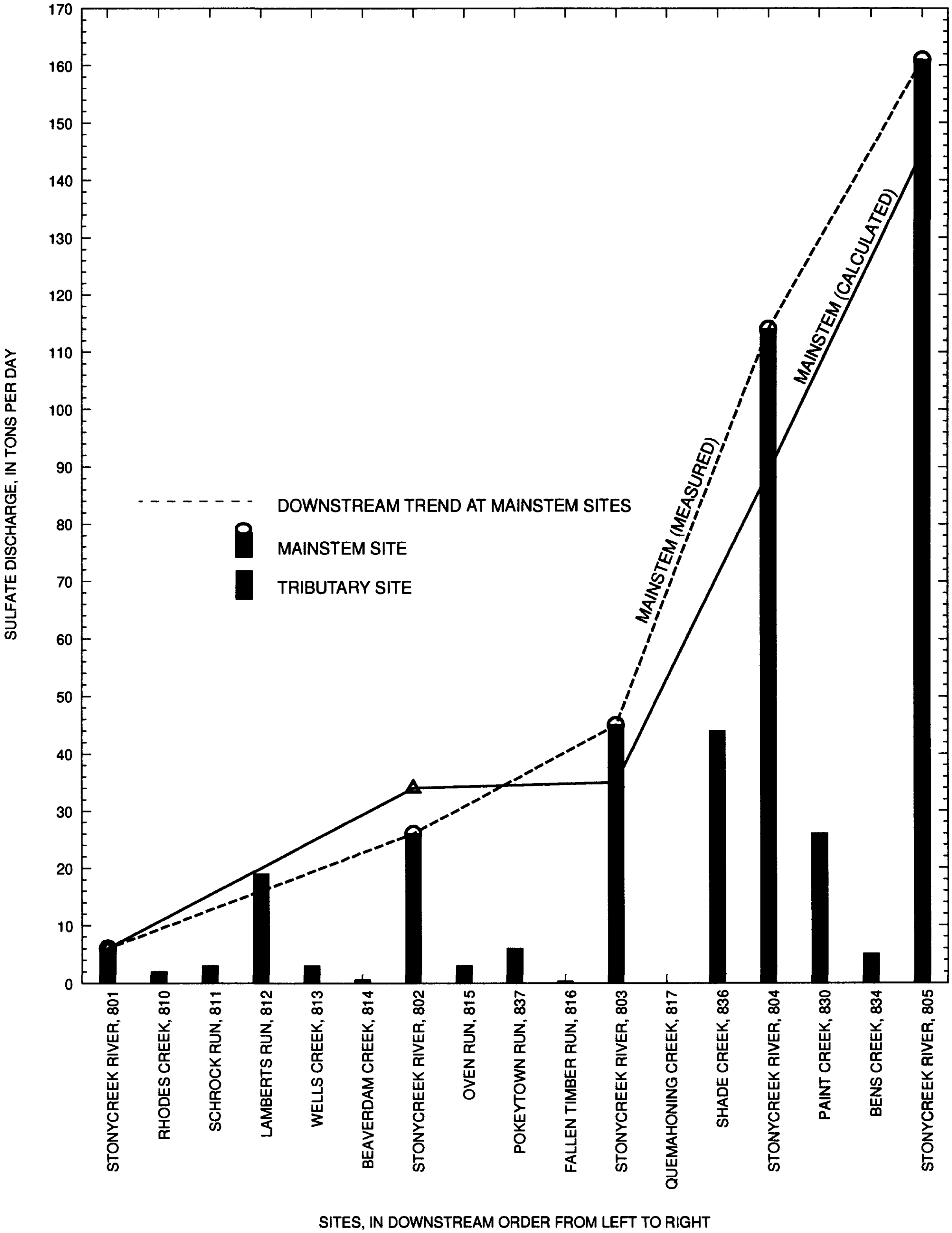

Figure 19. Measured total sulfate discharges in tributary streams and measured and calculated total sulfate discharges in the mainstem of the Stonycreek River on July 27 and 28, 1993.

Table 13. *Water-quality data for five coal-mine discharges and the receiving streams*

[µg/L, microgram per liter; mg/L, milligram per liter]

Site	Discharge, instantaneous (cubic feet per second)	pH (units)	Iron, total (µg/L as Fe	Manganese, total (µg/L as Mn)	Alkalinity (mg/L as $CaCO_3$)	Acidity, total heated (mg/L as $CaCO_3$)	Sulfate, total (mg/L as SO_4)
	<u>October 6, 1992</u>						
Dark Shade Creek above site 14	15.2	3.9	21,200	2,620	0	84	334
Site 14	1.51	3.7	1,980	6,860	0	100	678
Dark Shade Creek below site 14	17.5	3.9	19,200	2,910	0	82	342
	<u>October 6, 1992</u>						
Laurel Run above site 15	3.60	5.4	358	338	2.0	16	24
Site 15	.12	3.5	57,400	13,300	0	230	799
Laurel Run below site 15	4.30	4.9	1,840	695	2.0	22	45
	<u>September 8, 1993</u>						
South Fork Bens Creek above site 178	1.68	7.4	681	454	46	0	89
Site 178	2.14	6.5	3,460	484	162	0	606
South Fork Bens Creek below site 178	3.82	6.8	2,650	468	110	0	344
	<u>September 9, 1993</u>						
Wells Creek above site 17	1.22	7.2	199	462	26	0	233
Site 17	.32	3.4	1,860	1,740	0	58	499
Wells Creek below site 17	1.54	6.4	804	742	12	0	243
	<u>May 12, 1994</u>						
Wells Creek above site 17	19.1	6.8	1,050	303	11	0	83
Site 17	2.34	3.7	908	762	0	30	226
Wells Creek below site 17	21.4	6.4	1,030	358	7.4	.8	90
	<u>September 9, 1993</u>						
Wells Creek above site 22	1.52	6.3	806	752	10	3.6	243
Site 22	.30	2.9	24,400	7,410	0	174	880
Wells Creek below site 22	1.82	3.9	5,160	1,930	0	32	406
	<u>May 12, 1994</u>						
Wells Creek above site 22	23.4	6.4	1,330	378	7.4	4.4	91
Site 22	2.47	3.4	9,280	3,740	0	82	399
Wells Creek below site 22	25.8	5.3	2,240	733	2.2	6.2	115

Mine discharge 15 did affect Laurel Run even though the flow of the mine discharge was only 3 percent of the flow in Laurel Run. Concentrations of total iron, total manganese, total sulfate, and acidity increased and pH decreased.

Mine discharge 178 is a treated mine discharge that had a significant effect on the South Fork Bens Creek. One positive effect was the addition of alkalinity to the stream. The discharge accounted for 56 percent of the streamflow in South Fork Bens Creek.

Mine discharges 17 and 22 flow into Wells Creek and were sampled during low- and high-base flow. Mine discharge 22 enters Wells Creek about 900 ft downstream from where site 17 enters Wells Creek. These two discharges significantly affect the water quality of Wells Creek at both low- and high-base flow (table 13). Figure 20 graphically shows how these two mine discharges affect Wells Creek during low-base flow. The pH in Wells Creek decreased from 7.2 to 3.9. Stream alkalinity was completely depleted by the acidity of the two mine discharges. Sulfate discharges increased from 0.76 to 2.0 ton/d. Discharges of total iron increased from 1.3 to 51 lb/d. Plots of the data from sites 17 and 22 collected on May 12, 1994 (not shown), show that the two mine discharges had a similar effect on Wells Creek during high-base flow as is shown on figure 20 for low-base flow. The discharges and concentrations were different, but the trends were similar. The PI in Appendix 4 shows that sites 17 and 22 are ranked 28th and 7th, respectively, for mine-discharge remediation in the Stonycreek River Basin. The PI in table 8 shows that sites 17 and 22 are ranked second and first, respectively, for mine-discharge remediation in the Wells Creek Basin.

Surface-water-quality data collected from the mouth of Oven Run (site 815) and Pokeytown Run (site 837) and from the Stonycreek River above and below where each of those runs flow into the river are given in table 14. Oven Run flows into the Stonycreek River near the town of Rowena. Pokeytown Run flows into the Stonycreek River approximately 0.5 mi downstream from the Oven Run inflow. Both Oven Run and Pokeytown Run are severely affected by AMD, and each significantly deteriorates Stonycreek River water quality. The Oven Run outflow is the first source of highly degraded water from AMD into the Stonycreek River. Both have many mine discharges but a major discharge in each basin is responsible for most of the AMD in the two streams. Mine discharge site 3 has a significant effect on Oven Run, and mine discharge site 4 has a similar effect on Pokeytown Run. Mine discharges 3 and 4 ranked 8th and 5th, respectively, on the PI for the Stonycreek River Basin (Appendix 4). The flows at mine-discharge sites 3 and 4 on August 18, 1993, were 0.23 and 0.20 ft^3/s, respectively. The streamflows in Oven Run and Pokeytown Run on September 8, 1993, at low-base flow were 0.56 and 0.41 ft^3/s, respectively. If the discharges at the mine-discharge sites and the streamflow in the streams were similar on both days, mine-discharge site 3 accounted for 41 percent of the streamflow in Oven Run and mine-discharge site 4 accounted for 49 percent of the streamflow in Pokeytown Run.

Table 14. *Water-quality data collected on September 8, 1993, for Oven Run, Pokeytown Run, and the Stonycreek River above and below where each of the runs flows into the river*

[μg/L, microgram per liter; mg/L, milligram per liter]

Site	Discharge, instantaneous (cubic feet per second)	pH (units)	Iron, total (μg/L as Fe	Manganese, total (μg/L as Mn)	Alkalinity (mg/L as $CaCO_3$)	Acidity, total heated (mg/L as $CaCO_3$)	Sulfate, total (mg/L as SO_4)
Stonycreek River above Oven Run	17.4	7.6	309	296	42	0	382
Oven Run	.56	2.8	15,900	28,000	0	354	1,390
Stonycreek River below Oven Run	18.0	7.2	769	1,310	38	0	415
Stonycreek River above Pokeytown Run	23.0	6.3	599	1,410	32	0	472
Pokeytown Run	.41	2.7	490,000	13,600	0	2,180	4,120
Stonycreek River below Pokeytown Run	23.4	5.1	14,000	1,860	2	50	644

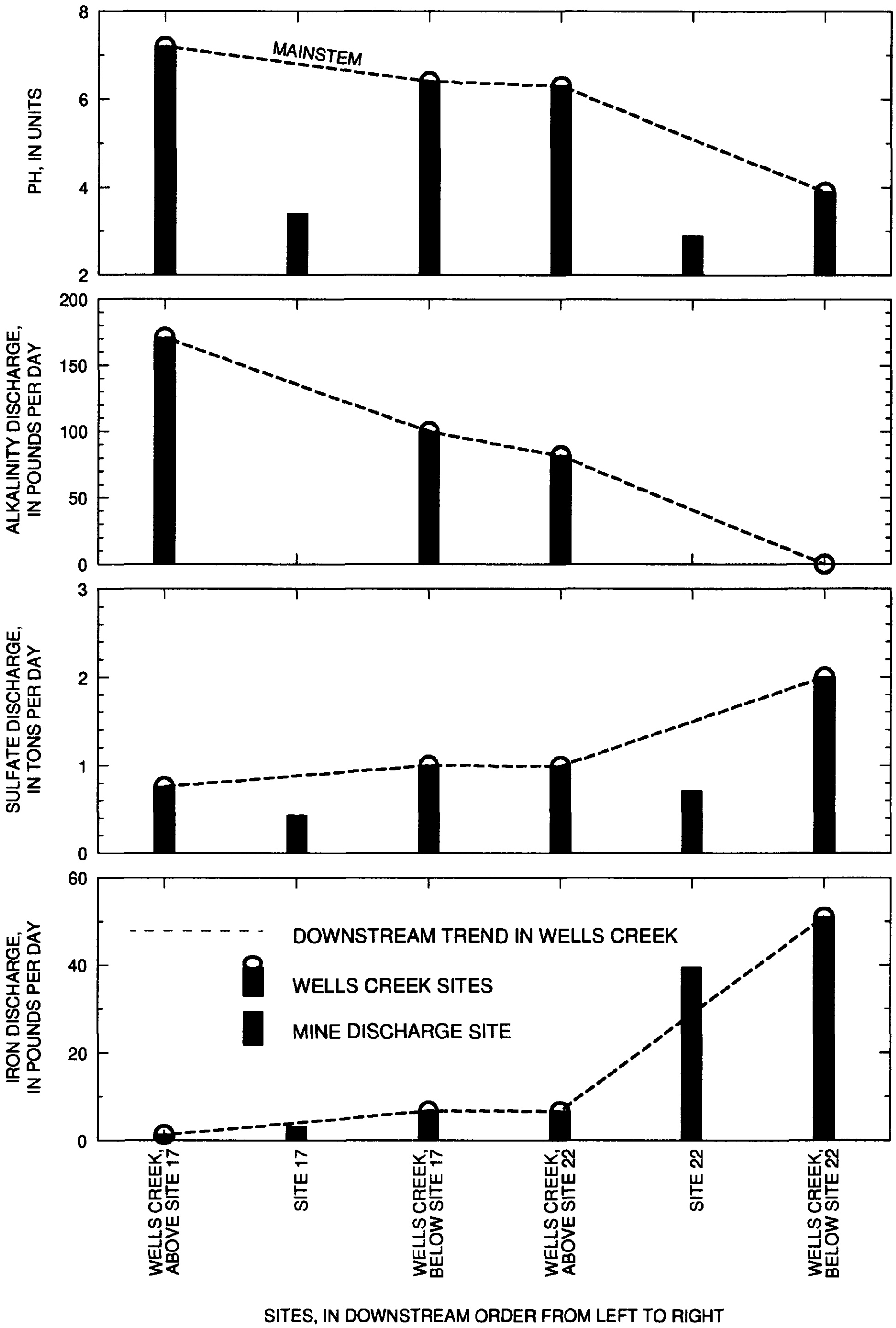

Figure 20. The effects of mine discharges 17 and 22 on Wells Creek on September 9,1993.

The pH in the Stonycreek River decreased from 7.6 above Oven Run to 5.1 below Pokeytown Run (fig. 21). The alkalinity in the Stonycreek River was adequate to neutralize the acidity from Oven Run, but the large acidity discharges from Pokeytown Run almost eliminated the available alkalinity in the river. Alkalinity in the Stonycreek River decreased from 42 mg/L above Oven Run to 2 mg/L below Pokeytown Run. Sulfate discharges in the Stonycreek River were 18 ton/d above Oven Run and 41 ton/d below Pokeytown Run. Total-iron discharges increased slightly in the Stonycreek River from the Oven Run inflow, but dramatically increased in the river because of the Pokeytown Run inflow. Total-iron discharges increased from 29 lb/d above Oven Run to 1,770 lb/d below Pokeytown Run.

The U.S. Department of Agriculture, Natural Resources Conservation Service, in cooperation with the Somerset Conservation District, the Somerset County Commissioners, and SCRIP as a supporting sponsor, plans to design and construct passive-treatment systems for the remediation of mine discharges in the Oven Run and Pokeytown Run Basins. A watershed plan includes six specific mine-drainage abatement projects. The design phase for the projects will be from 1994 to 1997, and the construction phase will be from 1995 to 1998. Preliminary plans suggest that SAPS, settling ponds, and chambered passive-treatment-wetlands that use composted mushroom spoil and cattails will be used to treat the mine discharges. The treatment measures are expected to improve the water quality in the Stonycreek River in a 4-mi reach from Oven Run to the Borough of Hooversville. Residents in the borough of Hooversville and surrounding areas will benefit from this project because the Hooversville Water Authority obtains its water supply from the Stonycreek River.

The effects of Oven Run and Pokeytown Run on the water quality of the Stonycreek River are shown in figures 15-19 and figure 21. Shade Creek and Paint Creek had an even greater effect on the water quality in the Stonycreek River (figs. 15-19) and these two streams contribute more acid mine-affected water to the Stonycreek River than any other tributaries in the Stonycreek River Basin. The Shade Creek and Paint Creek Basins have been heavily mined and have many abandoned-mine discharges. Water-resouce managers are considering remediation action in these two basins after the completion of the remediation work in the Oven Run and Pokeytown Run Basins.

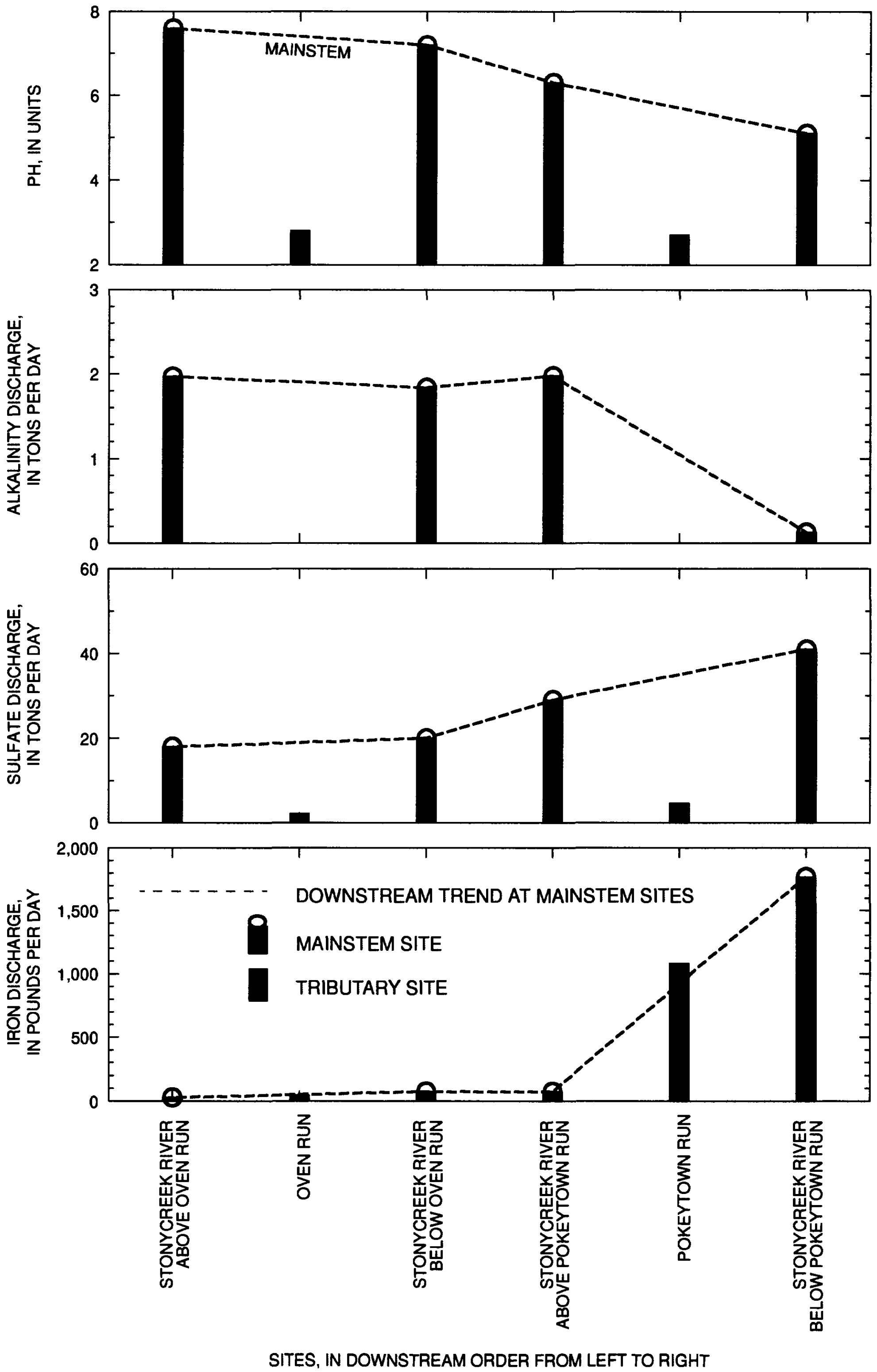

Figure 21. The effects of Oven Run and Pokeytown Run on the Stonycreek River on September 8, 1993.

SUMMARY

The Stonycreek River Basin drains an area 468 mi^2 in Somerset and Cambria Counties in southwestern Pennsylvania. Fourteen different coal beds throughout the basin are of mineable thickness, however, the Lower and Upper Kittanning and the Upper Freeport coals are the three coal beds that have been most extensively mined. Commercial mining of the coal resources began in the late 1800's with almost no concern for the protection of the land surface or water resources. Consequently, the water quality of the Stonycreek River and its tributaries has been severely degraded for many decades by acidic coal-mine drainage. From October 1991 through November 1994, the USGS, in cooperation with the Somerset Conservation District, conducted an investigation throughout the Stonycreek River Basin to locate and sample abandoned mine discharges, to prioritize the discharges for remediation, and to determine the effects of the mine discharges on the water quality of the Stonycreek River and its major tributaries. The location of the 270 mine discharges that were sampled were determined by use of a GPS receiver with a horizontal accuracy of 3 to 10 ft.

The water quality of the mine discharges varied considerably from discharges that were extremely acidic with high concentrations of iron, manganese, aluminum, and sulfate to discharges whose water quality met USEPA drinking water standards for most constituents. Of the 270 mine discharges sampled, 193 discharges exceeded effluent standards for pH, 122 discharges exceeded effluent standards for total-iron concentration, and 141 discharges exceeded effluent standards for total-manganese concentration. Ninety-four mine discharges exceeded effluent standards for pH and concentrations of total iron and total manganese; 38 mine discharges met effluent standards for all three constituents. Secondary drinking water standards for pH, iron, manganese, aluminum, and fluoride were met at five mine discharges.

Streamflow was an important factor when determining the contaminant discharges of the mine discharges. Mine discharge at site 20 contained a total-iron concentration of 4,760 mg/L, highest of all 270 mine discharges, but a streamflow of only 0.7 gal/min ranked it 26th of all 270 discharges with respect to total-iron discharge. The mine discharges that contained high concentrations of contaminants in addition to large streamflows were the discharges that contributed most of the contaminant discharges to the receiving streams.

A primary goal of the Stonycreek River Basin study was to develop a system that would prioritize all mine discharges for remediation. A PI was developed that ranked the severity of each mine discharge by use of seven specific constituents. The constituents included pH, streamflow, and discharges of total iron, total manganese, total heated acidity, total sulfate, and dissolved aluminum. The PI can be used by water-resource managers as a guide to determine which mine discharges have the greatest effect on stream-water quality and should be considered for remediation. A PI was developed for all mine discharges throughout the Stonycreek River Basin and for mine discharges in six subbasins that were moderately to severely effected by mine drainage. The subbasins were the Shade Creek, Paint Creek, Wells Creek, Quemahoning Creek, Oven Run, and Pokeytown Run Basins.

Water-resource managers propose to remediate the abandoned mine discharges by constructing passive-treatment systems that include aerobic wetlands, compost wetlands, and ALD's. Each of the three passive technologies is most appropriate for a particular type of mine water, but commonly, they are most effectively used in combination with each other. For mine discharges that are extremely acidic (acidity concentration greater than 300 mg/L as $CaCO_3$) with high concentrations of ferric iron (concentrations greater than 1.0 mg/L), the use of a SAPS would be most effective in treating the AMD. A SAPS combines ALD technology with the sulfate reduction mechanism of the compost wetland. A series of SAPS is commonly necessary until the AMD either meets effluent criteria or the limit of the area available for treatment is reached.

A network of 37 surface-water sampling sites was established to identify stream water quality during base flow. Water samples collected on July 27 and 28, 1993, are used to describe base-flow quality throughout the basin. From mainstem site 801 to mainstem site 805, water-quality degradation occurred that is attributed to the inflows of acidic mine discharges from affected tributaries in addition to inflows of mine discharges directly into the river. Shade Creek, Paint Creek, Oven Run, and Pokeytown Run are tributaries that significantly affect river water quality. From mainstem site 801 to 805, pH decreased from 6.8 to 4.2, alkalinity was completely depleted, and discharges of total iron increased from 30 to 684 lb/d. Very large discharges of manganese entered the mainstem from Shade Creek and Paint Creek. Manganese oxidation reactions and precipitation are strongly affected by pH and are very slow below pH 8.5. The manganese entering the mainstem from the tributary streams did not precipitate and had an additive affect on mainstem discharges. The attenuation of sulfate concentrations from mainstem sites 803 to 805 is because of dilution, but the significant increase in sulfate discharges from sites 803 to 805 is the result of increased streamflow. A good correlation existed between the measured mainstem sulfate discharges and the calculated mainstem sulfate discharges. The sulfate discharges were calculated by adding the sulfate discharges of the previous upstream mainstem site to the sulfate discharges of all sampled tributary streams entering the river between the two mainstem sites.

