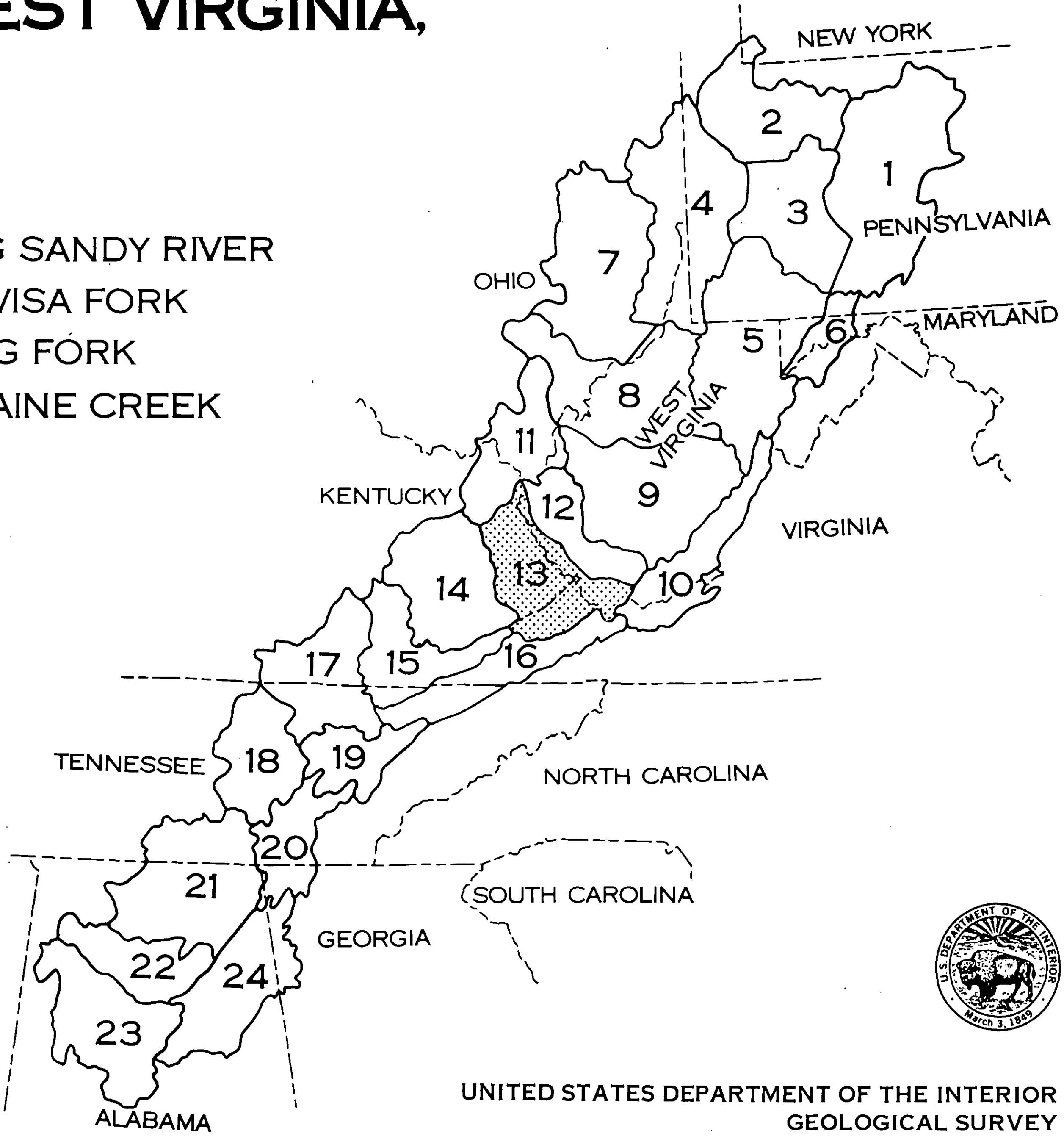
HYDROLOGY OF AREA 13, EASTERN COAL PROVINCE, KENTUCKY, VIRGINIA, AND WEST VIRGINIA,

- BIG SANDY RIVER
- LEVISA FORK
- TUG FORK
- BLAINE CREEK



UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES INVESTIGATIONS
OPEN FILE REPORT 82-505

HYDROLOGY OF AREA 13, EASTERN COAL PROVINCE, KENTUCKY, VIRGINIA, AND WEST VIRGINIA,

BY
JAY KIESLER, FERDINAND QUINONES, DONALD S. MULL AND
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LOUISVILLE, KENTUCKY
MAY, 1983

UNITED STATES DEPARTMENT OF THE INTERIOR

JAMES G. WATT, *SECRETARY*

GEOLOGICAL SURVEY

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CONTENTS

FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM OF UNITS (SI)

For convenience of readers who may want to use the International System of Units (SI), the data may be converted by using the following factors:

Multiply	By	To obtain
inches (in)	25.40	millimeters (mm)
inches per hour (in/h)	25.4	millimeters per hour (mm/h)
	2.54	centimeters per hour (cm/h)
feet (ft)	0.3048	meters (m)
feet per mile (ft/mi)	0.1894	meters per kilometer (m/km)
miles (mi)	1.609	kilometers (km)
square miles (mi^2)	2.590	square kilometers (km^2)
acres	4047	square meters (m^2)
acre-feet (acre-ft)	1233	cubic meters (m^3)
gallons per minute (gal/min)	0.06309	liters per second (L/s)
million gallons per day (Mgal/d)	0.04381	cubic meters per second (m^3/s)
	3785.	cubic meters per day (m^3/d)
cubic feet per second (ft^3/s)	0.02832	cubic meters per second (m^3/s)
cubic feet per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meters per second per square kilometer [$(m^3/s)/km^2$]
tons (tons)	0.9072	metric tons (t)
tons per square mile per year [$(tons/mi^2)/yr$]	0.3503	metric tons per square kilometer per year [$(t/km^2)/a$]

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in this report.

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Abstract

This report was prepared to aid mine owners, operators, and consulting engineers in the preparation and appraisal of mine permits. The report provides information about existing hydrologic conditions and sources of hydrologic information for Area 13 which is the Big Sandy River basin in the Appalachian Plateaus and the Ridge and Valley physiographic provinces.

The principal streams of the basin are the Levisa Fork and Tug Fork which join to form the Big Sandy River, and Blaine Creek which is a tributary of the Big Sandy River. These streams drain northward to the Ohio River.

Five major rock units underlie Area 13. The Connemaugh, Breathitt, and Lee Formations of Pennsylvanian age crop out over most of the area. Undifferentiated rocks of Mississippian and Devonian age and undifferentiated rocks of Silurian to Cambrian age are exposed in small outcrops in the southwestern and southeastern parts of Area 13. Most of the minable coal in Area 13 is in the Breathitt Formation.

Water use in 1980 averaged about 58 million gallons per day in Area 13 and about 61 percent of this came from ground-water supplies. Industrial use accounted for about 39.9 million gallons per day or a little over two-thirds of the total use.

Low-flow data show that medium to large streams rarely stop flowing and that streams draining primarily from the outcrop of the Lee Formation have greater low flows than streams draining from the outcorp of the Breathitt Formation. Floods are frequent, severe, and vary with drainage area, topography, and geology.

Maximum dissolved solids concentrations may range from less than 100 milligrams per liter in streams draining undisturbed basins to as much as 13,600 milligrams per liter in streams draining disturbed basins. Most streams in Area 13 have near-neutral pH values of 7 to 8 units. In streams draining basins with extensive mining, the sulfate concentrations can be as much as 18 times greater than in streams draining undisturbed basins. Other dissolved constituents in streamflow, such as iron and manganese, vary with location. Most trace constituents do not occur in troublesome concentrations either in water or in bottom material of stream channels.

Annual suspended-sediment yield data show a relation to the type of mining and to the percentage of the basin area disturbed by mining. Suspended-sediment yields where surface-mining predominates can be as much as 10 times greater than those where underground-mining prevail and as much as 100 times greater than those of an undisturbed basin. More than half of the suspended sediments in Area 13 are silts and clays.

Ground water in Area 13 occurs mostly in fracture openings in bedrock. Yields usually range from less than 1 to 50 gallons per minute from wells 200 feet or less in depth. Yields up to 300 gallons per minute are known from fractured sandstones of the Lee Formation near the Russell Fork fault in Buchanan County, Virginia. Similar yields may be obtained in the vicinity of other major faults in Area 13. The quality of ground water in Area 13 varies considerably from place to place, but generally is acceptable for most uses with proper treatment.

1.0 INTRODUCTION
1.1 Objective

Area 13 Report to Aid in Preparing and Appraising Mine Permit Applications

Existing hydrologic conditions and identification of sources of hydrologic information are presented.

A need for hydrologic information and analysis on a scale never before required nationally was initiated when the "Surface Mining Control and Reclamation Act of 1977" was signed into law as Public Law 95-87, on August 3, 1977. This need is partially met by this report which broadly characterizes the hydrology of a large basin in the eastern coal area of Kentucky and the southwestern coal areas of Virginia and West Virginia (fig. 1.1-1). This report, which is for Area 13, is one of a series that covers the coal provinces nationwide. The report contains a brief text with an accompanying map, chart, graph, or other illustration for each of a number of water-resources related topics. The summation of the topical discussions provides a description of the hydrology of the area.

The hydrologic information, presented and available through sources identified in this report, may be used in describing the hydrology of the general area of a proposed mine. However, it is expected that this hydrologic information will be supplemented by the lease applicant's specific site data, as well as data from other sources to provide a more detailed picture of the hydrology of the area in the vicinity of the mine and the anticipated hydrologic consequences of the mining operations.

The information contained herein should be useful to mine owners, operators, and consulting engineers in the preparation of permits, and to regulatory authorities in appraising the adequacy of permit applications.

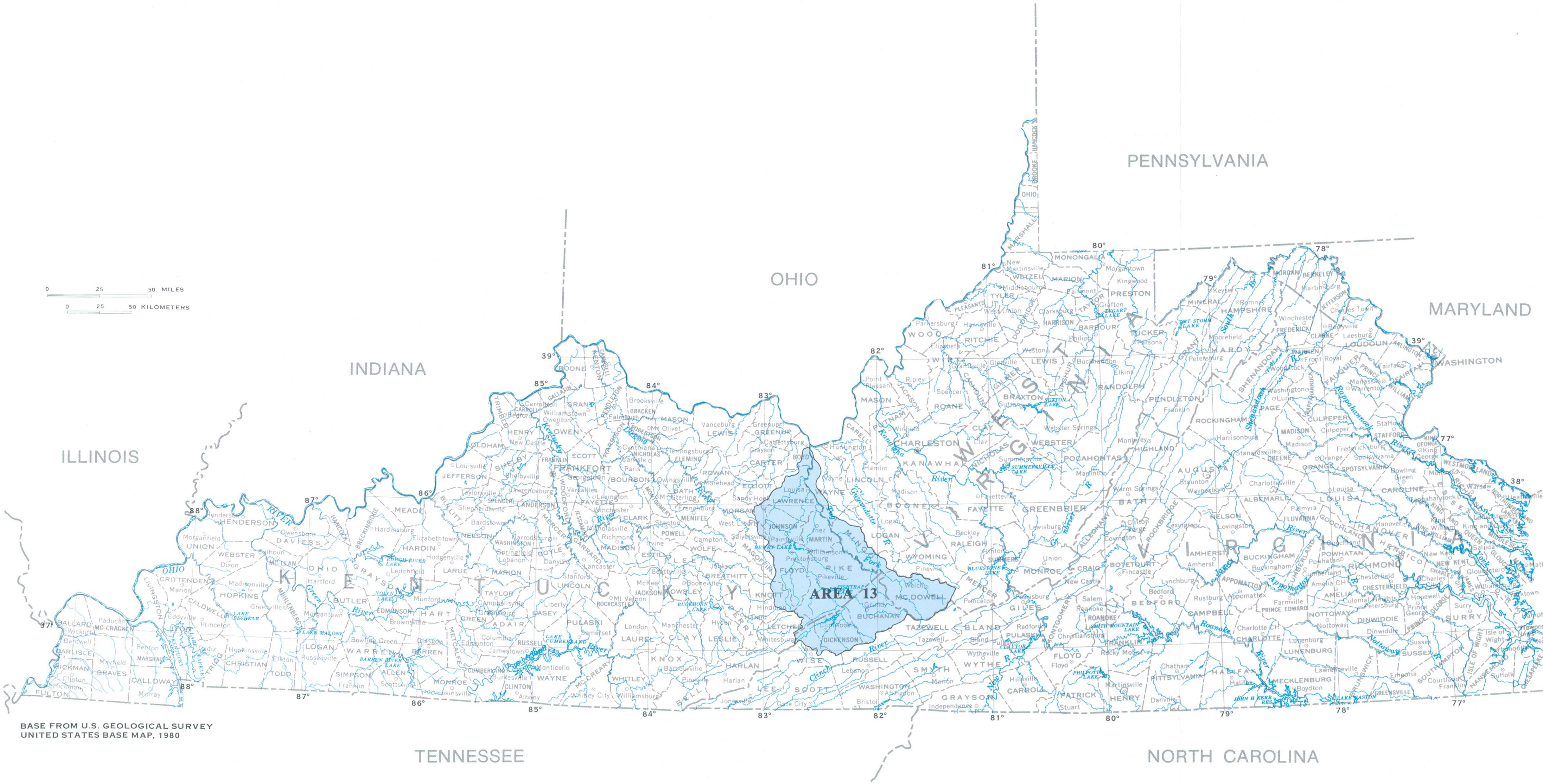


Figure 1.1-1 Location of Area 13.

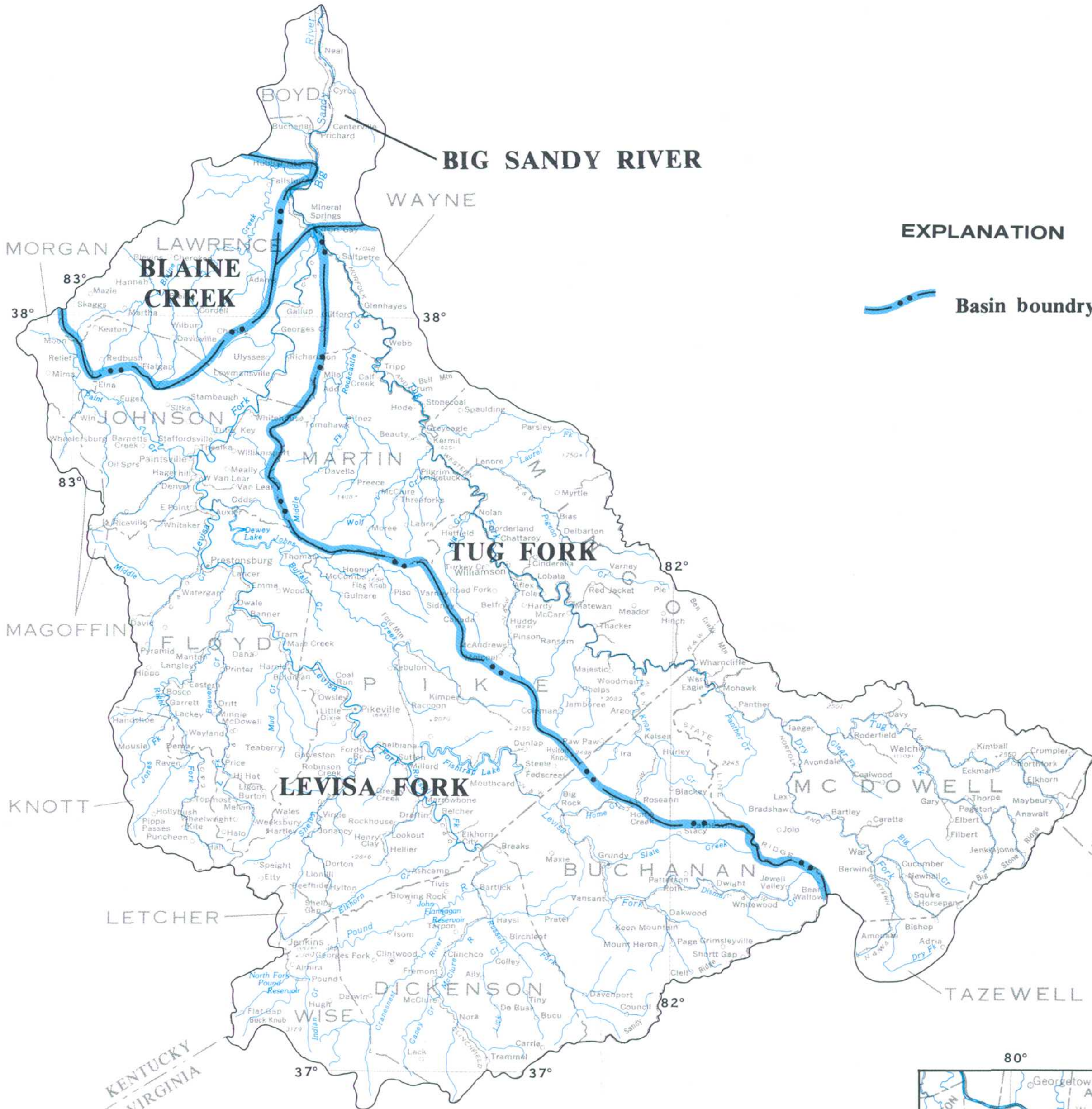
Area 13 Located in Central Part of Eastern Coal Province

Big Sandy River and its tributaries drain Area 13 in eastern Kentucky, southwestern Virginia and southwestern West Virginia, which are primarily in the Appalachian Plateaus physiographic province.

The Eastern Coal province has been divided into 24 hydrologic reporting areas. The divisions are based on drainage boundaries, location of basin, size, hydrology, and mining activities (see cover). Several drainage basins or parts of basins may be combined to form one reporting area (fig. 1.2-1).

Area 13 is in the central part of the Eastern Coal province in eastern Kentucky, southwestern Virginia and southwestern West Virginia (fig. 1.2-2). A large part of Area 13 lies within the Kanawha and Cumberland Mountain sections of the Appalachian Plateaus physiographic province (fig. 1.2-3). A small part of Area 13 in the southeastern corner lies within the Tennessee section of the Ridge and Valley province (Fenneman, 1946).

Area 13 is the Big Sandy River basin. The principal streams are the Levisa Fork and Tug Fork which join to form the Big Sandy River, and Blaine Creek which is a tributary of the Big Sandy River (fig. 1.2-1). Area 13 includes all or part of the Kentucky counties of: Boyd, Floyd, Johnson, Knott, Lawrence, Magoffin, Martin, and Pike; the West Virginia counties of: McDowell, Mingo, and Wayne; and the Virginia counties of: Buchanan, Dickerson, Tazewell, and Wise (fig. 1.2-1). The population densities range from 10 to 25 people per square mile in Martin County, Kentucky to a maximum of 250 or more people per square mile in Boyd County, Kentucky (U.S. Geological Survey, 1970). The principal cities are: Catlettsburg, Louisa, Paintsville, Pikeville, and Prestonsburg in Kentucky; Grundy, Haysi, and Clintwood in Virginia; and Kermit, Welch, and Williamson in West Virginia (fig 1.2-3).



BASE FROM U.S. GEOLOGICAL SURVEY
STATE BASE MAPS, 1:500,000: KENTUCKY
AND VIRGINIA, 1973; WEST VIRGINIA, 1972

SCALE 1:1,000,000

0 10 20 30 MILES

0 10 20 30 KILOMETERS

Figure 1.2-1 Drainage basins.

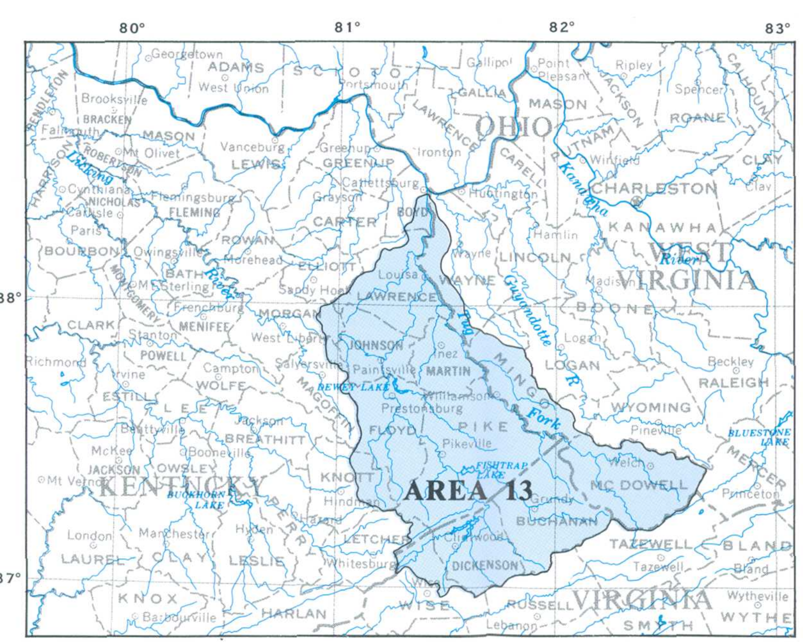


Figure 1.2-2 Coal-hydrology reporting Area 13 within Kentucky, Virginia, and West Virginia.

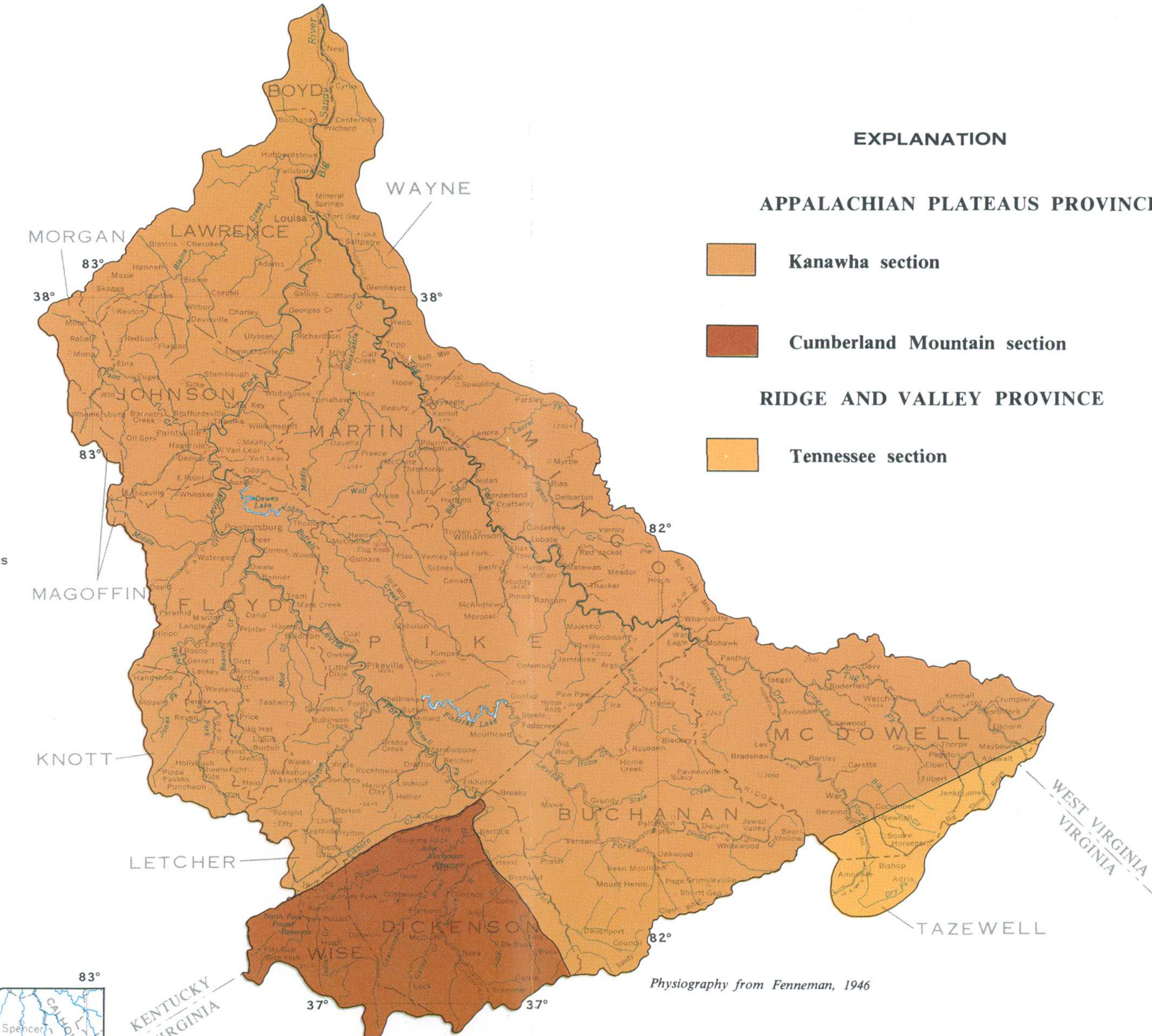


Figure 1.2-3 Physiographic divisions in Area 13.

Hydrologic Environment can be Adversely Altered by Surface Coal Mining

Erosion, sedimentation, decline in water levels, and degradation of water quality are typical problems associated with surface mining.

Surface mining can adversely affect the environment of undisturbed areas. Mining activities such as the removal of vegetation, excavation, and dumping of large volumes of unconsolidated spoil materials may create unstable areas of loose earth and rock. These erode easily and, if uncontrolled, can contribute sediment to surface stream channels and flood plains. Some of the adverse environmental effects associated with increased erosion can be decreased or prevented by reclamation during or after mining.

Adverse effects associated with erosion and increased sedimentation include excessive sediment deposition in streams and reservoirs which in turn increases the cost of maintaining navigation channels and of treating water for industrial and domestic uses. Other adverse effects include the destruction of life habitats, increased flooding due to filling of the stream channels and flood plains, and a reduction of the recreational use and aesthetic value of the land.