Mine discharges 17 and 22 had a major effect on the water quality of Wells Creek. Mine discharge 22 enters Wells Creek about 900 ft downstream from where mine discharge 17 enters Wells Creek. Data collected in Wells Creek above mine discharge 17 inflow and below mine discharge 22 inflow on September 9, 1993, show that pH decreased from 7.2 to 3.9, stream alkalinity was completely depleted by the two mine discharge acidities, sulfate discharges increased from 0.76 to 2.0 ton/d, and total-iron discharges increased from 1.3 to 51 lb/d. The PI for mine discharges 17 and 22 rank them 28th and 7th, respectively, for mine-discharge remediation in the Stonycreek River Basin. Oven Run and Pokeytown Run had a similar effect on the water quality of the Stonycreek River. Both streams are significantly affected by AMD and are the first major sources of AMD flowing into the Stonycreek River. The Pokeytown Run inflow is about 0.5 mi downstream from the Oven Run inflow. Both basins contain many mine discharges, but one major discharge in each basin is responsible for much of the AMD in each stream. Mine discharge at site 3 has a large effect on Oven Run, and mine discharge at site 4 has a similar effect on Pokeytown Run. Mine discharges at sites 3 and 4 ranked 8th and 4th, respectively, on the PI for the Stonycreek River Basin. Data collected in the Stonycreek River above Oven Run and below Pokeytown Run during low-base flow on September 8, 1993, show a decrease in pH from 7.6 to 5.1, a decrease in alkalinity from 42 to 2 mg/L, an increase in sulfate discharges from 18 to 41 ton/d, and an increase in total-iron discharges from 29 to 1,770 lb/d. The U.S. Department of Agriculture, Natural Resources Conservation Service, in cooperation with the Somerset Conservation District, the Somerset County Commissioners, and SCRIP as a supporting sponsor, plans to design and construct passive-treatment systems for the remediation of mine discharges in the Oven Run and Pokeytown Run Basins. The design phase for the projects will occur during 1994-97, and the construction phase will occur during 1995-98.

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APPENDIXES

Appendix 1. *Geographic information system (GIS) datasets*

Hydrography - Two sets of stream data were compiled for the study at 1:24,000 and 1:100,000-scales. Both have line and polygon topology. A stream layer was extracted from the Pennsylvania Department of Transportation (PennDOT) county line files using attributes for water features. This dataset was originally in the Intergraph format. The second dataset is from the Digital Line Graph (DLG) series 1:100,000-scale data from National Mapping Division (NMD). Specific infomation for the creation, accuracy, topological consistency, and attributes of these datasets can be found by contacting PennDOT and NMD.

Roads - This line dataset was extracted from the PennDOT county line files using attributes for transportation features. Specific information for the creation, accuracy, topological consistency, and attributes of this dataset can be found by contacting PennDOT.

Municipal boundaries - This dataset was created by digitizing county and township lines from paper 7.5-minute topographic quadrangles. Root Mean Square (RMS) errors were below 0.006 inches. Both line and polygon topology are present. The only attribute added to the line attribute table is CLASS and is defined as a character type with input and output size of one. CLASS is a code for distinguishing township lines from lines which are both township and county lines. Valid codes for this attribute are C and T which represent county and township, respectively. Attributes added to the polygon attribute table include: FIPPST, FIPPSCO, and CENSMCD. These attributes are defined as integer type with an input and output of two, three, and three, respectively. FIPPST is the state code, FIPPSCO is the couny code, and CENSMCD is the Census MCD code obtained from the Geographic Identification Code Scheme.

Drainage basin boundaries - In 1989, the Pennsylvania Department of Environmental Resources (PaDER), in cooperation with the USGS, published the Pennsylvania Gazetteer of Streams. This publication contains information related to named streams in Pennsylvania. Drainage basin boundaries are delineated on 7.5-minute series topographic paper quadrangles in Pennsylvania, a total of 878 quadrangles. These boundaries enclose catchment areas for named streams that flow through named hollows, using the hollow name, e.g., "Smith Hollow." This was done in an effort to name as many of the 64,000 streams as possible. RMS errors were below .006 inches and both line and polygon topology are present. Two attributes were added to the polygon attribute table; WRDS# and HUC. The WRDS# is the water resources data system number for streams from the PaDER water use database. This attribute is defined as an integer type with an input and output size of six. Valid codes are 45084-45804, which define the Stonycreek watershed. The HUC attribute is the USGS hydrologic unit code (HUC) number and is an integer type having an input and output size of eight. The valid HUC code is 05010007. Further information about this dataset can be found by contacting the USGS in Lemoyne, Pennsylvania.

Geology - The 1980 Geologic Map of Pennsylvania, by T.M. Berg and others (1980), is the source map for this dataset. This map shows surface geology, fomational contacts, faults, and several glacial advances, and is printed at a scale of 1:250,000 in the Transverse Mercator projection. A stable-base separate of geologic formation boundaries was scanned using a drum-type scanner. Only geologic contact lines and faults between different geologic formations are delineated on this dataset with some fault lines extending into areas of identical formations. The attribute FM was added to the polygon attribute table and is defined as a character item having an input and output value of two. This attribute is a two-letter abbreviation defined by the USGS Bulletin 1200, Lexicon of Geology Names of the United States for 1936-1960. Some positional errors exist in the dataset, therefore, the positional accuracy is 508 meters, or a scale of 1:1,000,000. The Geologic Map of Pennsylvania was never made to be a digital product and although this dataset has been used by the USGS, no warranty, expressed or implied, is made by the USGS as to the accuracy and functioning of the dataset nor shall the fact of distribution constitute any such warranty, and no responsibility is assumed by the USGS in connection herewith.

Land use/land cover - This dataset is a product of NMD and is called the Geographic Information Retrieval and Analysis System (GIRAS). This dataset has been attributed with the Anderson Level-II land use/land cover classifications for 1973-1977 and has line and polygon topology. Specific information for the creation, accuracy, topological consistency, and attributes of this dataset can be found by contacting NMD.

State game lands - This dataset was created by digitizing state game land lines from paper 7.5-minute topographic quadrangles. Root Mean Square (RMS) errors were below .006 inches. Both line and polygon topology are present. Attributes were not added to the dataset.

Special protection waters - Using the existing 1:24,000 and 1:100,000-scale hydrography layers, linear features were manually split and attributes were added to the line attribute tables. The only attribute added, QUAL, a character type with an input and output value of two, defines the stream reaches with a special protection code. Valid entries are HQ, for High Quality, and EV, for Exceptional Value. Since the linear topology has been altered, this dataset is a separate layer from the hydrography datasets. Only line topology is present.

Wetlands - This dataset was created by digitizing 7.5-minute quadrangles delineated with areas designated by the U.S. Fish and Wildlife Service (USFWS) for wetlands and combining existing 7.5-minute quadrangle datasets already digitized by USFWS into a single layer. Only eight quads were digitized by USGS: Bakerstown, Boswell, Johnstown, Ogletown, Rachelwood, Somerset, Stoystown, and Windber. RMS errors were below .006 inches. Both line and polygon topology are present. Attributes were not added to the line attribute table. Attributes added to the polygon attribute table are MAJOR1 and MINOR1, defined as integers with inputs and outputs of six for each. Valid codes and definitions are numerous and range in order, but can be obtained from the USFWS.

Mine discharges - This dataset contains information on all mine discharges sampled from April 1992 through November 1994 throughout the Stonycreek River Basin. Only point topology is present in the dataset. The point location was determined in the field using a Global Positioning System (GPS) receiver with differential correction from base station data. Attributes added to the dataset include: PRI_SCORE, PRI_RANK, and PRI_INDEX. These numeric values were determined by a program designed to prioritize the mine discharge sites for remediation based on comparative water quality data.

Surface-water-quality data - This dataset contains information on surface-water sites sampled on the mainstem of the Stonycreek River and major tributaries. Only point topology is present. The locations of the sites were determined from paper 7.5-minute topographic quadrangles. Attributes include all water quality data collected during the investigation.

Ground water site inventory (GWSI) data - The GWSI data for the Stonycreek River drainage system was retrieved from the GWSI database and imported to ARC/INFO. The dataset contains point information only, neither line nor polygon topology are present.

Pennsylvania water well inventory (PWWI) data - The PWWI data for the Stonycreek River drainage system was retrieved from the PWWI database and imported to ARC/INFO. The dataset contains point information only, neither line nor polygon topology are present.

DEM - DEM data for the project area were obtained from the NMD and clipped to the basin boundary. Specific information regarding the DEM data can be obtained by contacting NMD.

Appendix 2. *Location coordinates and station numbers for sampled mine discharges in the Stonycreek River Basin*

Site number	USGS topographic quadrangle	Latitude	Longitude	Station number
1	Hooversville	400731.1	785504.8	400731078550501
2	Hooversville	400734.6	785516.2	400735078551601
3	Stoystown	400648.0	785441.9	400648078544201
4	Hooversville	400749.4	785522.1	400749078552201
5	Hooversville	400900.0	785425.6	400900078542601
6	Hooversville	400849.0	785318.6	400849078531901
7	Hooversville	400930.2	785439.4	400930078543901
8	Hooversville	400927.4	785441.3	400927078544101
9	Somerset	400105.3	790046.4	400105079004601
10	Somerset	400121.8	790039.5	400122079004001
11	Somerset	400124.1	790041.8	400124079004201
12	Central City	400103.7	785056.0	400104078505601
13	Central City	400028.9	785112.4	400029078511201
14	Central City	400718.8	784824.7	400719078482501
15	Central City	400702.0	784809.6	400702078481001
16	Central City	400626.4	784816.3	400626078481601
17	Stoystown	400159.1	785947.7	400159078594801
18	Stoystown	400222.7	785928.5	400222078592801
19	Central City	400648.1	784847.3	400648078484701
20	Central City	400522.7	784756.4	400523078475601
21	Stoystown	400416.1	785332.5	400416078533201
22	Stoystown	400208.3	785927.8	400208078592801
23	Stoystown	400125.9	785823.9	400126078582401
24	Stoystown	400525.0	785450.8	400525078545101
25	Stoystown	400412.9	785449.6	400413078545001
26	Stoystown	400357.0	785337.1	400357078533701
27	Central City	400308.8	784744.2	400309078474401
28	Windber	401242.9	784924.5	401243078492401
29	Windber	401301.9	784945.0	401302078494501
30	Windber	401218.9	784924.4	401219078492401
31	Windber	401221.3	784929.0	401221078492901
32	Windber	401420.2	785125.5	401420078512601
33	Windber	401428.8	785132.6	401429078513301
34	Stoystown	400704.8	785358.2	400705078535801
35	Stoystown	400718.1	785343.1	400718078534301
36	Stoystown	400653.1	785530.0	400653078553001
37	Central City	400714.3	785034.8	400714078503501
38	Central City	400407.1	784814.6	400407078481501
39	Windber	400737.0	785125.3	400737078512501
40	Windber	400920.1	784914.4	400920078491401
41	Windber	400944.2	784914.7	400944078491501
42	Windber	401038.9	784936.6	401039078493701
43	Windber	401044.4	785008.5	401044078500901
44	Windber	401413.3	784824.2	401413078482401
45	Ogletown	401402.5	784356.8	401402078435701

Appendix 2. *Location coordinates and station numbers for sampled mine discharges in the Stonycreek River Basin—Continued*

Site number	USGS topographic quadrangle	Latitude	Longitude	Station number
46	Ogletown	401417.9	784408.0	401418078440801
47	Hooversville	400906.2	785945.5	400906078594601
48	Hooversville	400903.2	785926.8	400903078592701
49	Hooversville	400823.5	785612.7	400824078561301
50	Hooversville	400819.0	785539.9	400819078554001
51	Somerset	400537.4	790130.9	400537079013101
52	Boswell	400815.9	790337.7	400816079033801
53	Boswell	400820.9	790332.5	400821079033301
54	Boswell	400733.3	790646.5	400733079064601
55	Berlin	395750.9	785240.1	395751078524001
56	Berlin	395751.7	785238.0	395752078523801
57	Berlin	395745.3	785242.9	395745078524301
58	New Baltimore	395817.3	785217.2	395817078521701
59	Stoystown	400528.5	785450.4	400528078545001
60	Stoystown	400532.0	785449.4	400532078544901
61	Stoystown	400059.8	785524.8	400100078552501
62	Stoystown	400029.6	785624.0	400030078562401
63	Stoystown	400019.8	785604.8	400020078560501
64	Stoystown	400118.8	785512.3	400119078551201
65	Stoystown	400130.0	785451.4	400130078545101
66	Stoystown	400122.7	785502.5	400123078550201
67	Stoystown	400553.4	785634.2	400553078563401
68	Stoystown	400540.2	785554.2	400540078555401
69	Stoystown	400500.2	785555.2	400500078555501
70	Stoystown	400451.9	785557.6	400452078555801
71	Stoystown	400452.6	785432.3	400453078543201
72	Stoystown	400452.8	785434.3	400453078543401
73	Stoystown	400508.0	785445.3	400508078544501
74	Stoystown	400405.7	785449.4	400406078544901
75	Central City	401428.8	785049.6	401429078504901
76	Central City	400706.1	785038.1	400706078503801
77	Windber	401238.2	784844.0	401238078484401
78	Windber	401423.1	785114.8	401423078511501
79	Geistown	401507.3	785000.9	401507078500101
80	Windber	401502.5	785154.2	401503078515401
81	Windber	401428.8	785049.6	401429078505001
82	Central City	400249.6	784957.6	400250078495801
83	Central City	400116.9	785214.6	400117078521501
84	Central City	400236.1	785027.2	400236078502701
85	Windber	400733.7	785124.0	400734078512401
86	Windber	400752.0	784900.0	400752078490001
87	Stoystown	400707.8	785402.7	400708078540301
88	Hooversville	400914.2	785525.6	400914078552601
89	Hooversville	400916.8	785529.1	400917078552901
90	Hooversville	400918.0	785539.0	400918078553901

Appendix 2. *Location coordinates and station numbers for sampled mine discharges in the Stonycreek River Basin—Continued*

Site number	USGS topographic quadrangle	Latitude	Longitude	Station number
91	Hooversville	401218.5	785553.3	401219078555301
92	Hooversville	400939.3	785845.7	400939078584601
93	Hooversville	400900.0	785419.7	400900078542001
94	Hooversville	400746.9	785520.7	400747078552101
95	Hooversville	401311.6	785332.9	401312078533301
96	Windber	401408.2	785022.9	401408078502301
97	Hooversville	401335.8	785422.3	401336078542201
98	Central City	400248.1	785005.5	400248078500501
99	Central City	400245.8	785007.9	400246078500801
100	Windber	401417.6	784849.8	401418078485001
101	Windber	401415.1	784849.9	401415078485001
102	Windber	401400.4	784735.6	401400078473601
103	Windber	401356.1	784741.2	401356078474101
104	Windber	401351.5	784749.7	401352078475001
105	Stoystown	400124.3	785514.1	400124078551401
106	Central City	400323.0	785202.8	400323078520301
107	Johnstown	401847.6	785344.3	401848078534401
108	Johnstown	401846.2	785348.2	401846078534801
109	Johnstown	401844.0	785257.4	401844078525701
110	Geistown	401848.2	785224.5	401848078522401
111	Windber	401359.4	784646.5	401359078464601
112	Windber	401403.3	784647.6	401403078464801
113	Windber	401401.9	784643.0	401402078464301
114	Windber	401409.2	784648.1	401409078464801
115	Windber	401408.6	784638.3	401409078463801
116	Windber	401414.7	784641.5	401415078464101
117	Beaverdale	401516.5	784414.6	401516078441501
118	Beaverdale	401517.6	784413.6	401518078441401
119	Hooversville	400857.4	785403.2	400857078540301
120	Hooversville	400859.7	785414.1	400900078541401
121	Hooversville	400855.2	785340.4	400855078534001
122	Hooversville	400856.3	785344.8	400856078534501
123	Hooversville	400850.6	785242.5	400851078524201
124	Windber	401449.0	784615.4	401449078461501
125	Windber	401449.7	784613.5	401450078461301
126	Windber	401451.4	784612.5	401451078461201
127	Windber	401500.0	784552.0	401500078455201
128	Stoystown	400521.0	785613.2	400521078561301
129	Stoystown	400519.6	785614.1	400520078561401
130	Johnstown	401527.7	785248.5	401528078524801
131	Johnstown	401532.8	785242.3	401533078524201
132	Stoystown	400512.0	785620.2	400512078562001
133	Stoystown	400517.9	785621.4	400518078562101
134	Stoystown	400522.8	785625.1	400523078562501
135	Stoystown	400520.6	785759.5	400521078575901

Appendix 2. *Location coordinates and station numbers for sampled mine discharges in the Stonycreek River Basin—Continued*

Site number	USGS topographic quadrangle	Latitude	Longitude	Station number
136	Hooversville	400828.0	785536.7	400828078553701
137	Hooversville	400841.9	785449.5	400842078545001
138	Geistown	401502.3	784540.6	401502078454101
139	Geistown	401503.1	784539.9	401503078454001
140	Geistown	401504.7	784538.1	401505078453801
141	Geistown	401458.1	784520.5	401458078452001
142	Geistown	401500.0	784521.9	401500078452201
143	New Baltimore	395906.6	785228.4	395907078522801
144	Stoystown	395953.3	785236.5	395953078523601
145	Central City	400120.1	785158.6	400120078515901
146	Stoystown	400552.5	785632.3	400552078563201
147	Johnstown	401947.7	785533.0	401948078553301
148	Johnstown	401932.7	785534.2	401933078553401
149	Johnstown	401941.9	785534.1	401942078553401
150	Johnstown	401840.9	785459.2	401841078545901
151	Stoystown	400521.3	785757.6	400521078575801
152	Stoystown	400533.4	785712.4	400533078571201
153	Stoystown	400534.4	785709.2	400534078570901
154	Stoystown	400524.1	785622.7	400524078562301
155	Stoystown	400532.4	785557.3	400532078555701
156	Stoystown	400541.4	785556.6	400541078555701
157	Stoystown	400548.3	785555.2	400548078555501
158	Stoystown	400530.2	785450.6	400530078545101
159	Stoystown	400510.6	785447.5	400511078544801
160	Stoystown	400603.3	785613.4	400603078561301
161	Stoystown	400620.4	785546.0	400620078554601
162	Stoystown	400627.5	785530.3	400627078553001
163	Stoystown	400626.0	785537.8	400626078553801
164	Hooversville	400835.3	785525.8	400835078552601
165	Johnstown	401627.9	785412.3	401628078541201
166	Hooversville	401328.4	785914.3	401328078591401
167	Berlin	395752.4	785236.2	395752078523601
168	New Baltimore	395821.3	785218.4	395821078521801
169	New Baltimore	395920.4	785139.8	395920078514001
170	Berlin	395950.8	785241.3	395951078524101
171	Boswell	400802.0	790104.9	400802079010501
172	Boswell	400833.2	790044.9	400833079004501
173	Boswell	400947.3	790215.7	400947079021601
174	Boswell	401026.3	790102.8	401026079010301
175	Boswell	401013.0	790046.1	401013079004601
176	Boswell	400840.2	790246.2	400840079024601
177	Hooversville	401319.1	785926.9	401319078592601
178	Hooversville	401321.4	785924.1	401321078592401
179	Hooversville	401330.9	785915.7	401331078591601
180	Hooversville	401320.0	785959.0	401320078595901

Appendix 2. *Location coordinates and station numbers for sampled mine discharges in the Stonycreek River Basin—Continued*

Site number	USGS topographic quadrangle	Latitude	Longitude	Station number
181	Hooversville	401450.9	785331.3	401451078533101
182	Ligonier	400731.3	790746.0	400731079074601
183	Ligonier	400731.3	790746.0	400731079074602
184	Windber	401443.9	785132.0	401444078513201
185	Windber	401442.4	785134.9	401442078513501
186	Johnstown	401839.3	785459.2	401839078545901
187	Windber	401500.0	784637.7	401500078463801
188	Windber	401441.6	784617.7	401442078461801
189	Johnstown	401807.1	785426.9	401807078542701
190	Johnstown	401729.0	785454.1	401729078545401
191	Johnstown	401718.6	785436.7	401719078543701
192	Johnstown	401717.8	785436.5	401718078543601
193	Johnstown	401712.3	785434.2	401712078543401
194	Johnstown	401711.0	785434.0	401711078543401
195	Johnstown	401710.0	785434.0	401710078543401
196	Johnstown	401709.0	785433.8	401709078543401
197	Johnstown	401704.9	785434.5	401705078543401
198	Johnstown	401810.5	785519.8	401810078552001
199	Johnstown	401741.9	785510.3	401742078551001
200	Windber	400817.2	784957.7	400817078495801
201	Windber	400825.9	784927.4	400826078492701
202	Central City	400130.5	785151.1	400130078515101
203	Central City	400145.2	785021.9	400145078502201
204	Hooversville	401244.7	785434.0	401245078543401
205	Hooversville	401239.5	785512.1	401240078551201
206	Hooversville	401229.2	785451.0	401229078545101
207	Hooversville	401228.5	785454.8	401229078545501
208	Hooversville	400524.7	790451.4	400525079045101
209	Somerset	400644.4	790427.3	400644079042701
210	Stoystown	400231.1	785911.6	400231078591201
211	Berlin	395912.4	785707.8	395912078570801
212	New Baltimore	395901.0	785230.9	395901078523101
213	Central City	400032.6	785117.7	400033078511801
214	Windber	400815.9	784831.6	400816078483201
215	Windber	400826.1	784834.8	400826078483501
216	Windber	400942.7	784931.9	400943078493201
217	Windber	401332.4	784939.6	401332078494001
218	Windber	401406.0	785019.0	401406078501901
219	Ogletown	401331.6	784428.9	401332078442901
220	Windber	401249.4	784757.0	401249078475701
221	Windber	401031.2	785222.0	401031078522201
222	Windber	401100.2	785151.2	401100078515101
223	Somerset	400044.0	790035.1	400044079003501
224	Stoystown	400011.3	785525.8	400011078552601
225	Stoystown	400121.9	785516.6	400122078551701

Appendix 2. *Location coordinates and station numbers for sampled mine discharges in the Stonycreek River Basin—Continued*

Site number	USGS topographic quadrangle	Latitude	Longitude	Station number
226	Stoystown	400559.5	785539.3	400600078553901
227	Stoystown	400642.2	785444.7	400642078544501
228	Hooversville	400901.0	785416.3	400901078541601
229	Windber	401058.1	785204.6	401058078520501
230	Windber	401054.9	785208.9	401055078520901
231	Windber	401044.8	784906.4	401045078490601
232	Windber	401053.7	784935.6	401054078493601
233	Windber	401056.9	784935.2	401057078493501
234	Windber	401043.0	784937.0	401043078493701
235	Windber	401040.8	784938.3	401041078493801
236	Windber	401245.2	785140.1	401245078514001
237	Windber	401246.5	785139.8	401246078514001
238	Windber	401248.7	785135.9	401249078513601
239	Windber	401243.9	785147.9	401244078514801
240	Windber	401237.5	785147.1	401237078514701
241	Hooversville	401104.0	785425.8	401104078542601
242	Hooversville	400739.7	785522.2	400740078552201
243	Hooversville	401146.8	785306.7	401147078530701
244	Hooversville	401153.6	785252.0	401154078525201
245	Hooversville	401203.7	785228.5	401204078522801
246	Windber	401206.6	785224.7	401207078522501
247	Windber	401213.0	785219.0	401213078521901
248	Johnstown	401906.8	785450.5	401907078545001
249	Hooversville	400944.1	785450.1	400944078545001
250	Hooversville	400941.2	785446.7	400941078544701
251	Hooversville	400940.9	785446.5	400941078544601
252	Hooversville	400931.1	785448.1	400931078544801
253	Hooversville	401054.2	785424.7	401054078542501
254	Hooversville	401039.8	785423.3	401040078542301
255	Hooversville	401052.3	785436.6	401052078543701
256	Somerset	400651.0	790413.0	400651079041301
257	Somerset	400707.5	790410.4	400708079041001
258	Somerset	400706.2	790318.4	400706079031801
259	Hooversville	400838.7	785908.1	400839078590801
260	Hooversville	401122.7	785446.3	401123078544601
261	Stoystown	400609.6	785554.4	400610078555401
262	Stoystown	400113.0	785507.5	400113078550801
263	Stoystown	400419.9	785341.4	400420078534101
264	Stoystown	400547.9	785554.6	400548078555401
265	Central City	400709.9	784828.3	400710078482801
266	Central City	400715.0	784828.3	400715078482801
267	Windber	400742.4	785026.5	400742078502601
268	Geistown	401507.1	785038.4	401507078503801
269	Hooversville	401238.1	785424.2	401238078542401
270	Hooversville	401231.2	785519.8	401231078552001

Appendix 3. *Field data and laboratory analyses of mine discharges*

[ft^3/s, cubic foot per second; gal/min, gallon per minute; °C, degrees Celsius; µS/cm, microsiemen per centimeter at 25 degrees Celsius; mg/L, milligram per liter; <, less than; --, no data available]

Site number	Local identifier (Topographic quadrangle)	Date	Time	Discharge, instantaneous (ft^3/s)	Flow rate, instantaneous (gal/min)	Temperature, water (°C)	Specific conductance (µS/cm)	pH, water whole field (standard units)	Alkalinity, water (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)
1	Hooversville	06-17-92	0845	.04	16	11.0	2,580	2.8	0	2,360	1.3
		08-18-93	1405	.01	3.3	21.5	2,240	3.4	0	2,180	1.0
2	Hooversville	06-17-92	1030	.02	9.0	14.5	1,680	3.1	0	1,390	<1.0
3	Stoystown	06-17-92	1130	.35	155	11.0	2,570	2.8	0	2,890	<1.0
		08-18-93	1135	.23	105	11.0	2,580	3.4	0	3,160	16
		04-21-94	1100	1.1	501	10.5	2,220	2.7	0	2,360	16
4	Hooversville	06-17-92	1330	.78	348	11.5	1,750	2.8	0	1,540	<1.0
		08-18-93	1340	.20	90	12.0	1,800	3.3	0	1,740	7.0
		05-09-94	1520	.95	429	11.5	1,310	2.7	0	1,140	13
5	Hooversville	06-17-92	1430	.76	341	9.5	708	4.5	4	602	1.0
6	Hooversville	06-17-92	1530	.68	306	11.0	1,040	4.4	5	1,000	<1.0
		08-19-93	1325	.23	105	11.0	1,020	5.0	40	930	30
		05-09-94	1415	1.7	756	11.0	853	5.1	22	918	30
7	Hooversville	06-17-92	1620	.20	91	10.5	1,170	3.0	0	1,090	<1.0
		09-01-93	1310	.15	67	10.5	1,820	2.8	0	1,980	17
		05-09-94	1330	.69	312	10.0	866	2.9	0	798	19
8	Hooversville	06-17-92	1700	.01	5.8	16.5	2,290	2.8	0	2,640	<1.0
9	Somerset	06-18-92	0730	.02	6.7	10.5	836	6.1	62	688	2.8
10	Somerset	06-18-92	0815	.27	122	10.0	805	3.5	0	628	1.0
11	Somerset	06-18-92	0845	.30	136	10.5	710	4.4	2	628	1.1
12	Central City	06-24-92	1400	.19	86	15.0	2,750	6.4	130	3,020	37
13	Central City	06-24-92	1515	.12	52	10.5	1,970	6.0	30	1,890	8.2
14	Central City	06-24-92	1645	1.8	799	10.0	1,110	3.6	0	980	8.3
		10-06-92	1635	1.5	678	10.5	1,160	3.6	0	948	5.5
		10-06-92	1140	1.5	678	10.5	1,160	3.7	0	960	4.7
		10-07-92	0615	1.5	678	9.0	1,180	3.5	0	958	5.2
		08-18-93	1530	1.3	584	10.5	1,170	3.6	0	1,190	41
		05-03-94	1215	5.1	2,300	10.0	880	3.5	0	792	29
15	Central City	06-24-92	1745	.21	96	10.5	1,410	3.6	0	1,290	10
		10-06-92	0945	.12	56	9.5	1,380	3.5	0	1,120	15
		10-06-92	1545	.12	56	10.5	1,390	3.2	0	1,080	3.7
		10-07-92	0555	.12	56	9.0	1,410	3.2	0	1,090	12
		08-18-93	1610	.11	47	11.0	1,380	3.4	0	1,620	57
		05-03-94	1120	.27	120	10.0	853	3.0	0	684	37
16	Central City	06-24-92	1840	5.0	2,250	11.0	1,600	3.3	0	1,540	4.1
		08-18-93	1710	3.4	1,510	11.0	1,780	3.1	0	1,850	27
		05-03-94	1040	8.3	3,750	10.5	1,760	2.9	0	1,630	23
17	Stoystown	06-25-92	0840	.63	284	9.5	728	3.3	0	544	2.5
		09-09-93	0920	.33	146	10.5	780	3.4	0	606	<1.0
		08-31-93	0840	.34	151	9.5	774	3.3	0	596	11
		05-12-94	1125	2.5	1,120	9.0	438	3.6	0	302	6.9
18	Stoystown	06-25-92	0930	.02	11	9.5	515	6.4	46	404	12
19	Central City	06-29-92	1100	4.0	1,780	10.0	900	5.1	14	808	21
		10-06-92	1800	4.5	2,000	9.5	840	5.0	10	670	16
		10-07-92	0655	4.5	2,000	9.0	850	5.1	11	662	14

Appendix 3. *Field data and laboratory analyses of mine discharges—Continued*

[ft^3/s, cubic foot per second; gal/min, gallon per minute; °C, degrees Celsius; µS/cm, microsiemen per centimeter at 25 degrees Celsius; mg/L, milligram per liter; <, less than; --, no data available]

Date	Sulfate, dissolved (mg/L as SO_4)	Fluoride, total (mg/L as F)	Iron, total recoverable (µg/L as Fe	Iron, dissolved (µg/L as Fe	Iron, ferrous, dissolved (µg/L as Fe	Manganese, total recoverable (µg/L as Mn	Manganese, dissolved (µg/L as Mn)	Aluminum, total recoverable (µg/L as Al)	Aluminum, dissolved (µg/L as Al)	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
06-17-92	1,500	1.1	46,000	39,000	--	30,000	25,000	38,000	32,000	380	130
08-18-93	1,400	.7	10,000	10,000	680	20,000	20,000	22,000	22,000	272	126
06-17-92	990	.4	3,800	3,600	--	8,800	8,800	5,200	5,200	92	42
06-17-92	1,600	1.4	75,000	75,000	--	23,000	23,000	55,000	54,000	630	280
08-18-93	1,400	1	98,000	97,000	7,500	23,000	23,000	56,000	56,000	742	306
04-21-94	1,700	.9	64,000	64,000	2,900	21,000	21,000	48,000	48,000	524	222
06-17-92	960	.8	30,000	30,000	--	5,200	5,200	20,000	20,000	270	140
08-18-93	1,200	.8	23,000	23,000	1,000	3,900	3,800	22,000	22,000	258	114
05-09-94	880	.6	19,000	18,000	330	3,000	3,000	14,000	14,000	204	84
06-17-92	390	.2	40	30	--	2,600	2,600	800	800	9.4	0
06-17-92	630	.7	9,900	70	--	3,500	3,200	9,500	6,100	34	0
08-19-93	640	.6	6,000	500	--	2,900	2,800	7,100	4,300	26	--
05-09-94	540	.5	3,200	51	170	4,100	4,100	4,900	1,000	17	--
06-17-92	660	.7	11,000	11,000	--	2,400	2,400	20,000	20,000	180	58
09-01-93	1,300	1.0	26,000	26,000	840	4,400	4,400	43,000	42,000	364	104
05-09-94	610	.6	6,600	6,200	320	1,600	1,600	13,000	12,000	138	34
06-17-92	1,500	2.2	62,000	62,000	--	8,200	8,200	62,000	62,000	560	210
06-18-92	380	<.2	38,000	38,000	--	2,600	2,600	280	170	0	0
06-18-92	390	.2	750	700	--	91,000	900	2,000	1,900	24	5
06-18-92	360	<.2	5,800	5,000	--	1,600	1,400	1,000	800	20	0
06-24-92	1,700	<.2	13,000	5,400	--	17,000	17,000	250	200	0	0
06-24-92	1,200	.3	8,300	4,800	--	2,900	2,800	1,500	400	0	0
06-24-92	730	.3	880	800	--	6,700	6,500	10,000	9,700	88	7
10-06-92	680	.4	2,100	1,800	--	7,200	7,100	12,000	11,000	100	7
10-06-92	680	.3	2,000	1,700	--	6,900	6,900	11,000	11,000	100	8
10-07-92	700	.3	2,100	1,700	--	7,100	7,100	11,000	11,000	98	8
08-18-93	850	.4	760	610	220	7,200	7,200	12,000	12,000	96	8
05-03-94	610	.2	360	200	110	4,600	4,600	6,500	6,500	76	--
06-24-92	980	.6	60,000	60,000	--	17,000	17,000	16,000	16,000	222	68
10-06-92	800	.5	57,000	56,000	--	13,000	13,000	12,000	12,000	230	70
10-06-92	800	.6	57,000	57,000	--	13,000	13,000	14,000	14,000	222	70
10-07-92	800	.5	55,000	55,000	--	13,000	13,000	12,000	12,000	228	56
08-18-93	1,000	.5	58,000	57,000	47,000	14,000	14,000	15,000	15,000	208	56
05-03-94	540	.3	12,000	12,000	10,000	6,500	6,500	6,300	6,200	96	14
06-24-92	1,100	.4	63,000	63,000	--	8,600	8,600	18,000	18,000	250	130
08-18-93	1,300	.4	71,000	7,0,000	52,000	8,200	8,200	20,000	20,000	280	116
05-03-94	1,300	.3	39,000	38,000	22,000	8,700	8,600	19,000	19,000	286	116
06-25-92	370	<.2	3,400	3,400	--	1,900	1,900	5,000	5,000	58	20
09-09-93	500	.2	1,900	1,700	--	1,700	1,700	4,400	4,400	58	16
08-31-93	480	.2	2,200	1,900	400	1,800	1,800	4,400	4,400	60	16
05-12-94	200	<.2	990	880	240	800	780	1,700	1,700	32	8
06-25-92	240	<.2	6,600	1,800	--	870	730	<100	<100	0	0
06-29-92	480	.3	41,000	38,000	--	4,000	3,800	1,700	1,200	74	--
10-06-92	450	.4	35,000	35,000	--	3,700	3,700	2,000	1,800	86	0
10-07-92	460	.3	37,000	37,000	--	3,900	3,900	1,800	1,600	82	0

Appendix 3. ***Field data and laboratory analyses of mine discharges—Continued***

Site number	Local identifier (Topographic quadrangle)	Date	Time	Discharge, instantaneous (ft^3/s)	Flow rate, instantaneous (gal/min)	Temperature, water (°C)	Specific conductance (µS/cm)	pH, water whole field (standard units)	Alkalinity, water (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)
		05-03-94	1315	9.2	4,130	9.5	632	4.8	8	536	23
20	Central City	06-29-92	1300	.71	.7	29.0	12,900	2.4	0	35,100	<1.0
21	Stoystown	06-29-92	1400	.10	46	21.0	1,170	3.3	0	1,480	<1.0
22	Stoystown	06-30-92	0845	.50	224	10.0	1,410	3.0	0	1,100	2.5
		09-09-93	1025	.30	135	12.0	950	2.9	0	1,090	<1.0
		08-31-93	0940	.34	151	10.5	1,510	2.8	0	1,310	4.3
		05-12-94	1250	1.2	553	9.5	1,170	3.2	0	966	9.3
23	Stoystown	06-30-92	0930	.03	12	10.0	660	3.4	0	588	5.6
24	Stoystown	07-01-92	1000	.01	3.0	11.0	4,290	3.0	0	5,420	18
25	Stoystown	07-01-92	1045	.01	3.9	9.5	745	5.9	17	650	15
26	Stoystown	07-01-92	1130	<.01	1.5	15.0	3,000	3.1	0	3,900	3.2
27	Central City	07-01-92	1600	<.01	1.0	21.0	1,360	3.0	0	1,400	<1.0
28	Windber	07-13-92	1045	.19	84	10.5	838	3.1	0	800	4.9
		09-01-93	1500	.27	120	10.5	953	3.0	0	852	6.1
29	Windber	07-13-92	1215	.04	19	12.0	1,040	4.1	0	950	2.9
30	Windber	07-13-92	1400	.01	4.4	10.5	1,100	3.1	0	860	4.5
		09-01-93	1600	.02	6.7	11.0	990	3.0	0	812	5.4
31	Windber	07-13-92	1430	.35	155	24.5	818	3.2	0	618	<1.0
		09-01-93	1545	.01	<.1	26.0	688	3.3	0	534	<1.0
32	Windber	07-14-92	0930	.04	18	10.5	1,610	3.4	0	1,510	6.2
33	Windber	07-14-92	1020	.02	8.4	17.5	1,410	3.9	0	1,350	1.6
34	Stoystown	07-15-92	1130	.09	42	11.0	2,230	2.7	0	2,040	8.9
		08-18-93	1536	.10	45	11.0	2,530	3.4	0	2,650	10
		04-21-94	0930	.35	156	10.0	1,390	3.1	0	1,300	15
35	Stoystown	07-15-92	1225	.11	48	15.5	810	6.0	30	540	9.9
36	Stoystown	07-15-92	1330	.09	43	19.0	2,830	3.0	0	2,700	<1.0
		08-18-93	1050	.09	39	19.0	2,970	3.4	0	3,240	<1.0
		04-20-94	0800	.20	90	7.5	2,380	3.2	0	2,410	2.5
37	Central City	07-15-92	1445	.02	6.8	10.0	560	3.6	0	2,880	12
38	Central City	07-15-92	1620	.17	78	10.0	1,610	3.0	0	1,440	11
		05-03-94	0930	.37	167	10.5	1,380	2.6	0	1,210	19
39	Windber	07-16-92	1035	.14	63	13.0	560	6.2	64	462	16
40	Windber	07-16-92	1235	.17	75	17.5	1,020	3.1	0	796	6.6
		08-30-93	1500	<.01	.2	20.5	727	3.2	0	566	<1.0
41	Windber	07-16-92	1405	.10	42	15.5	460	3.6	0	374	1.1
		08-30-93	1500	<.01	.2	20.5	727	3.2	0	566	<1.0
42	Windber	07-16-92	1455	.08	36	13.5	2,130	3.1	0	2,070	11
		08-30-93	1540	<.01	.5	18.5	1,300	3.3	0	1,340	15
		05-03-94	1400	.67	300	10.0	1,450	3.0	0	1,220	36
43	Windber	07-16-92	1620	<.01	.5	27.5	943	3.5	0	670	7.7
44	Windber	07-17-92	0900	.30	133	10.5	1,240	3.6	0	1,270	3.6
45	Ogletown	07-17-92	1015	<.01	.04	21.5	1,950	9.7	198	1,300	33
46	Ogletown	08-18-93	1100	12	–	11.5	934	6.1	30	824	15
		07-17-92	1100	.05	20	16.0	955	3.2	0	856	2.3
47	Hooversville	08-13-92	1015	<.01	1.6	14.5	1,420	3.2	0	1,200	<1.0
48	Hooversville	08-13-92	1040	.02	8.0	15.5	960	4.5	0	796	2.1
49	Hooversville	08-13-92	1340	.01	3.4	11.5	760	6.7	140	548	40
50	Hooversville	08-13-92	1445	<.01	1.0	13.5	533	7.1	66	370	14
51	Somerset	09-14-92	1140	.04	18	11.5	450	4.3	0	346	2.0
52	Boswell	09-14-92	1415	<.01	.2	17.0	993	3.8	0	778	1.5

Appendix 3. *Field data and laboratory analyses of mine discharges—Continued*

Date	Sulfate, dissolved (mg/L as SO_4)	Fluoride, total (mg/L as F)	Iron, total recoverable (μg/L as Fe	Iron, dissolved (μg/L as Fe	Iron, ferrous, dissolved (μg/L as Fe	Manganese, total recoverable (μg/L as Mn	Manganese, dissolved (μg/L as Mn)	Aluminum, total recoverable (μg/L as Al)	Aluminum, dissolved (μg/L as Al)	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
05-03-94	370	0.2	16,000	14,000	220	2,700	2,700	1,400	910	52	--
06-29-92	27,000	4.2	4,760,000	4,360,000	--	60,000	60,000	160,000	160,000	19,688	8,170
06-29-92	630	<.2	6,900	7,600	--	7,100	7,700	1,100	1,200	62	38
06-30-92	750	.4	30,000	30,000	--	7,500	7,500	9,600	9,500	200	130
09-09-93	880	.4	24,000	23,000	--	7,400	7,200	9,500	9,200	174	94
08-31-93	930	.3	34,000	33,000	660	8,700	8,700	11,000	11,000	230	126
05-12-94	730	.3	21,000	21,000	610	7,100	7,100	12,000	11,000	172	80
06-30-92	360	.3	300	280	--	9,000	8,700	12,000	11,000	100	17
07-01-92	3,400	1.8	210,000	190,000	--	130,000	120,000	63,000	62,000	840	190
07-01-92	420	<.2	68,000	67,000	--	4,000	4,000	<100	<100	100	0
07-01-92	2,200	1.1	23,000	23,000	--	56,000	56,000	55,000	55,000	490	100
07-01-92	880	.4	30,000	30,000	--	12,000	12,000	42,000	42,000	420	120
07-13-92	430	.3	1,200	1,200	--	5,800	5,700	10,000	9,900	100	32
09-01-93	690	.3	1,700	1,700	170	5,700	5,700	12,000	12,000	114	28
07-13-92	620	.2	30	30	--	1,400	1,400	7,100	7,100	52	0
07-13-92	470	.4	2,100	2,100	--	7,600	7,600	14,000	14,000	140	40
09-01-93	680	.4	2,100	2,100	290	7,500	7,500	15,000	15,000	124	36
07-13-92	360	.3	2,000	2,000	--	5,700	5,600	9,200	9,100	98	30
09-01-93	430	.3	2,400	2,400	1,300	4,300	4,300	6,100	6,100	68	24
07-14-92	960	.4	1,100	900	--	4,300	4,200	6,300	6,100	64	12
07-14-92	860	.3	330	290	--	5,700	5,700	5,000	5,000	44	0
07-15-92	1,200	.8	32,000	32,000	--	14,000	14,000	21,000	21,000	310	150
08-18-93	1,600	.9	45,000	44,000	2,800	16,000	16,000	28,000	28,000	404	204
04-21-94	900	.5	12,000	11,000	1,100	6,500	6,500	10,000	10,000	--	52
07-15-92	300	.2	5,200	4,800	--	3,200	3,200	1,600	200	0	0
07-15-92	1,800	.2	13,000	13,000	--	42,000	42,000	2,900	2,900	160	84
08-18-93	2,600	.2	25,000	22,000	7,900	46,000	45,000	2,700	2,700	248	94
04-20-94	1,900	.6	16,000	15,000	13,000	37,000	37,000	9,100	9,000	232	0
07-15-92	260	.2	1,100	970	--	3,100	2,800	2,300	2,300	36	7
07-15-92	850	--	66,000	66,000	--	6,500	6,500	42,000	41,000	442	78
05-03-94	840	.2	34,000	34,000	25,000	4,400	4,400	31,000	31,000	384	112
07-16-92	210	<.2	820	390	--	610	600	<100	<100	0	0
07-16-92	420	.6	4,800	4,800	--	5,400	5,400	14,000	14,000	164	44
08-30-93	450	.4	3,400	3,200	400	13,000	13,000	8,600	8,300	102	28
07-16-92	200	.4	3,000	1,200	--	3,200	3,200	6,400	4,500	62	9
07-07-93	490	<.2	78,000	76,000	--	4,100	4,100	290	<130	120	--
07-16-92	1,300	.6	5,400	5,300	--	26,000	26,000	14,000	14,000	200	56
08-30-93	850	.3	2,600	2,000	600	12,000	12,000	5,000	4,900	74	22
05-03-94	930	.3	2,300	2,200	280	15,000	15,000	7,100	7,100	142	30
07-16-92	360	<.2	27,000	26,000	--	9,700	9,700	7,800	7,800	138	34
07-17-92	720	.3	140	140	--	2,500	2,500	5,400	5,400	62	6
07-17-92	860	.3	290	<10	--	5,500	1,500	4,200	730	0	--
08-18-93	480	<.2	57,000	41,000	--	4,700	4,600	<130	<130	56	--
07-17-92	490	.4	7,500	7,300	--	4,900	4,900	22,000	22,000	210	46
08-13-92	770	.6	38,000	37,000	--	14,000	14,000	9,200	8,900	192	66
08-13-92	560	.2	6,400	5,300	--	9,100	9,100	3,200	2,800	50	0
08-13-92	270	<.2	4,800	2,600	--	830	760	<130	<130	0	--
08-13-92	200	<.2	330	31	--	24	14	<130	<130	0	--
09-14-92	200	<.2	300	230	--	410	410	2,300	2,100	24	0
09-14-92	550	<.2	9,500	6,600	--	2,600	2,600	4,200	800	50	12