Acid-mine drainage is a common and troublesome water-quality problem. After mining, accelerated weathering of iron-bearing minerals such as pyrite and marcasite in spoil materials and coal beds produces sulfuric acid which accelerates the dissolution of minerals (fig. 1.3-1). Water draining from such a mined area generally has low pH values (2.5-5.0 units), increased sulfate and dissolved-solids concentrations, and higher than usual concentrations of aluminum, copper, lead, iron, manganese, and zinc. Adverse effects associated with acidic and highly mineralized mine drainage may include reduction of aquatic life, increased corrosiveness of water, limitations on the use of water for domestic and industrial purposes, and reduction of recreational uses and aesthetic values.

The adverse effects are most apparent on and near the mine site. Receiving streams for surface drainage and ground-water seepage at the mine site usually are most affected. Problems caused by suspended sediment, increased metals content, and low pH values will usually diminish in severity downstream from the mine. This is due to settling out of the sediment, and the buffering and dilution capacity of the stream.

Some wells and springs may go dry as ground-water levels decline because of excavation extending below the water table (fig. 1.3-2). The quality of ground water can also be affected even though the effect may take much longer to detect at points remote from mining activities.

The magnitude of the effect of surface mining on the surrounding hydrologic environment depends on several physical and chemical factors. The more influential factors include mining and reclamation methods, topography, geology, climate, rate and volume of water movement, the distance from the mine site, the time elapsed since mining began, and time elasped since reclamation began.

Some chemical and physical relations and trends that can result from surface coal mining are shown in figure 1.3-3. No proportion, ratio, or linearity is implied by these diagrams.

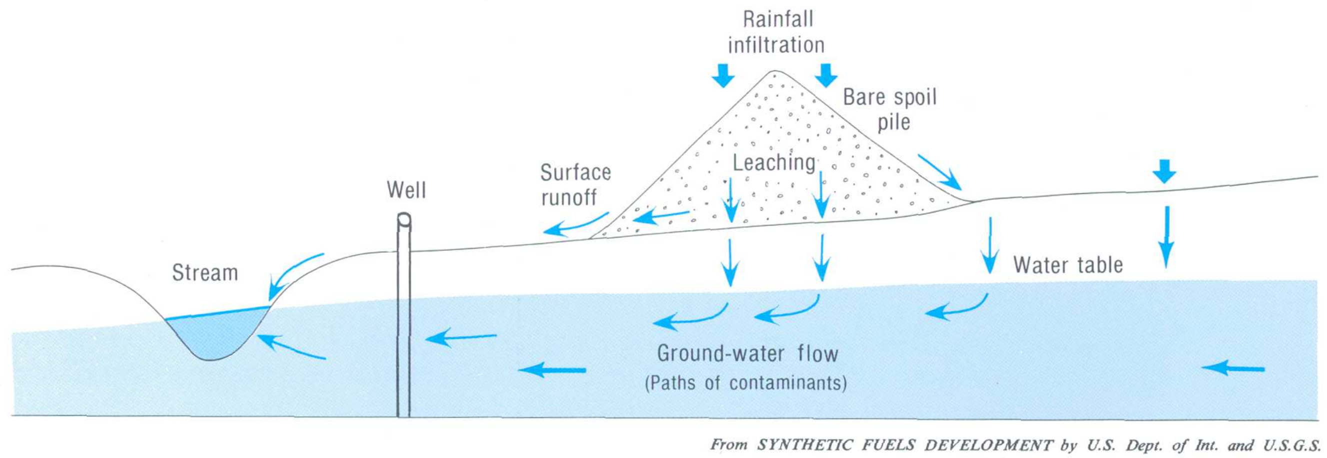


Figure 1.3-1 Movement of water in spoil material.

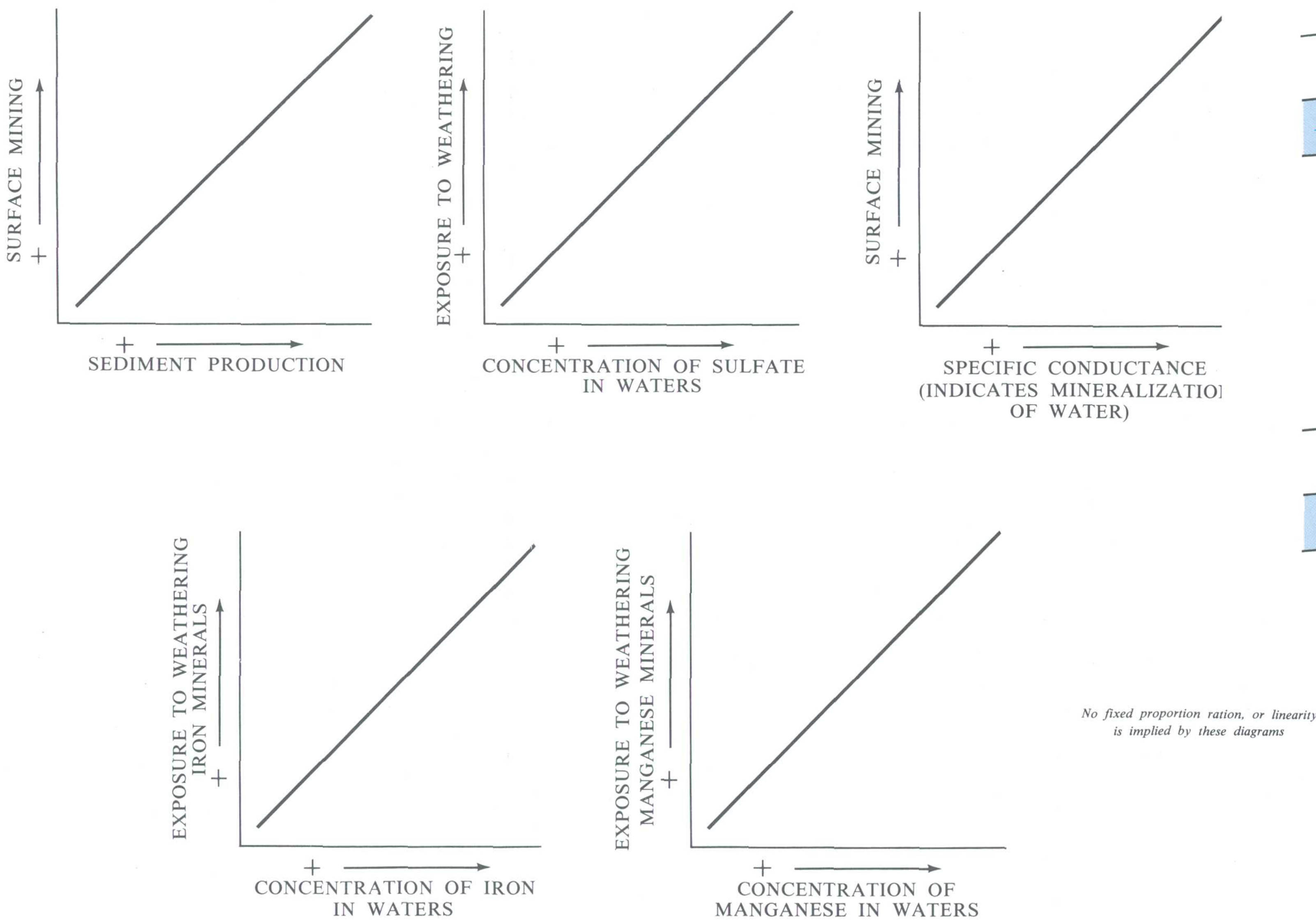


Figure 1.3-3 Examples of relations and trends that can result from surface mining.

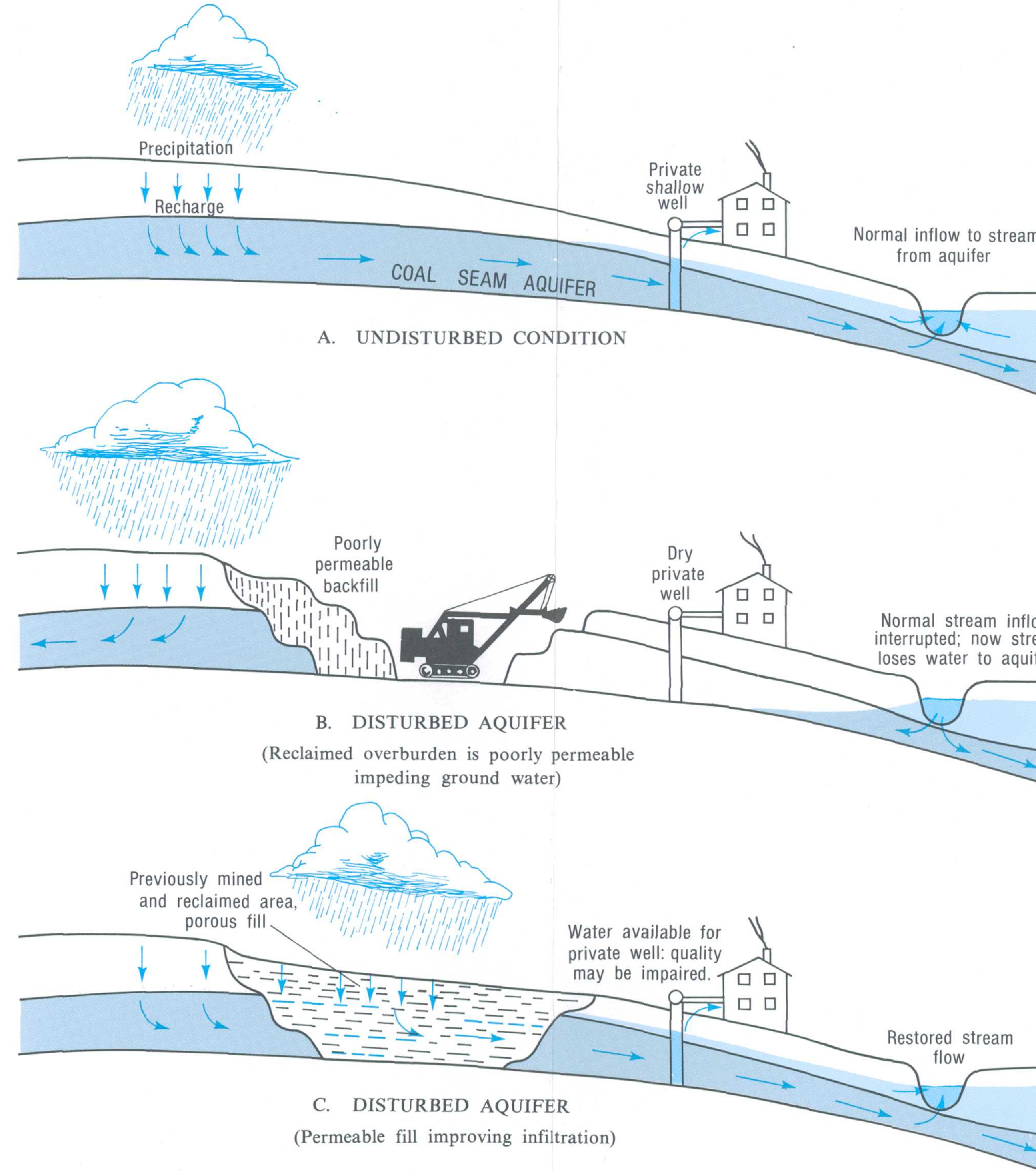


Figure 1.3-2 Possible impacts of mining an aquifer.

Area 13 Mainly Within the Appalachian Plateaus Province

Area 13 is within the Kanawha and Cumberland Mountain sections of the Appalachian Plateaus province, and the Tennessee section of the Ridge and Valley province.

Approximately 95 percent of Area 13 lies within the Appalachian Plateaus province (fig. 2.1-1). The Kanawha section, which extends across Kentucky, Virginia, and West Virginia, includes most of Area 13 (Fenneman, 1938). It is a dissected plateau characterized by narrow, crooked valleys and narrow, irregular steep-sided ridges underlain primarily by sandstones, siltstones, shales, and coals of Pennsylvanian age. The section is within the Levisa Fork, Tug Fork and the Big Sandy River basins.

The southwest corner of Area 13 lies in the Cumberland Mountain section (Fenneman, 1938). This section is a rugged hilly area with steep relief and is bounded by Pine Mountain on the west and a drainage divide with no prominent topographic features on the east. The Cumberland Mountain Section is underlain by sandstones, siltstones, shales, and coals of Pennsylvanian age and is drained primarily by the tributaries of the Russell Fork in southwest Virginia. A belt of Mississippi and Devonian age rocks is exposed on Pine Mountain.

The southeast corner of Area 13 lies within the Tennessee section of the Ridge and Valley province (Fenneman, 1938). This section consists of valley belts and even-crested ridges. The area is underlain by shale, sandstone, limestone and dolomite of Silurian to Cambrian age and is drained by the headwaters of the Tug Fork.

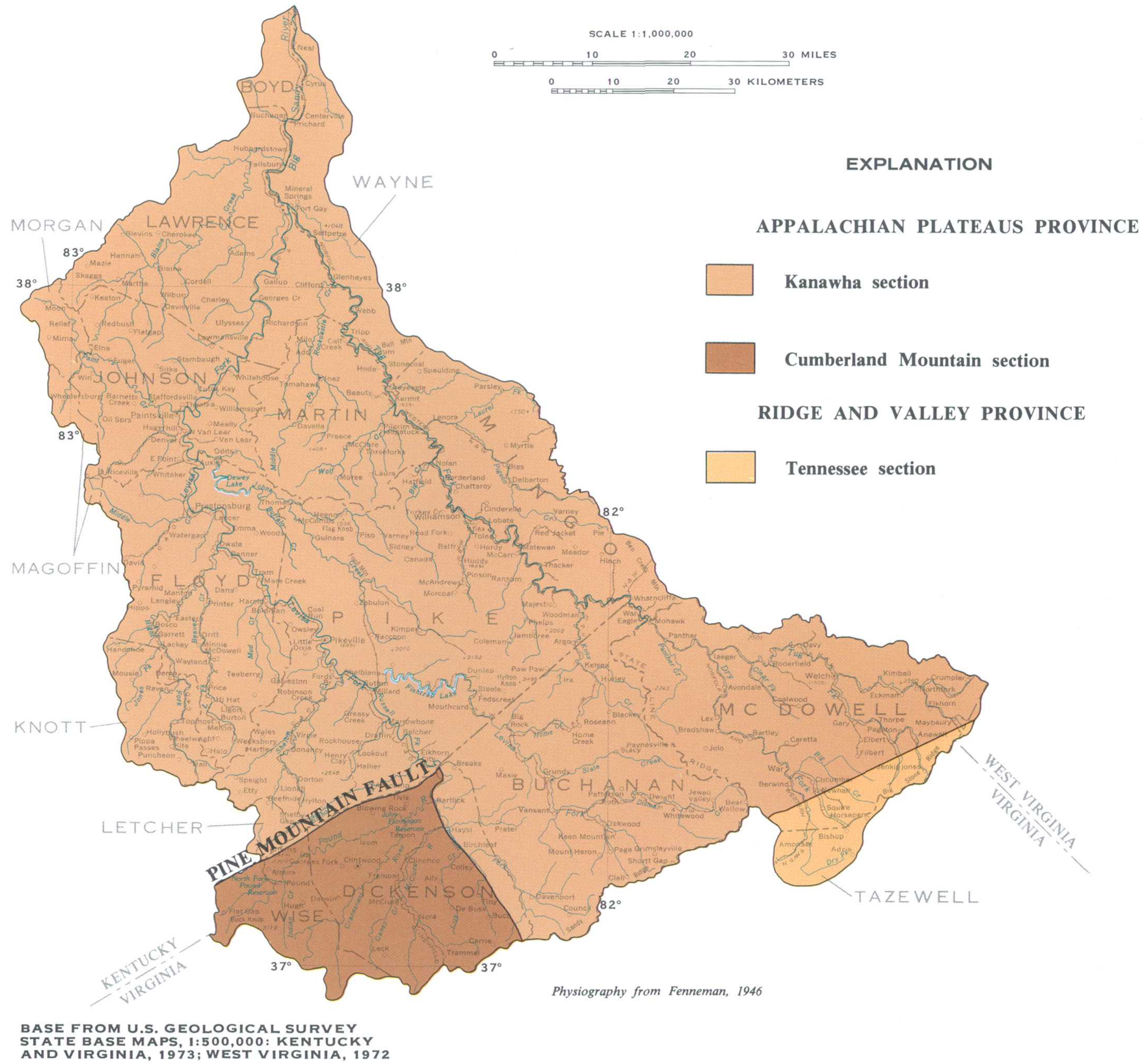


Figure 2.1-1 Physiographic divisions in Area 13.

Five Major Rock Units Underlie Area 13

Rocks underlying Area 13 are subdivided into the Conemaugh, Breathitt, and Lee Formations of Pennsylvanian age. Older rocks of Mississippian to Cambrian age underlie these rocks. Coal occurs in the rocks of Pennsylvanian age.

The nomenclature for Pennsylvanian rocks in Kentucky is used for equivalent units in Virginia and West Virginia. (See correlation chart fig. 2.2-1). The youngest coal bearing rocks, which are of Pennsylvanian age, occur mainly in the northern part of Area 13 in the Conemaugh Formation. The Conemaugh Formation is about 500 feet in thickness and consists mostly of shale, siltstone, and sandstone. The shale and siltstone, of various shades of red, green, and gray, are commonly calcareous, and may contain thin beds of limestone. A few thin and discontinuous coal beds occur in the lower part of the Conemaugh Formation.

The Breathitt Formation of Early and Middle Pennsylvanian age crops out extensively and its maximum thickness is about 3,500 feet. Regionally, the Breathitt and underlying Lee Formation intertongue and both formations thicken greatly to the south. For example, Hauser (1953, p. 10-11) states that in Johnson County the interval from the base of the Breathitt to the Fire Clay coal bed is about 350 feet, but the same interval in southern Pike and Floyd Counties is about 1,900 feet.

The Breathitt Formation consists of siltstone, sandstone, shale, coal, underclay, ironstone, and very little limestone. Most of the minable coal of Area 13 is in the Breathitt Formation. Siltstone and shale commonly intergrade, and rapid lateral changes in lithology are common. The siltstone and shale are carbonaceous and contain plant fragments. The sandstone is commonly fine grained and is characteristically micaceous. Individual sandstone beds of the Breathitt Formation range from 30 to 120 feet in thickness but are generally less massive and resistant than the sandstone beds of the underlying Lee Formation. Ironstone occurs mainly as siderite concretions and thin discontinuous lenses or nodules in the shale or siltstone (Rice and others, 1979).

Reserves for 21 coal beds in the Breathitt Formation in Kentucky were calculated by Harris in Huddle and others (1963). Strata considered equivalent to the Breathitt Formation in Virginia and West Virginia have at least 42 coal beds. The thickness of individual coal beds varies considerably from place to place and reaches a maximum of about 100 inches. Intervals between principal coal beds range from a few feet to more than 300 feet. None of the individual coal beds extend across the entire basin and frequently the same name has been applied to different coal beds, or different names have been applied to the same coal beds. These characterstics in combination with the names used in different states make basin-wide correlation of individual coal beds nearly impossible.

The Breathitt Formation is generally underlain by rocks of the Lee Formation. In some areas, rocks of Late Mississipian age are included in the Lee. The Lee Formation or rocks laterally equivalent to the Lee Formation are exposed in the southeast part of Area 13 and in stream valleys in Johnson and Lawrence Counties, Kentucky. The formation consists of sandstone, conglomerate, shale, siltstone, coal, and underclay. It is characterized by massive beds of orthoquartzite that locally contain lenses of conglomerate. In places sandstone makes up more than 80 percent of the formation. The Lee has been divided into eight members in southeast Kentucky (Rice and others, 1979). Shale, siltstone and coal are frequently interbedded and are more common in the upper part of the formation. Individual sandstone beds are more than 100 feet in thickness and are generally more coarse-grained near the bottom of the unit. In Virginia and West Virginia, rocks correlative with the Lee Formation are typically sandstone that are light gray, fine- to coarse-grained, thin- to thick-bedded, and locally massive. The sandstone contains white-weathering feldspar, mica, and carbonaceous grains.

The Lee Formation increases in thickness southward, from 400 to 500 feet in Johnson County, Kentucky to about 1,800 feet in Virginia. In Kentucky where the Lee Formation is in the subsurface, little information is available on the coal beds. From

Note: 2.2 Major Rock Units text continued from tip-in at left

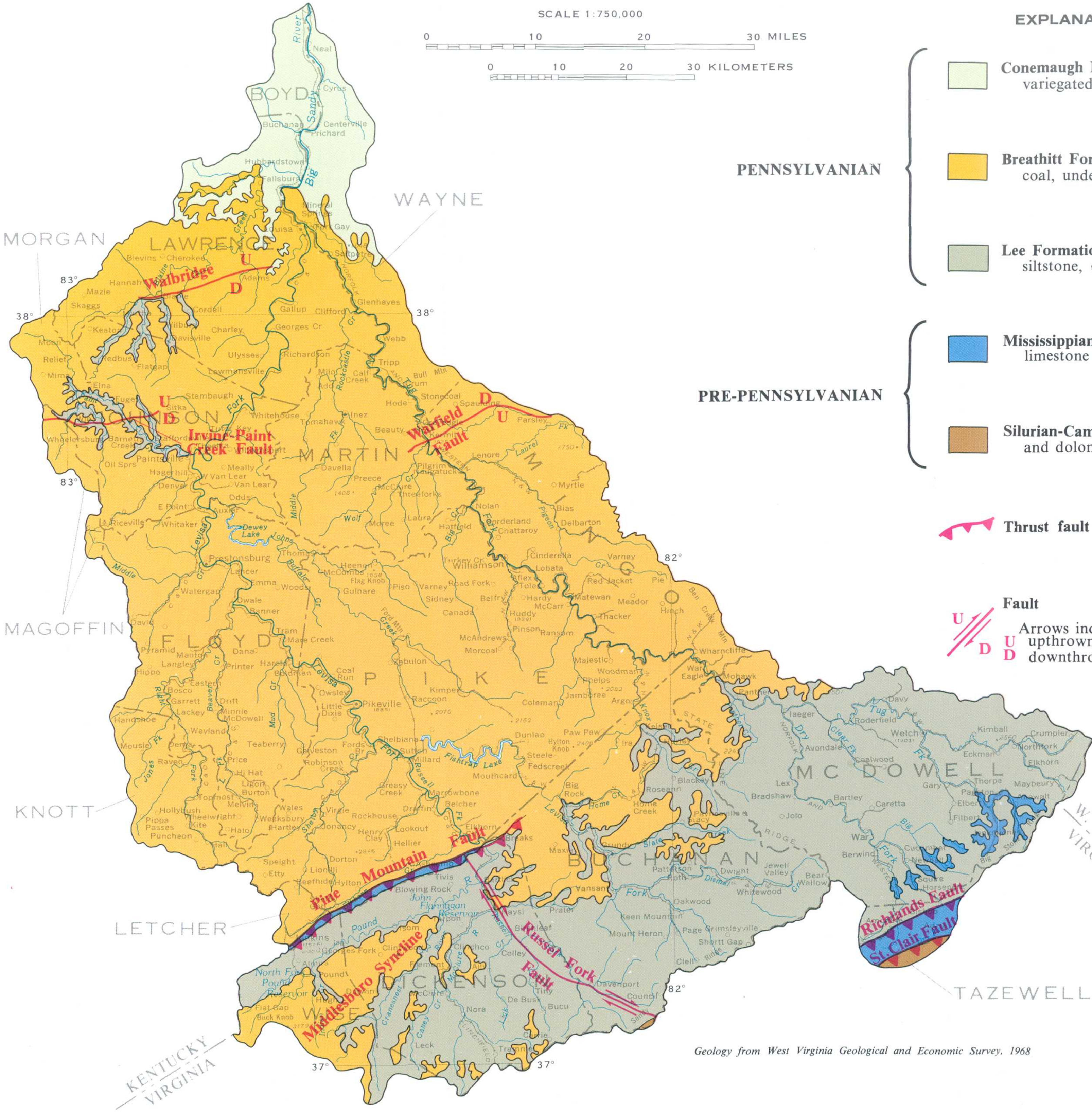
one to four coal beds are present in Johnson County, but only one is mined extensively. The coal beds are discontinuous, thin, and generally less than 20 inches in thickness. As many as 29 coal beds are named in the Lee Formation in Virginia and West Virginia; they range in thickness from less than 12 to 100 inches.

Pre-Pennsylvanian rocks vary in age from Mississippian to Cambrian. Although undifferentiated in this report, these rocks have been grouped into two map units (fig. 2.2-1). The rocks of Mississippian and Devonian age consist of shale, siltstone, limestone, and sandstone. They crop out on the north slope of Pine Mountain and near the southeastern border of the area in Tazewell County, Virginia. These strata range in thickness from about 2,400 to 3,100 feet. The other map unit includes rocks of Silurian, Ordovician, and Cambrian age that are exposed in two small areas along the southeastern border of Area 13. These strata consist primarily of shale, sandstone, limestone, and dolomite. Their thickness is highly variable due to extreme folding and faulting.

Structurally, the pre-Pennsylvanian rocks of Area 13 dip to the southeast. The Pennsylvanian rocks form a broad shallow trough in the eastern Kentucky coal fields (McFarlan, p. 137). The dip of the Pennsylvanian rocks is generally less than 5 degrees to the southeast on the northwestern side of this trough, is essentially flat in the central part, and gradually steepens to the northwest on the southeast side of the trough near Pine Mountain. Rocks on the southeast side of Pine Mountain dip as much as 20 to 30 degrees to the southeast, but are nearly flat-lying in the Middleboro Syncline and in most of Buchanan and McDowell Counties of Virginia.