Appendix 3. *Field data and laboratory analyses of mine discharges—Continued*

Site number	Local identifier (Topographic quadrangle)	Date	Time	Discharge, instantaneous (ft^3/s)	Flow rate, instantaneous (gal/min)	Temperature, water (°C)	Specific conductance (μS/cm)	pH, water whole field (standard units)	Alkalinity, water (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)
53	Boswell	09-14-92	1450	.01	4.6	14.5	900	3.6	0	780	<1.0
54	Boswell	09-14-92	1615	.25	111	11.0	333	6.7	72	212	10
55	Berlin	05-19-93	1020	.10	45	8.0	1,080	5.7	46	864	38
56	Berlin	05-19-93	1045	<.10	20	10.0	439	4.2	0	372	19
57	Berlin	05-19-93	1115	<.01	1.6	14.0	937	5.5	42	1,140	26
58	New Baltimore	05-19-93	1330	.08	35	9.5	1,300	5.9	52	1,240	23
59	Stoystown	05-19-93	1645	.01	3.1	12.0	4,190	2.9	0	4,420	11
60	Stoystown	05-19-93	1730	.01	6.4	14.0	5,410	2.9	0	8,060	5.8
61	Stoystown	05-20-93	0920	.13	60	12.5	305	6.7	96	214	22
62	Stoystown	05-25-93	1015	.12	52	8.0	506	3.5	0	324	5.0
63	Stoystown	05-25-93	1130	.62	277	14.5	977	3.4	0	742	9.3
		04-20-94	0940	1.8	805	9.5	881	3.1	0	562	4.8
64	Stoystown	05-25-93	1300	.04	19	18.5	608	6.4	26	494	7.8
65	Stoystown	05-26-93	0830	.13	58	10.5	345	5.8	11	284	6.4
66	Stoystown	05-26-93	0920	.13	58	15.0	343	6.8	38	200	8.6
67	Stoystown	06-01-93	1030	<.01	2.0	14.0	1,170	4.2	3	1,240	2.2
68	Stoystown	06-01-93	1145	.01	4.6	11.0	1,920	6.7	270	2,930	1.0
69	Stoystown	06-01-93	1245	<.01	.4	16.0	1,310	3.7	0	1,330	<1.0
70	Stoystown	06-01-93	1330	.09	41	10.0	699	4.0	0	1,240	6.3
71	Stoystow	06-01-93	1530	.01	3.8	20.5	1,520	3.8	0	3,090	3.5
72	Stoystown	06-01-93	1600	.02	8.6	12.0	1,900	3.7	0	2,320	3.9
73	Stoystown	06-01-93	1700	<.01	1.6	11.0	4,200	3.5	0	5,430	<1.0
74	Stoystown	06-02-93	0830	.01	2.4	9.5	359	6.5	30	394	9.9
75	Central City	07-12-93	1000	.07	30	24.0	830	3.3	0	628	1.3
76	Central City	07-12-93	1030	.08	35	12.5	776	3.4	0	740	30
77	Stoystown	06-01-93	1530	.01	3.8	20.5	1,520	3.8	0	3,090	3.5
78	Windber	07-12-93	1530	.14	65	11.5	1,070	4.5	12	1,400	11
79	Geistown	07-12-93	1630	<.01	2.0	31.0	4,660	2.2	0	9,240	4.5
80	Windber	07-13-93	0840	<.01	.4	22.0	2,520	2.7	0	1,860	2.0
81	Windber	07-13-93	1010	3.1	1400	11.5	1,020	4.8	3	954	6.0
82	Central City	08-18-93	1100	.03	12	11.5	934	6.1	30	824	15
83	Central City	08-18-93	1310	<.01	.8	14.0	2,080	4.5	0	2,310	2.7
84	Central City	08-30-93	1050	<.01	.5	9.0	2,490	6.1	84	3,230	33
85	Windber	08-30-93	1230	.01	2.5	14.0	505	4.6	0	462	2.4
86	Windber	08-30-93	1345	.02	9.0	18.0	336	6.6	15	284	3.2
87	Stoystown	08-30-93	1640	<.01	1.8	20.5	1,160	6.4	48	1,090	15
88	Hooversville	09-22-93	1015	<.01	1.2	11.5	570	6.5	20	496	5.1
89	Hooversville	09-22-93	1050	<.01	1.5	12.5	993	3.5	0	908	8.5
90	Hooversville	09-22-93	1200	<.01	1.9	10.0	1,160	2.9	0	744	5.2
91	Hooversville	09-22-93	1600	<.01	1.5	15.5	665	6.8	96	534	21
92	Hooversville	09-22-93	1700	<.01	1.7	14.5	1,820	5.8	3	1,920	<1.0
93	Hooversville	09-23-93	0915	<.01	2.2	9.5	860	3.6	0	720	20
94	Hooversville	09-23-93	1020	<.01	2.5	16.5	3,670	3.0	0	4,630	<1.0
95	Hooversville	05-11-94	0830	2.2	981	10.0	1,060	4.6	0	986	5.6
96	Windber	05-17-94	1315	.12	52	10.0	1,120	6.3	26	1,070	7.5
97	Hooversville	05-17-94	1650	.44	197	11.0	1,530	3.2	0	1,460	2.3
		11-17-94	0900	.12	54	11.0	1,310	4.1	0	1,410	22
98	Central City	05-24-94	1730	.01	2.4	14.0	726	6.1	28	594	11
99	Central City	05-24-94	1820	<.01	.4	15.0	1,620	6.2	18	2,000	6.6
100	Windber	05-25-94	0900	.79	352	10.0	720	5.8	12	622	8.3

Date	Sulfate, dissolved (mg/L as SO_4)	Fluoride, total (mg/L as F)	Iron, total recoverable (µg/L as Fe	Iron, dissolved (µg/L as Fe	Iron, ferrous, dissolved (µg/L as Fe	Manganese, total recoverable (µg/L as Mn	Manganese, dissolved (µg/L as Mn)	Aluminum, total recoverable (µg/L as Al)	Aluminum, dissolved (µg/L as Al)	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
09-14-92	510	0.3	1,200	1,200	--	680	650	7,800	7,700	72	11
09-14-92	97	<.2	7,900	7,700	--	630	620	<140	<140	0	0
05-19-93	630	<.1	72,000	72,000	--	10,000	10,000	<130	<130	94	--
05-19-93	230	<.2	240	220	--	5,300	5,300	3,600	3,500	32	--
05-19-93	630	<.2	130,000	120,000	--	20,000	19,000	<130	<130	204	--
05-19-93	790	.6	47,000	46,000	--	4,400	4,400	540	510	46	--
05-19-93	2,700	1.4	73,000	73,000	72,000	78,000	78,000	55,000	55,000	660	142
05-19-93	5,000	2.2	18,000	18,000	4,400	140,000	140,000	86,000	86,000	720	122
05-20-93	21	<.2	2,000	1,500	--	150	140	<130	<130	0	--
05-25-93	260	.3	360	230	140	4,900	4,900	9,000	9,000	64	8
05-25-93	260	.4	4,100	4,100	3,000	7,800	7,800	19,000	19,000	140	26
04-20-94	460	.3	2,300	2,300	1,600	5,600	5,600	17,000	17,000	176	26
05-25-93	300	<.2	2,900	1,400	--	1,700	1,600	<100	<100	0	0
05-26-93	140	<.2	170	<10	--	120	120	<130	<130	0	--
05-26-93	120	<.2	500	110	--	260	250	<130	<130	0	--
06-01-93	770	<.2	3,000	1,500	--	9,000	8,300	2,200	1800	36	--
06-01-93	1,900	<.2	130	110	0	1,400	1,400	<100	<100	0	0
06-01-93	870	.4	620	580	360	11,000	11,000	23,000	23,000	190	28
06-01-93	800	.5	210	190	130	16,000	16,000	17,000	17,000	146	13
06-01-93	2,200	.8	2,200	2,200	1,400	59,000	59,000	68,000	68,000	532	34
06-01-93	1,400	.7	800	600	520	44,000	44,000	56,000	56,000	440	32
06-01-93	4,000	1.3	90,000	90,000	260	120,000	120,000	57,000	57,000	780	216
06-02-93	150	<.2	11,000	11,000	0	3,800	3,700	200	<130	8.0	0
07-12-93	490	.2	5,500	3,900	--	3,400	3,400	3,400	3,400	80	24
07-12-93	570	.2	17,000	17,000	8,000	3,200	3,100	9,800	9,800	126	36
06-01-93	2,200	.8	2,200	2,200	1,400	59,000	59,000	68,000	68,000	532	34
07-12-93	870	<.2	30	10	--	1,200	1,200	810	810	28	--
07-12-93	6,200	.2	1,300,000	--	--	10,000	9,800	100,000	99,000	3,940	2,940
07-13-93	1,300	<.2	130,000	130,000	46,000	6,100	6,100	26,000	26,000	700	440
07-13-93	720	<.2	6,900	6,900	--	2,800	2,700	2,600	1,900	44	--
08-18-93	480	<.2	57,000	41,000	--	4,700	4,600	<130	<130	56	--
08-18-93	1,500	.2	620	490	--	1,500	1,500	1,100	1,100	18	--
08-30-93	2,100	<.2	40,000	38,000	--	9,900	9,900	240	<130	0	--
08-30-93	280	<.2	1,900	1,200	--	2,600	2,300	130	<130	11	--
08-30-93	140	<.2	610	52	--	500	490	<130	<130	0	--
08-30-93	590	<.2	11,000	8,400	--	4,300	4,200	150	150	0	--
09-22-93	260	.2	<10	<10	--	60	60	210	<130	0	--
09-22-93	600	.2	19,000	19,000	13,000	4,300	4,300	3,400	3,400	82	22
09-22-93	560	.3	4,700	4,700	320	1,200	1,200	7,300	7,300	124	64
09-22-93	230	.2	120	18	--	88	83	440	<130	0	--
09-22-93	1,100	<.2	1,000	<10	--	1,200	1,200	480	240	12	--
09-23-93	460	.3	490	470	150	2,400	2,300	1,100	1,000	34	7
09-23-93	1,700	.7	130,,000	130,000	96,000	150,000	150,000	26,000	25,000	714	200
05-11-94	690	.3	3,500	2,300	--	2,000	2,000	3,000	2,900	30	--
05-17-94	700	<.2	610	530	--	460	450	230	<130	0	--
05-17-94	1,000	.3	28,000	28,000	23,000	1,400	1,400	15,000	15,000	186	44
11-17-94	700	.2	53,000	53,000	53,000	1,300	1,300	6,100	6,100	204	--
05-24-94	470	<.2	8,900	4,500	--	2,000	1,600	220	<130	0	--
05-24-94	1,400	<.2	20,000	18,000	--	12,000	12,000	160	150	26	--
05-25-94	420	<.2	50	23	--	690	690	700	440	1.2	--

Site number	Local identifier (Topographic quadrangle)	Date	Time	Discharge, instantaneous (ft^3/s)	Flow rate, instantaneous (gal/min)	Temperature, water (°C)	Specific conductance (µS/cm)	pH, water whole field (standard units)	Alkalinity, water (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)
101	Windber	05-25-94	1000	.26	117	10.5	1,310	3.2	0	1,180	3.5
102	Windber	05-25-94	1230	.03	15	13.0	186	4.7	0	270	1.5
103	Windber	05-25-94	1310	.97	436	10.5	1,350	3.2	0	1,250	3.3
		11-17-94	1045	.07	33	10.0	3,110	2.7	0	3,780	2.4
104	Windber	05-25-94	1400	.44	200	11.0	2,400	3.0	0	2,270	3.6
		11-17-94	1110	.05	22	10.0	2,990	3.3	0	3,190	2.0
105	Stoystown	05-26-94	0840	.01	6.0	12.5	328	3.7	0	222	4.0
106	Central City	06-07-94	1305	.11	51	16.5	210	7.1	78	180	6.4
107	Johnstown	06-14-94	0950	.02	9.2	11.5	715	5.2	4	528	5.9
108	Johnstown	06-14-94	1030	.13	60	11.0	810	7.0	48	642	12
109	Johnstown	06-14-94	1120	.40	180	15.5	1,230	5.9	44	1,200	2.3
110	Geistown	06-14-94	1300	1.0	449	13.0	1,220	4.5	0	1,310	4.6
		11-21-94	1250	.88	396	12.5	1,420	3.0	0	1,260	11
111	Windber	06-20-94	1050	.07	30	12.0	992	3.4	0	1,000	2.1
112	Windber	06-22-94	1115	.03	12	10.0	1,430	3.5	0	1,530	3.1
113	Windber	06-22-94	1140	.02	7.9	10.0	1,610	3.3	0	1,590	3.3
114	Windber	06-22-94	1215	.01	5.5	17.5	1,620	3.5	0	1,780	<1.0
115	Windber	06-22-94	1430	.01	3.9	18.0	1,840	3.6	0	2,090	<1.0
116	Windber	06-22-94	1500	.03	15	18.0	1,410	3.6	0	1,490	<1.0
117	Beaverdale	06-27-94	1110	.05	21	15.5	2,470	3.1	0	4,360	3.2
118	Beaverdale	06-27-94	1130	<.01	.3	19.0	2,380	2.6	0	3,150	1.4
119	Hooversville	06-27-94	1550	.01	4.0	15.5	177	5.0	3	140	5.9
120	Hooversville	06-27-94	1645	.02	7.5	20.0	810	3.2	0	474	1.0
121	Hooversville	06-28-94	0810	3.4	1,510	12.0	718	6.0	18	662	9.4
122	Hooversville	06-28-94	0840	<.01	.2	18.0	5,010	2.9	0	10,880	2.7
123	Hooversville	06-28-94	0930	.55	248	10.0	804	6.4	68	728	20
124	Windber	07-06-94	0945	.04	18	14.5	3,350	2.6	0	4,260	4.2
		11-17-94	1240	<.01	.7	13.0	3,060	3.2	0	3,380	9.0
125	Windber	07-06-94	1030	.50	225	23.0	3,670	2.4	0	5,070	<1.0
		11-17-94	1300	.02	10	9.5	3,030	2.6	0	3,630	1.3
126	Windber	07-06-94	1100	.06	26	17.5	1,430	2.9	0	1,370	<1.0
127	Windber	07-06-94	1150	<.01	1.3	22.5	2,340	2.6	0	2,370	1.2
128	Stoystown	07-06-94	1620	.06	28	12.5	1,520	3.6	0	1,690	8.0
129	Stoystown	07-06-94	1700	.04	17	14.5	2,060	3.7	0	2,550	7.5
130	Johnstown	07-07-94	0840	.56	250	12.0	1,170	3.9	0	1,150	1.2
131	Johnstown	07-07-94	0750	.01	3.1	11.5	864	3.3	0	760	3.1
132	Stoystown	07-13-94	1300	.01	4.3	19.0	1,100	5.9	8	1,200	2.2
133	Stoystown	07-13-94	1400	<.01	.4	15.0	1,720	3.8	0	1,990	7.8
134	Stoystown	07-13-94	1450	.01	4.0	18.5	1,140	4.1	0	1,310	<1.0
135	Stoystown	07-13-94	1730	.13	60	11.5	731	6.6	176	668	15
136	Hooversville	07-14-94	0750	.02	7.5	10.0	288	6.6	86	234	5.6
137	Hooversville	07-14-94	0840	.40	180	9.5	360	5.3	6	352	5.5
138	Geistown	07-21-94	1010	<.01	1.6	18.0	1,280	2.7	0	1,360	5.3
139	Geistown	07-21-94	1100	.03	13	16.5	2,520	2.6	0	2,600	4.6
140	Geistown	07-21-94	1130	.06	27	16.5	3,090	2.5	0	3,270	5.6
		11-17-94	1500	.04	20	7.5	2,600	3.0	0	3,640	<1.0
141	Geistown	07-21-94	1230	.11	48	21.5	3,820	2.7	0	5,520	4.0
		11-17-94	1420	.04	18	9.0	3,360	2.9	0	5,250	<1.0
142	Geistown	07-21-94	1300	.01	2.5	22.0	4,280	2.2	0	5,530	8.1
143	New Baltimore	08-01-94	1010	<.01	1.4	13.5	1,650	3.9	0	2,310	8.4

Appendix 3. *Field data and laboratory analyses of mine discharges—Continued*

Date	Sulfate, dissolved (mg/L as SO_4)	Fluoride, total (mg/L as F)	Iron, total recoverable (µg/L as Fe	Iron, dissolved (µg/L as Fe	Iron, ferrous, dissolved (µg/L as Fe	Manganese, total recoverable (µg/L as Mn	Manganese, dissolved (µg/L as Mn)	Aluminum, total recoverable (µg/L as Al)	Aluminum, dissolved (µg/L as Al)	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
05-25-94	780	0.2	1,700	1,700	170	1,800	1,800	4,800	4,700	94	40
05-25-94	81	<.2	60	48	--	440	420	330	310	12	--
05-25-94	1,100	.3	1,500	1,500	250	4,900	4,900	6,500	6,500	92	26
11-17-94	1,900	.7	12,000	12,000	920	20,000	20,000	28,000	27,000	350	122
05-25-94	1,600	.4	6,800	6,500	500	14,000	14,000	14,000	13,000	194	72
11-17-94	1,800	.7	9,300	9,200	840	22,000	20,000	24,000	24,000	314	108
05-26-94	240	<.2	9,700	7,800	--	4,000	3,700	1,000	930	34	12
06-07-94	5.1	<.2	2,000	640	--	630	570	<130	<130	0	--
06-14-94	330	<.2	490	22	--	280	230	670	260	19	--
06-14-94	430	<.2	90	45	--	44	41	200	<130	0	--
06-14-94	650	<.2	39,000	39,000	--	2,100	2,100	170	170	62	--
06-14-94	780	<.2	30,000	28,000	--	2,300	2,300	3,800	3,500	100	--
11-21-94	1,200	<.2	45,000	39,000	43,000	3,000	2,700	4,800	4,200	102	--
06-20-94	600	.4	530	510	410	6,500	6,300	8,700	8,500	82	19
06-22-94	920	.4	380	330	150	5,200	5,000	8,300	8,,000	74	12
06-22-94	1,000	.4	450	410	--	6,100	6,000	9,900	9,600	92	18
06-22-94	1,200	.5	640	640	--	7,200	7,200	8,800	8,800	90	14
06-22-94	1,200	.6	990	950	400	11,000	11,000	8,000	8,000	92	15
06-22-94	990	.5	870	870	370	6,600	6,600	6,400	6,400	76	13
06-27-94	2,400	.9	33,000	30,000	24,000	68,000	64,000	120,000	110,000	934	248
06-27-94	1,900	.7	60,000	54,000	32,000	33,000	33,000	67,000	65,000	734	260
06-27-94	74	<.2	150	56	--	330	310	180	<130	32	--
06-27-94	350	<.2	5,700	5,400	840	2,100	1,900	770	770	112	60
06-28-94	400	.3	760	71	--	940	880	2,400	330	7.6	--
06-28-94	6,100	2.0	690,000	650,000	230,000	37,000	36,000	320,000	310,000	3,620	1,580
06-28-94	420	<.2	170	85	--	50	50	190	<130	.0	--
07-06-94	3,000	1.1	47,000	47,000	1,500	53,000	53,000	89,000	89,000	866	--
11-17-94	1,800	.7	12,000	11,000	1,200	27,000	26,000	54,000	52,000	512	118
07-06-94	3,200	1.4	130,000	130,000	6,900	66,000	65,000	87,000	86,000	1,176	--
11-17-94	1,800	1.0	83,000	83,000	5,200	44,000	44,000	57,000	57,000	908	338
07-06-94	810	.5	3,900	3,900	770	24,000	24,000	28,000	28,000	276	--
07-06-94	1,600	1.6	110,000	110,000	27,000	32,000	32,000	1,200	1,200	486	--
07-06-94	1,000	.4	230	220	200	11,000	11,000	6,400	6,400	66	--
07-06-94	1,500	.5	810	880	430	18,000	18,000	8,600	8,600	92	--
07-07-94	640	.2	80	60	60	1,600	1,500	2,500	2,500	30	--
07-07-94	420	<.2	25,000	15,000	15,000	4,900	4,900	1,500	1,500	62	--
07-13-94	740	<.2	8,600	8,600	--	8,500	8,400	250	180	58	--
07-13-94	1,100	.4	470	420	250	16,000	16,000	11,000	11,000	152	14
07-13-94	810	<.2	510	430	260	9,600	9,600	2,200	2,200	72	--
07-13-94	250	<.2	1,200	840	--	140	140	<130	<130	0	--
07-14-94	58	<.2	1,800	1,300	--	170	160	<130	<130	0	--
07-14-94	170	.2	50	17	--	310	300	1,300	1,000	30	--
07-21-94	870	.3	17,000	17,000	1,700	23,000	23,000	11,000	11,000	214	126
07-21-94	1,600	.4	59,000	59,000	2,500	39,000	39,000	20,000	20,000	468	306
07-21-94	2,000	.5	70,000	70,000	3,300	48,000	48,000	33,000	32,000	684	388
11-17-94	1,500	.5	140,000	140,000	3,700	39,000	39,000	23,000	23,000	782	396
07-21-94	1,500	1.9	210,000	200,000	110,000	110,000	110,000	75,000	74,000	1,304	550
11-17-94	2,900	1.4	230,000	230,000	190,000	72,000	71,000	63,000	63,000	1,332	336
07-21-94	3,400	1.3	140,000	140,000	5,900	93,000	93,000	49,000	49,000	1,120	700
08-01-94	1,300	1.6	390	350	380	51,000	51,000	37,000	37,000	258	--

Appendix 3. *Field data and laboratory analyses of mine discharges—Continued*

Site number	Local identifier (Topographic quadrangle)	Date	Time	Discharge, instantaneous (ft^3/s)	Flow rate, instantaneous (gal/min)	Temperature, water (°C)	Specific conductance (μS/cm)	pH, water whole field (standard units)	Alkalinity, water (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)
144	Stoystown	08-01-94	1150	.41	185	11.0	1,590	6.0	100	1,850	9.4
145	Central City	08-01-94	1415	.01	4.9	13.0	2,600	6.2	140	3,410	12
146	Stoystown	08-01-94	1050	<.01	1.1	25.0	1,030	6.7	38	956	6.7
147	Johnstown	08-10-94	0920	<.01	.5	21.0	1,350	6.8	88	1,300	4.6
148	Johnstown	08-10-94	1010	<.01	.2	21.5	1,480	6.3	70	1,770	3.0
149	Johnstown	08-10-94	1115	.69	310	14.0	2,480	5.7	48	2,840	3.8
		11-21-94	1000	2.0	884	13.0	2,840	5.7	66	3,210	31
150	Johnstown	08-10-94	1245	<.01	1.0	20.5	2,390	7.3	232	2,360	6.4
151	Stoystown	07-21-92	1145	.28	126	10.5	725	6.5	190	640	44
152	Stoystown	07-21-92	1230	.64	289	10.5	870	6.5	96	792	30
153	Stoystown	07-21-92	1320	<.01	.3	9.5	700	6.3	26	676	12
154	Stoystown	07-21-92	1435	.06	28	17.0	1,640	3.5	0	1,170	1.2
155	Stoystown	07-21-92	1600	.04	20	14.0	2,200	3.2	0	2,390	1.1
156	Stoystown	07-22-92	1130	.08	36	12.5	2,200	3.5	0	2,210	31
		08-17-93	1135	.10	45	14.0	2,220	3.8	0	2,420	14
157	Stoystown	07-22-92	1305	.01	3.6	15.5	2,200	6.7	370	3,090	94
158	Stoystown	07-22-92	1410	<.01	.5	15.5	4,020	3.8	0	6,000	20
159	Stoystown	07-22-92	1545	.01	2.3	15.5	1,210	4.6	3	1,330	4.4
160	Stoystown	07-22-92	1545	.38	171	10.5	1,830	3.1	0	1,460	11
		08-17-93	1220	.24	110	11.0	1,810	3.4	0	1,670	9.7
		05-09-94	1635	.60	272	10.5	1,370	2.9	0	1,180	10
161	Stoystown	07-22-92	1620	.04	20	15.5	1,380	3.2	0	1,160	<1.0
162	Stoystown	07-23-92	0945	.01	5.0	16.0	2,170	3.1	0	2,170	<1.0
163	Stoystown	07-23-92	1025	<.01	2.0	16.0	1,990	3.0	0	1,860	2.7
164	Hooversville	07-23-92	1130	.22	97	11.0	1,680	2.8	0	1,500	2.9
		08-18-93	1315	.20	90	11.0	2,220	3.4	0	2,370	6.8
		05-03-94	1710	1.2	540	10.5	1,640	2.8	0	1,530	7.4
165	Johnstown	07-23-92	1500	.03	18	20.0	3,090	2.7	0	5,020	1.2
		09-01-93	1400	.07	33	19.0	4,910	2.5	0	9,650	<1.0
		04-19-94	1600	.07	33	12.5	4,980	2.4	0	5,680	14
166	Hooversville	07-24-92	0940	.03	13	12.0	2,270	2.7	0	2,420	1.6
		09-01-93	1000	.01	4.0	16.0	2,520	2.6	0	2,660	<1.0
		05-09-94	1100	.17	77	10.5	1,960	2.5	0	1,710	5.9
167	Berlin	08-03-92	1025	.03	5.0	12.0	665	3.5	0	574	4.8
168	New Baltimore Qua	08-03-92	--	.01	2.3	12.5	1,180	6.0	38	1,070	18
		08-03-92	1110	.01	2.3	12.5	1,180	7.0	38	1,070	18
169	New Baltimore Qua	08-03-92	1255	.03	15	10.0	1,210	6.0	28	1,250	16
170	Berlin	08-03-92	1500	.32	142	12.0	1,790	6.2	130	2,040	17
171	Boswell	05-11-94	1200	.15	69	14.0	366	6.6	19	288	5.4
172	Boswell	08-05-92	1000	.07	30	14.0	1,710	2.8	0	1,640	<1.0
		09-02-93	0830	<.01	<.1	18.0	1,460	2.9	0	1,070	8.1
173	Boswell	08-05-92	1115	1.0	470	10.5	1,460	6.2	100	1,180	23
174	Boswell	08-05-92	1155	.02	7.5	13.0	1,450	5.0	12	1,200	13
175	Boswell	08-05-92	1315	.01	5.0	15.5	1,060	3.2	0	708	5.7
176	Boswell	08-05-92	1530	.73	330	11.0	890	5.9	34	760	15
		09-02-93	0920	.09	39	11.0	967	5.9	28	988	17
		05-10-94	0820	.22	101	11.0	1,000	6.2	20	1,020	14
177	Hooversville	08-06-92	0920	.02	7.0	11.5	2,000	2.7	0	1,750	1.9
178	Hooversville	08-06-92	0940	3.6	1,620	12.5	1,350	5.9	160	1,070	26
		09-08-93	1820	2.1	962	12.5	1,320	6.5	162	1,120	30

Appendix 3. *Field data and laboratory analyses of mine discharges—Continued*

Date	Sulfate, dissolved (mg/L as SO_4)	Fluoride, total (mg/L as F)	Iron, total recoverable (µg/L as Fe	Iron, dissolved (µg/L as Fe	Iron, ferrous, dissolved (µg/L as Fe	Manganese, total recoverable (µg/L as Mn	Manganese, dissolved (µg/L as Mn)	Aluminum, total recoverable (µg/L as Al)	Aluminum, dissolved (µg/L as Al)	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
08-01-94	1,000	<0.2	13,000	12,000	--	35,000	35,000	150	<130	0	--
08-01-94	2,000	<.2	70	29	--	280	260	170	160	0	--
08-01-94	600	.4	1,600	79	--	120	120	300	140	0	--
08-10-94	610	.3	81,000	60,000	--	1,600	1,200	260	<130	0	--
08-10-94	1,100	.5	100,000	98,000	--	2,000	2,000	390	<130	92	--
08-10-94	1,600	<.2	300,000	300,000	--	3,000	2,900	790	580	540	--
11-21-94	3,100	<.2	390,000	330,000	--	4,400	4,100	650	400	634	--
08-10-94	1,300	.4	6,400	1,200	--	1,200	1,100	890	150	0	--
07-21-92	190	<.2	3,000	2,000	--	260	240	<100	<100	0	0
07-21-92	360	<.2	40	20	--	100	100	200	<100	0	0
07-21-92	330	<.2	230	<10	--	320	300	2,600	<100	0	0
07-21-92	690	<.2	2,200	2,200	--	8,000	8,000	700	700	50	15
07-21-92	1,400	1.2	3,900	3,900	--	5,000	5,000	13,000	13,000	150	44
07-22-92	1,400	.8	4,400	4,400	--	2,800	2,800	12,000	12,000	100	14
08-17-93	1,400	.7	3,100	2,800	660	2,500	2,500	9,200	9,200	98	10
07-22-92	1,700	<.2	3,000	2,500	--	17,000	16,000	300	300	0	0
07-22-92	3,600	1.7	200,000	200,000	--	120,000	120,000	74,000	73,000	850	9
07-22-92	770	.5	3,100	2,900	--	24,000	24,000	13,000	13,000	92	0
07-22-92	960	<.2	5,900	5,700	--	13,000	13,000	7,200	7,100	120	54
08-17-93	1,100	<.2	6,100	6,100	1,000	12,000	12,000	7,300	7,100	124	48
05-09-94	900	<.2	4,400	4,400	1,000	11,000	11,000	5,600	5,600	104	30
07-22-92	770	<.2	3,600	3,500	--	11,000	11,000	2,600	2,600	82	40
07-23-92	1,400	.8	2,500	2,400	--	17,000	17,000	12,000	12,000	130	42
07-23-92	1,200	.3	7,100	7,100	--	21,000	21,000	7,000	7,000	140	64
07-23-92	840	.8	26,000	25,000	--	5,100	4,900	17,000	16,000	260	130
08-18-93	1,400	1.0	64,000	63,000	1,000	6,600	6,600	39,000	39,000	504	242
05-03-94	1,000	.6	37,000	36,000	680	5,000	5,000	23,000	23,000	338	160
07-23-92	2,200	.8	320,000	300,000	--	5,700	5,700	97,000	97,000	1,600	770
09-01-93	5,800	1	760,000	750,000	300,000	8,600	8,600	210,000	210,000	2,760	1,190
04-19-94	4,700	1.0	630,000	570,000	440,000	6,600	6,000	170,000	150,000	2,342	628
07-24-92	1,500	.4	150,000	150,000	--	1,900	1,900	45,000	45,000	820	440
09-01-93	2,100	.4	140,000	130,000	130,000	2,400	2,300	58,000	58,000	806	436
05-09-94	1,100	--	120,000	120,000	44,000	1,500	1,500	34,000	34,000	596	332
08-03-92	280	.3	1,700	940	--	6,600	6,600	7,300	7,200	76	17
08-03-92	670	<.2	33,000	21,000	--	3,400	2,300	<130	<130	19	--
08-03-92	670	<.2	33,000	21,000	--	3,400	2,300	<130	<130	19	--
08-03-92	720	.2	74,000	73,000	--	12,000	12,000	300	300	120	0
08-03-92	1,000	<.2	9,700	9200	--	35,000	35,000	300	200	0	0
05-11-94	150	<.2	950	570	--	510	500	140	<130	0	--
08-05-92	950	.6	6,600	6,700	--	14,000	14,000	24,000	24,000	260	70
09-02-93	910	.2	110,000	110,000	88,000	11,000	11,000	2,000	2,000	284	110
08-05-92	810	<.2	34,000	34,000	--	4,400	4,400	<100	200	0	0
08-05-92	930	<.2	180,000	180,000	--	13,000	13,000	1,000	800	340	0
08-05-92	480	.3	37,000	37,000	--	11,000	11,000	5,400	5,300	120	68
08-05-92	450	<.2	110,000	110,000	--	6,100	6,100	<100	<100	162	0
09-02-93	620	<.2	120,000	120,000	120,000	7,300	7,300	<130	<130	186	--
05-10-94	640	<.2	130,000	130,000	--	8,100	7,800	<130	<130	232	--
08-06-92	1,000	.5	59,000	58,000	--	1,700	1,700	40,000	39,000	520	240
08-06-92	640	<.2	17,000	1,800	--	620	620	8,500	200	0	0
09-08-93	610	<.2	3,500	1,700	--	480	480	1,000	<130	0	--

Appendix 3. *Field data and laboratory analyses of mine discharges—Continued*

Site number	Local identifier (Topographic quadrangle)	Date	Time	Discharge, instantaneous (ft^3/s)	Flow rate, instantaneous (gal/min)	Temperature, water (°C)	Specific conductance (µS/cm)	pH, water whole field (standard units)	Alkalinity, water (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)
179	Hooversville	05-11-94	1050	.02	7.5	10.5	1,180	3.8	0	1,020	3.6
180	Hooversville	08-06-92	1115	.06	25	11.0	2,350	2.7	0	2,420	3.1
		09-01-93	1100	.07	30	11.0	2,590	2.4	0	2,480	<1.0
		05-09-94	1145	.38	171	11.0	1,630	2.3	0	1,350	3.3
181	Hooversville	07-14-93	1535	.01	5.0	8.5	1,220	3.3	0	1,110	<1.0
182	Ligonier	07-14-93	1730	<.01	1.0	15.0	232	5.2	16	160	8.3
183	Ligonier	07-14-93	1740	.01	3.0	17.5	353	4.2	0	210	1.7
184	Windber	07-15-93	0850	.10	45	13.5	2,700	2.8	0	2790	18
		04-19-94	1210	.17	75	13.5	2,710	2.5	0	2,490	23
185	Windber	07-15-93	0930	<.01	1.9	18.0	3,420	2.7	0	3,050	1.6
186	Johnstown	08-10-94	1330	.05	22	15.5	2,350	4.8	4	2,520	10
187	Windber	07-15-93	1140	.08	36	11.5	1,740	2.4	0	1,630	1.6
		04-19-94	1430	1.0	470	11.5	1,940	2.5	0	1,390	<1.0
188	Windber	07-15-93	1240	.11	51	18.0	2,270	2.6	0	3,070	1.3
		04-19-94	1330	.05	24	16.0	1,770	2.8	0	1,620	<1.0
189	Johnstown	08-10-94	1500	1.2	539	12.0	1,200	3.4	0	1,080	3.9
		11-21-94	1150	1.2	554	11.5	1,270	3.1	0	980	4.6
190	Johnstown	08-15-94	1000	.13	60	12.0	2,130	3.1	0	2,380	30
		11-21-94	1100	.10	47	11.5	2,370	3.0	0	2,110	14
191	Johnstown	08-15-94	1115	.01	5.0	16.5	3,020	2.8	0	4,140	5.6
192	Johnstown	08-15-94	1200	<.01	2.1	15.0	3,120	3.3	0	4,280	20
193	Johnstown	08-15-94	1245	<.01	2.0	15.5	1,110	6.9	194	1,060	34
194	Johnstown	08-15-94	1340	.03	13	11.5	1,720	6.8	132	1,740	30
195	Johnstown	08-15-94	1400	.01	6.4	14.5	765	7.1	168	580	32
196	Johnstown	08-15-94	1445	.03	12	12.5	903	6.8	224	704	40
197	Johnstown	08-15-94	1525	.13	60	12.0	780	7.2	134	656	29
198	Johnstown	08-15-94	1700	<.01	.3	17.5	1,020	4.0	0	968	<1.0
199	Johnstown	08-15-94	1800	<.01	.5	20.0	965	7.1	156	744	29
200	Windber	08-22-94	1100	.02	7.5	8.5	305	4.6	2	316	22
201	Windber	08-22-94	1210	<.01	1.6	11.5	258	4.2	0	260	18
202	Central City	08-03-92	1200	.12	54	14.0	2,090	6.1	138	2,350	18
203	Central City	08-03-92	1540	<.01	<.1	15.0	3,100	3.8	0	4,100	16
204	Hooversville	08-04-92	1110	.13	60	12.0	2,450	2.7	0	2,510	7.0
		05-09-94	0945	.35	158	10.5	620	3.1	0	382	5.1
205	Hooversville	08-04-92	1445	.17	75	11.5	1,280	6.3	150	1,080	44
206	Hooversville	10-11-94	1630	.02	7.2	10.5	516	7.1	102	438	30
207	Hooversville	08-04-92	1600	.49	221	11.0	907	4.9	2	926	3.9
		09-01-93	1210	.35	156	11.0	975	4.2	1	918	2.7
208	Somerset	08-05-92	1050	.83	374	11.0	694	6.2	0	2,270	<1.0
		08-19-93	1115	.55	248	11.5	730	6.0	56	606	30
		05-04-94	0820	1.1	475	10.0	625	5.8	40	464	24
209	Somerset	08-05-92	1130	.14	64	19.5	1,670	3.5	46	534	15
210	Berlin	08-05-92	1535	.22	97	10.5	872	5.8	38	746	19
211	Berlin	08-06-92	1000	1.2	487	16.5	1090	6.6	84	744	17
212	New Baltimore	07-07-93	0945	.66	26	18.5	1,940	3.3	0	1,950	<1.0
213	Central City	07-07-93	1110	.01	2.3	18.5	1,780	3.0	0	1,710	4.1
214	Windber	07-07-93	1300	.03	12	19.0	814	3.1	0	624	<1.0
215	Windber	07-07-93	1420	.02	7.3	22.5	1,080	3.0	0	694	<1.0
216	Windber	07-07-93	1520	.02	6.7	17.5	584	5.5	17	608	<1.0
217	Windber	07-08-93	0835	.01	2.5	13.5	1,750	2.9	0	1,380	2.1

Appendix 3. *Field data and laboratory analyses of mine discharges—Continued*

Date	Sulfate, dissolved (mg/L as SO_4)	Fluoride, total (mg/L as F)	Iron, total recoverable (µg/L as Fe	Iron, dissolved (µg/L as Fe	Iron, ferrous, dissolved (µg/L as Fe	Manganese, total recoverable (µg/L as Mn	Manganese, dissolved (µg/L as Mn)	Aluminum, total recoverable (µg/L as Al)	Aluminum, dissolved (µg/L as Al)	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
05-11-94	800	<0.2	95,000	85,000	80,000	6,000	5,900	700	700	172	2
08-06-92	1,400	.5	180,000	170,000	--	2,000	2,000	44,000	43,000	820	470
09-01-93	2,000	.4	120,000	120,000	1,400	2,400	2,400	51,000	51,000	780	438
05-09-94	960	.3	80,000	79,000	900	1,100	1,100	25,000	25,000	476	276
07-14-93	900	<.2	28,000	26,000	900	13,000	12,000	3,300	3,200	146	96
07-14-93	120	<.2	15,000	14,000	--	2,200	2,100	<130	<130	17	--
07-14-93	210	.2	1,400	1,100	--	2,700	3,100	3,900	3,900	40	4
07-15-93	2,300	<.2	120,000	120,000	110,000	4,200	4,200	24,000	24,000	448	114
04-19-94	2,100	.4	150,000	150,000	150,000	3,400	3,300	30,000	29,000	640	178
07-15-93	2,400	.3	61,000	54,000	2,400	4,000	4,000	28,000	27,000	580	386
08-10-94	1,600	.5	15,000	8,000	--	3,800	3,800	13,000	6,100	80	--
07-15-93	1,300	.3	26,000	25,000	980	3,100	3,000	22,000	22,000	380	216
04-19-94	1,100	.4	33,000	33,000	680	2,500	2,500	15,000	15,000	306	172
07-15-93	2,400	.6	31,000	31,000	7,000	42,000	42,000	100,000	100,000	820	168
04-19-94	1,400	.6	5,900	5,500	1,500	23,000	23,000	65,000	65,000	512	68
08-10-94	690	.2	1,300	1,200	180	700	690	6,400	6,200	100	15
11-21-94	1,100	.2	1,800	1,500	170	810	740	7,300	6,600	70	17
08-15-94	1,600	.6	18,000	17,000	5,400	4,100	4,100	3,400	3,400	140	58
11-21-94	3,200	.6	26,000	23,000	5,700	5,000	4,600	3,900	3,600	140	84
08-15-94	3,000	1.3	180,000	97,000	180,000	8,500	8,400	8,900	8,700	478	314
08-15-94	2,900	1.4	190,000	190,000	160,000	9,500	9,400	12,000	12,000	526	100
08-15-94	470	.2	1,400	980	--	130	100	<130	<130	0	--
08-15-94	960	.3	28,000	26,000	--	2,900	2,900	<130	<130	0	--
08-15-94	120	<.2	100	<10	--	10	<10	<130	<130	0	--
08-15-94	220	<.2	30	<10	--	<10	<10	<130	<130	0	--
08-15-94	250	.2	1,900	<10	--	79	12	340	<130	0	--
08-15-94	370	<.2	3,800	2,600	2,300	720	720	10,000	10,000	78	--
08-15-94	160	.3	230	22	--	170	150	160	<130	0	--
08-22-94	140	.3	240	50	--	520	490	680	610	24	--
08-22-94	110	.3	350	130	--	630	570	670	580	26	--
08-03-92	1,300	<.2	150	150	--	86	41	640	220	0	--
08-03-92	2,100	.7	7,000	6,400	--	24,000	22,000	17,000	16,000	160	7
08-04-92	1,400	.3	48,000	48,000	--	3,100	3,100	55,000	54,000	620	256
05-09-94	320	<.2	1,900	1,900	200	270	270	4,800	4,800	80	28
08-04-92	610	.3	52,000	51,000	--	1,100	1,100	200	<100	0	0
10-11-94	180	<.2	420	<10	--	23	<10	190	<130	0	--
08-04-92	550	.3	4,200	560	--	950	940	6,200	4,000	42	0
09-01-93	710	.2	4,400	750	900	1,200	1,200	9,000	8,000	56	--
08-05-92	1,300	.7	3,700	3,700	--	13,000	13,000	120,000	120,000	680	30
08-19-93	350	.2	9,500	4,800	--	1,300	1,300	3,500	370	0	--
05-04-94	330	.3	6,100	2,100	--	1,100	1,100	2,300	440	0	--
08-05-92	300	.3	8,700	3,700	--	1,200	1,200	3,600	200	0	0
08-05-92	450	<.2	8,100	7,500	--	4,600	4,300	200	300	0	0
08-06-92	430	.2	1,200	50	--	1,600	1,600	<130	<130	0	--
07-07-93	1,300	.6	2,400	2,000	990	53,000	51,000	33,000	32,000	252	24
07-07-93	1,200	.6	35,000	32,000	7,100	11,000	10,000	39,000	36,000	396	142
07-07-93	440	.4	870	840	220	2,000	2,000	5,900	5,900	58	11
07-07-93	610	.4	4,000	2,600	540	6,600	6,500	4,700	4,300	108	62
07-07-93	490	<.2	78,000	76,000	--	4,100	4,100	290	<130	120	--
07-08-93	990	.3	44,000	43,000	3,000	3,100	3,000	19,000	18,000	356	214

Appendix 3. *Field data and laboratory analyses of mine discharges—Continued*

Site number	Local identifier (Topographic quadrangle)	Date	Time	Discharge, instantaneous (ft^3/s)	Flow rate, instantaneous (gal/min)	Temperature, water (°C)	Specific conductance (µS/cm)	pH, water whole field (standard units)	Alkalinity, water (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)
218	Windber	07-08-93	1010	0.07	33	10.5	1,350	5.6	80	1,100	28
219	Ogletown	07-08-93	1130	.04	18	27.0	3,270	2.4	0	3,530	1.0
		05-03-94	1530	.15	68	11.0	1,500	2.6	0	1,310	1.0
220	Windber	07-08-93	1300	.02	8.6	10.0	782	3.5	0	514	1.4
221	Windber	07-08-93	1440	.13	60	16.5	1,280	3.2	0	1,190	1.1
222	Windber	07-08-93	1523	.00	1.2	13.0	572	5.6	24	662	8.7
223	Somerset	08-16-94	1100	.06	25	16.0	460	5.6	10	508	5.1
224	Windber	08-16-93	1420	.07	30	15.0	1,510	6.4	180	1,490	54
225	Stoystown	08-17-93	1525	.02	--	12.5	1,180	5.5	40	--	7.9
		08-16-93	1620	.13	60	12.5	995	6.3	26	946	13
226	Stoystown	08-17-93	1525	.02	7.5	12.5	1,180	5.5	40	364	7.9
227	Stoystown	08-18-93	1200	.02	7.5	19.5	2,590	3.0	0	2,990	<1.0
		04-21-94	1015	.19	85	9.0	1,890	2.8	0	1,760	<1.0
228	Hooversville	08-19-93	1115	<.01	<.1	10.0	1,760	5.5	24	1,990	25
229	Windber	08-22-94	1600	.05	24	15.0	628	6.2	20	638	3.8
230	Windber	08-22-94	1700	.02	7.2	16.5	605	6.1	34	534	11
231	Windber	09-06-94	1045	.11	48	10.5	1,010	3.4	0	1,010	2.8
232	Windber	09-06-94	1210	<.01	1.3	20.0	2,270	2.7	0	2,060	3.0
233	Windber	09-06-94	1250	<.01	1.0	20.0	1,920	2.7	0	1,780	<1.0
234	Windber	09-06-94	1350	.02	7.9	16.5	1,430	3.5	0	1,030	5.4
235	Windber	09-06-94	1420	.02	7.9	15.0	700	3.7	0	672	1.3
236	Windber	09-12-94	1015	.10	45	9.5	1,120	5.4	15	1,130	18
237	Windber	09-06-94	1420	.02	7.9	15.0	700	3.7	0	672	1.3
		09-12-94	1115	<.01	.2	10.5	938	3.6	0	884	6.3
238	Windber	09-12-94	1215	.03	14	10.0	1,060	5.3	40	1,080	24
239	Windber	09-12-94	1310	<.01	.1	11.0	266	6.0	44	196	20
240	Windber	09-12-94	1515	<.01	.2	14.0	595	5.8	10	616	1.5
241	Hooversville	09-13-94	0845	.01	3.4	10.5	302	5.5	3	250	7.1
242	Hooversville	09-13-94	1000	.05	22	18.5	11,600	2.3	0	27,340	2.2
		11-21-94	1415	.04	18	17.5	9,700	2.2	0	20,320	3.3
243	Hooversville	09-19-94	1320	.02	7.9	11.0	353	6.3	28	268	8.6
244	Hooversville	09-19-94	1400	.01	4.8	10.0	313	6.3	32	316	12
245	Hooversville	09-19-94	1730	.30	12	16.5	834	6.0	36	788	8.3
246	Windber	09-19-94	1750	.01	3.9	15.5	1,120	6.4	30	1,180	6.9
247	Windber	09-19-94	1820	.15	67	15.5	1,350	6.6	54	1,500	12
248	Johnstown	09-20-94	0900	.25	114	11.5	1,840	6.2	58	1,810	23
249	Hooversville	09-21-94	1130	.09	41	13.0	1,260	4.8	1	1,390	4.0
250	Hooversville	09-21-94	1200	<.01	1.4	14.0	1,420	3.1	0	1,420	<1.0
251	Hooversville	09-21-94	1230	<.01	.7	14.5	1,780	2.9	0	1,590	<1.0
252	Hooversville	09-21-94	1340	<.01	.8	13.5	1,650	3.3	0	2,110	3.6
253	Hooversville	09-21-94	1500	<.01	1.9	16.5	1,430	3.7	0	1,920	<1.0
254	Hooversville	09-21-94	1600	<.01	1.0	16.5	820	3.4	0	690	<1.0
255	Hooversville	09-21-94	1740	.05	24	10.5	560	5.7	64	480	30
256	Somerset	09-26-94	1030	<.01	.8	10.0	133	5.8	28	102	9.4
257	Somerset	09-26-94	1200	<.01	1.1	14.0	671	6.9	84	576	21
258	Somerset	09-26-94	1300	.01	3.3	14.5	1,310	3.8	0	1,380	5.0
259	Hooversville	09-26-94	1450	1.9	867	11.5	878	6.3	98	748	24
260	Hooversville	09-27-94	0900	.04	18	10.0	353	6.0	38	296	7.4
261	Stoystown	10-03-94	1100	.21	96	11.5	1,120	4.6	1	1,000	2.1
262	Stoystown	10-03-94	1300	.01	3.0	11.5	367	6.4	16	296	7.0

Date	Sulfate, dissolved (mg/L as SO_4)	Fluoride, total (mg/L as F)	Iron, total recoverable (µg/L as Fe	Iron, dissolved (µg/L as Fe	Iron, ferrous, dissolved (µg/L as Fe	Manganese, total recoverable (µg/L as Mn	Manganese, dissolved (µg/L as Mn)	Aluminum, total recoverable (µg/L as Al)	Aluminum, dissolved (µg/L as Al)	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
07-08-93	670	<0.2	690	220	--	33	81	310	150	0	--
07-08-93	2,400	.8	160,000	140,000	10,000	31,000	30,000	13,000	12,000	940	608
05-03-94	910	.3	69,000	69,000	--	13,000	13,000	5,600	5,600	328	208
07-08-93	530	.3	310	290	110	5,700	5,700	4,600	4,600	54	13
07-08-93	850	.2	2,900	2,700	800	2,400	2,400	4,600	4,600	66	22
07-08-93	290	<.2	30	28	--	45	45	<130	<130	0	--
08-16-94	260	<.2	2,500	2,500	--	3,000	3,000	820	210	5.8	--
08-16-93	750	.3	830	450	--	3,900	3,900	150	140	0	--
08-17-93	170	<.2	16,000	1,900	--	5,300	2,300	540	<130	0	--
08-16-93	55	.3	120,000	57,000	--	6,600	6,600	8,500	910	76	--
08-17-93	170	<.2	16,000	1,900	--	5,300	2,300	540	<130	0	--
08-18-93	1,600	1.1	21,000	21,000	1,500	19,000	19,000	110,000	110,000	940	258
04-21-94	1,100	.7	12,000	12,000	1,300	14,000	13,000	71,000	69,000	536	142
08-19-93	1,300	.2	220,000	170,000	--	8,300	8,300	1,400	640	324	--
08-22-94	340	<.2	2,200	27	--	380	95	270	<130	0	--
08-22-94	290	.2	4,000	3,600	--	2,000	2,000	<130	<130	0	--
09-06-94	830	.4	1,600	880	320	10,000	10,000	5,700	5,700	108	18
09-06-94	1,900	<.2	69,000	68,000	39,000	23,000	23,000	1,300	1,300	422	250
09-06-94	1,700	<.2	41,000	41,000	2,500	23,000	23,000	4,000	4,000	336	206
09-06-94	1,100	.2	34,000	26,000	8,900	12,000	10,000	1,100	1,100	146	46
09-06-94	640	.3	620	500	130	7,500	7,300	2,000	1,900	60	--
09-12-94	780	<.2	40	24	--	720	730	790	730	48	--
09-06-94	640	.3	620	500	130	7,500	7,300	2,000	1,900	60	--
09-12-94	720	.2	50,000	12,000	11,000	1,400	1,400	1,900	150	82	11
09-12-94	710	<.2	70	69	--	62	57	260	240	24	--
09-12-94	88	<.2	43,000	1,800	--	1,300	1,400	1,000	<130	20	--
09-12-94	410	<.2	4,700	29	--	2,600	2,000	4,400	<130	12	--
09-13-94	190	.2	5,300	3,300	--	1,600	1,600	250	250	22	--
09-13-94	20,000	8.9	2,750,000	2,750,000	2,440,000	28,000	28,000	940,000	980,000	12,240	4,410
11-21-94	27,000	--	2,660,000	2,210,000	2,120,000	22,000	20,000	780,000	660,000	9,664	3,920
09-19-94	130	<.2	2,000	630	--	43	35	330	<130	0	--
09-19-94	110	<.2	220	34	--	17	<10	190	<130	0	--
09-19-94	470	<.2	210	46	--	120	90	<130	<130	0	--
09-19-94	690	<.2	20	--	--	240	--	<130	--	0	--
09-19-94	840	<.2	490	64	--	840	800	150	<130	0	--
09-20-94	1,000	.2	30,000	30,000	--	1,400	1,400	3,900	650	13	--
09-21-94	1,100	.5	36,000	33,000	--	5,600	5,500	1,600	1,500	84	--
09-21-94	1,600	1	9,500	9,000	1,900	3,600	3,500	17,000	16,000	180	44
09-21-94	1,800	1.0	11,000	9,800	1,100	6,300	5,400	20,000	17,000	256	98
09-21-94	2,000	1.3	5,600	2,600	790	13,000	13,000	42,000	37,000	320	28
09-21-94	1,900	.6	630	470	420	7,800	7,100	46,000	43,000	310	0
09-21-94	950	.3	3,800	3,200	330	2,000	1,700	8,400	7,200	100	20
09-21-94	300	<.2	7,100	6,500	--	480	450	150	<130	0	--
09-26-94	31	<.2	540	520	--	240	240	<130	<130	5.4	--
09-26-94	310	.2	570	36	--	33	16	460	<130	0	--
09-26-94	970	.3	38,000	38,000	40,000	8,300	8,300	5,300	5,300	162	6
09-26-94	440	.2	180	60	--	190	180	320	<130	0	--
09-27-94	170	<.2	9,400	8,500	--	410	400	<130	<130	16	--
10-03-94	830	<.2	90	50	--	7,100	6,600	3,300	3,100	28	--
10-03-94	190	<0.2	8,600	8,600	--	2,500	2,100	<130	<130	4.0	--