The major structural feature in Area 13 is the Cumberland overthrust block which is bounded on the northwest by the Pine Mountain Fault and on the northeast by the Russell Fork Fault. Other structural features are shown on the geologic map in figure 2.2-1. In general, the local structures do not hinder the mining of coal except in the vicinity of major faults where the coal beds are disrupted and offset.

The geologic map of Area 13 shown in Figure 2.2-1 is highly generalized. The availability of detailed 7.5 minute geologic-quadrangle maps is shown on the index map (section 10.1). Each map has a geologic columnar section and most have a geologic cross section that shows the stratigraphic relation of coal beds to other rocks. The geology of Virginia and West Virginia is shown on the state geologic maps of Virginia (1963) and West Virginia (1968). In addition, the geology and mineral resources of Area 13 are described in detail in many published reports, some of which are listed in the references.



EXPLANATION

PENNSYLVANIAN

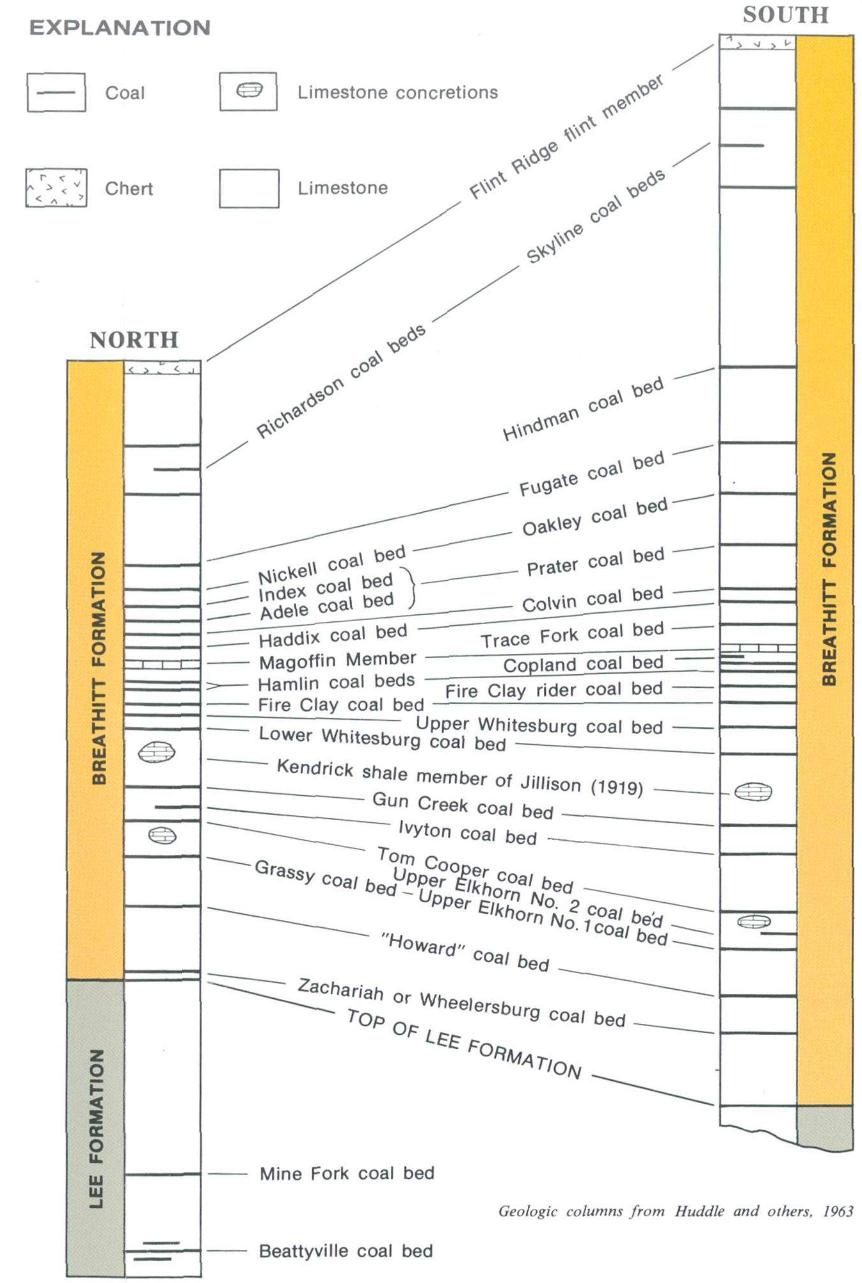
- **Conemaugh Formation** Shale and siltstone, variegated sandstone, and few thin coal beds
- **Breathitt Formation** Siltstone, sandstone, shale, coal, underclay, ironstone, and limestone
- **Lee Formation** Sandstone, conglomerate, shale, siltstone, coal and underclay

PRE-PENNSYLVANIAN

- **Mississippian-Devonian** Shale, siltstone, limestone and sandstone
- **Silurian-Cambrian** Shale, sandstone, limestone and dolomite

Thrust fault Sawteeth on upper plate

Fault U D Arrows indicate relative movement; U upthrown side D downthrown side



Generalized geologic columns showing the variety of coal names and southward thickening of units

CORRELATION CHART

GEOLOGIC SYSTEMS		EASTERN KENTUCKY	VIRGINIA	WEST VIRGINIA REVISED TERMINOLOGY	WEST VIRGINIA FORMER TERMINOLOGY
PERMIAN				Dunkard Group	Green Fm. Washington Fm. Waynesburg Fm.
PENNSYLVANIAN	?				
	LOWER			Monongahela Group	
		Conemaugh		Conemaugh Group	
	MIDDLE		Harlan Fm.	Allegheny Formation	
	UPPER	Breathitt Group	Wise Fm. Gladeville Ss. Norton Fm.	Pottsville Group	Kanawha Formation
					New River Formation
		Lee Formation	Lee Fm.		Pocahontas Formation

Figure 2.2-1 Generalized geology.

Area 13 Comprised Entirely of the Big Sandy River Basin

The Big Sandy River basin is 4,294 square miles at its confluence with the Ohio River; its principal tributaries are Levisa Fork, Tug Fork, and Blaine Creek.

The Big Sandy River basin is Area 13 consisting of 2,284 mi^2 in eastern Kentucky, 990 mi^2 in southwestern Virginia, and 1,020 mi^2 in southwestern West Virginia (Bower and Jackson, 1981; Wilson, 1979; USGS, Richmond, Va., written commun. 1980).

Levisa Fork, with 2,326 mi^2, is the largest drainage basin in Area 13 and flows north from Virginia into Kentucky (fig 2.3-1). The principal tributaries to the Levisa Fork are Dismal Creek and Pound River in Virginia; Russell Fork in Virginia and Kentucky; and Shelby, Beaver, Johns, and Paint Creeks in Kentucky.

Tug Fork flows north from Virginia into West Virginia, and forms the Kentucky-West Virginia state line. The principal streams in the Tug Fork basin are Dry Fork in Virginia and West Virginia; Knox Creek in Virginia and Kentucky; Pigeon Creek in West Virginia; and Rockcastle Creek in Kentucky.

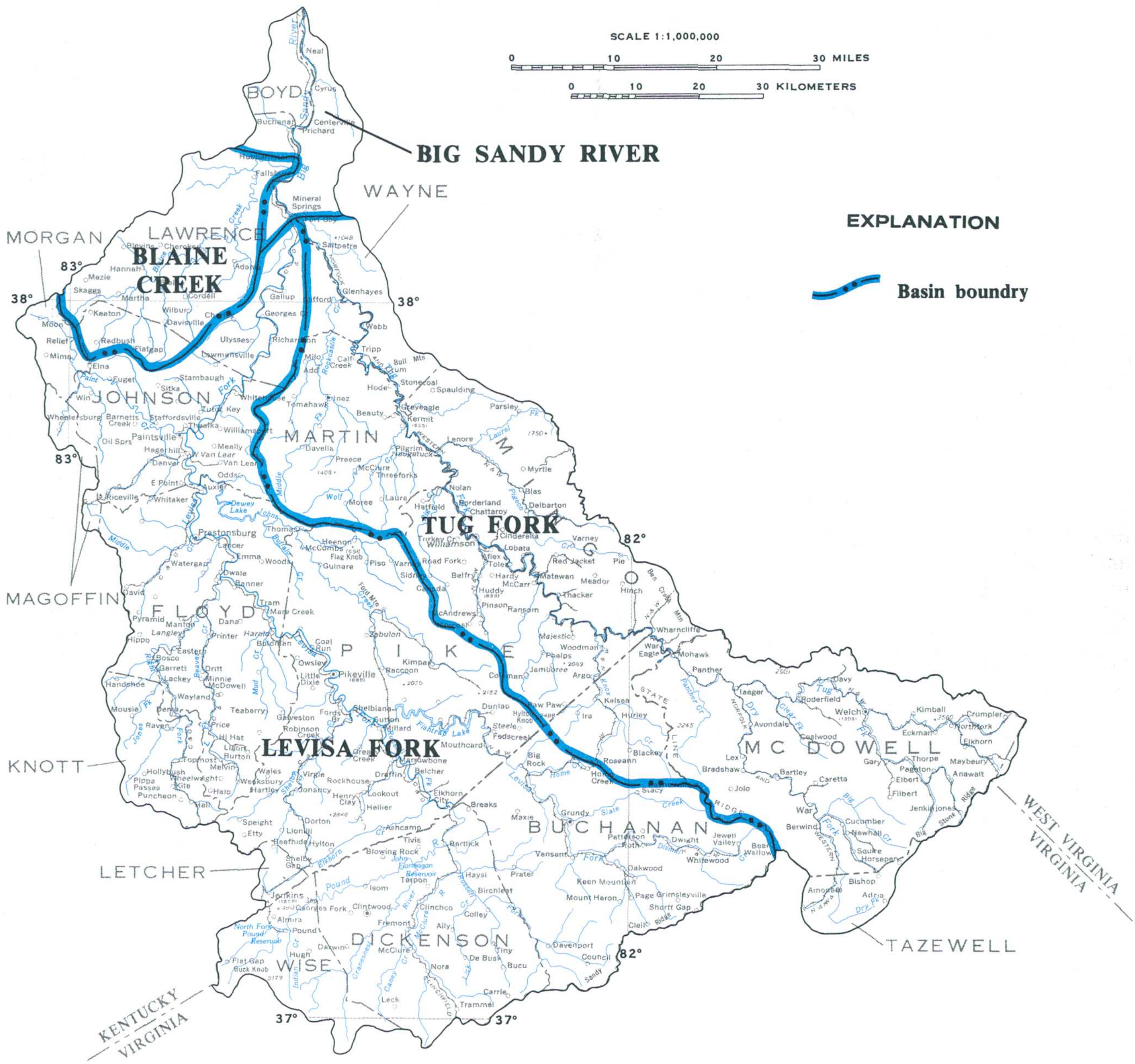
Levisa Fork and Tug Fork join at Louisa, Ky. to form the mainstem Big Sandy River. The Big Sandy River flows north into the Ohio River upstream of Ashland, Ky.. Blaine Creek, which drains into the Big Sandy River at Fallsburg, Ky., is the largest tributary downstream of Louisa. Drainage areas for the principal basins in Area 13 are as follows:

Basin	Drainage area at mouth (mi^2)
Big Sandy River (confluence with the Ohio River)	4,294
Levisa Fork	2,326
Dismal Creek	91
Russell Fork	679
Pound River	221
Shelby Creek	115
Beaver Creek	240
Johns Creek	224
Paint Creek	169
Tug Fork	1,559
Dry Fork	494
Knox Creek	113
Pigeon Creek	142
Rockcastle Creek	121
Blaine Creek	265

There are four reservoirs in Area 13: Fishtrap Lake, on the Levisa Fork, near Millard, Ky.; North Fork Pound River Lake at Pound, Va.; John W. Flannagan Reservoir, on the Pound River, near Bartlick, Va.; and Dewey Lake on Johns Creek near Van Lear, Ky. (U.S. Geological Survey, 1978a, 1978b). A fifth reservoir, Paintsville, which is on Paint Creek near Staffordsville, Ky. is under construction (oral commun. Randy Spurlock, Corps of Engineers, Huntington, W.Va., 1981). All the reservoirs in Area 13 are used for flood control, recreational, and low-flow augmentation. Drainage area; maximum capacity; elevation at which maximum capacity occurs; surface area at normal summer pool; and the elevation of summer pool are given below for each reservoir. All elevations are referenced to the National Geodetic Vertical Datum of 1929.

Reservoir	Drainage area (mi^2)	Capacity (acre-ft) Elevation (feet)	Surface area (acres) Elevation (feet)
North Fork Pound River Lake	17.2	11,290	154
		1,644	1,611
John Flannagan Reservoir	221	145,700	1,145
		1,446	1,396
Fishtrap Lake	392	164,360	1,131
		825	757
Dewey Lake	206	93,300	1,100
		686	650
Paintsville (under construction)	103	73,500	1,139
		731	709

Drainage areas for other selected locations in Area 13 are available from Bower and Jackson (1981), Wilson (1979) and from the United States Geological Survey Offices in Louisville, Ky., Richmond, Va., and Charleston, W. Va.



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972

Figure 2.3-1 Principal streams and major drainage basins.

Forests Cover 92 Percent of Area 13

Deciduous forest land, agricultural land, urban or built-up land and barren land are the four major land uses in Area 13.

A detailed survey of land use and land cover in Area 13 was completed in 1981. Land cover information from 1973 to 1976 from the Landsat satellite data base was used for the survey (fig 2.4-1).

Most of the area is classified as forest land, primarily deciduous, (Anderson and others, 1976) and occupies about 92 percent of Area 13. The other 8 percent is classified as barren, urban, and argicultural land. Barren land, which includes both active and orphan mined areas, is about 2 percent of the total area; agricultural land is about 4 percent; and urban land is about 2 percent. The agricultural land is concentrated in river valleys and flood plains in the northern part of the area. Most of the urban areas are located in the Levisa Fork and Tug Fork flood plains.

Land-use and land-cover information and maps in greater detail than shown in figure 2.4-1 are available in U.S. Geological Survey open-file reports titled Land Use Series. Information on the Land Use Series is available from the National Cartographic Information Center, U.S. Geological Survey, National Center, Reston, VA 22092. Additional land-use information is being collected by the U.S Geological Survey in the Tug Fork basin. This information is being catalogued in association with a project to determine the effects of land use on floods in that basin (personal commun. A.G. Scott, U.S. Geological Survey, Reston, Va., 1981).

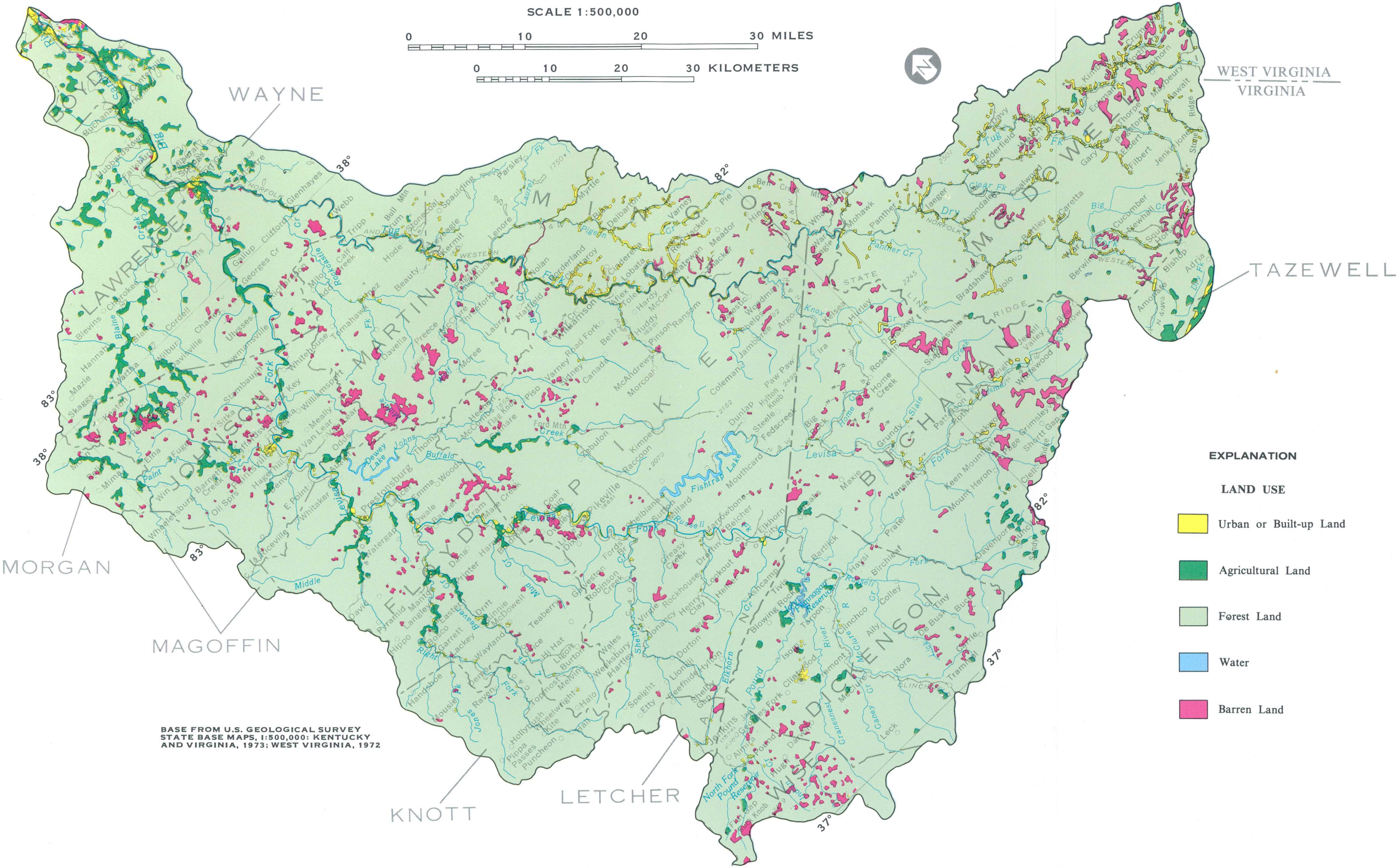


Figure 2.4-1 Land use and land cover, 1973-1976.

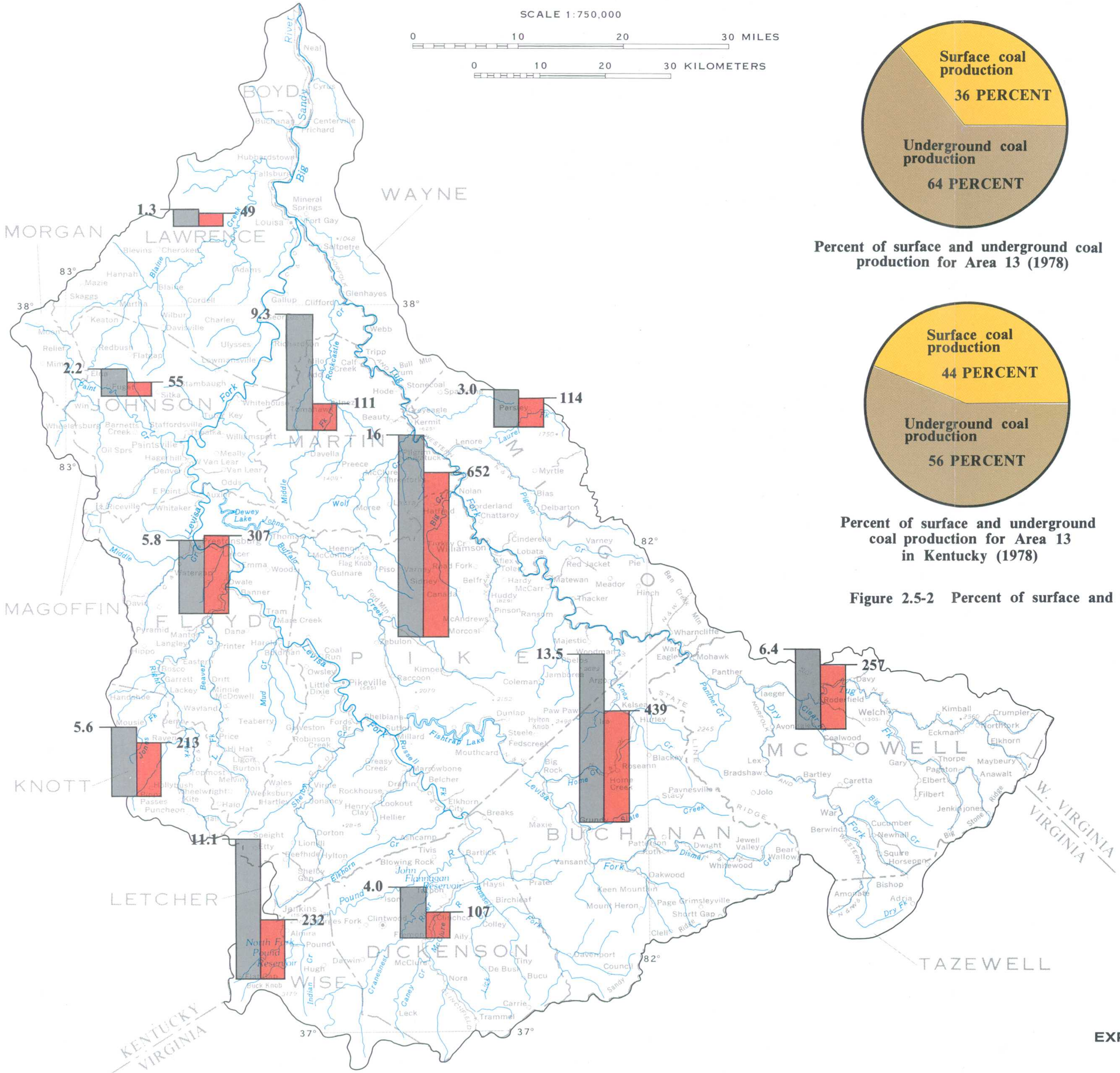
Coal Production in 1978 was 78 Million Tons

Underground mines produced about 50 million tons and surface mines produced 28 million tons of coal in Area 13 in 1978 and 53 percent of the total came from Pike County, Kentucky and Buchanan and Wise Counties in Virginia.

Coal production information presented here is based on production in the Kentucky counties of Floyd, Johnson, Lawrence, Martin, and Pike; the Virginia counties of Buchanan, Dickerson, and Wise; and the West Virginia counties of McDowell and Mingo.

About 78 million tons of coal were produced in Area 13 during 1978 from approximately 2,500 mines (Beard, 1978; Kirkpatrick, 1979; and Miller, W.N., 1978). Of this total, about 28 million tons were produced from about 700 surface mines. More than half of the total coal production during 1978 in Area 13 was from three counties. Pike County, Kentucky was the principal producer with about 16 million tons, followed by Buchanan and Wise Counties, Virginia with 14 and 11 million tons respectively (fig 2.5-1).

Surface mines produced about 36 percent of the coal during 1978 (fig. 2.5-2). Martin County, Kentucky and Wise County, Virginia were the major producers from surface mines. Approximately 222 surface mines in these counties produced about 12 million tons of coal. Data for several years of coal production in Kentucky, shown in figure 2.5-3, indicate that production from surface mining appears to be decreasing (Currens and Smith, 1977) while total production continues to increase. This decrease may be the result of a decrease in the demand for coal. It may also result from the reduction of coal seams which can be economically mined with surface techniques or the conversion of auger strip mines to underground operations. In West Virginia, within Area 13, surface mining accounted for less than 10 percent of the total coal produced in 1978. The terrain within these counties is much more rugged than in Kentucky or Virginia and coal deposits are deeper.



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972

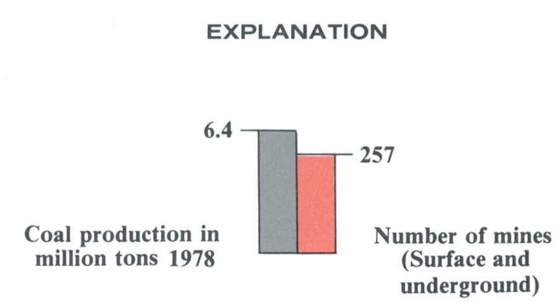


Figure 2.5-1 Coal production and number of mines in Area 13 for 1978, by county.

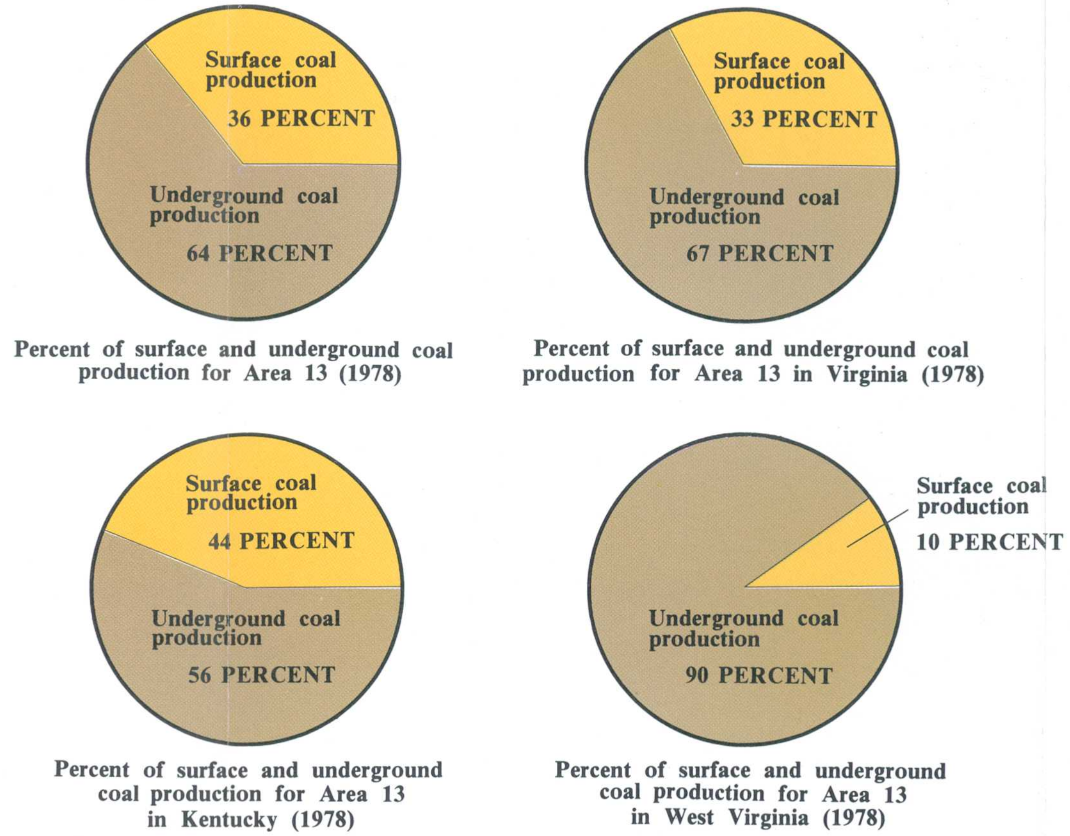


Figure 2.5-2 Percent of surface and underground coal production during 1978.

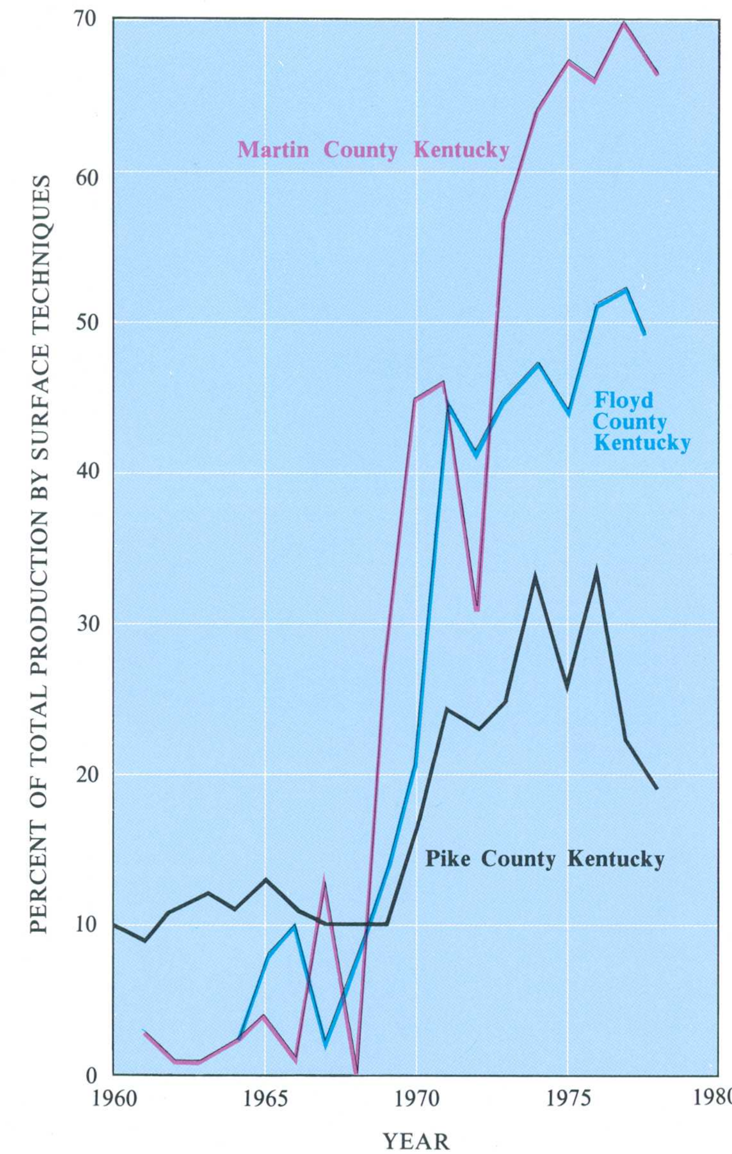


Figure 2.5-3 Percentage of total coal produced by surface mines in three counties in Kentucky.

Soils are Derived from Sandstone, Siltstone, and Shale

Most of the soils are shallow to deep and well drained on steep slopes and are formed from residuum derived from sandstone, siltstone, and shale.

Most of the soils in Kentucky in Area 13 are of the Jefferson-Shelocta soil association (fig. 2.6-1 and table 2.6-1). These are deep, usually well drained, acid soils (pH values less than 7.0), occupying steep slopes, narrow ridge tops, and flood plains. They are formed from residuum (weathering rock products) of sandstone, siltstone, and shale on slopes varying from 20 to 60 percent (Soil Conservation Service, 1979a).

Most of the soils in West Virginia in Area 13 are of the Clymer-Dekalb-Jefferson soil association (fig. 2.6-1 and table 2.6-1). These are deep to moderately deep, well-drained acid soils occupying the steep slopes of the higher mountains. They are formed from residuum of acid sandstone and shale on slopes varing from 3 to 60 percent (Soil Conservation Service, 1979c).

Most of the soils in Virginia in Area 13 are of the Dekalb-Berks-Weikert soil association (fig. 2.6-1 and table 2.6-1). These are shallow to deep, usually well drained, acid soils occupying mountain slopes. They are formed mainly from residuum of acid sandstone and shale on slopes varing from 2 to 60 percent (Soil Conservation Service, 1979b).

There are a number of other soil associations in Area 13 associated with flood plains and terraces of major mountain streams and dissected uplands and mountains (fig. 2.6-1 and table 2.6-2). They occupy relatively small areas and are shown under the classification of assorted associations.

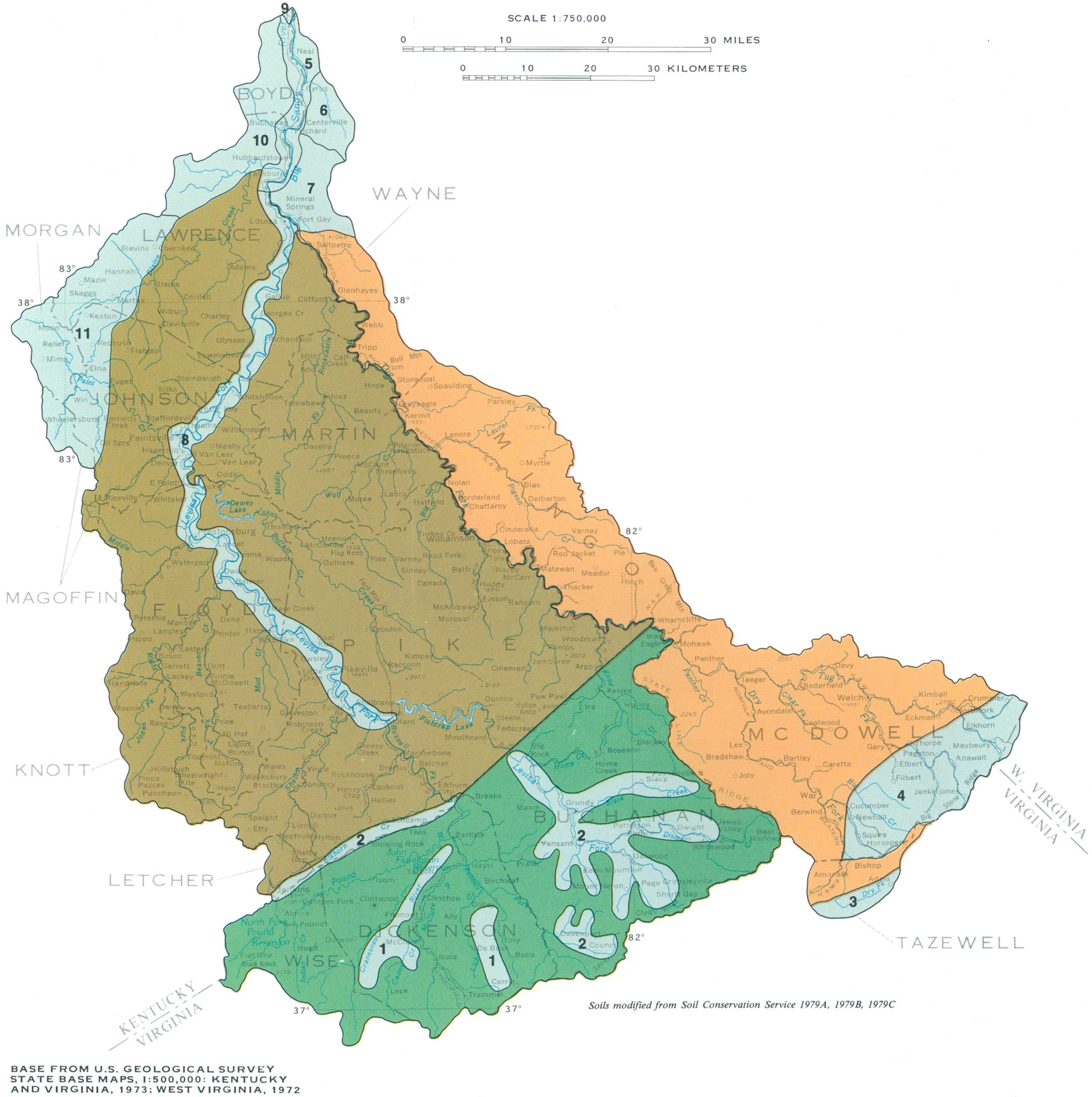


Figure 2.6-1 Generalized soil associations.

Table 2.6-1 General soils characteristics

SOIL ASSOCIATION	PHYSICAL DESCRIPTION	DEPTH TO BEDROCK (FEET)	PERMEABILITY (IN/HR)	SLOPE
Dekalb- Berks- Weikert	Shallow to deep Steep to very steep Soils formed mainly in residium from acid sandstone, siltstone, and shale on mountains	0.8-3.3	0.6-6	2-60
Clymer- Dekalb- Jefferson	Deep to moderately deep Well drained soils Steep side slopes of higher mountains formed from residium from acid sandstone and shale	1.5-8.0	6.2-6.3	3-60
Jefferson- Shelocta	Steep side slopes of higher mountains with narrow ridge tops and flood plains in the Cumberland Mountains formed in residium or creep material from acid sandstone, siltstone, and shale	5-8	0.63-6.3	20-60

Table 2.6-2 Soils grouped in assorted associations

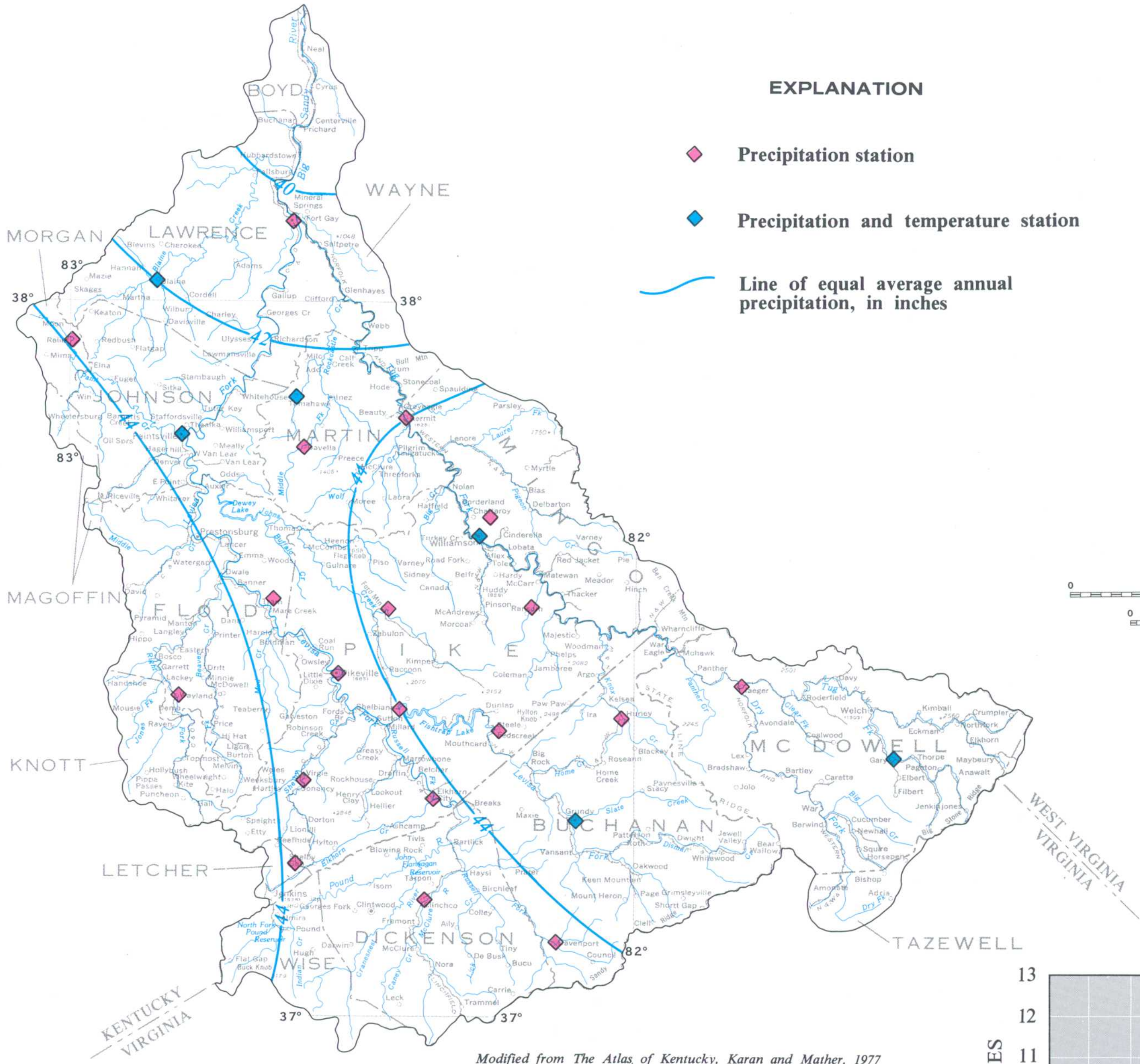
1	Clymer-Dekalb	5	Urbanland - Huntington - Wheeling	9	Elk-Weinbacl-Melvin
2	Jefferson-Dekalb	6	Gilpin-Upshur-Vandalia	10	Vandalia-Upshur
3	Calvin-Berks	7	Clymer-Gildin-Upshur	11	Latham-Shelocta
4	Clymer-Gilpin	8	Pope-Bonnie-Allechem		

Annual Precipitation Averages from 40 to 44 Inches

The 24-hour 10-year frequency of rainfall ranges from 4.0 to 4.4 inches.

Precipitation throughout Area 13 is produced mainly by the interaction of low-pressure westerly systems accompanied by southerly winds bearing moist, warm air from the Gulf of Mexico. Periodically, high pressure systems from the north also produce rain, snow and sleet. Precipitation across Area 13 is fairly uniform, ranging from about 40 to 44 inches per year (fig. 2.7-1). However, average annual precipitation can vary as much as 25 percent from one year to the next. Measurable precipitation is recorded on an average of 110 to 150 days per year (Karen and Mathers, 1977). The average precipitation for August through October is about 23 percent less than the average preciptation for January through May. The high precipitation in July is due to heavy summer thunderstorms (fig. 2.7-2).

Although annual averages of precipitation vary significantly, intense storms are fairly uniform throughout the area. Intense storms are usually produced by southerly systems that cover a large area. The 24-hour 10-year frequency of rainfall ranges from about 4.0 inches in the northern part of the basin to about 4.4 inches in the southern section (fig. 2.7-3). The 12-hour 10-year frequency of rainfall ranges from about 3.5 inches in the north to about 3.8 in the south (National Oceanic and Atmospheric Administration, 1961).



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972

Figure 2.7-1 Average annual precipitation and precipitation stations.

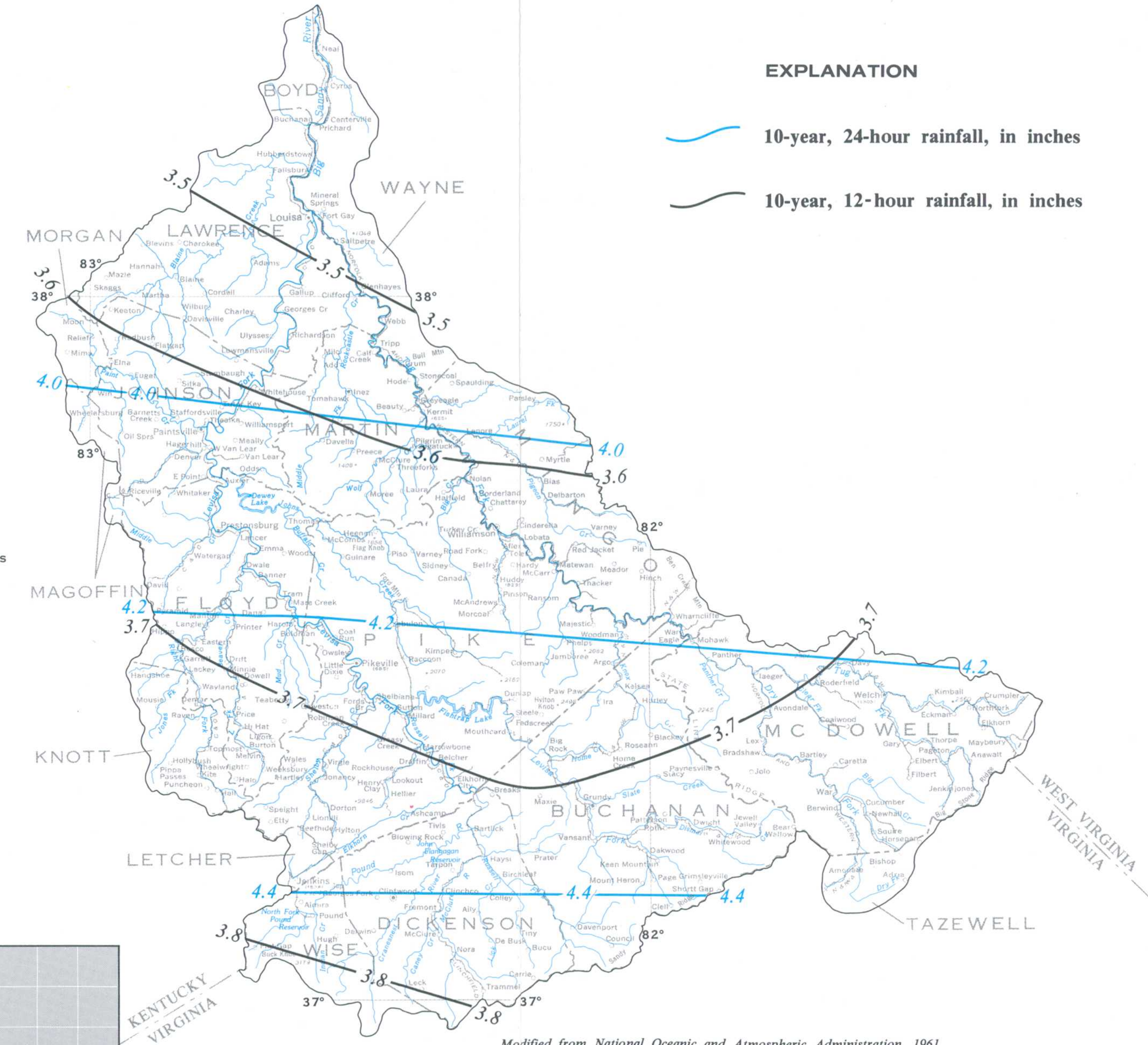


Figure 2.7-3 24-hour and 12-hour 10-year frequency lines of equal rainfall.

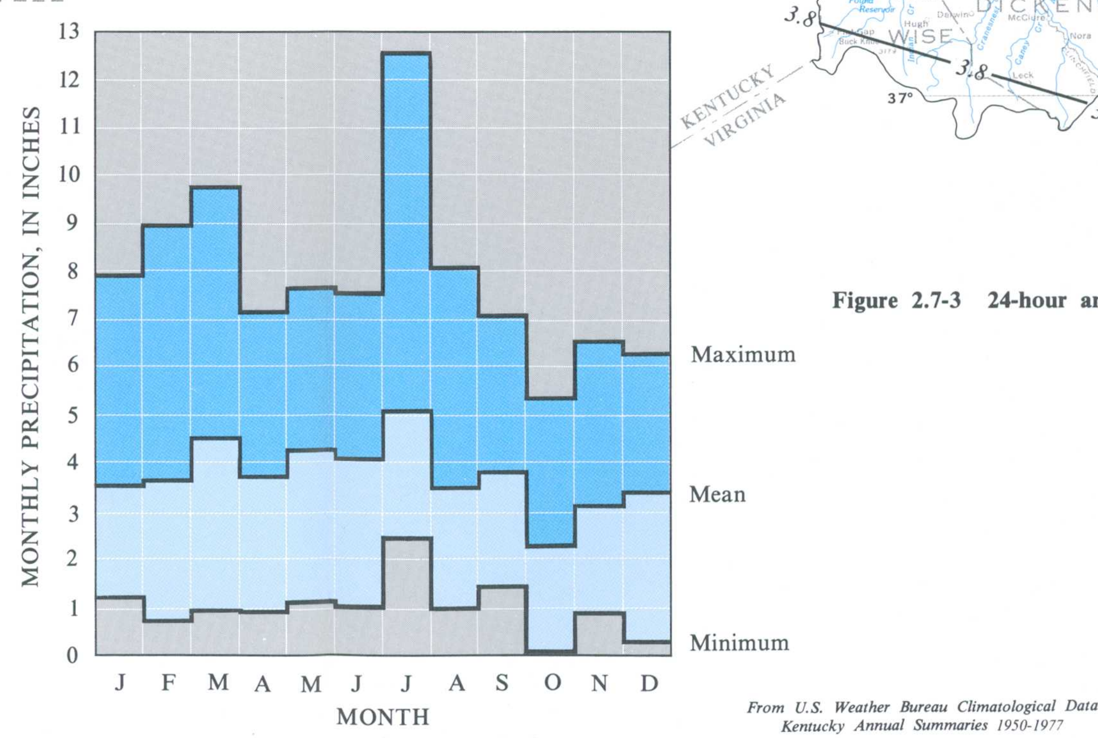


Figure 2.7-2 Monthly maximum, minimum and mean precipitation for Pikeville, Kentucky, 1950-77.

An Average of Fifty-Eight Million Gallons of Water were Used in Area 13 During 1980

Ground water accounted for 61 percent of the water used for public supply, industrial purposes, and rural needs.

Water-use information presented here is based on usage in the following counties; Floyd, Johnson, Lawrence, Martin, and Pike in Kentucky; Buchanan and Dickerson in Virginia; and McDowell and Mingo in West Virginia. Ground water supplied 35.3 Mgal/d or 61 percent of the average 58.1 Mgal/d used in Area 13 during 1980 (fig. 3.0-1).

Industrial uses accounted for 39.9 Mgal/d or 69 percent of the total used (fig 3.0-2) and ground water supplied 23.9 Mgal/d or 60 percent of this total. The largest industrial use was in Lawrence County, Kentucky (13.9 Mgal/d) and McDowell County, West Virginia (22.4 Mgal/d). Coal mining was the largest industrial user. All industrial usages in Mingo and McDowell Counties, West Virginia are associated with mining and half of the 0.2 Mgal/d used for industrial purposes in Virginia were used in mining related activities.

Public water supplies accounted for 8.1 Mgal/d or 14 percent of the total water use (fig 3.0-2). Surface water supplied 6.2 Mgal/d or about 77 percent of this total. The largest public supply use was in the Kentucky Counties of Floyd (1.9 Mgal/d), Johnson (1.7 Mgal/d), and Pike (2.0 Mgal/d).

Rural usages accounted for 10 Mgal/d and ground water supplied 9.4 Mgal/d or 94 percent of this total. Rural uses include water for households, livestock, and irrigation. The largest rural use was in Pike County, Kentucky (3.3 Mgal/d), Buchanan County, Virginia (2.1 Mgal/d), and Martin County, Kentucky (1.7 Mgal/d).