Appendix 3. *Field data and laboratory analyses of mine discharges—Continued*

Site number	Local identifier (Topographic quadrangle)	Date	Time	Discharge, instantaneous (ft^3/s)	Flow rate, instantaneous (gal/min)	Temperature, water (°C)	Specific conductance (µS/cm)	pH, water whole field (standard units)	Alkalinity, water (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)
263	Stoystown	10-03-94	1630	0.01	4.8	15.5	1,290	6.5	54	1,340	14
264	Stoystown	10-03-94	1710	<.01	1.6	13.5	2,570	6.4	340	3,090	97
265	Central City	10-11-94	0930	<.01	1.2	9.5	1,270	6.3	84	--	9.2
266	Central City	10-11-94	1010	<.01	.8	8.0	2,160	6.8	168	1,650	44
267	Windber	10-11-94	1110	<.01	.4	10.5	210	6.6	90	148	26
268	Geistown	10-11-94	1330	.09	40	11.5	1,200	6.3	64	1,230	19
269	Hooversville	10-11-94	1745	.01	4.8	10.0	1,010	3.7	0	1,020	>2.7
270	Hooversville	10-11-94	1840	.18	80	9.5	713	6.6	112	682	28

Appendix 3. Field data and laboratory analyses of mine discharges—Continued

Date	Sulfate, dissolved (mg/L as SO_4)	Fluoride, total (mg/L as F)	Iron, total recoverable (µg/L as Fe	Iron, dissolved (µg/L as Fe	Iron, ferrous, dissolved (µg/L as Fe	Manganese, total recoverable (µg/L as Mn	Manganese, dissolved (µg/L as Mn)	Aluminum, total recoverable (µg/L as Al)	Aluminum, dissolved (µg/L as Al)	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
10-03-94	910	<0.2	16,000	14,000	--	1,700	1,500	<130	<130	0	--
10-03-94	1,400	<.2	2,900	2,400	--	14,000	13,000	<130	<130	0	--
10-11-94	480	.3	72,000	63,000	--	5,400	5,100	480	<130	32	--
10-11-94	480	.2	6,500	4,200	--	310	310	<130	<130	0	--
10-11-94	4.5	<.2	15,000	12,000	--	3,000	3,000	<130	<130	0	--
10-11-94	680	<.2	700	280	--	680	680	880	300	0	--
10-11-94	980	<.2	290	180	100	500	500	12,000	12,000	80	5
10-11-94	310	.2	110	13	--	10	<10	200	<130	0	--

Appendix 4. *Prioritization index (PI) for all mine discharges*

[lb/d, pounds per day; gal/min, gallons per minute; <, less than]

Site number	pH (units)	Iron, total (lb/d as Fe)	Rank	Score	Acidity, total heated (lb/d as $CaCO_3$)	Rank	Score	Sulfate, total (lb/d as $CaCO_3$)	Rank	Score	Aluminum, dissolved (lb/d as Al)	Rank	Score	Manganese, total (lb/d as Mn)	Rank	Score	Discharge, instantaneous, (gal/min)	Final score	PI
16	3.3	1,700	1	10	6,750	1	10	29,700	1	10	486	2	10	232	1	10	2,250	50	1
19	5.1	876	3	10	1,580	6	10	10,300	4	10	25.6	20	10	85.4	4	10	1,780	50	2
81	4.8	116	13	10	739	11	10	12,100	3	10	31.9	17	10	47.0	10	10	1,400	50	3
95	4.6	41.2	24	10	353	23	10	8,120	6	10	34.1	15	10	23.5	19	10	981	50	4
4	2.8	125	11	10	1,130	8	10	4,010	17	10	83.5	7	10	21.7	20	10	348	50	5
125	2.4	351	6	10	3,180	3	10	8,640	5	10	232	4	10	178	2	10	225	50	6
22	3.0	80.6	16	10	538	15	10	2,016	24	10	25.5	21	10	20.2	22	10	224	50	7
3	2.8	140	10	10	1,170	7	10	2,976	19	10	100	5	10	42.8	11	10	155	50	8
110	4.5	162	9	10	539	14	10	4,200	16	10	18.9	26	10	12.4	30	9	449	49	9
208	6.2	16.6	39	9	3,050	4	10	5,830	10	10	539	1	10	58.3	9	10	374	49	10
104	3.0	16.3	41	9	466	18	10	3,840	18	10	31.2	18	10	33.6	12	10	200	49	11
141	2.7	121	12	10	751	10	10	864	49	9	42.6	10	10	63.4	7	10	48	49	12
242	2.3	726	4	10	3,230	2	10	5,280	12	10	259	3	10	7.39	42	9	22	49	13
14	3.6	8.44	62	8	844	9	10	7,000	8	10	93.0	6	10	64.2	6	10	799	48	14
103	3.2	7.85	67	8	481	17	10	5,760	11	10	34.0	16	10	25.6	16	10	436	48	15
63	3.4	13.6	45	9	465	19	10	864	48	9	63.2	8	10	25.9	14	10	277	48	16
97	3.2	66.2	19	10	440	21	10	2,360	21	10	35.5	14	10	3.31	67	8	197	48	17
160	3.1	12.1	49	9	246	27	10	1,970	25	10	14.6	31	9	26.7	13	10	171	48	18
15	3.6	69.1	18	10	256	26	10	1,130	42	9	18.4	28	9	19.6	23	10	96	48	19
38	3.0	61.8	21	10	414	22	10	796	51	9	38.4	13	10	6.08	47	9	78	48	20
188	2.6	19.0	37	9	502	16	10	1,470	32	9	61.2	9	10	25.7	15	10	51	48	21
121	6.0	13.8	44	9	138	41	9	7,250	7	10	5.98	52	9	17.0	26	10	1,510	47	22
149	5.7	1116	2	10	2010	5	10	5,950	9	10	2.16	76	8	11.2	34	9	310	47	23
6	4.4	36.4	28	9	125	45	9	2310	22	10	22.4	22	10	12.9	29	9	306	47	24
164	2.8	30.3	32	9	303	25	10	978	45	9	18.6	27	10	5.94	48	9	97	47	25
189	3.4	8.41	64	8	647	12	10	4460	15	10	40.1	11	10	4.53	61	8	539	46	26
176	5.9	436	5	10	642	13	10	1780	27	10	.40	126	6	24.2	18	10	330	46	27
17	3.3	11.6	51	9	198	33	9	1260	36	9	17.0	29	9	6.48	45	9	284	45	28
7	3.0	12.0	50	9	197	34	9	721	53	9	21.8	23	10	2.62	78	8	91	45	29
204	2.7	34.6	30	9	446	20	10	1010	44	9	38.9	12	10	2.23	85	7	60	45	30

Appendix 4. *Prioritization index (PI) for all mine discharges—Continued*

Site number	pH (units)	Iron, total (lb/d as Fe)	Rank	Score	Acidity, total heated (lb/d as $CaCO_3$)	Rank	Score	Sulfate, total (lb/d as $CaCO_3$)	Rank	Score	Aluminum, dissolved (lb/d as Al)	Rank	Score	Manganese, total (lb/d as Mn)	Rank	Score	Discharge, instantaneous, (gal/min)	Final score	PI
117	3.1	8.32	65	8	235	30	9	605	61	8	27.7	19	10	17.1	25	10	21	45	31
165	2.7	69.1	17	10	346	24	10	475	72	8	21.0	24	10	1.23	99	7	18	45	32
207	4.9	11.1	53	9	111	46	9	1460	33	9	10.6	35	9	2.52	81	8	221	44	33
184	2.8	64.8	20	10	242	29	9	1240	39	9	13.0	32	9	2.27	84	7	45	44	34
34	2.7	16.1	43	9	156	39	9	605	60	8	10.6	36	9	7.06	43	9	42	44	35
140	2.5	22.7	35	9	222	31	9	648	57	8	10.4	37	9	15.6	28	9	27	44	36
124	2.6	10.2	56	8	187	35	9	648	58	8	19.2	25	10	11.4	32	9	18	44	37
190	3.1	13.0	48	9	101	47	9	1150	40	9	2.45	72	8	2.95	69	8	60	43	38
219	2.4	34.6	29	9	203	32	9	518	70	8	2.59	71	8	6.70	44	9	18	43	39
109	5.9	84.2	15	10	134	42	9	1400	34	9	.37	131	6	4.54	60	8	180	42	40
31	3.2	3.72	85	7	182	36	9	670	56	8	16.9	30	9	10.6	37	9	155	42	41
101	3.2	2.39	92	7	132	43	9	1100	43	9	6.60	49	9	2.53	80	8	117	42	42
40	3.1	4.32	79	8	148	40	9	378	81	8	12.6	34	9	4.86	55	8	75	42	43
36	3.0	6.71	71	8	82.6	56	8	929	47	9	1.50	84	7	21.7	21	10	43	42	44
187	2.4	11.2	52	9	164	38	9	562	65	8	9.50	41	9	1.34	96	7	36	42	45
42	3.1	2.33	94	7	86.4	53	9	562	66	8	6.05	51	9	11.2	33	9	36	42	46
180	2.7	54.0	22	10	246	28	9	420	77	8	12.9	33	9	.60	129	6	25	42	47
28	3.1	1.21	117	6	101	48	9	433	74	8	9.98	39	9	5.85	49	9	84	41	48
172	2.8	2.38	93	7	93.6	51	9	342	84	7	8.64	43	9	5.04	54	9	30	41	49
212	3.3	.75	133	6	78.6	57	8	406	78	8	9.98	38	9	16.5	27	10	26	41	50
1	2.8	8.83	60	8	73.0	59	8	288	93	7	6.14	50	9	5.76	50	9	16	41	51
178	5.9	330	7	10	.01	206	3	12400	2	10	3.89	59	8	12.1	31	9	1620	40	52
130	3.9	.24	164	4	90.0	52	9	1920	26	10	7.50	46	9	4.80	56	8	250	40	53
10	3.5	1.10	119	6	35.1	77	8	571	64	8	2.78	70	8	133	3	10	122	40	54
248	6.2	41.0	25	10	17.8	99	7	1370	35	9	.89	99	7	1.92	88	7	114	40	55
249	4.8	17.7	38	9	41.3	72	8	541	68	8	.74	106	7	2.76	73	8	41	40	56
126	2.9	1.22	116	6	86.1	54	9	253	97	7	8.74	42	9	7.49	41	9	26	40	57
139	2.6	9.20	59	8	73.0	58	8	250	98	7	3.12	65	8	6.08	46	9	13	40	58
60	2.9	1.38	112	6	55.3	63	8	384	80	8	6.60	48	9	10.8	35	9	6.4	40	59
173	6.2	192	8	10	.01	218	2	4570	14	10	1.13	93	7	24.8	17	10	470	39	60

Appendix 4. *Prioritization index (PI) for all mine discharges—Continued*

Site number	pH (units)	Iron, total (lb/d as Fe)	Rank	Score	Acidity, total heated (lb/d as $CaCO_3$)	Rank	Score	Sulfate, total (lb/d as $CaCO_3$)	Rank	Score	Aluminum, dissolved (lb/d as Al)	Rank	Score	Manganese, total (lb/d as Mn)	Rank	Score	Discharge, instantaneous, (gal/min)	Final score	PI
11	4.4	9.47	57	8	32.6	80	8	588	63	8	1.31	89	7	2.61	79	8	136	39	61
44	3.6	.22	170	4	99.0	49	9	1150	41	9	8.62	44	9	3.99	63	8	133	39	62
231	3.4	.92	125	6	62.2	62	8	478	71	8	3.28	62	8	5.76	51	9	48	39	63
5	4.5	.16	180	4	38.5	75	8	1560	31	9	3.27	64	8	10.6	36	9	341	38	64
221	3.2	2.09	96	7	47.5	68	8	612	59	8	3.31	61	8	1.73	92	7	60	38	65
55	5.7	38.9	27	10	50.8	66	8	340	85	7	.07	182	4	5.40	52	9	45	38	66
156	3.5	1.90	100	7	43.2	71	8	605	62	8	5.18	56	8	1.21	101	7	36	38	67
76	3.4	7.14	69	8	52.9	65	8	239	99	7	4.12	58	8	1.34	95	7	35	38	68
166	2.7	23.4	34	9	128	44	9	234	100	7	7.02	47	9	.30	164	4	13	38	69
20	2.4	40.0	26	10	165	37	9	227	103	7	1.34	87	7	.50	138	5	.7	38	70
144	6.0	28.9	33	9	.01	208	3	2220	23	10	.29	139	5	77.7	5	10	185	37	71
261	4.6	.10	195	3	32.3	81	8	956	46	9	3.57	60	8	8.18	39	9	96	37	72
70	4.0	.10	196	3	71.8	60	8	394	79	8	8.36	45	9	7.87	40	9	41	37	73
227	3.0	1.89	101	7	84.6	55	8	144	118	6	9.90	40	9	1.71	93	7	7.5	37	74
24	3.0	7.56	68	8	30.2	83	7	122	124	6	2.23	74	8	4.68	58	8	3	37	75
142	2.2	4.20	81	8	33.6	79	8	102	132	6	1.47	85	7	2.79	72	8	2.5	37	76
211	6.6	7.01	70	8	.01	243	2	2510	20	10	.76	102	7	9.35	38	9	487	36	77
225	6.3	86.4	14	10	54.7	64	8	39.6	171	4	.66	110	6	4.75	57	8	60	36	78
21	3.3	3.81	84	7	34.2	78	8	348	83	7	.66	109	6	3.92	64	8	46	36	79
155	3.2	.94	123	6	36.0	76	8	336	86	7	3.12	66	8	1.20	102	7	20	36	80
46	3.2	1.80	103	7	50.4	67	8	118	126	6	5.28	55	8	1.18	104	7	20	36	81
8	2.8	4.32	80	8	39.0	74	8	104	130	6	4.32	57	8	.57	134	6	5.8	36	82
59	2.9	2.72	90	7	24.6	88	7	100	133	6	2.05	78	8	2.90	71	8	3.1	36	83
79	2.2	31.2	31	9	94.6	50	9	149	116	6	2.38	73	8	.24	172	4	2	36	84
170	6.2	16.5	40	9	.01	220	2	1700	30	9	.34	136	5	59.6	8	10	142	35	85
12	6.4	13.4	46	9	.01	228	2	1750	29	9	.21	148	5	17.5	24	10	86	35	86
62	3.5	.23	169	4	39.9	73	8	162	113	6	5.62	54	9	3.06	68	8	52	35	87
58	5.9	19.7	36	9	19.3	97	7	332	88	7	.21	145	5	1.85	89	7	35	35	88
186	4.8	3.96	82	7	21.1	95	7	422	75	8	1.61	82	7	1.00	109	6	22	35	89
100	5.8	.21	173	4	5.07	137	5	1770	28	9	1.86	79	8	2.91	70	8	352	34	90

Appendix 4. *Prioritization index (PI) for all mine discharges—Continued*

Site number	pH (units)	Iron, total (lb/d as Fe)	Rank	Score	Acidity, total heated (lb/d as $CaCO_3$)	Rank	Score	Sulfate, total (lb/d as $CaCO_3$)	Rank	Score	Aluminum, dissolved (lb/d as Al)	Rank	Score	Manganese, total (lb/d as Mn)	Rank	Score	Discharge, instantaneous, (gal/min)	Final score	PI
210	5.8	9.43	58	8	<0.01	205	3	524	69	8	0.35	134	6	5.35	53	9	97	34	91
75	3.3	1.98	99	7	28.8	85	7	176	111	6	1.22	90	7	1.22	100	7	30	34	92
161	3.2	.86	129	6	19.7	96	7	185	106	7	.62	112	6	2.64	77	8	20	34	93
129	3.7	.17	179	4	18.8	98	7	306	91	7	1.75	80	8	3.67	66	8	17	34	94
72	3.7	.08	205	3	45.4	69	8	144	117	6	5.78	53	9	4.54	59	8	8.6	34	95
191	2.8	10.8	54	9	28.7	86	7	180	107	7	.52	118	6	.51	137	5	5	34	96
259	6.3	1.87	102	7	.01	227	2	4580	13	10	1.35	86	7	1.98	87	7	867	33	97
111	3.4	.19	175	4	29.5	84	7	216	104	7	3.06	69	8	2.34	82	7	30	33	98
154	3.5	.74	134	6	16.8	100	7	232	101	7	.24	143	5	2.69	76	8	28	33	99
128	3.6	.08	206	3	22.2	91	7	336	87	7	2.15	77	8	3.70	65	8	28	33	100
177	2.7	4.96	75	8	43.7	70	8	84.0	141	5	3.28	63	8	.14	184	4	7	33	101
94	3.0	3.90	83	7	21.4	94	7	51.0	167	4	.75	103	7	4.50	62	8	2.5	33	102
73	3.5	1.73	104	7	15.0	102	7	76.8	147	5	1.09	94	7	2.30	83	7	1.6	33	103
137	5.3	.11	192	3	64.8	61	8	367	82	7	2.16	75	8	.67	126	6	180	32	104
13	6.0	5.18	74	8	.01	210	3	749	52	9	.25	142	5	1.81	91	7	52	32	105
169	6.0	13.3	47	9	21.6	93	7	130	121	6	.05	192	3	2.16	86	7	15	32	106
174	5.0	16.2	42	9	30.6	82	7	83.7	143	5	.07	181	4	1.17	105	7	7.5	32	107
71	3.8	.10	198	3	24.3	90	7	100	135	6	3.10	68	8	2.69	74	8	3.8	32	108
77	3.8	.10	199	3	24.3	89	7	100	134	6	3.10	67	8	2.69	75	8	3.8	32	109
32	3.4	.24	167	4	13.8	105	7	207	105	7	1.32	88	7	.93	113	6	18	31	110
116	3.6	.16	184	4	13.7	106	7	178	110	6	1.15	92	7	1.19	103	7	15	31	111
234	3.5	3.22	86	7	13.8	104	7	104	131	6	.10	169	4	1.14	106	7	7.9	31	112
205	6.3	46.8	23	10	.01	221	2	549	67	8	.09	176	4	.99	110	6	75	30	113
78	4.5	.02	235	2	21.8	92	7	679	54	9	.63	111	6	.94	112	6	65	30	114
179	3.8	8.55	61	8	15.5	101	7	72.0	150	5	.06	185	4	.54	135	6	7.5	30	115
209	3.5	6.68	72	8	.01	199	3	230	102	7	.15	156	5	.92	114	6	64	29	116
2	3.1	.41	148	5	9.94	115	6	107	128	6	.56	116	6	.95	111	6	9	29	117
181	3.3	1.68	106	7	8.76	119	6	54.0	161	5	.19	149	5	.78	119	6	5	29	118
162	3.1	.15	185	4	7.80	124	6	84.0	142	5	.72	107	7	1.02	107	7	5	29	119
192	3.3	4.79	76	8	13.3	107	7	73.1	149	5	.30	138	5	.24	173	4	2.1	29	120

Appendix 4. *Prioritization index (PI) for all mine discharges—Continued*

Site number	pH (units)	Iron, total (lb/d as Fe)	Rank	Score	Acidity, total heated (lb/d as $CaCO_3$)	Rank	Score	Sulfate, total (lb/d as $CaCO_3$)	Rank	Score	Aluminum, dissolved (lb/d as Al)	Rank	Score	Manganese, total (lb/d as Mn)	Rank	Score	Discharge, instantaneous, (gal/min)	Final score	PI
26	3.1	0.41	147	5	8.82	118	6	39.6	170	4	0.99	96	7	1.01	108	7	1.5	29	121
236	5.4	.02	238	2	25.9	87	7	421	76	8	.39	127	6	.39	153	5	45	28	122
56	4.2	.06	216	3	7.68	125	6	55.2	158	5	.84	101	7	1.27	98	7	20	28	123
82	6.1	8.21	66	8	8.06	123	6	69.1	151	5	.02	211	3	.68	124	6	12	28	124
175	3.2	2.22	95	7	7.20	128	6	28.8	187	4	.32	137	5	.66	128	6	5	28	125
151	6.5	4.54	77	8	.01	238	2	287	94	7	.15	157	5	.39	152	5	126	27	126
35	6.0	3.00	89	7	.01	207	3	173	112	6	.12	164	4	1.84	90	7	48	27	127
23	3.4	.04	226	2	14.4	103	7	51.8	166	4	1.58	83	7	1.30	97	7	12	27	128
112	3.5	.06	219	2	10.7	113	6	132	120	6	1.15	91	7	.75	120	6	12	27	129
215	3.0	.35	152	5	9.46	117	6	53.4	163	4	.38	129	6	.58	132	6	7.3	27	130
258	3.8	1.51	108	7	6.42	131	6	38.4	174	4	.21	147	5	.33	160	5	3.3	27	131
213	3.0	.97	122	6	10.9	111	6	33.1	178	4	.99	95	7	.30	163	4	2.3	27	132
185	2.7	1.39	111	6	13.2	108	7	54.7	159	5	.62	114	6	.09	198	3	1.9	27	133
152	6.5	.14	186	4	.01	236	2	1250	38	9	.35	135	6	.35	158	5	289	26	134
123	6.4	.51	143	5	.01	231	2	1250	37	9	.39	128	6	.15	182	4	248	26	135
54	6.7	10.5	55	8	.01	251	1	129	122	6	.19	151	5	.84	118	6	111	26	136
29	4.1	.01	254	1	11.9	110	6	141	119	6	1.62	81	8	.32	162	5	19	26	137
214	3.1	.13	188	4	8.35	122	6	63.4	154	5	.85	100	7	.29	165	4	12	26	138
41	5.5	8.42	63	8	13.0	109	6	52.9	164	4	.01	213	3	.44	146	5	9	26	139
48	4.5	.61	141	5	4.80	139	5	53.8	162	5	.27	141	5	.87	116	6	8	26	140
113	3.3	.04	227	2	8.72	120	6	94.8	138	5	.91	98	7	.58	131	6	7.9	26	141
158	3.8	1.20	118	6	5.10	136	5	21.6	196	3	.44	123	6	.72	122	6	.5	26	142
122	2.9	1.66	107	7	8.69	121	6	14.6	215	3	.74	104	7	.09	200	3	.2	26	143
223	5.6	.75	132	6	1.74	169	4	78.0	146	5	.06	186	4	.90	115	6	25	25	144
220	3.5	.03	232	2	5.57	134	6	54.7	160	5	.47	121	6	.59	130	6	8.6	25	145
235	3.7	.06	215	3	5.69	133	6	60.7	155	5	.18	152	5	.71	123	6	7.9	25	146
216	5.5	6.27	73	8	9.65	116	6	39.4	172	4	.01	225	2	.33	159	5	6.7	25	147
217	2.9	1.32	114	6	10.7	112	6	29.7	184	4	.54	117	6	.09	196	3	2.5	25	148
247	6.6	.39	149	5	.01	244	1	675	55	8	.10	168	4	.68	125	6	67	24	149
268	6.3	.34	156	5	.01	226	2	326	89	7	.14	158	5	.33	161	5	40	24	150