Additional water-use information can be obtained from the following offices:

Kentucky
U.S. Geological Survey, WRD
Room 572 Federal Building
600 Federal Place
Louisville, KY 40202

or

Virginia
U.S. Geological Survey, WRD
Room 304
200 West Grace St.
Richmond, VA 23220

or

West Virginia
U.S. Geological Survey, WRD
Room 3017 Federal Building
500 Quarrier Street, East
Charleston, WV 25301

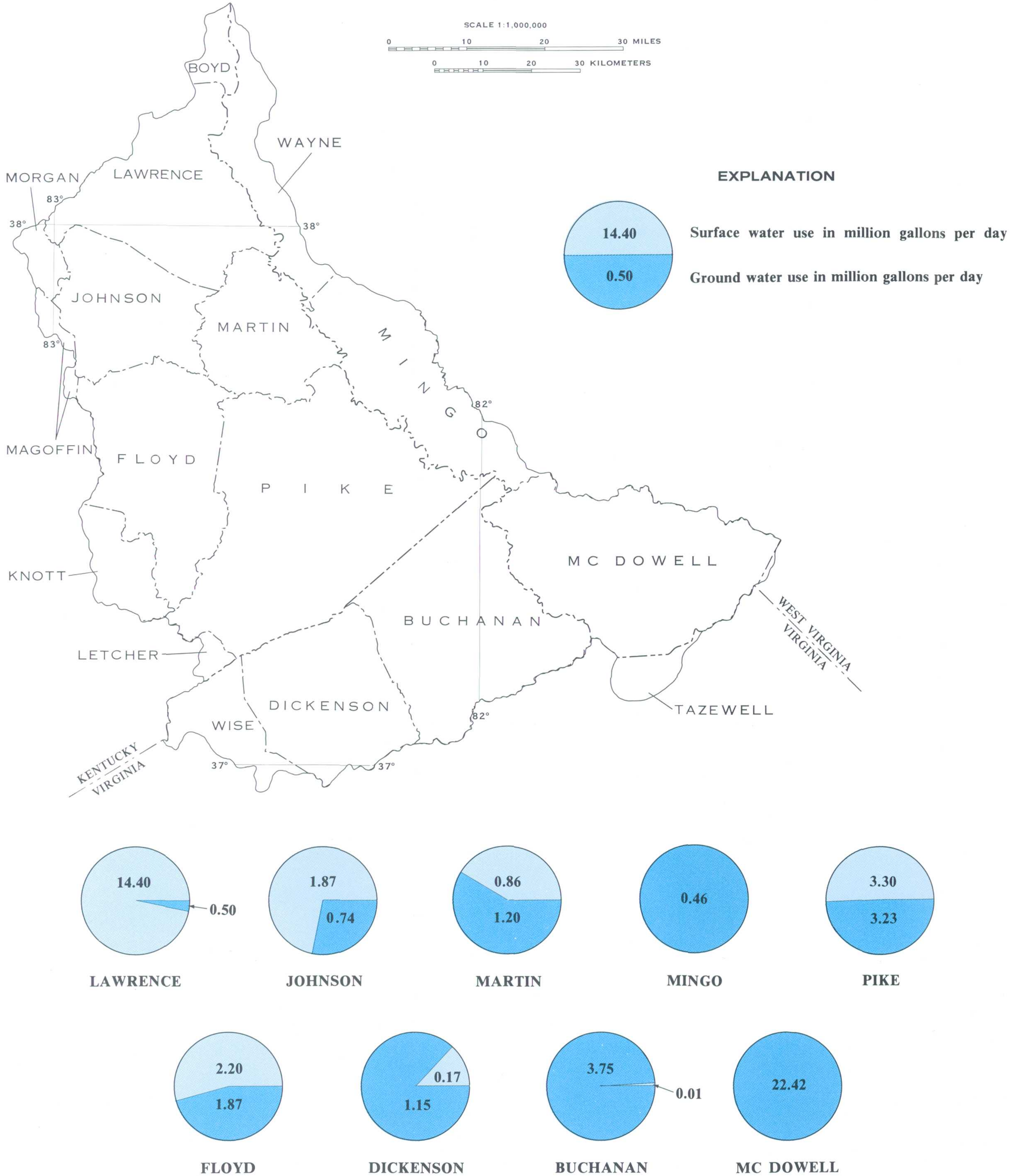


Figure 3.0-1 Water use by counties in 1980 for Area 13.

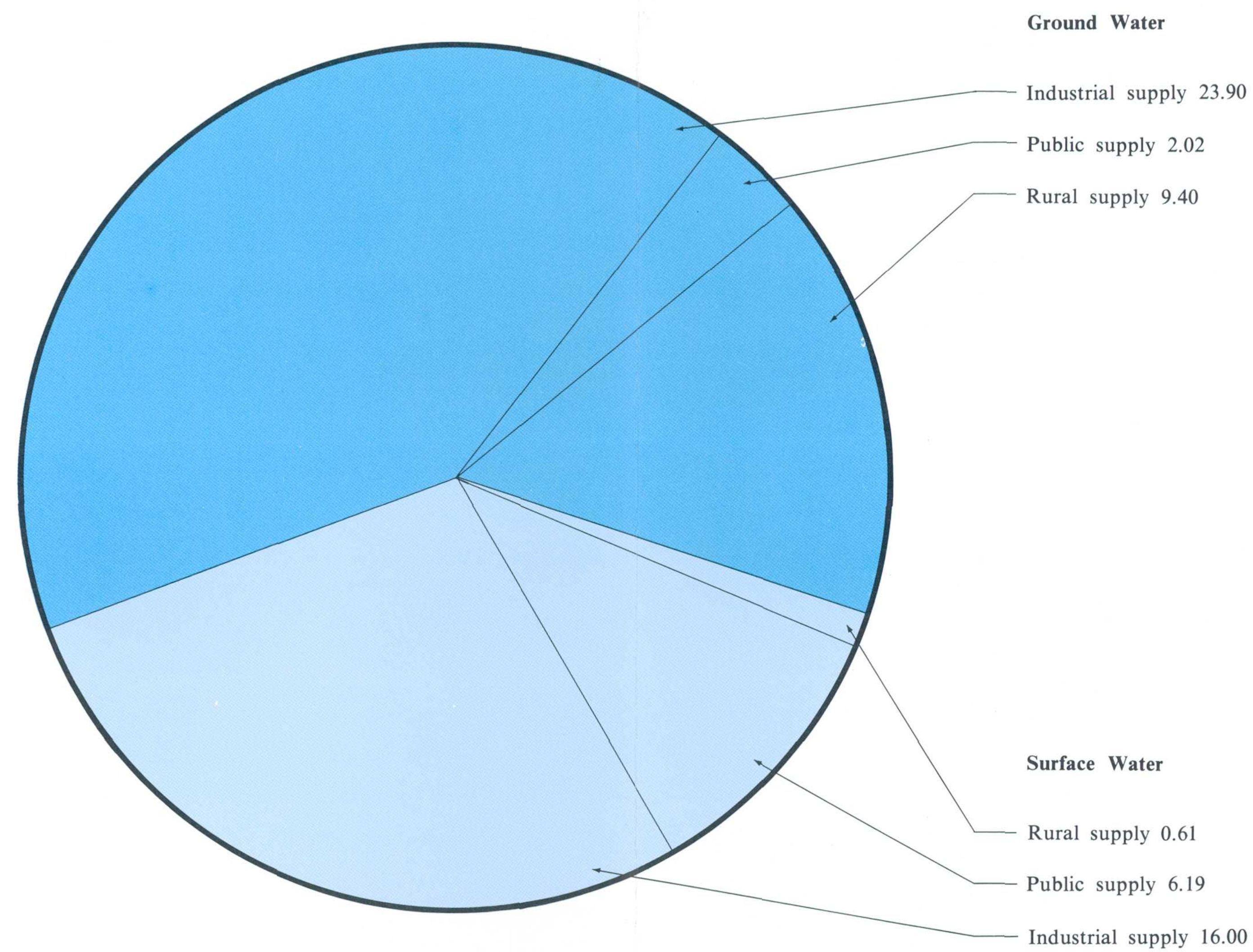


Figure 3.0-2 Water-use distribution for Area 13, in million gallons per day.

Information on Surface Water Available for 296 Sites

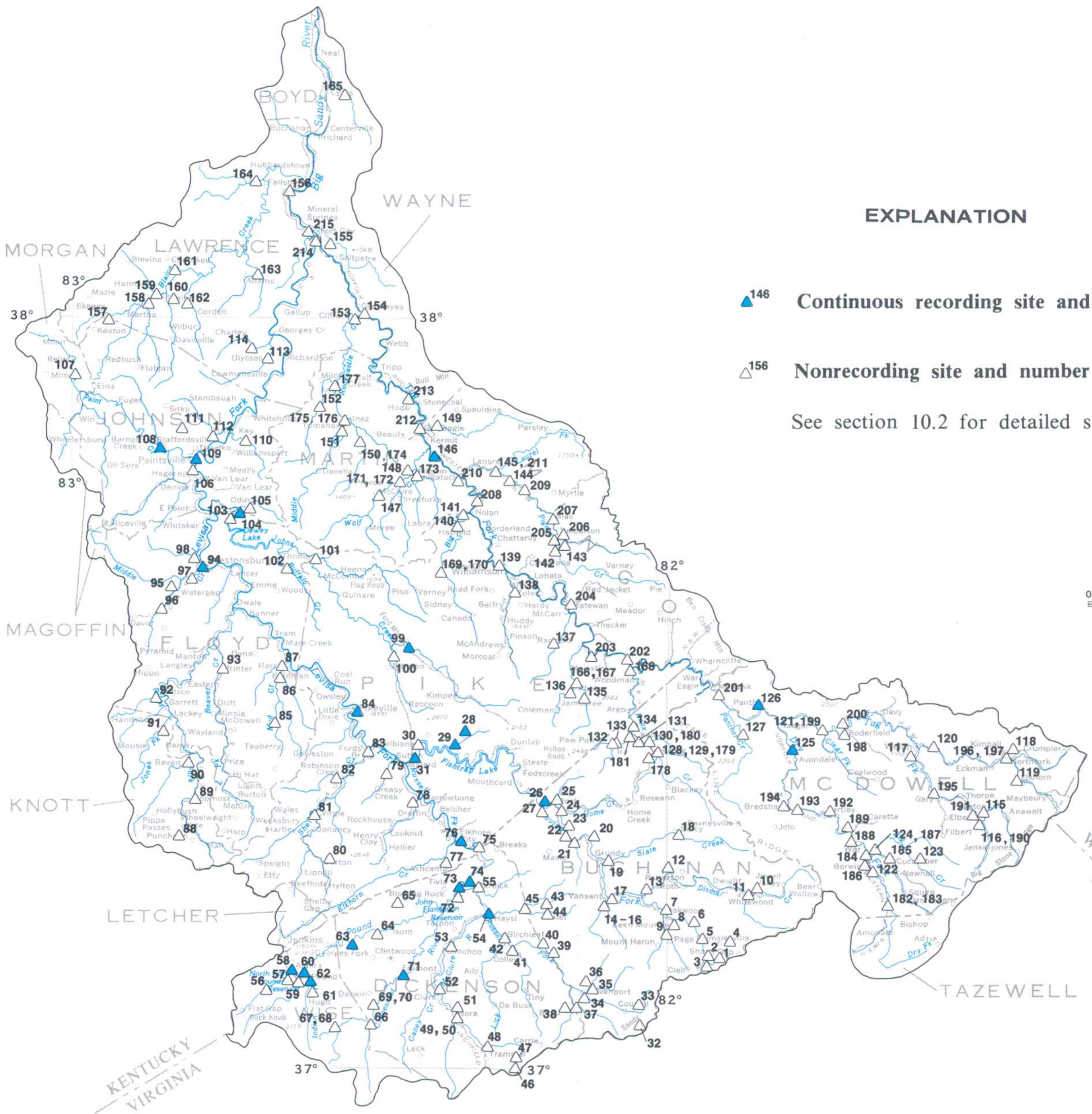
The U.S. Geological Survey surface-water data-collection effort in Area 13 was expanded in response to the Surface Mining Control and Reclamation Act of 1977. Information on surface water is now available for 215 active and 81 inactive sites.

Streamflow and water-quality information is available for 215 active and 81 inactive sites. Prior to the passage of the Act, data were available for only 115 active sites and 29 inactive sites. In support of the Act, 102 surface-water data collection sites were established in 1979 and 52 of the previous 115 active sites were discontinued, bringing the total of active sites in 1979 to 165 and the number of inactive sites to 81. During 1980 an additional 50 sites were established. Details on the location, period of record and type of data available are given in figure 4.1-1 and section 10.2 for the active sites and in figure 4.1-2 and section 10.3 for the inactive sites.

Twenty-two active sites have instrumentation to record stream stage continuously with time. This type of data is also available for 17 of the 81 inactive sites. These data can be converted to stream discharge after each station is rated or calibrated. Records of stream stage and flow are valuable data which can be used to analyze the hydrology of basins, to design structures, and to determine water availability. Various data analysis techniques, such as flow-duration curves, flood-frequency relations, and low-flow analyses (to be presented in subsequent sections) rely on a record of stage and discharge with time.

Streamflow data are published in the annual reports "Water Resources Data for Kentucky", "Water Resources Data for Virginia", and "Water Resources Data for West Virginia". The information is also readily available through the National Water Data Exchange (NAWDEX) as described in section 9.2.

Surface-water quality data were limited prior to 1979 when the water-quality collection effort was expanded in response to the Act. This expansion of data-collection occurred in two ways; collection on a regular 6-week interval of water-quality data at selected continuously recording sites, and collection of water-quality data at supplemental sites on streams where streamflow was not continuously recorded. These supplemental sites were generally on smaller streams where the influences of mining were more apt to be measured. Streamflows were measured and water samples were collected for selected physical and chemical analyses at approximately three month intervals in order to determine seasonal quality and quantity variations. All water-quality sampling was done as simultaneously as possible in the three states to provide area-wide water-quality data during a particular flow condition. Surface-water quality data are available from the "Water Resources Data" reports for Kentucky, Virginia, and West Virginia or from NAWDEX.



EXPLANATION

▲146 Continuous recording site and number

△156 Nonrecording site and number

See section 10.2 for detailed site description.

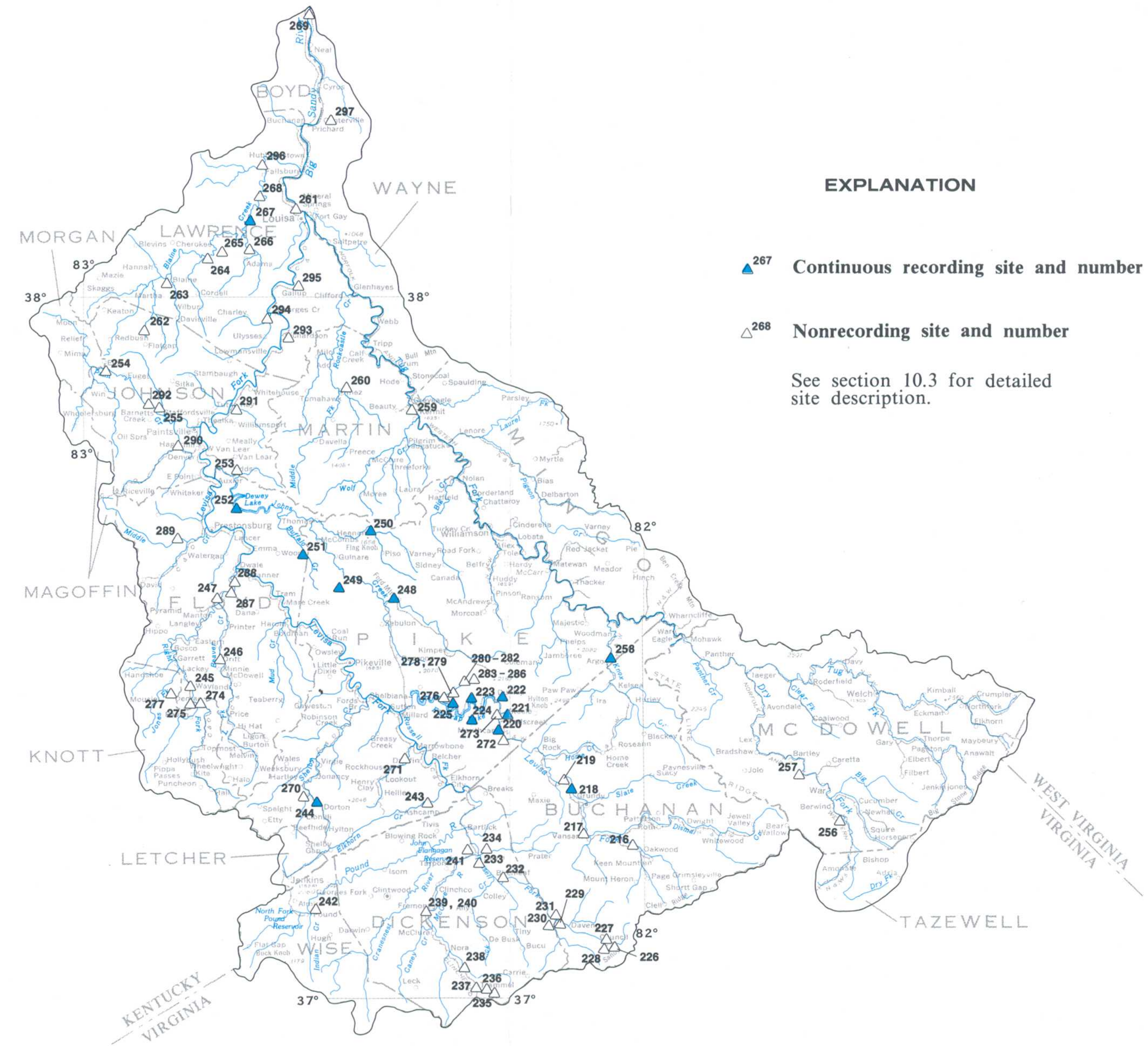
SCALE 1:1,000,000

0 10 20 30 MILES

0 10 20 30 KILOMETERS

BASE FROM U.S. GEOLOGICAL SURVEY
STATE BASE MAPS, 1:500,000: KENTUCKY
AND VIRGINIA, 1973; WEST VIRGINIA, 1972

Figure 4.1-1 Surface-water sites active in 1979.



EXPLANATION

▲267 Continuous recording site and number

△268 Nonrecording site and number

See section 10.3 for detailed site description.

Figure 4.1-2 Inactive surface water sites.

Ground-Water Data Available for 291 Sites

Miscellaneous information from a large number of domestic and industrial wells is available but there are no active long-term observation wells in Area 13.

Surface mining and other land disturbances can alter the quality and quantity of ground water. Price and others (1962b) summarized the type of well, depth to water, and depth of wells as of 1961 in Floyd, Martin, and Pike Counties Kentucky, in Hydrologic Atlas 36 (fig. 4.2-1). Data for Johnson and Lawrence Counties are summarized in Hydrologic Atlas 37 (Price and others, 1962a). Data for Buchanan County, Virginia are summarized by Epps (1978).

The locations of wells in all three states for which chemical analyses of water are available are given in section 10.4. Data from these analyses were used in the summary of ground-water quality in section 8.0.

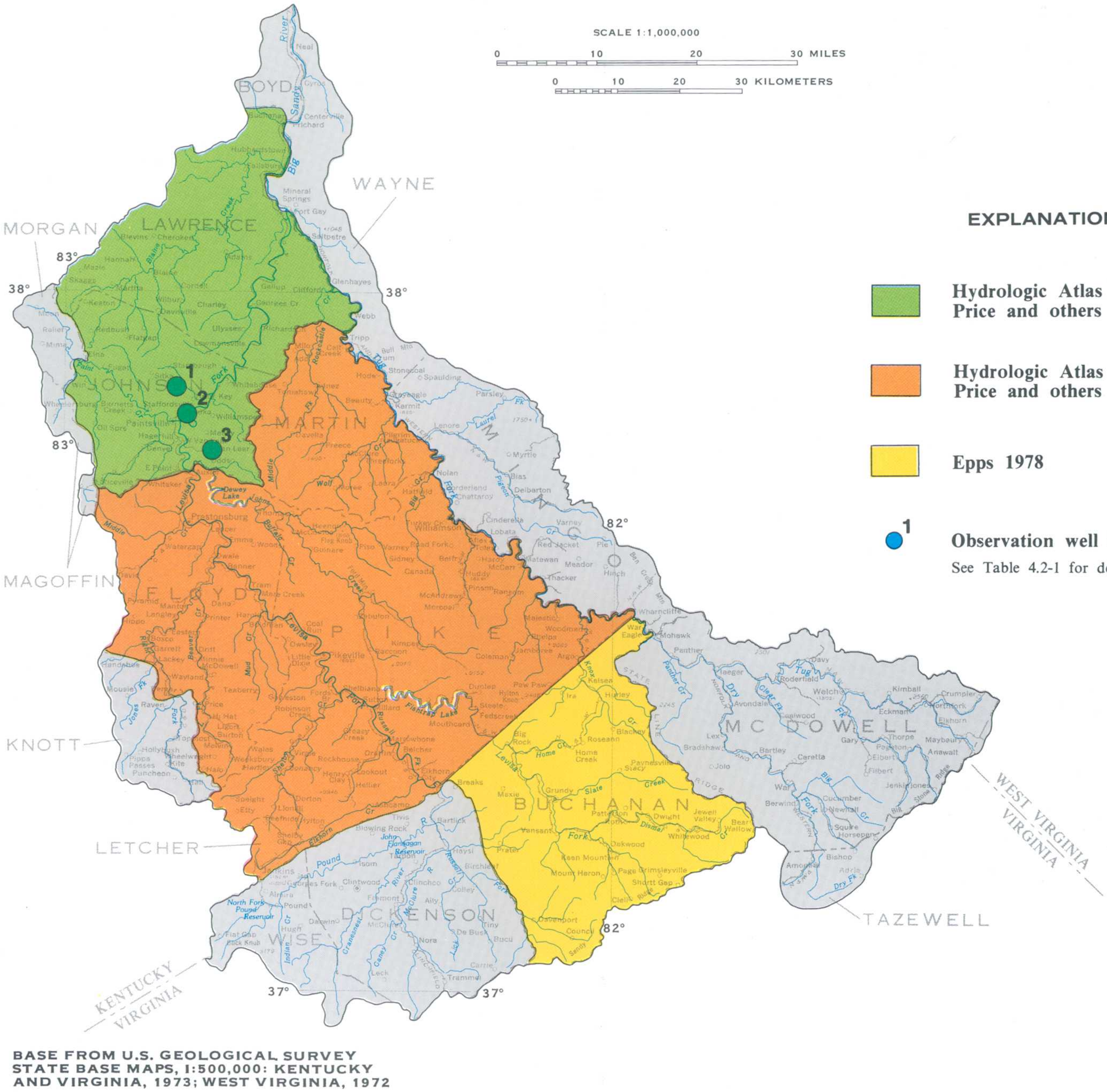
Long-term water-level information is available for three wells (fig. 4.2-1 and table 4.2-1). Although these ground-water monitoring wells were discontinued in 1971, 1976, and 1977 their records provide some information on long-term water-level trends in Area 13.

A study of the hydrogeology of the Eastern Coal Field Region in Kentucky was begun in 1980 by the Kentucky Geological Survey. This study will gather additional data on the aquifers in the area and will establish a system of observation wells to supplement the present ground-water monitoring program.

Ground-water data collected for this report as well as historical data, are published in the annual reports "Water Resources in Kentucky", "Water Resources in Virginia", and "Water Resources in West Virginia". The information is also readily available through the National Water Data Exchange (NAWDEX) as described in section 9.2.

Table 4.2-1 Ground-water stations equipped with continuous recorders

SITE NUMBER	SITE IDENTIFICATION NUMBER	DEPTH OF WELL, IN FEET	FORMATION TAPPED	PERIOD OF RECORD
1	375052082484401	585	Lee	1968-77
2	374818082455901	79	Alluvium	1950-52, 1960-71
3	374610082453001	115	Breathitt	1951-76



EXPLANATION

Hydrologic Atlas 36
Price and others 1962

Hydrologic Atlas 37
Price and others 1962

Epps 1978

1 Observation well and number

See Table 4.2-1 for detailed description.

Figure 4.2-1 Recording ground-water observation well network and summary of ground water availability reports.

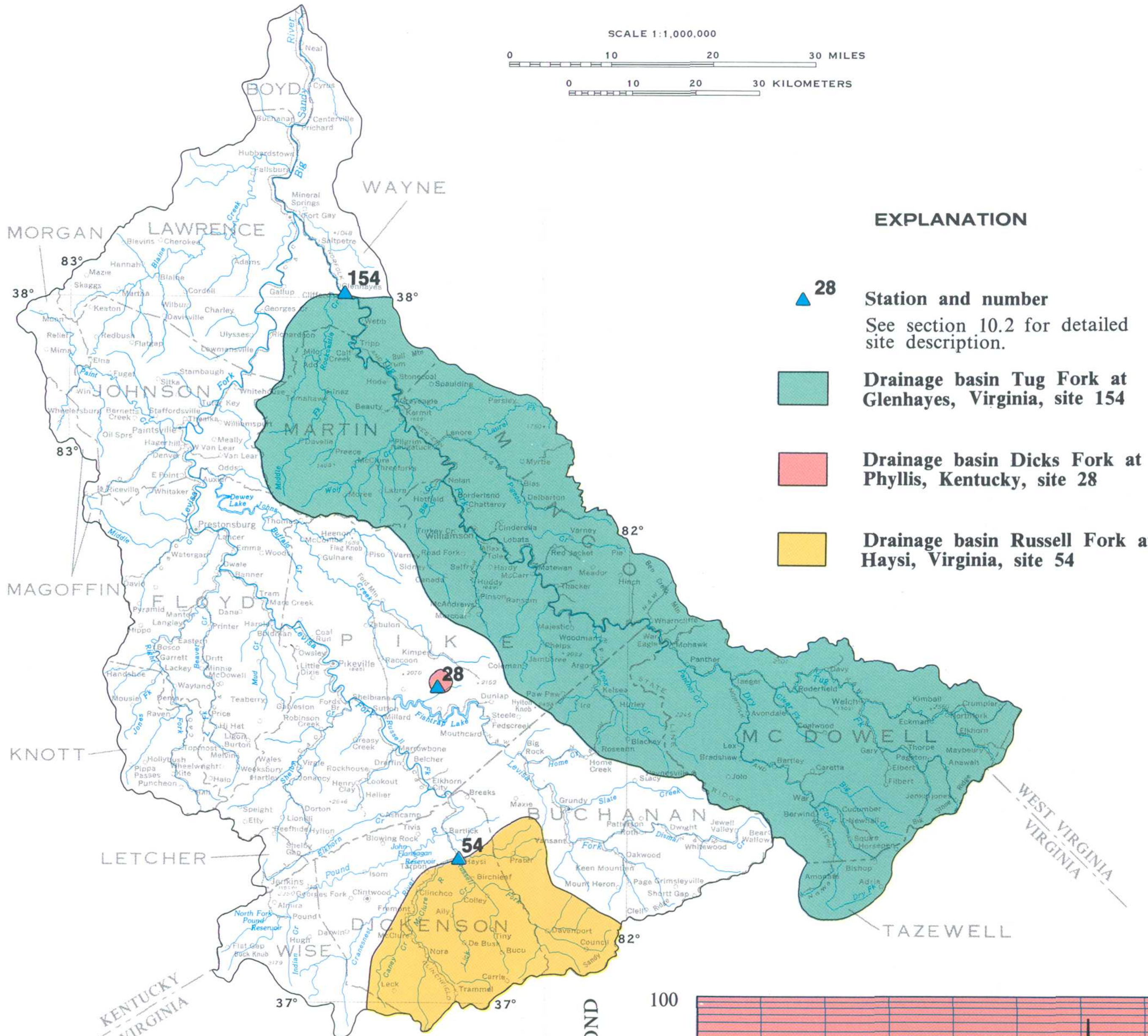
Streamflow Varies Seasonally

Mean daily discharges of streams fluctuate seasonally with precipitation and evapotranspiration. Streamflow on the Levisa Fork and some of its tributaries is regulated by dams.

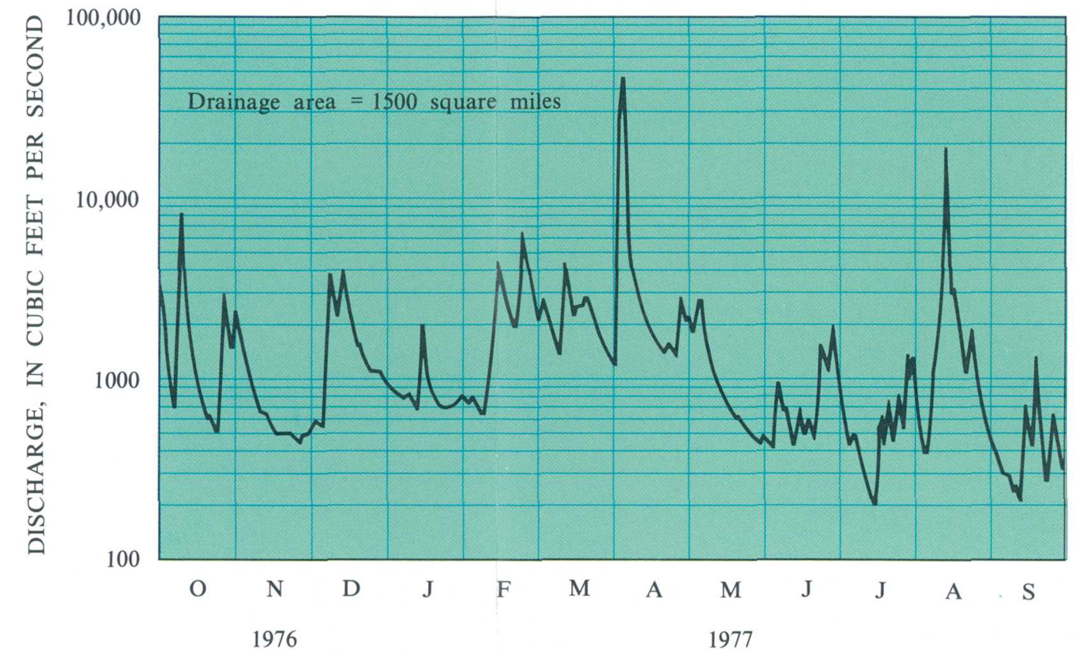
Streamflow throughout Area 13 varies seasonally with precipitation and evapotranspiration. However, flows in the main stem of Levisa Fork, Johns Creek, and Pound River are regulated by dams, thus minimizing the precipitation effects. Evaporation effects are increased due to the large free water surface of the lakes.

Streamflows at sites throughout Area 13 increase during the first part of the water year, which begins in October and ends in September, as precipitation increases and evapotranspiration decreases. Increasing precipitation, both as rain or snow, augments the flows through the winter months and spring thunderstorms help maintain a relatively high runoff through May. Increasing evapotranspiration tends to decrease streamflow during the summer months (fig. 5.1-1). The low-flow season normally begins in August and lasts through October.

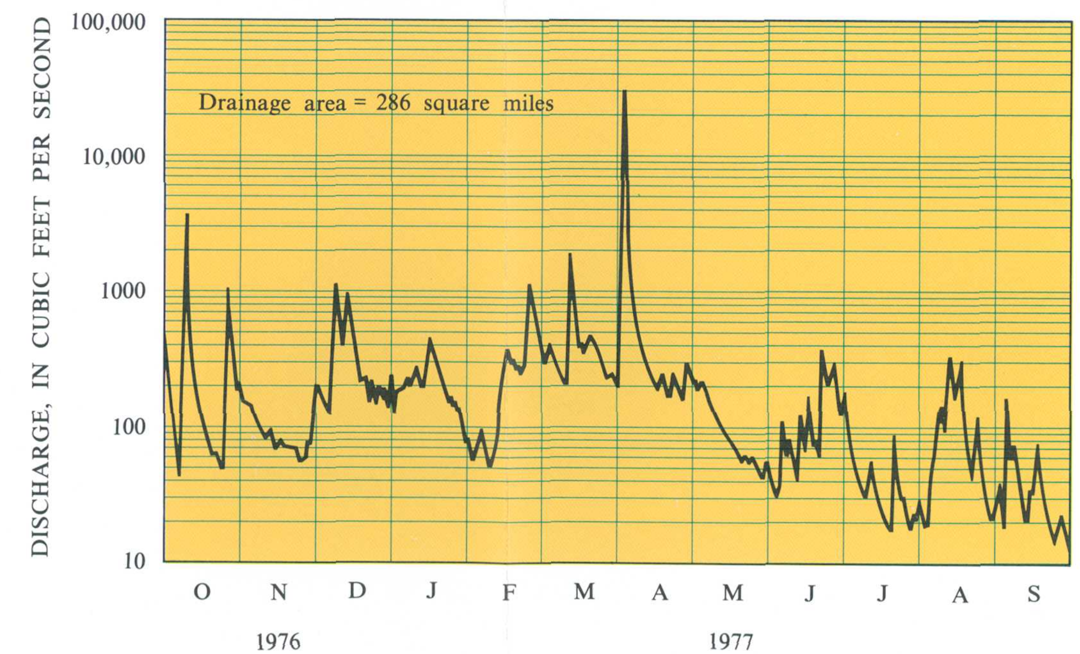
The flow of the Levisa Fork basin, (2,326 mi^2), is regulated by four reservoirs and a fifth reservoir is nearing completion (see section 2.3). The four reservoirs regulate streamflow from 836 mi^2 (36 percent) of the basin and the fifth will regulate an additional 103 mi^2 (4 percent) of the basin.



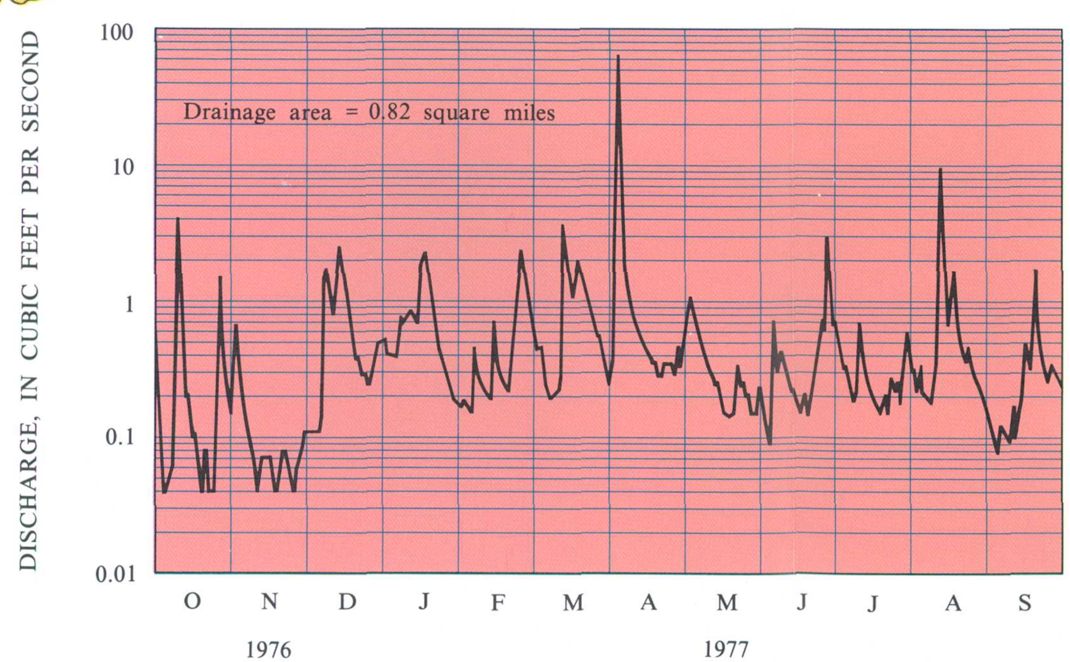
BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972



Tug Fork at Glenhayes, West Virginia, mean daily discharge, 1977 water year.



Russell Fork at Haysi, Virginia, mean daily discharge, 1977 water year.



Dicks Fork at Phyllis, Kentucky, mean daily discharge, 1977 water year.

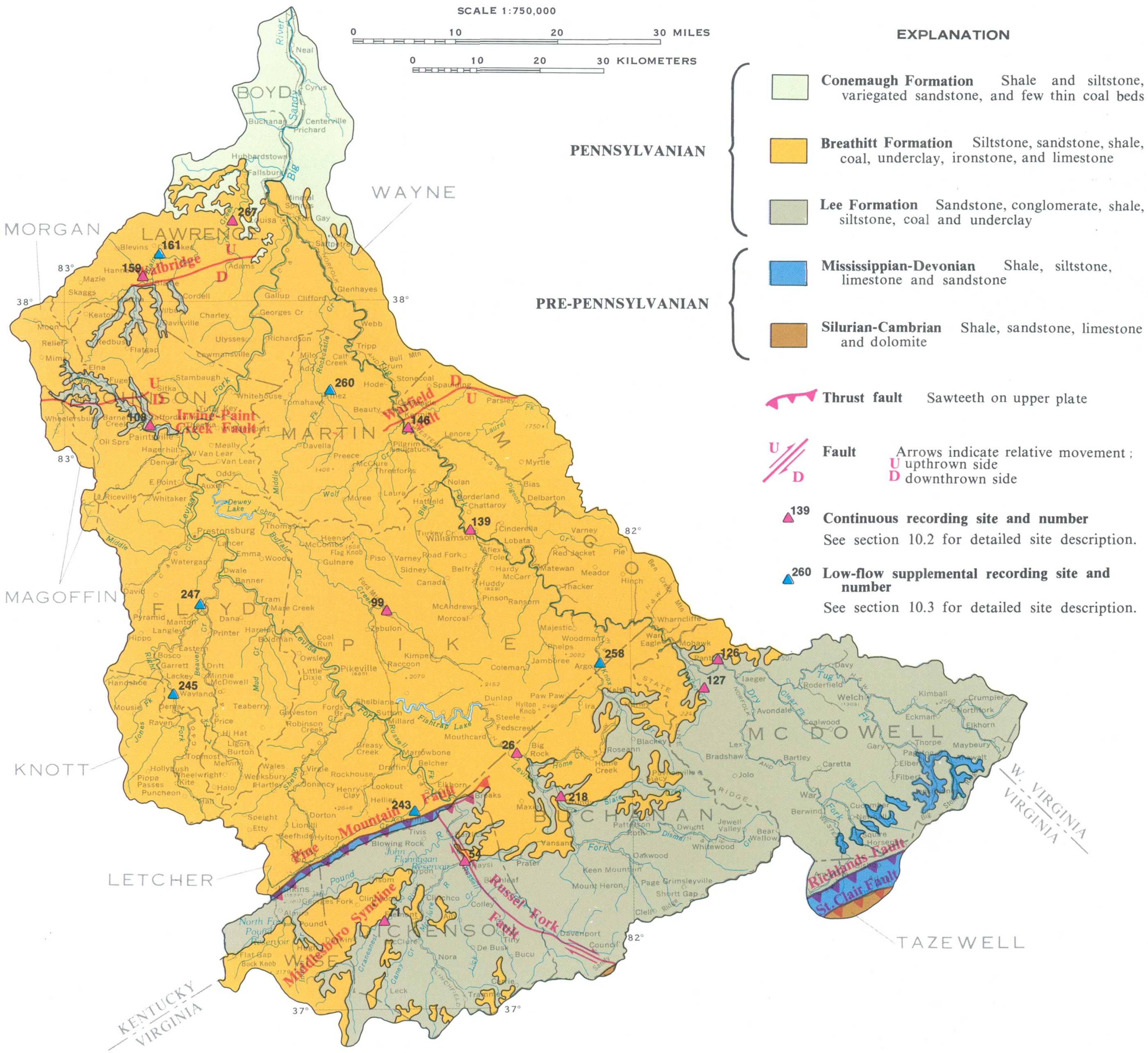
Figure 5.1-1 Mean daily discharge hydrographs for selected sites in Area 13.

Low-Flow Data Available for 18 Sites in Area 13

Low-flow sites range in size from 30.8 to 3,892 square miles and the 7-day 10-year low flows range from 0 to 76.2 cubic feet per second.

A network of low-flow stations has been in operation throughout Kentucky for many years. Some results of the flow frequency analyses at continuous recording, and from supplemental, low-flow partial record sites, were published in 1974 and 1980 (Swisshelm, 1974; Sullavan, 1980). Data are available for 18 sites in Area 13, consisting of 10 in Kentucky, 4 in Virginia, and 4 in West Virginia (fig. 5.2-1). Drainage areas of the sites range from 30.8 to 3,892 mi^2, with only 2 sites less than 50 mi^2 and only 7 less than 100 mi^2 (table 5.2-1). Basins of similar size with drainage areas predominately in the Lee Formation generally have greater 7-day 10-year low flows than sites with drainage basins predominately in the Breathitt Formation (fig. 5.2-2).

The topography and geology of an area are the most important factors controlling low flow. The steep basin and channel slopes in Area 13 cause rapid runoff. This, in addition to the semi-impervious nature of the rocks, results in insignificant recharge to the ground-water system. Thus, there is little ground water available to sustain base flow and many of the small mountain streams stop flowing at times during the period of August through October.



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972

Figure 5.2-1 Low-flow network.

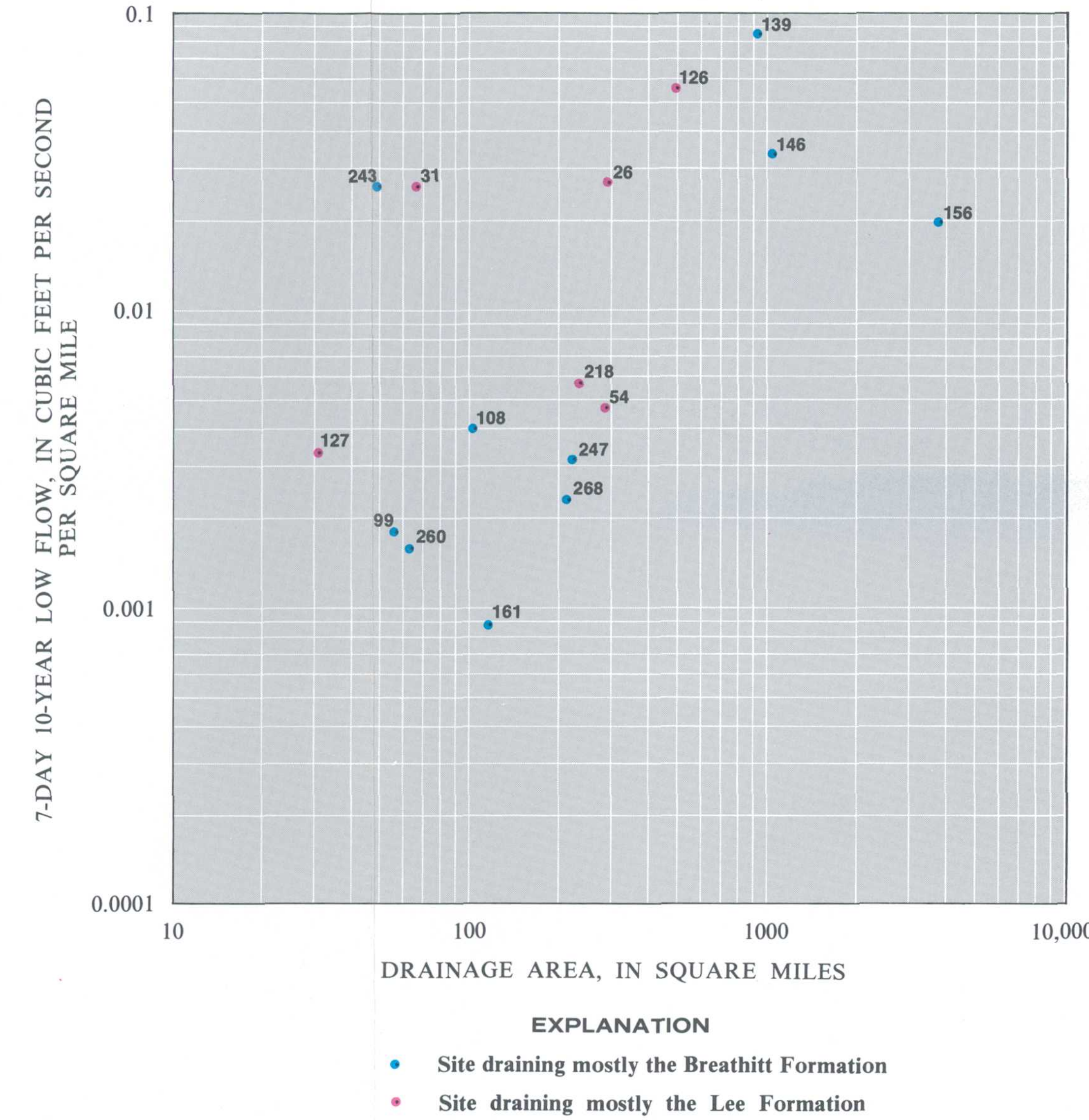


Figure 5.2-2 7-day 10-year low flows for sites draining the Lee and Breathitt Formations in Area 13.

Table 5.2-1 7-day 2-year and 7-day 10-year low flows at continuous record sites

SITE NUMBER	DRAINAGE AREA (mi^2)	7-DAY 2-YEAR (cubic feet per second)	7-DAY 10-YEAR (cubic feet per second)
218	235	6.7	1.3
26	297	20.1	7.9
54	286	6.1	1.3
71	66.5	3.9	1.7
99	56.3	.6	.1
108	103	1.6	.4
126	502	48.8	27.4
127	30.8	.7	.1
139	941	118.3	67.8
158	1185	81.6	38.9
156	3892	160	76.2
268	217	2.7	.5

Table 5.2-2 7-day 2-year and 7-day 10-year low flows at supplemental sites

SITE NUMBER	DRAINAGE AREA (mi^2)	7-DAY 2-YEAR (cubic feet per second)	7-DAY 10-YEAR (cubic feet per second)
243	48.8	2.2	1.3
245	73.9	0.0	0.0
247	228	6.0	.7
258	95.9	.2	0.0
260	63.1	.9	.1
161	119	.9	.1

Flooding Severe in Area 13

Intense precipitation and steep slopes produce flooding of short duration and of large magnitude in most of Area 13.

Intense storms and steep slopes cause severe flooding. Area 13 is characterized by steep slopes and narrow valleys, reducing the runoff travel time from the headwaters to lower parts of the area. In most small basins, floods are of short duration but large magnitude.

Peak discharge data have been collected at 28 sites in Area 13 over the last 56 years (fig 5.3-1). Peak discharges of maximum known floods at these sites vary from 32.5 to 404 $(ft^3/s)/mi^2$ at sites 109 and 76, respectively. Comparison of runoff and precipitation at sites on streams with different drainage areas show that streamflow increases rapidly in response to precipitation (figure 5.3-2 to 5.3-5). The April 1977 flood data shown represent frequencies greater than 100 years occurrence; however, the streams receded to near normal base-flow conditions within several days after the peaks. Flood flows and their recurrence intervals are shown in Table 5.3-1.

Floods are random and vary from basin to basin. Maximum known flows were measured for 9 of the 18 sites for the April 1977 flood. Floods with recurrence intervals of greater than 100 years occurred at sites 16, 218, 26, 54, 71, 139, and 146. The flood at site 127 had a recurrence interval of 50 years and at site 99 an interval of 9 years (Runner, 1980).

Techniques for estimating magnitude and frequency of floods at sites throughout Kentucky and Virginia have been developed by McCabe (1962), Hannum (1976), and Miller, E.M. (1978). A technique for estimating flood frequencies and magnitudes in West Virginia is in preparation.

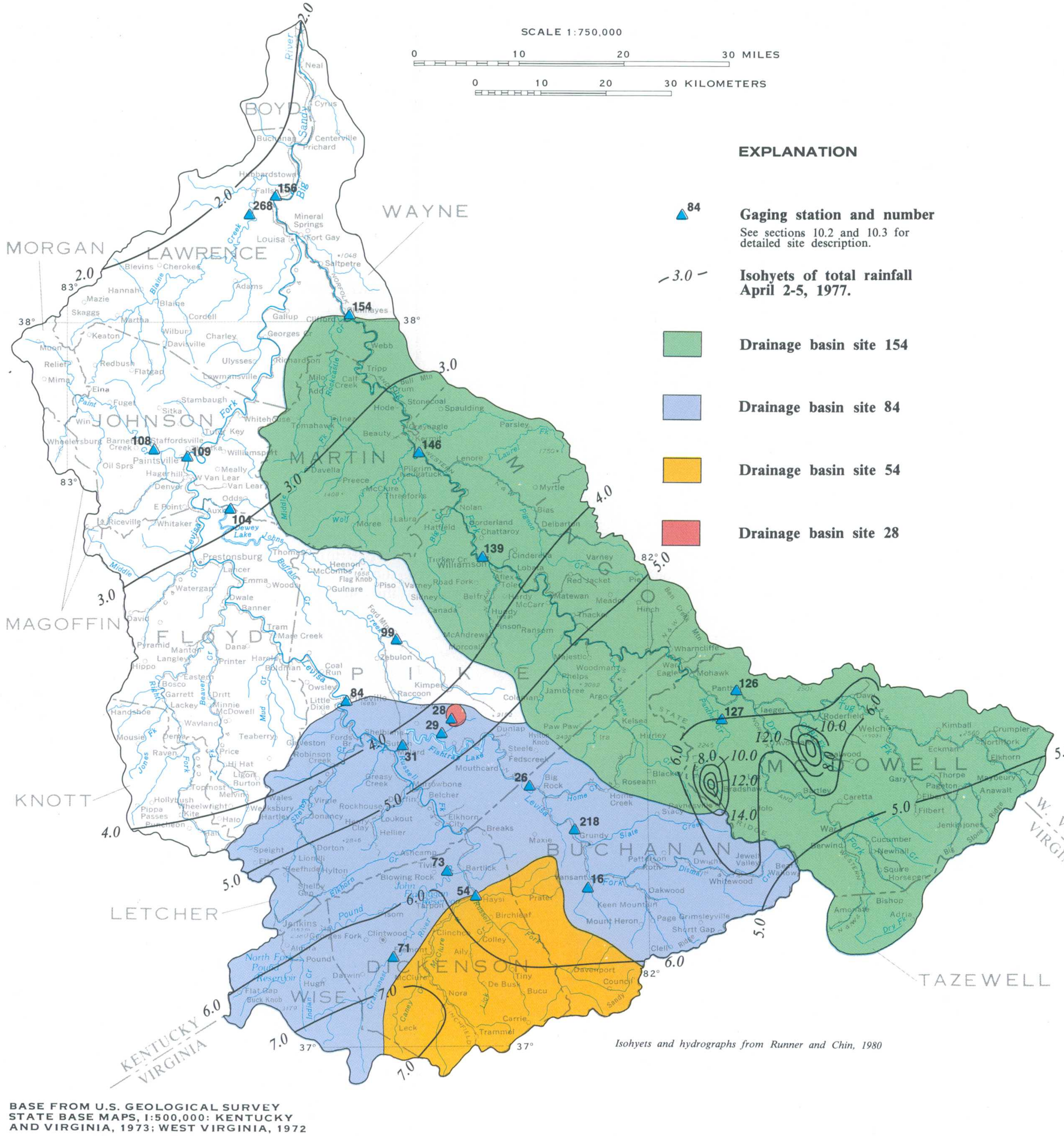


Figure 5.3-1 Location of selected gaging stations, drainage basins and isohyets of total rainfall for April 2-5, 1977.

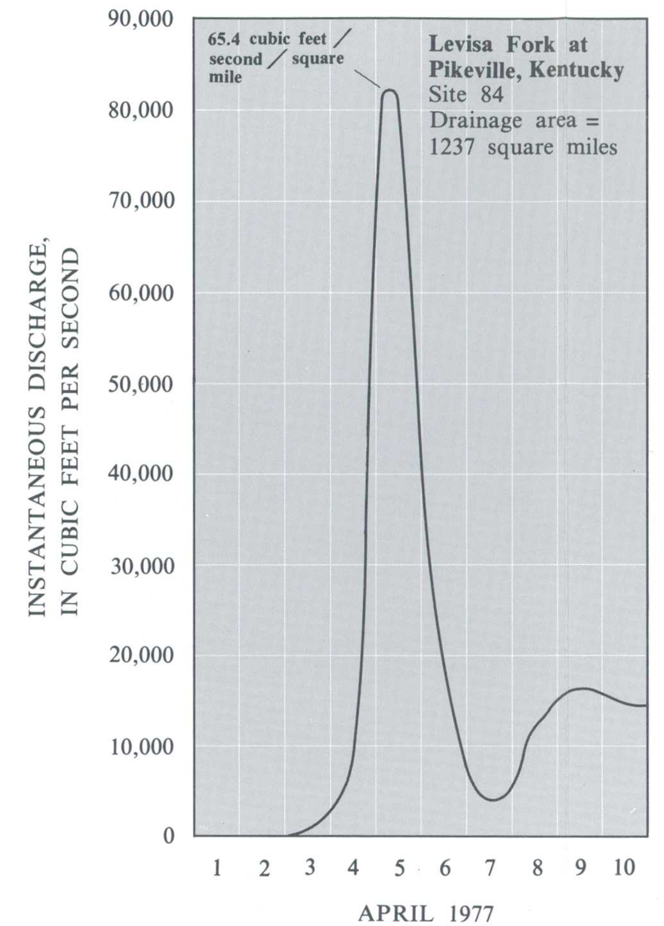


Figure 5.3-2 Flood hydrograph at Levisa Fork at Pikeville, Kentucky, April 1977 flood.