Appendix 4. *Prioritization index (PI) for all mine discharges—Continued*

Site number	pH (units)	Iron, total (lb/d as Fe)	Rank	Score	Acidity, total heated (lb/d as $CaCO_3$)	Rank	Score	Sulfate, total (lb/d as $CaCO_3$)	Rank	Score	Aluminum, dissolved (lb/d as Al)	Rank	Score	Manganese, total (lb/d as Mn)	Rank	Score	Discharge, instantaneous, (gal/min)	Final score	PI
224	6.4	0.30	160	5	<0.01	229	2	270	95	7	0.05	194	3	1.40	94	7	30	24	151
33	3.9	.03	231	2	4.44	143	5	86.7	139	5	.50	120	6	.57	133	6	8.4	24	152
114	3.5	.04	228	2	5.94	132	6	79.2	145	5	.58	115	6	.48	142	5	5.5	24	153
30	3.1	.11	191	3	7.39	127	6	24.8	193	3	.74	105	7	.40	150	5	4.4	24	154
232	2.7	1.08	120	6	6.58	130	6	29.6	185	4	.02	206	3	.36	157	5	1.3	24	155
127	2.6	1.72	105	7	7.58	126	6	25.0	192	3	.02	209	3	.50	140	5	1.3	24	156
39	6.2	.62	140	5	.01	216	3	159	114	6	.08	180	4	.46	143	5	63	23	157
96	6.3	.38	150	5	.01	223	2	437	73	8	.08	178	4	.29	167	4	52	23	158
194	6.8	4.37	78	8	.01	255	1	150	115	6	.02	207	3	.45	145	5	13	23	159
120	3.2	.51	142	5	10.1	114	6	31.5	182	4	.07	183	4	.19	176	4	7.5	23	160
115	3.6	.05	224	2	4.31	145	5	56.2	157	5	.37	130	6	.51	136	5	3.9	23	161
159	4.6	.09	204	3	2.54	162	5	21.3	197	3	.36	132	6	.66	127	6	2.3	23	162
163	3.0	.17	178	4	3.36	155	5	28.8	186	4	.17	154	5	.50	139	5	2	23	163
253	3.7	.01	242	2	7.07	129	6	43.3	168	4	.98	97	7	.18	180	4	1.9	23	164
138	2.7	.33	157	5	4.11	146	5	16.7	206	3	.21	146	5	.44	147	5	1.6	23	165
47	3.2	.73	135	6	3.69	151	5	14.8	214	3	.17	153	5	.27	169	4	1.6	23	166
171	6.6	.79	131	6	.01	247	1	124	123	6	.11	166	4	.42	149	5	69	22	167
135	6.6	.86	130	6	.01	242	2	180	108	7	.09	170	4	.10	192	3	60	22	168
202	6.1	.10	200	3	.01	212	3	842	50	9	.14	160	5	.06	218	2	54	22	169
255	5.7	2.05	97	7	.01	203	3	86.4	140	5	.04	199	3	.14	185	4	24	22	170
260	6.0	2.03	98	7	3.46	153	5	36.7	176	4	.03	203	3	.09	202	3	18	22	171
51	4.3	.07	212	3	5.18	135	6	43.2	169	4	.45	122	6	.09	201	3	18	22	172
167	3.5	.10	197	3	4.56	142	5	16.8	205	3	.43	124	6	.40	151	5	5	22	173
27	3.0	.36	151	5	5.04	138	5	10.6	230	2	.50	119	6	.14	183	4	1	22	174
218	5.6	.27	161	5	.01	202	3	265	96	7	.06	188	4	.01	241	2	33	21	175
9	6.1	3.06	88	7	.01	215	3	30.6	183	4	.01	215	3	.21	175	4	6.7	21	176
269	3.7	.02	241	2	4.61	141	5	56.5	156	5	.69	108	7	.03	228	2	4.8	21	177
132	5.9	.44	146	5	2.99	158	5	38.2	175	4	.01	229	2	.44	148	5	4.3	21	178
25	5.9	3.18	87	7	4.68	140	5	19.7	200	3	.01	237	2	.19	177	4	3.9	21	179
131	3.3	.93	124	6	2.31	164	4	15.6	207	3	.06	189	4	.18	178	4	3.1	21	180

Appendix 4. Prioritization index (PI) for all mine discharges—Continued

Site number	pH (units)	Iron, total (lb/d as Fe)	Rank	Score	Acidity, total heated (lb/d as $CaCO_3$)	Rank	Score	Sulfate, total (lb/d as $CaCO_3$)	Rank	Score	Aluminum, dissolved (lb/d as Al)	Rank	Score	Manganese, total (lb/d as Mn)	Rank	Score	Discharge, instantaneous, (gal/min)	Final score	PI
143	3.9	<0.01	256	1	4.33	144	5	21.8	195	3	0.62	113	6	0.86	117	6	1.4	21	181
250	3.1	.16	183	4	3.02	157	5	26.9	189	4	.27	140	5	.06	212	3	1.4	21	182
64	6.4	.66	137	5	.01	233	2	68.4	152	5	.02	205	3	.39	154	5	19	20	183
37	3.6	.09	203	3	2.94	159	5	21.2	198	3	.19	150	5	.25	171	4	6.8	20	184
105	3.7	.70	136	5	2.45	163	4	17.3	204	3	.07	184	4	.29	166	4	6	20	185
53	3.6	.07	210	3	3.97	149	5	28.2	188	4	.43	125	6	.04	223	2	4.6	20	186
134	4.1	.02	234	2	3.46	152	5	38.9	173	4	.11	167	4	.46	144	5	4	20	187
57	5.5	2.50	91	7	3.92	150	5	12.1	225	2	.01	245	1	.38	156	5	1.6	20	188
233	2.7	.49	144	5	4.03	147	5	20.4	199	3	.05	195	3	.28	168	4	1	20	189
252	3.3	.05	221	2	3.07	156	5	19.2	201	3	.36	133	6	.12	186	4	.8	20	190
118	2.6	.22	172	4	2.64	161	5	6.84	237	2	.23	144	5	.12	187	4	.3	20	191
197	7.2	1.37	113	6	.01	268	1	180	109	6	.09	173	4	.06	217	2	60	19	192
66	6.8	.35	153	5	.01	259	1	83.5	144	5	.09	175	4	.18	179	4	58	19	193
229	6.2	.63	138	5	.01	217	2	97.9	136	5	.04	200	3	.11	189	4	24	19	194
18	6.4	.87	128	6	.01	235	2	31.7	180	4	.01	216	3	.11	188	4	11	19	195
226	5.5	1.44	109	6	.01	200	3	15.3	210	3	.01	219	2	.48	141	5	7.5	19	196
80	2.7	.62	139	5	3.36	154	5	6.24	241	2	.12	162	5	.03	227	2	.4	19	197
65	5.8	.12	190	3	.01	204	3	97.4	137	5	.09	174	4	.08	203	3	58	18	198
157	6.7	.13	187	4	.01	249	1	73.4	148	5	.01	217	2	.73	121	6	3.6	18	199
168	6.0	.91	127	6	.52	180	4	18.5	202	3	.01	242	2	.09	195	3	2.3	18	200
89	3.5	.34	155	5	1.48	171	4	10.8	229	2	.06	187	4	.08	207	3	1.5	18	201
108	7.0	.07	213	3	.01	262	1	310	90	7	.09	172	4	.03	225	2	60	17	202
61	6.7	1.44	110	6	.01	252	1	15.1	213	3	.09	171	4	.11	191	3	60	17	203
106	7.1	1.22	115	6	.01	264	1	3.06	253	1	.08	179	4	.39	155	5	51	17	204
230	6.1	.35	154	5	.01	211	3	25.1	191	3	.01	221	2	.17	181	4	7.2	17	205
263	6.5	.92	126	6	.01	239	2	52.4	165	4	.01	231	2	.10	193	3	4.8	17	206
67	4.2	.07	208	3	.86	177	4	18.5	203	3	.04	197	3	.22	174	4	2	17	207
90	2.9	.11	193	3	2.83	160	5	12.8	219	2	.17	155	5	.03	230	2	1.9	17	208
251	2.9	.09	202	3	2.15	167	4	15.1	211	3	.14	159	5	.05	220	2	.7	17	209
270	6.6	.11	194	3	.01	245	1	298	92	7	.12	163	4	.01	246	1	80	16	210

Appendix 4. *Prioritization index (PI) for all mine discharges—Continued*

Site number	pH (units)	Iron, total (lb/d as Fe)	Rank	Score	Acidity, total heated (lb/d as $CaCO_3$)	Rank	Score	Sulfate, total (lb/d as $CaCO_3$)	Rank	Score	Aluminum, dissolved (lb/d as Al)	Rank	Score	Manganese, total (lb/d as Mn)	Rank	Score	Discharge, instantaneous, (gal/min)	Final score	PI
238	5.3	0.01	246	1	4.03	148	5	119	125	6	0.04	198	3	0.01	244	1	14	16	211
183	4.2	.05	223	2	1.44	172	4	7.56	235	2	.14	161	5	.10	194	3	3	16	212
265	6.3	1.04	121	6	.46	182	4	6.91	236	2	.01	250	1	.08	206	3	1.2	16	213
245	6.0	.03	233	2	.01	209	3	67.7	153	5	.02	210	3	.02	234	2	12	15	214
107	5.2	.05	220	2	2.10	168	4	36.4	177	4	.03	202	3	.03	226	2	9.2	15	215
241	5.5	.22	171	4	.90	176	4	7.75	234	2	.01	226	2	.07	210	3	3.4	15	216
262	6.4	.31	159	5	.14	193	3	6.84	238	2	.01	238	2	.09	199	3	3	15	217
74	6.5	.32	158	5	.23	187	4	4.32	245	1	.01	241	2	.11	190	3	2.4	15	218
43	3.5	.16	181	4	.83	178	4	216	257	1	.05	196	3	.06	214	3	.5	15	219
102	4.7	.01	248	1	2.16	166	4	14.6	216	3	.06	190	3	.08	204	3	15	14	220
98	6.1	.26	163	4	.01	214	3	13.5	218	2	.01	240	2	.06	215	3	2.4	14	221
254	3.4	.05	225	2	1.20	173	4	11.4	226	2	.09	177	4	.02	233	2	1	14	222
86	6.6	.07	211	3	.01	240	2	15.1	212	3	.01	214	3	.05	219	2	9	13	223
200	4.6	.02	237	2	2.16	165	4	12.6	221	2	.05	191	3	.05	222	2	7.5	13	224
145	6.2	.01	260	1	.01	219	2	118	127	6	.01	228	2	.02	235	2	4.9	13	225
68	6.7	.01	253	1	.01	253	1	105	129	6	.01	234	2	.08	208	3	4.6	13	226
85	4.6	.06	217	2	.33	184	4	8.40	232	2	.01	239	2	.08	205	3	2.5	13	227
93	3.6	.01	244	1	.90	175	4	12.1	224	2	.03	204	3	.06	211	3	2.2	13	228
87	6.4	.24	168	4	.01	230	2	12.7	220	2	.01	243	2	.09	197	3	1.8	13	229
92	5.8	.02	240	2	.24	186	4	22.4	194	3	.01	236	2	.02	232	2	1.7	13	230
84	6.1	.24	165	4	.01	213	3	12.6	222	2	.01	259	1	.06	213	3	.5	13	231
133	3.8	.01	263	1	.73	179	4	5.28	242	2	.05	193	3	.08	209	3	.4	13	232
136	6.6	.16	182	4	.01	241	2	5.22	243	2	.01	220	2	.02	237	2	7.5	12	233
264	6.4	.06	218	2	.01	232	2	26.9	190	3	.01	246	1	.27	170	4	1.6	12	234
182	5.2	.18	177	4	.20	189	4	1.44	261	1	.01	255	1	.03	231	2	1	12	235
69	3.7	.01	262	1	.91	174	4	4.18	246	1	.11	165	4	.05	221	2	.4	12	236
99	6.2	.10	201	3	.12	194	3	6.72	239	2	.01	263	1	.06	216	3	.4	12	237
228	5.5	.26	162	5	.39	183	4	1.56	260	1	.01	262	1	.01	245	1	.1	12	238
243	6.3	.19	176	4	.01	224	2	12.3	223	2	.01	218	2	.01	251	1	7.9	11	239
246	6.4	.01	266	1	.01	234	2	32.3	179	4	.01	233	2	.01	243	2	3.9	11	240

Appendix 4. *Prioritization index (PI) for all mine discharges—Continued*

Site number	pH (units)	Iron, total (lb/d as Fe)	Rank	Score	Acidity, total heated (lb/d as $CaCO_3$)	Rank	Score	Sulfate, total (lb/d as $CaCO_3$)	Rank	Score	Aluminum, dissolved (lb/d as Al)	Rank	Score	Manganese, total (lb/d as Mn)	Rank	Score	Discharge, instantaneous, (gal/min)	Final score	PI
49	6.7	0.20	174	4	<0.01	250	1	11.0	228	2	<0.01	235	2	0.03	224	2	3.4	11	241
198	4.0	.01	243	2	.28	185	4	1.33	262	1	.04	201	3	<.01	256	1	.3	11	242
148	6.3	.24	166	4	.22	188	4	2.64	254	1	<.01	269	1	<.01	250	1	.2	11	243
196	6.8	<.01	259	1	<.01	258	1	31.7	181	4	.02	212	3	<.01	262	1	12	10	244
119	5.0	<.01	252	1	1.54	170	4	3.55	252	1	<.01	232	2	.02	236	2	4	10	245
201	4.2	<.01	255	1	.50	181	4	2.11	258	1	.01	223	2	.01	242	2	1.6	10	246
150	7.3	.08	207	3	<.01	269	1	15.6	208	3	<.01	253	1	.01	240	2	1	10	247
83	4.5	<.01	257	1	.17	192	3	14.4	217	2	.01	224	2	.01	238	2	.8	10	248
237	3.6	.12	189	4	.20	190	3	1.73	259	1	<.01	266	1	<.01	252	1	.2	10	249
203	3.8	<.01	249	1	.19	191	3	2.52	255	1	.02	208	3	.03	229	2	.1	10	250
206	7.1	.04	229	2	<.01	266	1	15.6	209	3	.01	222	2	<.01	258	1	7.2	9	251
147	6.8	.49	145	5	<.01	254	1	3.66	251	1	<.01	260	1	<.01	247	1	.5	9	252
244	6.3	.01	245	1	<.01	222	2	6.34	240	2	<.01	230	2	<.01	265	1	4.8	8	253
267	6.6	.07	209	3	<.01	246	1	.02	270	1	<.01	264	1	.01	239	2	.4	8	254
52	3.8	.02	236	2	.12	195	3	1.32	263	1	<.01	248	1	<.01	248	1	.2	8	255
239	6.0	.05	222	2	.02	198	3	.11	269	1	.01	270	1	.01	261	1	.1	8	256
195	7.1	.01	250	1	.01	263	1	9.22	231	2	.01	227	2	.01	267	1	6.4	7	257
193	6.9	.03	230	2	.01	261	1	11.3	227	2	.01	244	1	.01	253	1	2	7	258
222	5.6	.01	268	1	.01	201	3	4.18	247	1	.01	249	1	.01	268	1	1.2	7	259
146	6.7	.02	239	2	.01	248	1	7.92	233	2	.01	252	1	.01	259	1	1.1	7	260
256	5.8	.01	258	1	.05	196	3	.30	268	1	.01	257	1	.01	257	1	.8	7	261
266	6.8	.06	214	3	.01	257	1	4.61	244	1	.01	258	1	.01	254	1	.8	7	262
240	5.8	.01	247	1	.03	197	3	.98	265	1	.01	268	1	.01	249	1	.2	7	263
88	6.5	.01	269	1	.01	237	2	3.74	250	1	.01	251	1	.01	266	1	1.2	6	264
153	6.3	<.01	267	1	<.01	225	2	1.19	264	1	<.01	265	1	<.01	263	1	0.3	6	265
91	6.8	<.01	264	1	<.01	256	1	4.14	248	1	<.01	247	1	<.01	260	1	1.5	5	266
257	6.9	<.01	251	1	<.01	260	1	4.09	249	1	<.01	254	1	<.01	269	1	1.1	5	267
50	7.1	<.01	261	1	<.01	267	1	2.40	256	1	<.01	256	1	<.01	270	1	1	5	268
199	7.1	<.01	265	1	<.01	265	1	0.96	266	1	<.01	261	1	<.01	264	1	0.5	5	269
45	9.7	<.01	270	1	<.01	270	1	0.41	267	1	<.01	267	1	<.01	255	1	0.04	5	270

Appendix 5. *Field data and laboratory analyses for surface-water sites*

[ft^3/s, cubic foot per second; °C, degrees Celsius; µS/cm, microsiemen per centimeter at 25 degrees Celsius; mg/L, milligram per liter; ug/L, micrograms per liter; <, less than; --, no data available]

Date	Time	Discharge, instantaneous (ft^3/s)	Temperature, water (°C)	Specific conductance (µS/cm)	pH (standard units)	Alkalinity, total (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)	Sulfate, total (mg/L as SO_4)
03039200 Clear Run near Buckstown, Pa., Site 808 (LAT 40 02 49N LONG 078 50 00W)									
September 1, 1992	1510	1.8	15.0	1,200	6.7	42	982	9.2	600
July 27, 1993	1715	.78	21.5	2,320	6.2	50	1,770	8.2	1,200
May 23, 1994	1820	3.2	15.0	620	6.0	26	490	5.5	280
03039300 Wells Creek at Mostoller, Pa., Site 813 (LAT 40 04 11N LONG 078 56 45W)									
September 2, 1992	0820	2.6	12.0	665	6.1	15	564	3.1	200
July 27, 1993	1015	3.9	19.5	689	4.8	2	556	<1.0	330
May 24, 1994	0840	12	13.0	385	5.9	3	--	<1.0	160
03039340 Beaverdam Creek at Stoystown, Pa., Site 814 (LAT 40 05 35N LONG 078 57 16W)									
September 2, 1992	0910	2.5	12.5	397	6.4	96	336	19	79
July 27, 1993	0845	2.3	19.5	460	7.7	100	336	25	100
May 24, 1994	0930	9.9	14.0	311	7.4	66	216	6.9	71
03039440 Quemahoning Creek at Boswell, Pa., Site 818 (LAT 40 09 54N LONG 079 01 51W)									
September 1, 1992	1130	19	15.0	400	6.1	34	362	9.6	140
July 28, 1993	1130	10	20.0	650	5.8	42	504	14	280
May 23, 1994	1150	67	16.0	290	6.6	20	246	4.7	100
03039700 Dark Shade Creek at Central City, Pa., Site 824 (LAT 40 06 18N LONG 078 47 55W)									
September 1, 1992	1610	3.1	18.5	209	3.8	0	140	<1.0	65
July 28, 1993	1315	1.4	23.5	231	3.7	0	152	<1.0	160
May 23, 1994	1435	13	16.5	125	4.1	0	94	<1.0	45
03039750 Dark Shade Creek at Reitz, Pa., Site 826 (LAT 40 08 03N LONG 078 48 53W)									
September 2, 1992	0815	21	11.0	682	3.8	0	612	1.6	350
July 28, 1993	1015	13	15.0	1,130	3.3	0	990	1.4	770
May 23, 1994	1050	53	13.0	550	3.8	0	468	2.6	330
03039920 Little Paint Creek at Scalp Level, Pa., Site 829 (LAT 40 14 46N LONG 078 50 49W)									
September 1, 1992	1450	1.9	23.5	410	5.5	4	360	<1.0	170
July 28, 1993	1820	1.1	28.5	490	5.7	2	426	<1.0	260
May 24, 1994	0915	10	13.0	236	6.7	7	200	2.3	87
03039925 North Fork Bens Creek at North Fork, Pa., Site 833 (LAT 40 15 58N LONG 079 01 01W)									
September 1, 1992	0910	1.3	13.0	61	6.7	3	90	<1.0	9.0
July 27, 1993	1350	.86	18.0	64	7.0	3	78	<1.0	7.7
May 23, 1994	1215	6.4	11.5	50	6.9	3	58	<1.0	9.2
03039930 South Fork Bens Creek near Thomasdale, Pa., Site 831 (LAT 40 13 41N LONG 079 02 49W)									
September 1, 1992	0805	8.9	13.0	44	6.4	8	80	1.5	8.0
July 27, 1993	1250	3.5	19.0	490	7.2	7	88	1.8	7.7
May 23, 1994	1015	7.7	11.5	330	5.8	4	52	<1.0	8.0
03039950 South Fork Bens Creek near Ferndale, Pa., Site 832 (LAT 40 15 02N LONG 078 58 20W)									
September 1, 1992	1015	7.0	13.5	773	5.6	92	668	19	320
July 27, 1993	1035	6.6	18.0	840	7.3	100	654	23	320
May 23, 1994	1430	33	16.0	383	6.9	46	312	10	140

***Appendix 5.** Field data and laboratory analyses for surface-water sites—Continued*

[ft^3/s, cubic foot per second; °C, degrees Celsius; µS/cm, microsiemen per centimeter at 25 degrees Celsius; mg/L, milligram per liter; ug/L, micrograms per liter; <, less than; --, no data available]