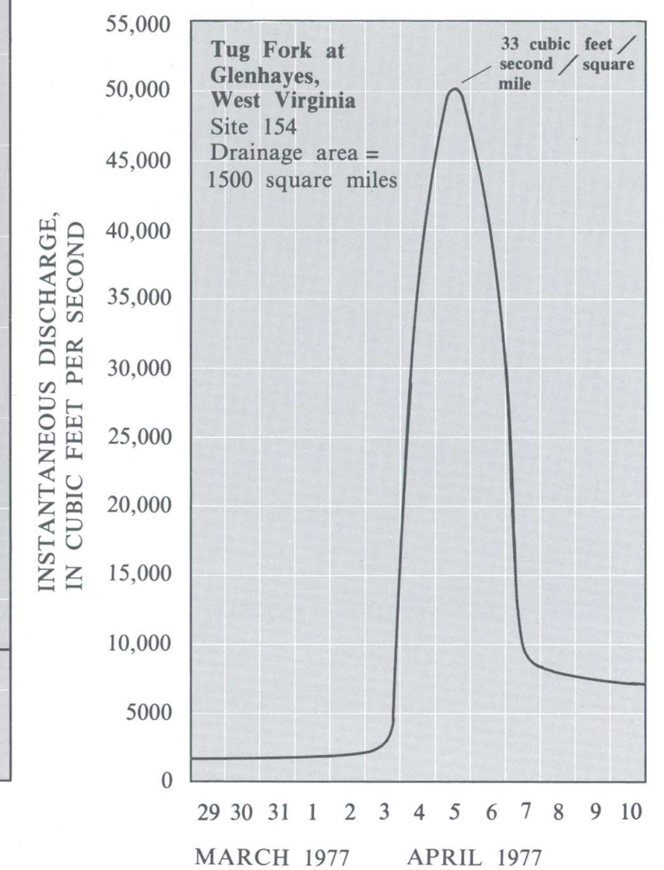


Figure 5.3-5 Flood hydrograph at Tug Fork at Glenhayes, West Virginia, April 1977 flood.

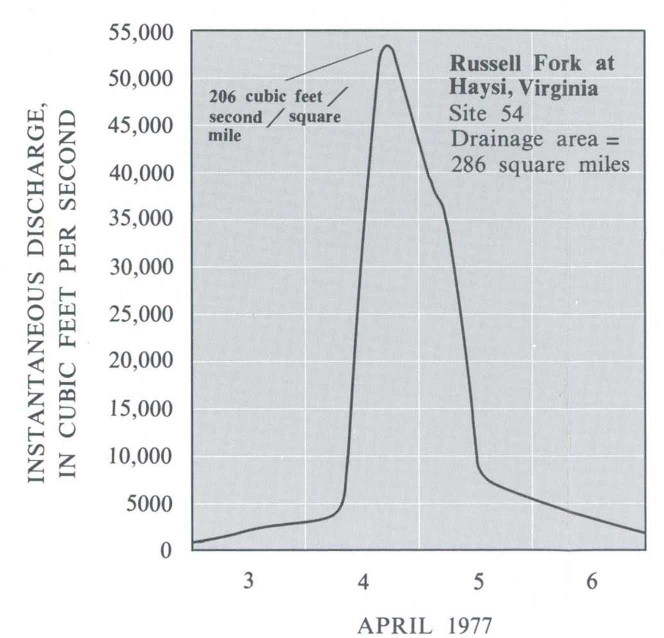


Figure 5.3-3 Flood hydrograph at Russell Fork at Haysi, Virginia, April 1977 flood.

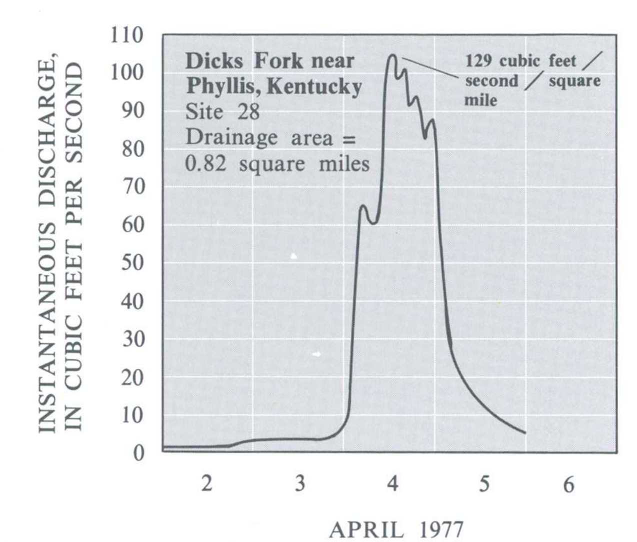


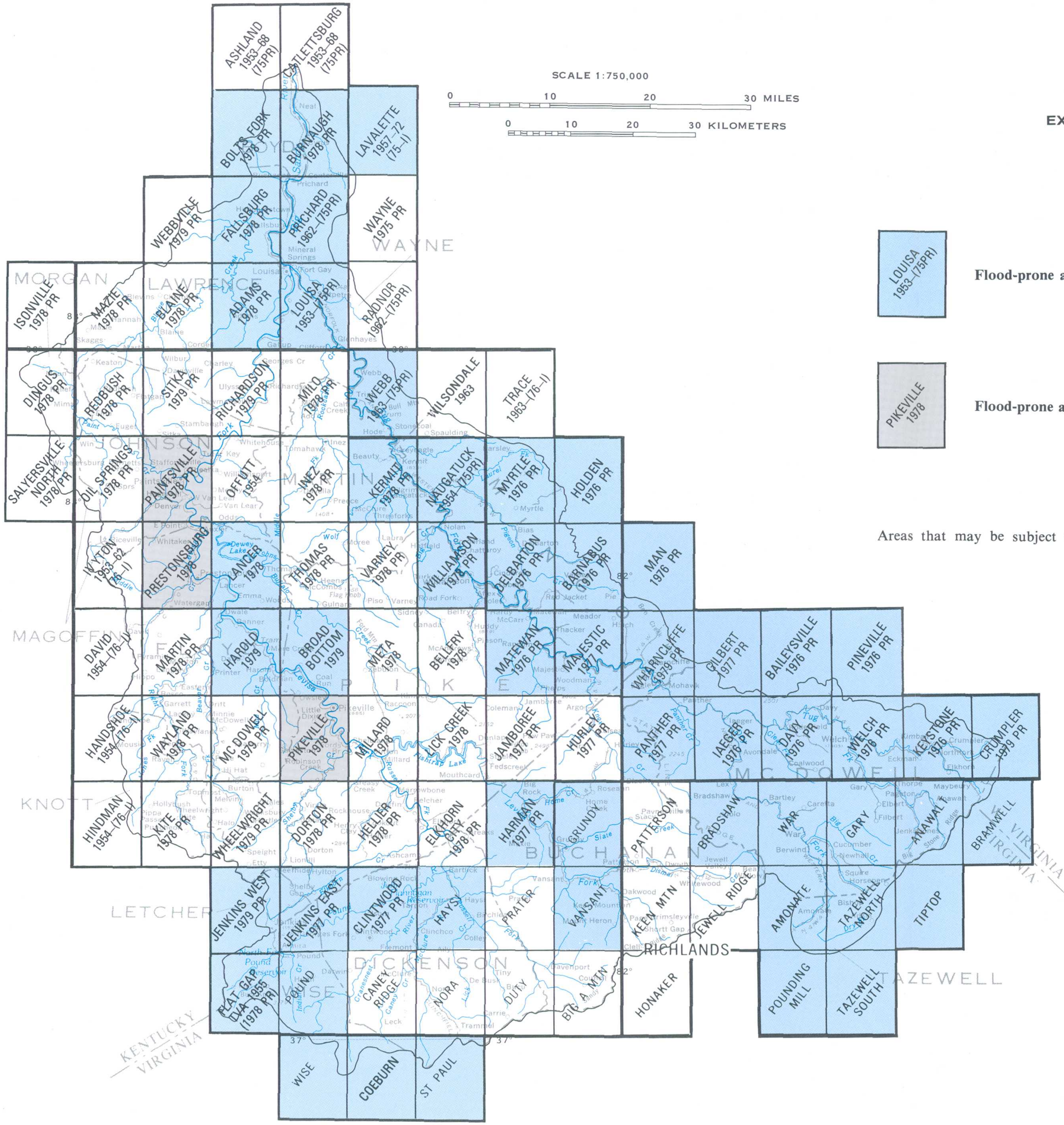
Figure 5.3-4 Flood hydrograph at Dicks Fork at Phyllis, Kentucky, April 1977 flood.

Maps Delineating Flood-Prone Areas Available for Some Streams

Limits of the 100-year recurrence interval flood or the maximum known flood are shown on maps for part of Area 13.

The National Flood Insurance Act of 1968, and the Flood Disaster Protection Act of 1973, established programs for investigating the severity and extent of flooding in urban areas and rural communities. In 1968, the U.S. Geological Survey began a program to delineate flood-prone areas and maximum-known floods for selected areas. The objective of this program was to define the 100-year flood in areas identified as subject to flooding. An attempt was made to select areas where enough information was available to estimate the altitude of the 100-year flood. A map delineating the maximum-known flood regardless of the recurrence interval was prepared for areas where information was not available to define a flood-frequency relation.

Maps for flood-prone areas within Area 13 are available (fig. 5.4-1). These include maps where the 100-year flood has been defined and maps where the maximum known flood has been delineated. Areas that may be subject to flooding are outlined on 7.5-minute quadrangle topographic bases at a scale of 1:24,000. Also, several Flood Insurance Studies by the Federal Emergency Management Agency of the Federal Insurance Administration have been completed for some sections of Area 13. For additional information concerning these studies contact the Federal Insurance Administration at the following toll-free number 1-800-638-6620.



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972

EXPLANATION

LOUISA 1953–(75PR) — Flood-prone area shown for flood with 100-year frequency

PIKEVILLE 1978 — Flood-prone area shown for highest known flood regardless of frequency

Areas that may be subject to flooding are outlined on 7.5-minute quadrangle topographic maps.

Maps may be obtained from the following agencies:

Kentucky Geological Survey
University of Kentucky
Lexington, KY 40506

Kentucky Department of Commerce
Map Sales Office
133 Holmes Street
Frankfort, KY 40601

U.S. Geological Survey
600 Federal Place, Room 572
Louisville, KY 40202

U.S. Geological Survey
200 West Grace St., Room 304
Richmond, VA 23220

U.S. Geological Survey
500 Quarrier Street East, Room 3017
Charleston, West Virginia 25301

Figure 5.4-1 Flood-prone areas mapped.

Flow-Duration Data Available for 24 Stations

Lee Formation will sustain flows longer than the Breathitt Formation.

The flow-duration curve is a cumulative frequency curve that shows the percent of time that a discharge was equalled or exceeded (Searcy, 1959). Mean-daily discharges are particularly suitable for flow-duration analysis because they are available from continuous recording stations. Flow-duration curves developed from a sufficient record (10 years) can be used to estimate the percent of time that a given amount of flow was exceeded at ungaged sites and can also to be used to predict the distribution of future flows for water-supply studies (Searcy, 1959).

Flow-duration data for 24 stations in Area 13 (fig 5.5-1) are given in table 5.5-1. Length of record ranges from 11 to 59 years, but several of the sites are affected by regulation. Eighteen of the sites are in the Levisa Fork basin, where most of the coal production takes place.

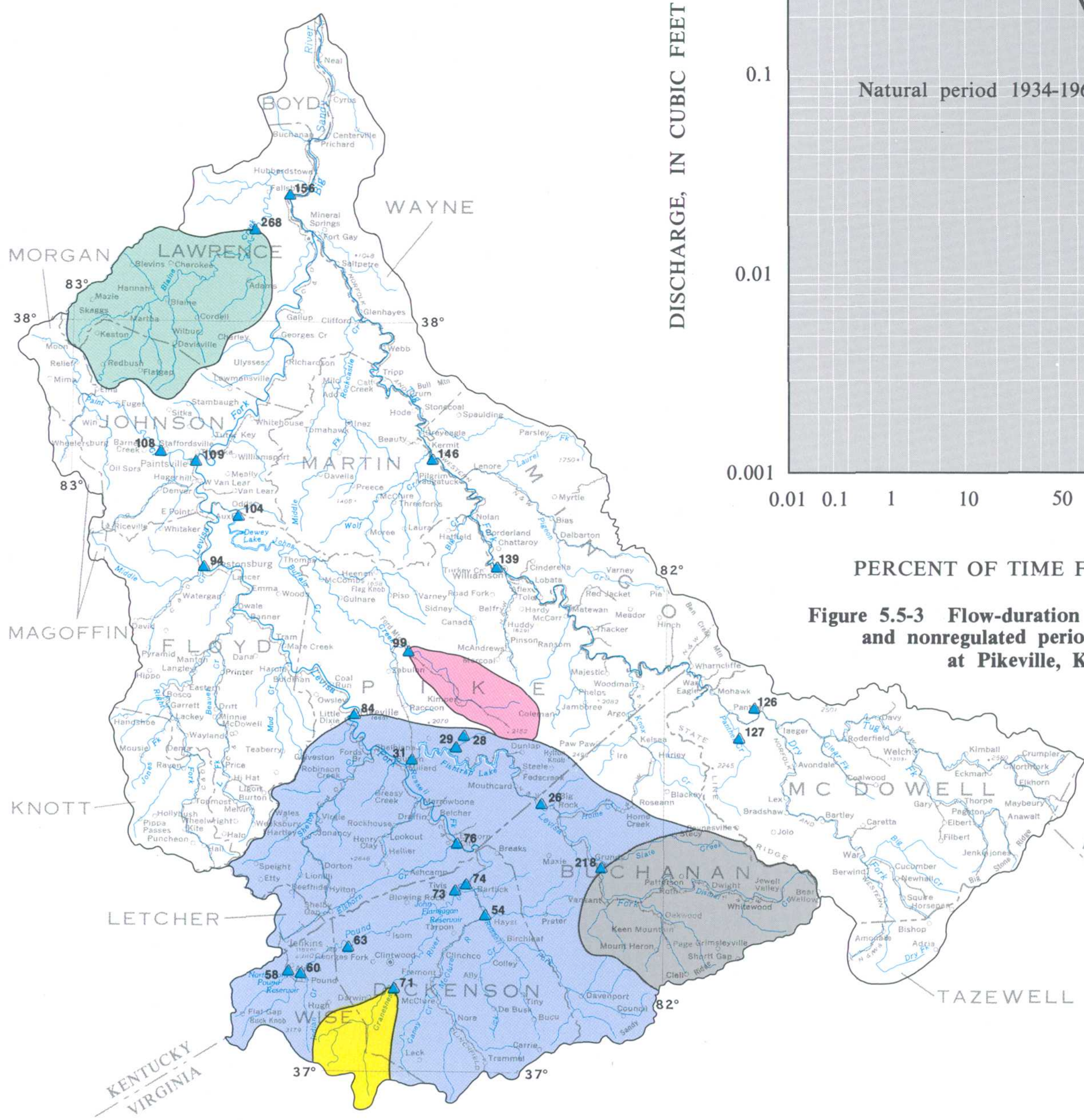
Geology is the primary factor controlling low flows. Figure 5.5-2 shows that low flows are sustained longer in the Lee Formation in the southern part of Area 13 than in the Breathitt Formation to the north. Flows at site 71, in the Lee Formation, exceed 0.031 $(ft^3/s)/mi^2$ about 99 percent of the time while at site 99, in the Breathitt Formation, 0.0041 $(ft^3/s)/mi^2$ is exceeded 99 percent of the time.

The shape of the flow-duration curve can give valuable information about a basin. "As the shape of the flow-duration curve is determined by the hydrologic and geologic characteristics of the drainage area, the curve may be used to study the characteristics of a drainage basin or to compare the characteristics of one basin with highly variable stream whose flow is largely from direct runoff, whereas a curve with a flat slope reveals the presence of surface- or ground-water storage, which tends to equalize the flow (fig. 5.5-3). The slope of the lower end of the duration curve shows the characteristics of the perennial storage in the drainage basin; a flat slope at the lower end indicates a large amount of storage; a steep slope indicates a negligible amount (fig 5.5-2). Streams whose high flows come largely from snowmelt tend to have a flat slope at the upper end. The same is true for streams with large flood-plain storage or those that drain swamp areas" (Searcy, 1959).

Flow regulation can affect the flow-duration curve. Flow regulation in the Levisa Fork basin increases low flows and reduces peak discharges (fig. 5.5-3). Site 84, Levisa Fork at Pikeville, Kentucky, has a drainage area of 1,237 mi^2. There are three reservoirs regulating flow from 631 mi^2 in the basin. Figure 5.5-3 shows that prior to regulation a flow of 0.0022 $(ft^3/s)/mi^2$ was exceeded 99.9 percent of the time. After regulation 0.044 $(ft^3/s)/mi^2$ was exceeded 99.9 percent of the time. Peak discharges that are exceeded 0.2 percent of the time declined from 21 $(ft^3/s)/mi^2$ before regulation to 17 $(ft^3/s)/mi^2$ after regulation.

EXPLANATION

- Site and number. See section 10.2 and 10.3 for detailed site description.
- Levisa Fork at Pikeville, Kentucky, site 84
- Blaine Creek near Yatesville, Kentucky, site 268
- Levisa Fork at Grundy, Virginia, site 218
- Johns Creek near Meta, Kentucky, site 99
- Cranes Nest River near Clintwood, Virginia, site 71



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972

Figure 5.5-1 Selected sites and drainage basins where flow-duration data are available.

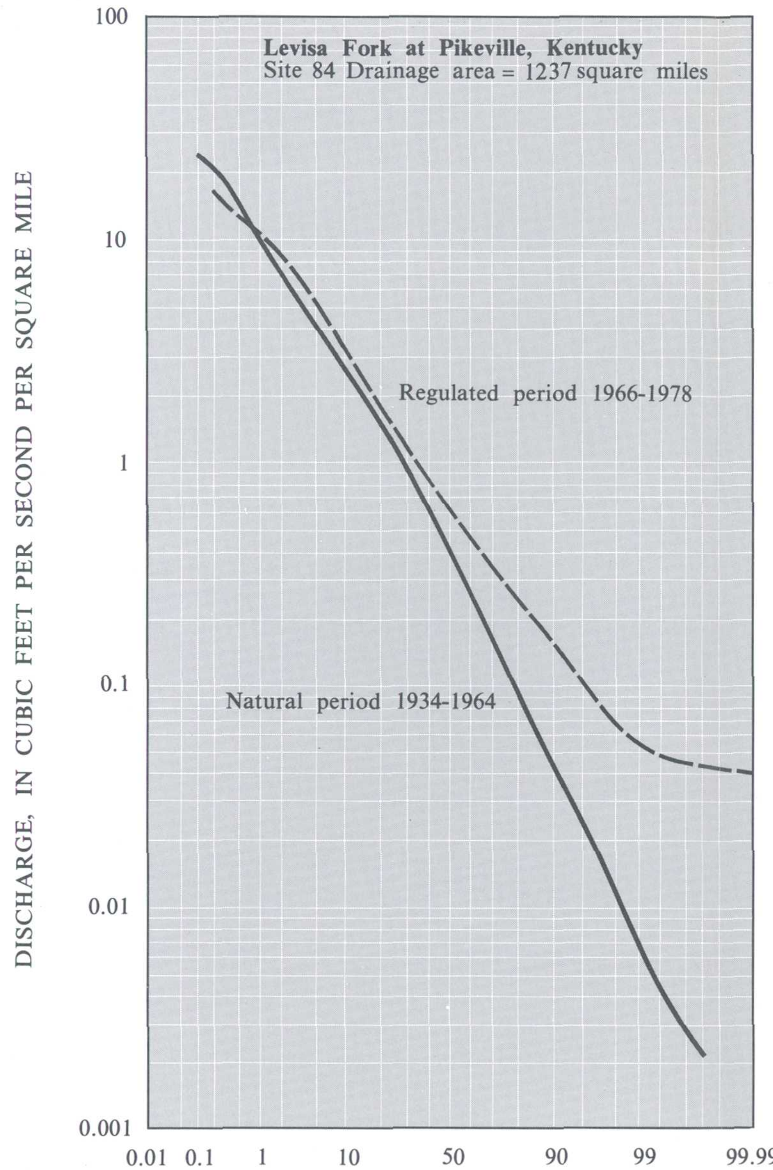


Figure 5.5-3 Flow-duration curve for the regulated and nonregulated period for Levisa Fork at Pikeville, Kentucky.

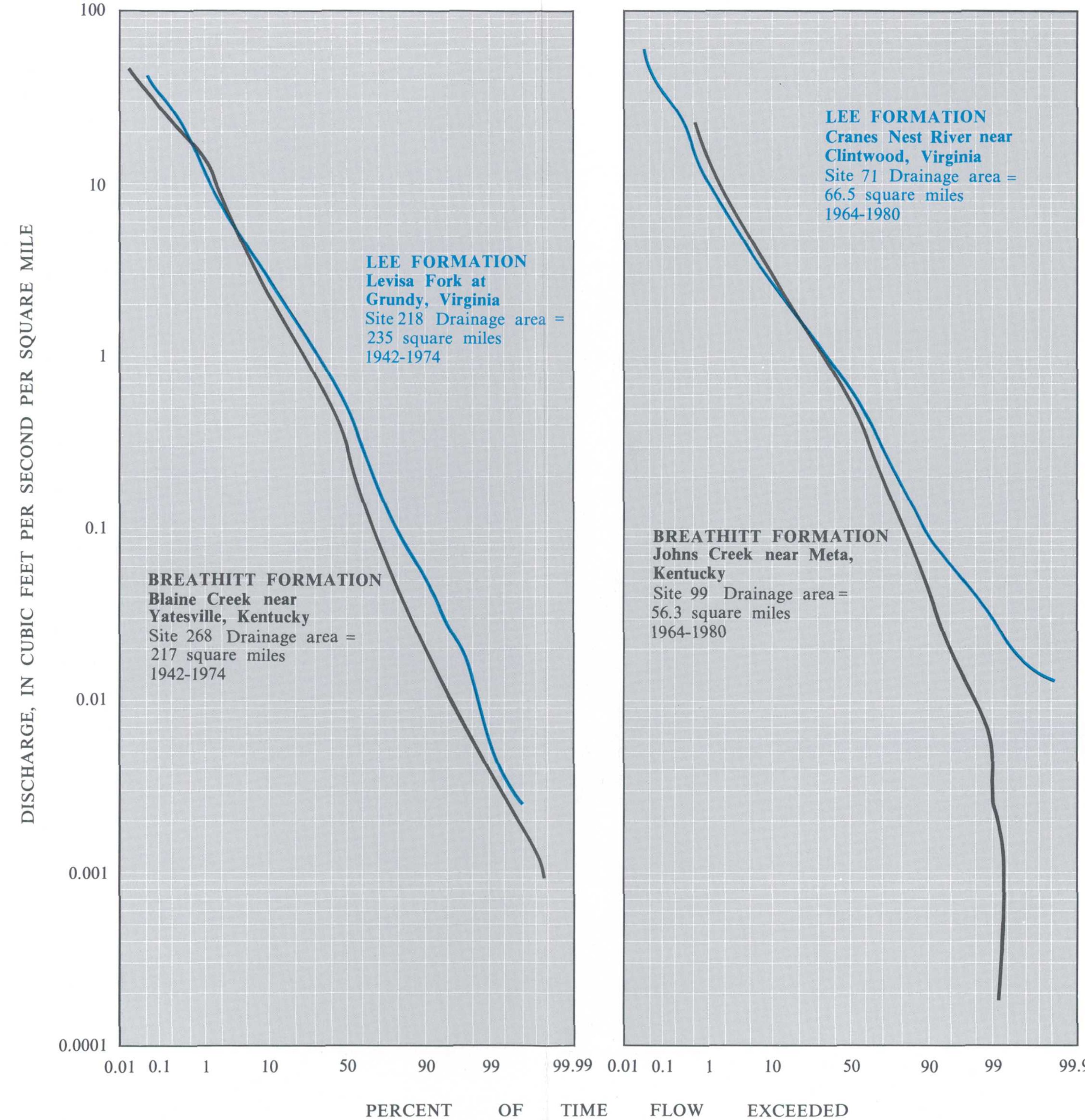


Figure 5.5-2 Flow-duration curves for sites draining the Lee and Breathitt Formations.

Water-Quality Data Available for 282 Sites

Data collected during 1979 and 1980 in addition to historical data provide a general view of water quality.

Water-quality data frequently show the effects of surface-coal mining and other land-use activities. The Act establishes a series of maximum permissible limits for a number of water-quality constituents and physical properties in effluents draining mined areas. The primary ones are:

- pH range from 6.0 to 9.0 units.

- Total manganese concentration of 4,000 micrograms per liter.

- Total iron concentration of 7,000 micrograms per liter.

- Total suspended-solids concentration of 70 milligrams per liter.

Sufficient data to describe seasonal water-quality variations are also required by the Act.

The surface-water quality collection sites in Area 13 consist of 197 active sites (fig. 6.1-1 and section 10.2). Data from 125 of these active sites were used in this section, supplemented by historical data when needed. At these 125 sites, samples were collected at various frequencies for the determination of pH, specific conductance, alkalinity, temperature, iron, and manganese concentrations (total and dissolved), sulfate, dissolved solids, and suspended-sediment concentrations. In addition, concentrations of most common constituents (calcium, magnesium, sodium, potassium, chloride, and fluoride), select trace constituents (barium, cadmium, chromium, copper, lead, silver, zinc, cyanide, arsenic, mercury, and selenium), and percent of coal in bottom material were determined from samples collected during low-flow conditions.