Date	Fluoride, total (mg/L as F)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Aluminum, total recoverable (µg/L as Al)	Aluminum, dissolved (µg/L as Al	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
03039200 Clear Run near Buckstown, Pa., Site 808 (LAT 40 02 49N LONG 078 50 00W)									
September 1, 1992	<0.2	1,800	150	290	200	940	<130	0	0
July 27, 1993	<.2	6,100	4,800	600	600	140	<130	0	--
May 23, 1994	<.2	360	120	610	560	370	300	0	--
03039300 Wells Creek at Mostoller, Pa., Site 813 (LAT 40 04 11N LONG 078 56 45W)									
September 2, 1992	<.2	320	31	800	780	<130	<130	0	0
July 27, 1993	<.2	240	90	1,900	1,900	1,400	1,400	14	--
May 24, 1994	<.2	770	150	1,000	950	1,000	150	5.2	--
03039340 Beaverdam Creek at Stoystown, Pa., Site 814 (LAT 40 05 35N LONG 078 57 16W)									
September 2, 1992	<.2	430	78	41	23	220	<130	0	0
July 27, 1993	<.2	360	20	70	50	400	400	0	--
May 24, 1994	<.2	460	24	47	31	<130	<130	0	--
03039440 Quemahoning Creek at Boswell, Pa., Site 818 (LAT 40 09 54N LONG 079 01 51W)									
September 1, 1992	<.2	3,300	2,400	720	720	<130	<130	0	0
July 28, 1993	<.2	4,500	2,700	1,700	1,600	190	<130	0	--
May 23, 1994	<.2	3,100	2,100	940	900	<130	<130	0	--
03039700 Dark Shade Creek at Central City, Pa., Site 824 (LAT 40 06 18N LONG 078 47 55W)									
September 1, 1992	<.2	1,500	1,400	530	530	2,500	2,500	34	3
July 28, 1993	<.2	1,000	980	680	660	3,000	3,000	36	4
May 23, 1994	<.2	1,000	980	320	330	1,800	1,800	22	0
03039750 Dark Shade Creek at Reitz, Pa., Site 826 (LAT 40 08 03N LONG 078 48 53W)									
September 2, 1992	.3	18,000	16,000	3,100	3,100	4,900	4,600	70	8
July 28, 1993	.2	24,000	21,000	5,000	4,900	8,800	8,600	120	42
May 23, 1994	.2	8,300	5,500	2,500	2,400	4,400	4,100	54	4
03039920 Little Paint Creek at Scalp Level, Pa., Site 829 (LAT 40 14 46N LONG 078 50 48W)									
September 1, 1992	<.2	6,100	1,600	410	360	7,100	<130	12	0
July 28, 1993	<.2	7,600	5,300	460	450	3,600	200	19	--
May 24, 1994	<.2	8,700	6,300	200	220	3,700	510	15	--
03039925 North Fork Bens Creek at North Fork, Pa., Site 833 (LAT 40 15 58N LONG 079 01 01W)									
September 1, 1992	<.2	20	<10	<10	<10	<130	<130	6.0	0
July 27, 1993	<.2	2,300	20	460	<50	3,100	<130	2.4	--
May 23, 1994	<.2	30	<10	32	22	<130	<130	5.6	--
03039930 South Fork Bens Creek near Thomasdale, Pa., Site 831 (LAT 40 13 41N LONG 079 02 43W)									
September 1, 1992	<.2	190	<10	29	<10	180	<130	2.4	0
July 27, 1993	<.2	2,300	50	280	210	1,900	200	0	--
May 23, 1994	<.2	110	20	25	16	<130	130	5.0	--
03039950 South Fork Bens Creek near Ferndale, Pa., Site 832 (LAT 40 15 02N LONG 078 58 20W)									
September 1, 1992	<.2	900	<10	230	230	370	<130	0	0
July 27, 1993	.2	950	490	--	--	--	--	0	--
May 23, 1994	<.2	1,300	120	200	200	510	<130	0	--

Appendix 5. *Field data and laboratory analyses for surface-water sites—Continued*

Date	Time	Discharge, instantaneous (ft^3/s)	Temperature, water (°C)	Specific conductance (μS/cm)	pH (standard units)	Alkalinity, total (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)	Sulfate, total (mg/L as SO_4)
03039957 Bens Creek at Ferndale, Pa., Site 824 (LAT 40 16 58N LONG 078 56 10W)									
September 1, 1992	1120	10	15.5	525	6.1	66	454	14	190
July 28, 1993	1245	8.0	23.5	630	7.4	76	478	16	230
May 23, 1994	1615	58	17.5	260	7.8	32	226	11	85
03040000 Stonycreek River at Ferndale, Pa., Site 805 (LAT 40 17 08N LONG 078 55 15W)									
September 1, 1992	1140	198	19.5	498	5.4	2	414	<1.0	240
July 27, 1993	0920	127	23.0	820	4.2	0	802	<1.0	470
May 23, 1994	1700	541	19.5	411	4.8	2	362	<1.0	190
395836078554901 Glades Creek near Shanksville, Pa., Site 806 (LAT 39 58 36N LONG 078 55 49W)									
September 1, 1992	0740	3.2	13.0	554	6.9	74	428	15	160
July 27, 1993	0810	3.9	19.5	761	6.7	100	678	20	250
May 24, 1994	1325	6.6	18.0	588	6.1	66	500	14	190
400014078540201 Stonycreek River at Shanksville, Pa., Site 801 (LAT 40 00 14N LONG 078 54 02W)									
September 1, 1992	0850	11	16.0	557	6.8	58	532	10	190
July 27, 1993	1245	11	23.5	740	6.8	100	596	19	220
May 24, 1994	1225	21	18.0	446	6.4	50	360	11	140
400033078511601 Boone Run near Shanksville, Pa., Site 807 (LAT 40 00 33N LONG 078 51 16W)									
September 1, 1992	1400	3.2	15.0	161	6.8	5	134	1.3	61
July 27, 1993	1400	.84	22.5	490	5.0	10	506	2.7	270
May 23, 1994	1900	5.1	14.5	141	6.0	2	134	1.0	60
400056078540501 Rhoads Creek at Shanksville, Pa., Site 810 (LAT 40 00 56N LONG 078 54 05W)									
September 1, 1992	1030	14	18.5	610	6.8	24	540	5.1	280
July 27, 1993	1110	2.5	22.5	535	6.3	48	538	6.4	230
May 24, 1994	1045	23	16.5	412	6.6	15	352	3.4	170
400058078552301 Schrock Run near Shanksville, Pa., Site 811 (LAT 40 00 58N LONG 078 55 23W)									
September 1, 1992	0945	2.2	12.5	1,220	6.8	64	1,010	15	610
July 27, 1993	0950	1.3	19.5	1,390	5.8	28	1,110	9.1	730
May 24, 1994	1135	3.4	15.0	825	6.4	26	684	6.8	440
400337078513701 Calendars Run at Buckstown, Pa., Site 809 (LAT 40 03 37N LONG 078 51 37W)									
September 1, 1992	1300	.11	13.0	224	7.1	30	180	3.6	30
July 28, 1993	1440	<.01	18.5	250	6.1	20	190	5.3	19
May 23, 1994	1715	.87	15.5	160	7.1	10	144	2.1	40
400414078545101 Lamberts Run at Lambertsville, Pa., Site 812 (LAT 40 04 14N LONG 078 54 51W)									
September 1, 1992	1135	2.6	14.0	2,330	6.7	28	2,360	5.9	1,500
July 27, 1993	1420	3.9	20.5	2,550	6.6	14	2,450	3.1	1,800
May 23, 1994	2000	7.2	18.0	2,350	6.1	30	2,450	6.5	1,800
400611078555801 Stonycreek River at Kantner, Pa., Site 802 (LAT 40 06 11N LONG 078 55 58W)									
September 2, 1992	1000	35	13.5	650	6.0	42	564	8.3	260
July 27, 1993	1140	23	23.5	884	7.2	42	678	9.1	420
May 23, 1994	1620	91	20.0	567	7.6	22	470	4.5	260
400701078481601 Laurel Run at Central City, Pa., Site 825 (LAT 40 07 01N LONG 078 48 16W)									
September 1, 1992	1710	7.2	17.5	137	6.1	8	144	2.0	44
July 28, 1993	1200	2.0	20.5	229	5.0	3	192	1.9	120
May 23, 1994	1400	10	16.0	99	5.1	2	106	<1.0	38

Appendix 5. *Field data and laboratory analyses for surface-water sites—Continued*

Date	Fluoride, total (mg/L as F)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Aluminum, total recoverable (µg/L as Al)	Aluminum, dissolved (µg/L as Al	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
03039987 Bens Creek at Ferndale, Pa., Site 834 (LAT 40 16 58N LONG 078 56 10W)									
September 1, 1992	<0.2	80	<10	<10	<10	<130	<130	0	0
July 28, 1993	<.2	210	30	<50	<50	200	160	0	--
May 23, 1994	<.2	270	<10	56	40	250	<130	0	--
03040000 Stonycreek River at Ferndale, Pa., Site 805 (LAT 40 17 08N LONG 078 55 15W)									
September 1, 1992	<.2	1,200	630	1,300	1,200	990	640	15	0
July 27, 1993	<.2	1,000	340	2,600	2,500	4,700	4,400	34	--
May 23, 1994	<.2	1,700	630	1,400	1,400	1,800	1,100	16	--
395836078554901 Glades Creek near Shanksville, Pa., Site 806 (LAT 39 58 36N LONG 078 55 49W)									
September 1, 1992	<.2	420	37	400	380	<130	<130	0	0
July 27, 1993	<.2	960	50	600	600	1,000	100	0	--
May 24, 1994	<.2	460	77	930	820	290	<130	0	--
400014078540201 Stonycreek River at Shanksville, Pa., Site 801 (LAT 40 00 14N LONG 078 54 02W)									
September 1, 1992	<.2	1,000	83	450	210	820	130	0	0
July 27, 1993	<.2	500	40	500	440	330	<100	0	--
May 24, 1994	<.2	390	220	820	780	<130	<130	0	--
400033078511601 Boone Run near Shanksville, Pa., Site 807 (LAT 40 00 33N LONG 078 51 16W)									
September 1, 1992	<.2	1,500	720	290	290	340	<130	8.6	0
July 27, 1993	<.2	3,900	2,700	1,200	1,200	1,200	400	12	--
May 23, 1994	<.2	990	720	360	390	630	440	12	--
400056078540501 Rhoads Creek at Shanksville, Pa., Site 810 (LAT 40 00 56N LONG 078 54 05W)									
September 1, 1992	<.2	140	100	81	57	1,300	1,300	0	0
July 27, 1993	<.2	120	14	130	130	<100	<100	0	--
May 24, 1994	<.2	160	21	1,000	880	<130	<130	0	--
400058078552301 Schrock Run near Shanksville, Pa., Site 811 (LAT 40 00 58N LONG 078 55 23W)									
September 1, 1992	.2	5,400	130	2,500	2,200	3,200	<130	0	0
July 27, 1993	<.2	5,800	2,800	6,000	5,800	2,800	<100	0	--
May 24, 1994	<.2	1,300	590	4,000	3,600	660	<130	0	--
400337078513701 Calendars Run at Buckstown, Pa., Site 809 (LAT 40 03 37N LONG 078 51 37W)									
September 1, 1992	<.2	160	45	170	160	<130	<130	0	0
July 28, 1993	<.2	40	10	60	<50	<100	<100	0	--
May 23, 1994	.2	310	100	820	730	600	180	0	--
400414078545101 Lamberts Run at Lambertsville, Pa., Site 812 (LAT 40 04 14N LONG 078 54 51W)									
September 1, 1992	<.2	930	81	1,300	1,200	440	<130	0	0
July 27, 1993	<.2	1,800	140	1,500	1,300	1,000	170	0	--
May 23, 1994	<.2	3,700	300	3,400	3,100	1,300	250	0	--
400611078555801 Stonycreek River at Kantner, Pa., Site 802 (LAT 40 06 11N LONG 078 55 58W)									
September 2, 1992	<.2	160	61	75	65	240	150	0	0
July 27, 1993	<.2	240	20	170	100	240	200	0	--
May 23, 1994	<.2	180	<10	450	400	370	290	0	--
400701078481601 Laurel Run at Central City, Pa., Site 825 (LAT 40 07 01N LONG 078 48 16W)									
September 1, 1992	<.2	2,300	620	590	540	1,900	<130	7.4	0
July 28, 1993	<.2	2,700	2,100	1,000	1,000	800	<100	11	--
May 23, 1994	<.2	760	640	480	500	670	360	0	--

Appendix 5. Field data and laboratory analyses for surface-water sites—Continued

Date	Time	Discharge, instantaneous (ft^3/s)	Temperature, water (°C)	Specific conductance (µS/cm)	pH (standard units)	Alkalinity, total (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)	Sulfate, total (mg/L as SO_4)
400706078552801 Oven Run at Rowena, Pa., Site 815 (LAT 40 07 06N LONG 078 55 28W)									
September 2, 1992	1100	0.57	13.0	1,930	2.7	0	2,130	<1.0	1,100
July 27, 1993	1700	.55	23.5	2,350	2.8	0	2,740	<1.0	2,000
May 24, 1994	1020	3.1	12.5	1,320	3.2	0	1,240	<1.0	820
400738078552801 Pokeytown Run at Wilbur, Pa., Site 837 (LAT 40 07 38N LONG 078 55 28W)									
July 27, 1993	1610	.68	19.0	2,960	2.9	0	3,970	<1.0	3,500
SEP 08...	1100	.40	15.0	3,510	2.7	0	6,370	<1.0	4,100
May 24, 1994	1100	2.0	14.5	1,670	3.1	0	2,090	1.0	1,400
400822079035901 North Branch Quemahoning Creek near Coal Junction, Pa., Site 820 (LAT 40 08 22N LONG 079 03 59W)									
September 1, 1992	0830	6.9	15.0	124	6.4	13	148	3.3	30
July 27, 1993	0845	1.8	21.0	135	6.3	15	116	4.7	35
May 23, 1994	0840	30	13.0	87	5.5	6	90	2.0	25
400826078580401 Higgins Run near Boswell, Pa., Site 823 (LAT 40 08 26N LONG 078 58 04W)									
September 1, 1992	1640	2.0	14.5	970	6.6	86	828	16	460
July 28, 1993	1430	3.0	17.5	910	6.3	86	736	18	420
May 23, 1994	1500	6.3	15.5	620	7.4	60	514	2.3	250
400841078544901 Fallen Timber Run at Hooversville, Pa., Site 816 (LAT 40 08 41N LONG 078 54 49W)									
September 1, 1992	1815	.32	13.5	502	5.3	3	498	1.6	270
July 27, 1993	1500	.30	17.0	457	5.0	2	422	1.0	320
May 24, 1994	1200	1.2	12.0	310	5.5	4	294	2.9	160
400854078490201 Clear Shade Creek at Reitz, Pa., Site 827 (LAT 40 08 54N LONG 078 49 02W)									
September 2, 1992	0915	34	12.5	42	5.9	4	90	<1.0	10
July 28, 1993	0850	7.1	20.5	57	6.3	10	94	2.4	8.4
May 23, 1994	1140	75	14.5	40	5.4	4	48	<1.0	93
400908078585701 Twomile Run near Boswell, Pa., Site 822 (LAT 40 09 08N LONG 078 58 57W)									
September 1, 1992	1600	.52	16.0	510	5.4	3	514	<1.0	240
July 28, 1993	1315	.48	21.0	662	6.2	12	592	<1.0	320
May 23, 1994	1410	4.3	18.0	490	6.7	6	458	1.2	230
400954079040501 Beaverdam Creek at Jennerstown, Pa., Site 819 (LAT 40 09 54N LONG 079 04 05W)									
September 1, 1992	1000	2.3	13.5	97	6.5	28	124	6.2	10
July 28, 1993	1015	1.5	19.5	208	6.1	34	156	8.3	43
May 23, 1994	1025	9.8	12.5	86	6.9	12	64	3.1	21
401017079005301 Roaring Run at Pilltown, Pa., Site 821 (LAT 40 10 17N LONG 079 00 53W)									
September 1, 1992	1200	3.5	16.5	282	6.1	24	292	5.6	97
July 28, 1993	1230	1.0	22.5	872	6.1	46	706	12	430
May 23, 1994	1250	17	19.5	250	6.8	20	206	5.5	91
401018078542901 Stonycreek River at Blough, Pa., Site 803 (LAT 40 10 18N LONG 078 54 29W)									
September 1, 1992	1745	51	21.5	660	5.4	11	576	<1.0	310
July 27, 1993	1310	23	27.0	1,100	3.8	0	896	<1.0	720
May 23, 1994	1730	122	20.5	617	6.8	5	498	1.2	310
401059078495201 Roaring Fork near Hillsboro, Pa., Site 828 (LAT 40 10 59N LONG 078 49 52W)									
September 2, 1992	1025	4.8	13.5	142	4.5	0	162	<1.0	50
July 28, 1993	0730	1.8	19.0	203	3.5	0	142	<1.0	120
May 23, 1994	1240	13	13.5	80	5.0	1	74	<1.0	28

Appendix 5. ***Field data and laboratory analyses for surface-water sites—Continued***

Date	Fluoride, total (mg/L as F)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Aluminum, total recoverable (µg/L as Al)	Aluminum, dissolved (µg/L as Al	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
400706078552801 Oven Run at Rowena, Pa., Site 815 (LAT 40 07 06N LONG 078 55 28W)									
September 2, 1992	0.8	23,000	23,000	21,000	21,000	26,000	26,000	350	124
July 27, 1993	.5	21,000	19,000	39,000	36,000	46,000	42,000	450	136
May 24, 1994	.5	15,000	15,000	15,000	15,000	19,000	18,000	190	66
400738078552801 Pokeytown Run at Wilbur, Pa., Site 837 (LAT 40 07 38N LONG 078 55 28W)									
July 27, 1993	1.1	400,000	400,000	14,000	14,000	140,000	140,000	1,740	670
SEP 08...	1.7	490,000	520,000	14,000	13,000	190,000	180,000	2,180	650
May 24, 1994	.6	100,000	100,000	6,700	6,700	55,000	55,000	528	166
400822079035901 North Branch Quemahoning Creek near Coal Junction, Pa., Site 820 (LAT 40 08 22N LONG 079 03 59W)									
September 1, 1992	<.2	1,100	40	380	370	210	<130	0	0
July 27, 1993	<.2	1,700	160	320	320	200	<100	0	--
May 23, 1994	<.2	580	250	330	350	180	<130	4.0	--
400826078560401 Higgins Run near Boswell, Pa., Site 823 (LAT 40 08 26N LONG 078 56 04W)									
September 1, 1992	<.2	160	<10	52	33	<130	<130	0	0
July 28, 1993	<.2	210	24	110	59	200	<100	0	--
May 23, 1994	<.2	440	<10	160	130	260	140	0	--
400841078544901 Fallen Timber Run at Hooversville, Pa., Site 816 (LAT 40 08 41N LONG 078 54 49W)									
September 1, 1992	.3	490	50	710	670	1,300	720	20	0
July 27, 1993	.3	100	90	570	570	1,200	600	9.6	--
May 24, 1994	<.2	250	52	280	240	740	260	1.4	--
400854078490201 Clear Shade Creek at Reitz, Pa., Site 827 (LAT 40 08 54N LONG 078 49 02W)									
September 2, 1992	<.2	140	48	53	43	170	<130	7.2	0
July 28, 1993	<.2	140	100	<50	<50	<100	<100	0	--
May 23, 1994	<.2	140	85	88	80	190	<130	6.2	--
400908078585701 Twomile Run near Boswell, Pa., Site 822 (LAT 40 09 08N LONG 078 58 57W)									
September 1, 1992	<.2	120	50	2,900	2,800	860	730	13	0
July 28, 1993	<.2	140	40	2,200	2,200	760	700	7.6	--
May 23, 1994	<.2	390	<10	2,100	2,100	800	<130	6.2	--
400954079040501 Beaverdam Creek at Jennerstown, Pa., Site 819 (LAT 40 09 54N LONG 079 04 05W)									
September 1, 1992	<.2	290	130	90	84	140	<130	0	0
July 28, 1993	<.2	600	28	330	290	200	<100	0	--
May 23, 1994	<.2	450	80	190	160	170	<130	0	--
401017079005301 Roaring Run at Pilltown, Pa., Site 821 (LAT 40 10 17N LONG 079 00 53W)									
September 1, 1992	<.2	2,600	1,500	820	820	180	<130	0	0
July 28, 1993	.2	4,500	1,200	2,200	2,200	200	<130	0	--
May 23, 1994	<.2	2,100	890	620	600	370	<130	0	--
401018078542901 Stonycreek River at Blough, Pa., Site 803 (LAT 40 10 18N LONG 078 54 29W)									
September 1, 1992	<.2	1,200	270	1,100	1,100	710	140	7.0	0
July 27, 1993	.2	1,700	490	2,800	2,800	7,500	7,500	62	5
May 23, 1994	<.2	2,700	410	1,300	1,300	1,800	<130	7.8	--
401059078495201 Roaring Fork near Hillsboro, Pa., Site 828 (LAT 40 10 59N LONG 078 49 52W)									
September 2, 1992	<.2	500	380	1,100	1,100	680	680	15	0
July 28, 1993	<.2	1,000	750	1,400	1,400	700	700	16	--
May 23, 1994	<.2	240	170	440	450	540	510	11	--

Appendix 5. *Field data and laboratory analyses for surface-water sites—Continued*

Date	Time	Discharge, instantaneous (ft^3/s)	Temperature, water (°C)	Specific conductance (µS/cm)	pH (standard units)	Alkalinity, total (mg/L as $CaCO_3$)	Residue at 105 °C, dissolved (mg/L)	Carbon, inorganic, total (mg/L as C)	Sulfate, total (mg/L as SO_4)
401121078562801 Quemahoning Creek at Quemahoning Reservoir Outflow, Site 817 (LAT 40 11 21N LONG 078 56 28W)									
September 1, 1992	1500	13	25.0	266	5.5	18	260	3.4	84
July 27, 1993	1900	.09	26.0	206	7.1	50	146	11	35
May 23, 1994	1915	74	20.0	201	7.2	12	192	2.3	64
401243078535501 Shade Creek at Seanor, Pa., Site 836 (LAT 40 12 43N LONG 078 53 55W)									
September 1, 1992	1610	80	18.5	322	4.5	0	282	<1.0	140
July 28, 1993	1700	40	27.5	670	3.5	0	474	<1.0	410
May 24, 1994	1030	137	13.5	300	3.8	0	228	<1.0	130
401437078530201 Stonycreek River near Windber, Pa., Site 804 (LAT 40 14 37N LONG 078 53 02W)									
September 2, 1992	1220	122	17.5	456	5.5	2	402	<1.0	210
July 28, 1993	1520	77	27.5	840	3.9	0	654	<1.0	550
May 24, 1994	1330	386	17.0	390	5.2	2	334	<1.0	170
401441078530201 Paint Creek near Windber, Pa., Site 830 (LAT 40 14 41N LONG 078 53 02W)									
September 2, 1992	1105	14	14.0	1,220	3.6	0	1,210	<1.0	720
July 28, 1993	1420	9.9	24.5	1,380	3.4	0	1,210	<1.0	960
May 24, 1994	1400	43	17.0	800	3.6	0	732	3.0	510
401821078543601 Solomon Run at Johnstown, Pa., Site 835 (LAT 40 18 21N LONG 078 54 36W)									
September 1, 1992	1320	22	23.0	1,080	6.0	5	1,020	1.3	550
July 27, 1993	1515	2.6	27.0	1,150	6.6	7	914	2.7	560
May 23, 1994	1845	6.8	18.0	770	6.8	24	690	9.1	330

Appendix 5. *Field data and laboratory analyses for surface-water sites—Continued*

Date	Fluoride, total (mg/L as F)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Aluminum, total recoverable (µg/L as Al)	Aluminum, dissolved (µg/L as Al	Acidity, total heated (mg/L as $CaCO_3$)	Acidity, mineral (methyl orange) (mg/L as $CaCO_3$)
401121078562301 Quemahoning Creek at Quemahoning Reservoir Outflow, Site 817 (LAT 40 11 21N LONG 078 56 28W)									
September 1, 1992	<0.2	40	16	<10	<10	<130	<130	0	0
July 27, 1993	<.2	260	260	550	120	600	<100	0	--
May 23, 1994	<.2	100	<10	300	280	<130	<130	0	--
401243078535501 Shade Creek at Seanor, Pa., Site 836 (LAT 40 12 43N LONG 078 53 55W)									
September 1, 1992	<.2	1,800	1,500	1,200	1,200	1,600	1,600	28	1
July 28, 1993	<.2	550	340	2,800	2,800	4,200	4,000	48	12
May 24, 1994	<.2	1,600	860	1,300	1,200	2,000	1,900	19	--
401437078530201 Stonycreek River near Windber, Pa., Site 804 (LAT 40 14 37N LONG 078 53 02W)									
September 2, 1992	<.2	850	500	1,100	1,100	1,200	1,100	14	0
July 28, 1993	<.2	470	380	3,000	2,900	4,500	4,400	40	3
May 24, 1994	<.2	1,200	410	970	910	1,100	340	6.2	--
401441078530201 Paint Creek near Windber, Pa., Site 830 (LAT 40 14 41N LONG 078 53 02W)									
September 2, 1992	.3	14,000	8,100	6,700	6,700	15,000	15,000	138	22
July 28, 1993	.2	8,800	5,200	10,000	10,000	13,000	13,000	104	9
May 24, 1994	.2	7,200	3,600	5,100	4,800	9,100	8,200	70	3
401821078543601 Solomon Run at Johnstown, Pa., Site 835 (LAT 40 18 21N LONG 078 54 36W)									
September 1, 1992	<.2	31,000	17,000	1,600	1,600	840	<130	40	0
July 27, 1993	<.2	17,000	8,200	2,700	2,700	1,800	<100	11	--
May 23, 1994	<.2	11,000	4,200	820	780	1,100	<130	0	--