In addition to this network, numerous inactive stream sites in the area have historical water-quality data. Analysis of the historical data and data collected during 1979 and 1980 are presented in the following sections of this report.

The samples collected in 1979 and 1980 were taken during the spring, summer, and fall seasons in order to sample during high, medium, and low flows; but sampling during extreme high flow conditions was not accomplished. Several streams in July and September 1980, were dry. The data collected provide a synoptic view of water quality during the time of sampling.

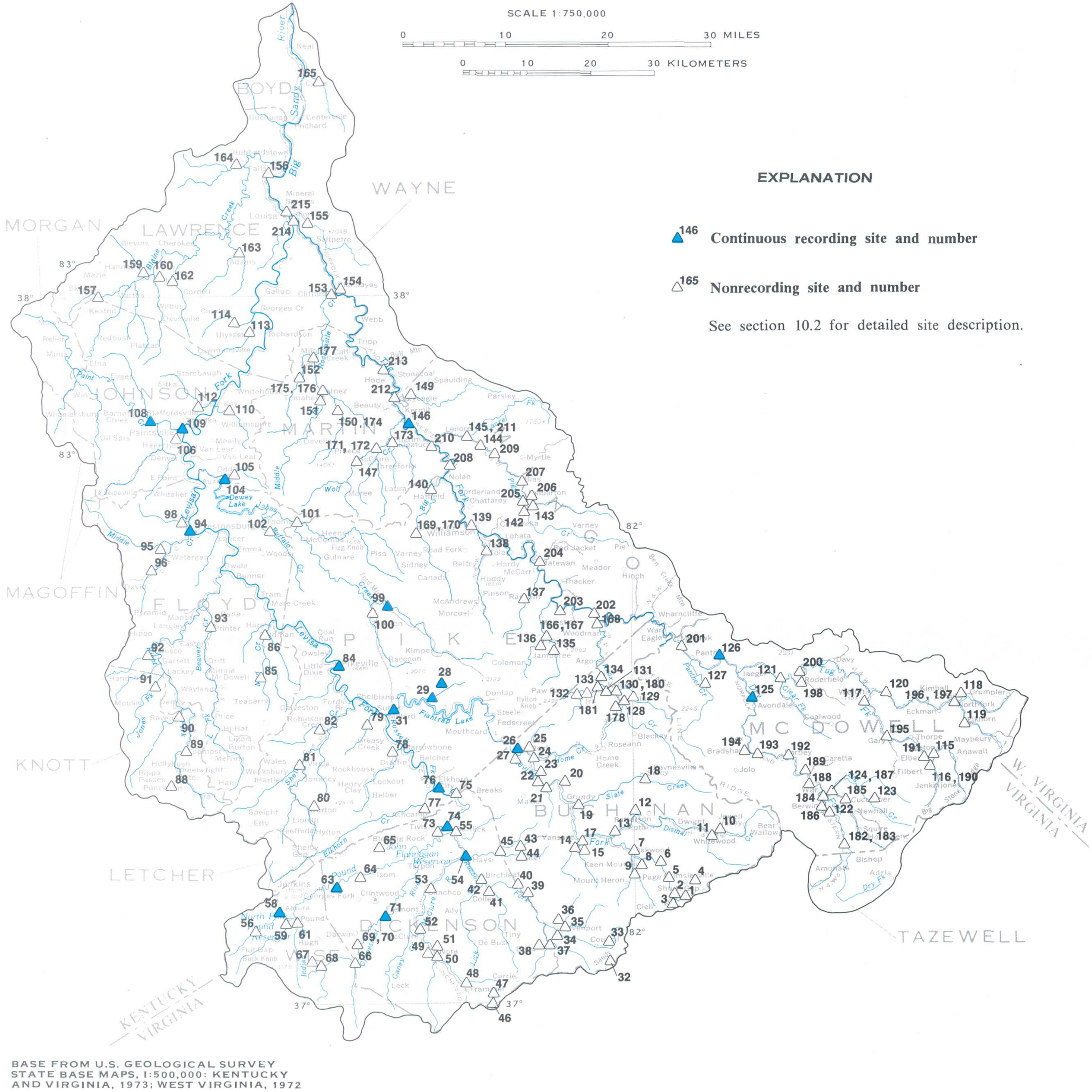


Figure 6.1-1 Location of active water-quality sites, 1980.

Specific Conductance and Dissolved Solids Reflect the Land-Use Activities

Dissolved solids data show that concentrations are higher in disturbed areas.

Specific conductance is a general indicator of the amount of dissolved solids in water, (Hem, 1970) and is commonly used to estimate specific ion concentrations. At many sites, correlations may be developed between specific conductance and dissolved solids, chloride, hardness, and sulfate concentrations.

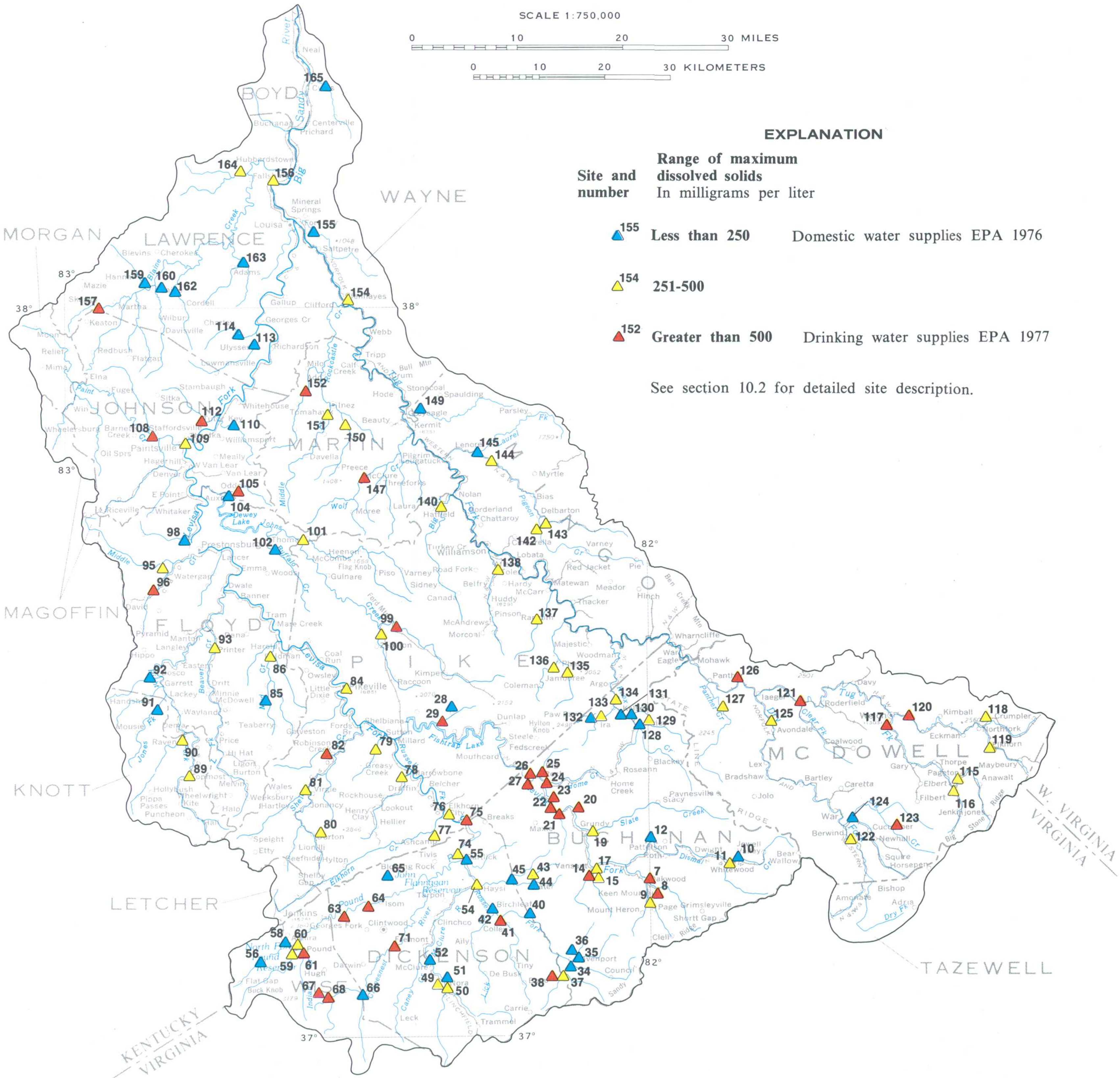
Specific conductance and dissolved solids data can be an indication of land-use activity. For example, data were analyzed for 10 sites that represent basins with no land disturbance, basins where underground mining was dominate, and basins where surface mining was dominate (table 6.2-1). This analysis indicated that 90 percent of the dissolved solid concentrations for sites in the undisturbed basins were in the range from 35 to 77 mg/L and 90 percent of the concentrations for sites in the surface-mined basins were in the range from 82 to 634 mg/L.

Federal drinking water standards recommend that dissolved solids should not exceed 500 mg/L, but 1,000 mg/L is permitted if water of better quality is not available. Dissolved solids concentrations exceeded 500 mg/L at 35 sites in Area 13 (fig. 6.2-1). At sites 22, 29, 71, 108, and 157, the dissolved solids concentration exceeded 1,000 mg/L. The median concentration at sites 22, 27, 68, 82, 147, and 157 exceeded 500 mg/L and the median concentration at site 157 was 6,915 mg/L.

Dissolved-solids concentrations of water in streams draining Area 13 range from 24 mg/L at site 65, to 16,800 mg/L at site 157; the median value is 216 mg/L. Ninety percent of the dissolved solids concentrations range from 60 to 620 mg/L. A summary of dissolved solids at selected sites in Area 13 is given in section 10.5.

Specific conductance values measured at selected sites on streams draining Area 13 range from 10 μmhos/cm at site 99 to 26,000 μmhos/cm at site 157; 90 percent range from 93 to 840 μmhos/cm. The median of the measured values in Area 13 is 336 μmhos/cm. Median specific conductance values at specific sites range from 62 μmhos/cm to 2,500 μmhos/cm (sites 55 and 157 respectively). A summary of the specific conductance values at select sites in Area 13 is given in section 10.6.

A significant correlation was determined between specific conductance values and dissolved-solids concentrations for Area 13 (fig. 6.2-2). This correlation and correlations developed at specific sites can be used to estimate the dissolved solids concentrations of water in streams in the Area.



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972

Figure 6.2-1 Range of maximum dissolved-solid concentrations at selected sites in Area 13.

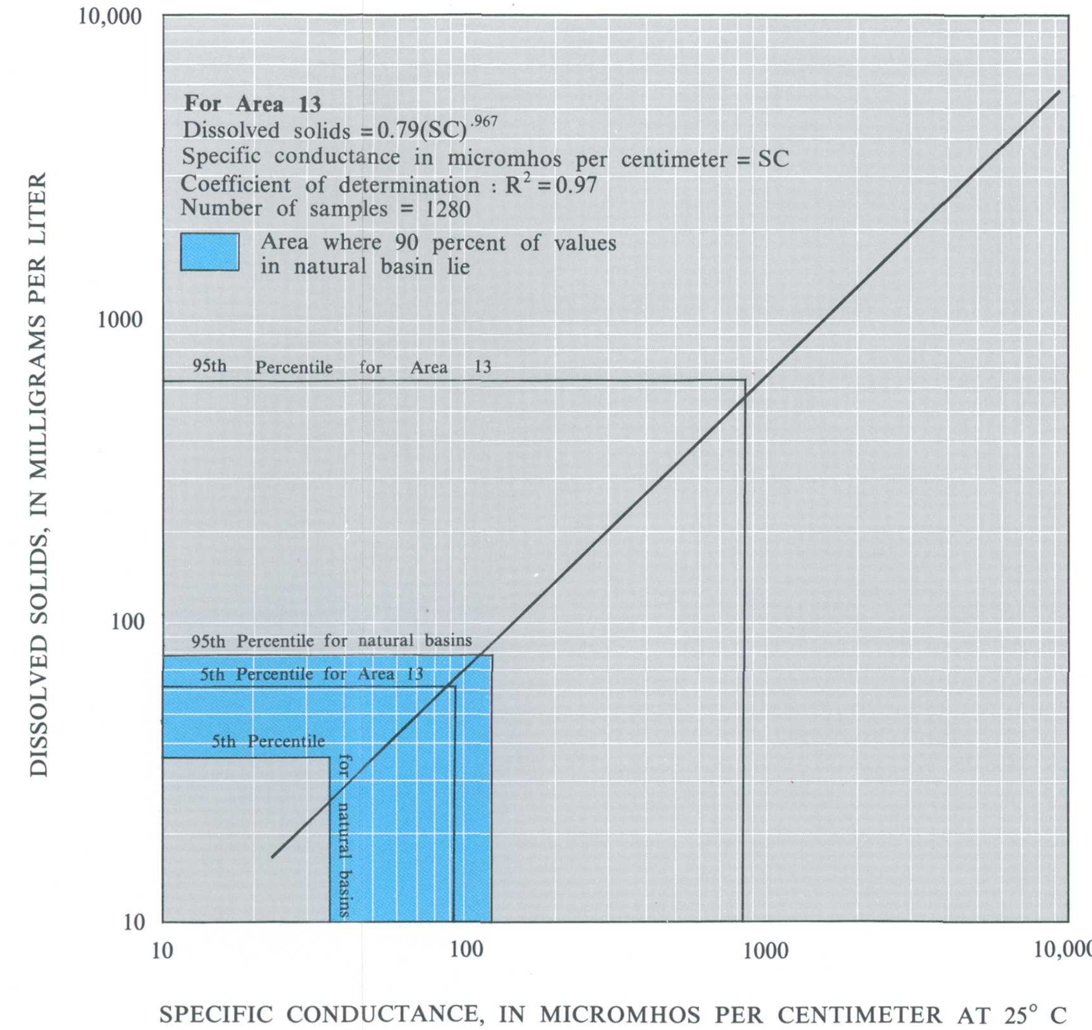


Figure 6.2-2 Relation of the dissolved-solids concentration and specific conductance values for Area 13.

Table 6.2-1 Comparison of percentiles of dissolved-solids concentrations in streams draining undisturbed and mined basins.

	MINIMUM	PERCENTILE 5	25	50	75	90	MAXIMUM
Natural	24	35	50	52	60	77	109
Underground-mine	50	58	126	240	366	497	630
Surface-mine	80	82	214	350	533	634	892

Low pH is Not Common in the Area

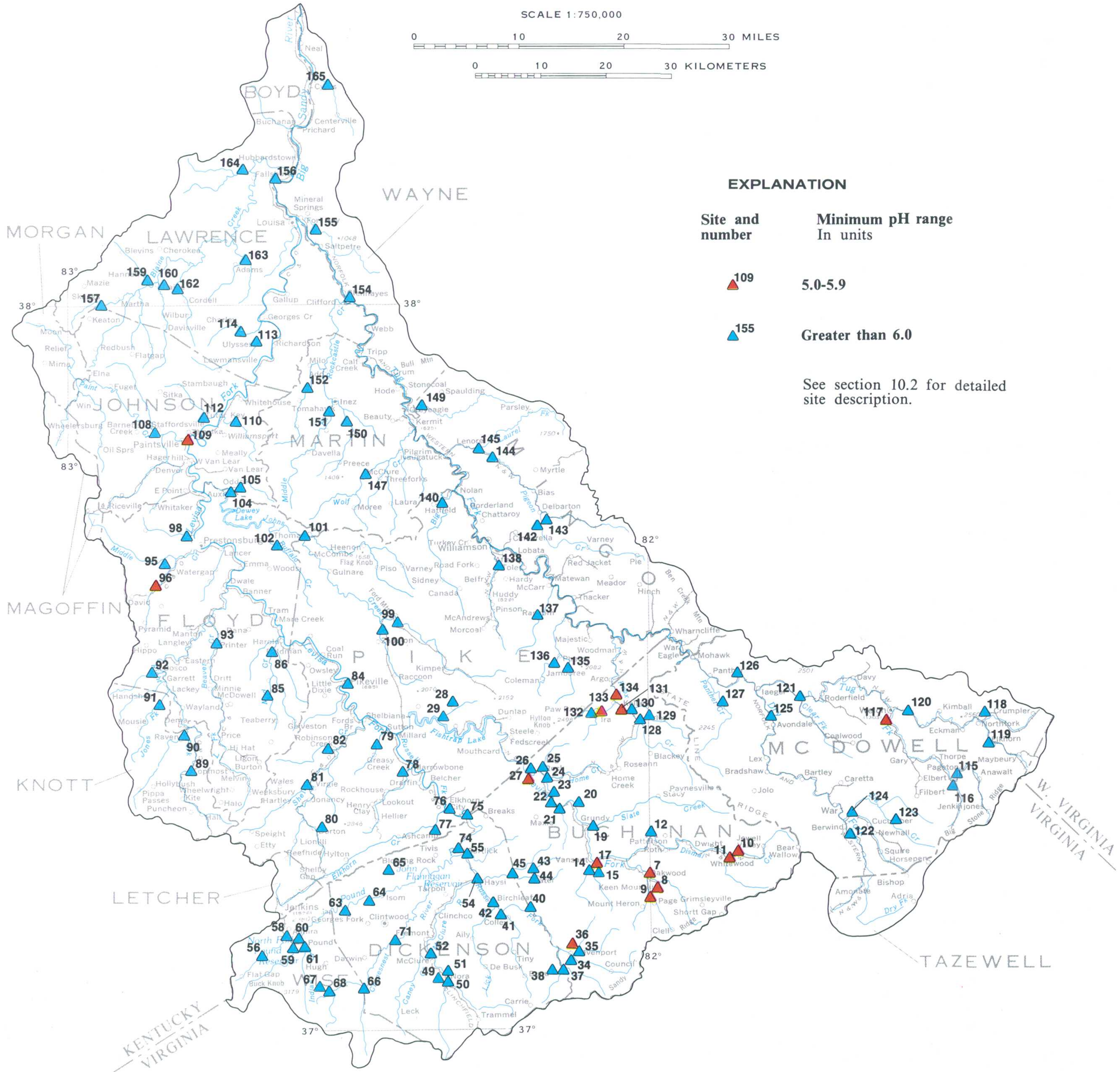
pH values may vary from near neutral to alkaline; lower pH values are generally associated with mining activities in Area 13.

A pH value of 7.0 units is neutral, while values less than 7.0 units represent acidic water and values greater than 7.0 units represent alkaline waters. Natural acidity usually is caused by the presence of dissolved carbon dioxide or the hydrolysis of salts of weak acids and strong bases. Sources of these materials include rainfall, weathered rocks, and organic matter in soils.

In areas affected by surface mining, acid is produced from the oxidation of pyrite or marcasite. These minerals normally contain compounds of sulfur, which upon oxidation and hydrolysis produce sulfuric acid. The acid may lower the pH of waters receiving mine drainage to values as low as 2.0 pH units.

Values of pH observed at sampling sites in Area 13 range from 5.6 units at sites 9 and 27 to 9.4 units at site 123. The median pH value observed in Area 13 was 7.4 units. Median pH values at specific sites range from 6.2 units at site 56 to 8.6 units at site 123. A statistical summary of pH values measured at selected sites in the Area 13 is given in section 10.7.

Most samples were collected at sites not directly draining mined areas. It is probable that low pH values occur in the immediate vicinity of mined areas, however the acids are probably neutralized close to their source by reaction with calcareous material and alkaline water in the streams. Minimum pH values for Area 13 are grouped into ranges and shown on figure 6.3-1. Mine drainage effects throughout the basin are more evident from other water-quality characteristics discussed in other sections of this report.



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972

Figure 6.3-1 Range of minimum pH values at selected sites in Area 13.

Sulfate Concentrations in Streams Indicate Effects of Land-Use Activities

Sulfate concentrations can be 18 times greater in surface-mined basins than in undisturbed basins in Area 13.

Sulfur is not a major constituent in the earth's crust, but is widely distributed in igneous and sedimentary rocks as metallic sulfides. The sulfurous minerals pyrite and marcasite are commonly associated with coal beds (Hem, 1970). Surface mining exposes these materials to weathering, accelerating their oxidation and the production of sulfuric acid.

The variability of sulfate concentrations in streams draining an area is primarily due to the presence of reactive minerals in the rock, the length of time of exposure of these materials to weathering, and the quantity of water leaving the areas. Sulfate concentrations are highest during low flow, when contact time with sulfur-bearing rocks is fairly long, and lower during high flow (Quinones and others, 1981).

Sulfate concentrations are 3 to 18 times greater in surface mined basins than in undisturbed basins (table 6.4-1). Samples collected at sites 12, 28, and 65 in undisturbed basins, have sulfate concentrations ranging from 4.5 to 32 mg/L and a median of 18 mg/L for 58 samples. Sulfate concentration at sites 224, 225, and 249, draining basins with surface mining range from 15 to 580 mg/L and have a median of 230 mg/L for 32 samples.

Sulfate concentrations observed at specific sites in Area 13 (fig. 6.4-1) range from 4.8 to 1,600 mg/L. Ninety percent of the concentrations range from 19 to 309 mg/L. Twenty-six sites have maximum values exceeding Enviromental Protection Agency (1976) recommended limits for domestic use of 250 mg/L. A statistical summary of data at selected sites in Area 13 is given in section 10.8.

Significant relations exist between specific-conductance values and sulfate concentrations at several long term sites in Area 13 (fig. 6.4-2). The same relation for all of Area 13 is also significant. The relation expressed by regression equations can be used to estimate sulfate concentrations at gaged and ungaged sites. In addition these relations can be an indication of land use activity in the basin. The relation for site 99 shows a higher sulfate concentration at a particular specific conductance than for site 29 where there is no land disturbance. The location of the line for all of Area 13 may be an indication of land disturbance throughout the basin.

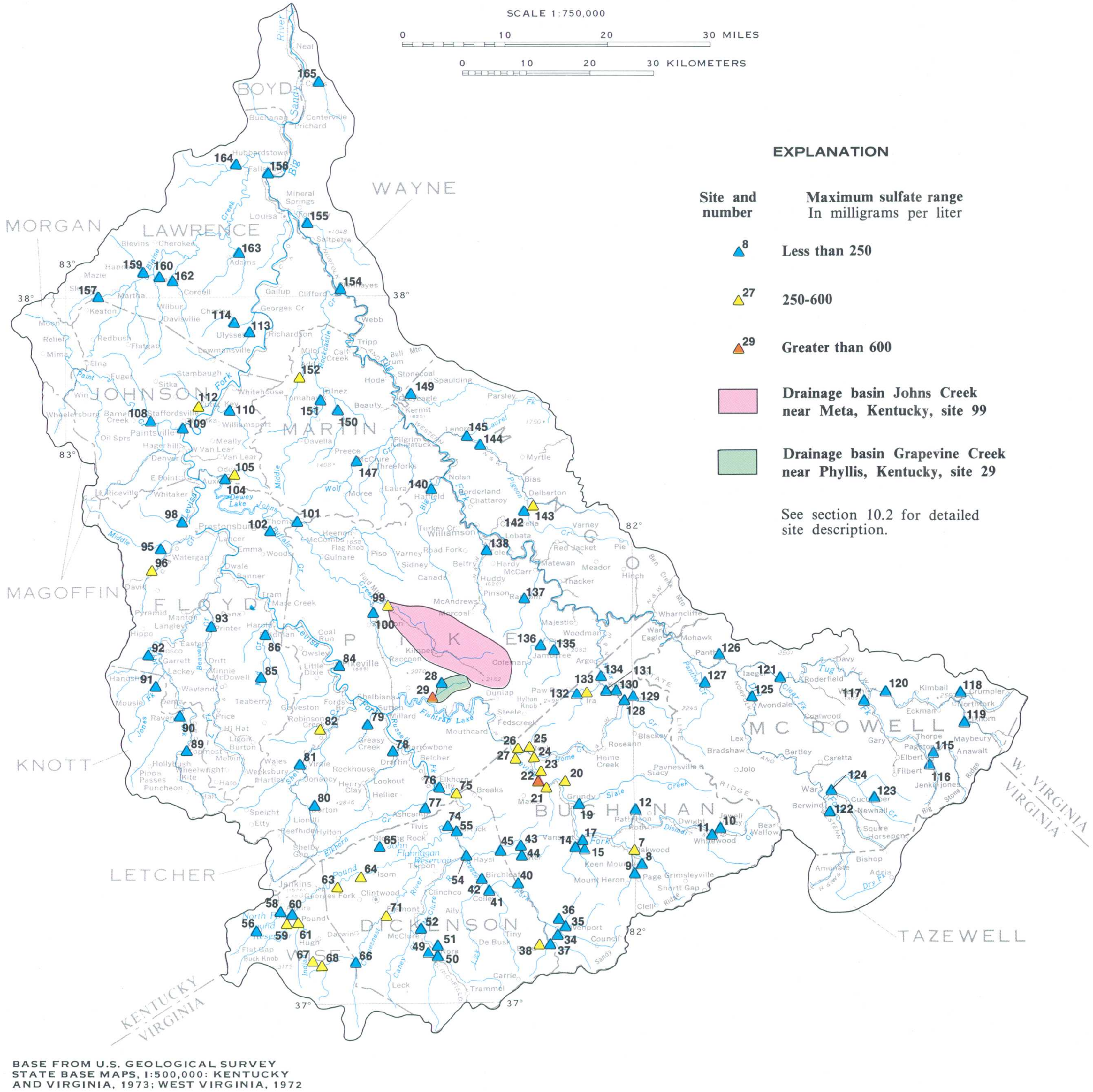


Figure 6.4-1 Range of maximum sulfate concentrations at selected sites in Area 13.

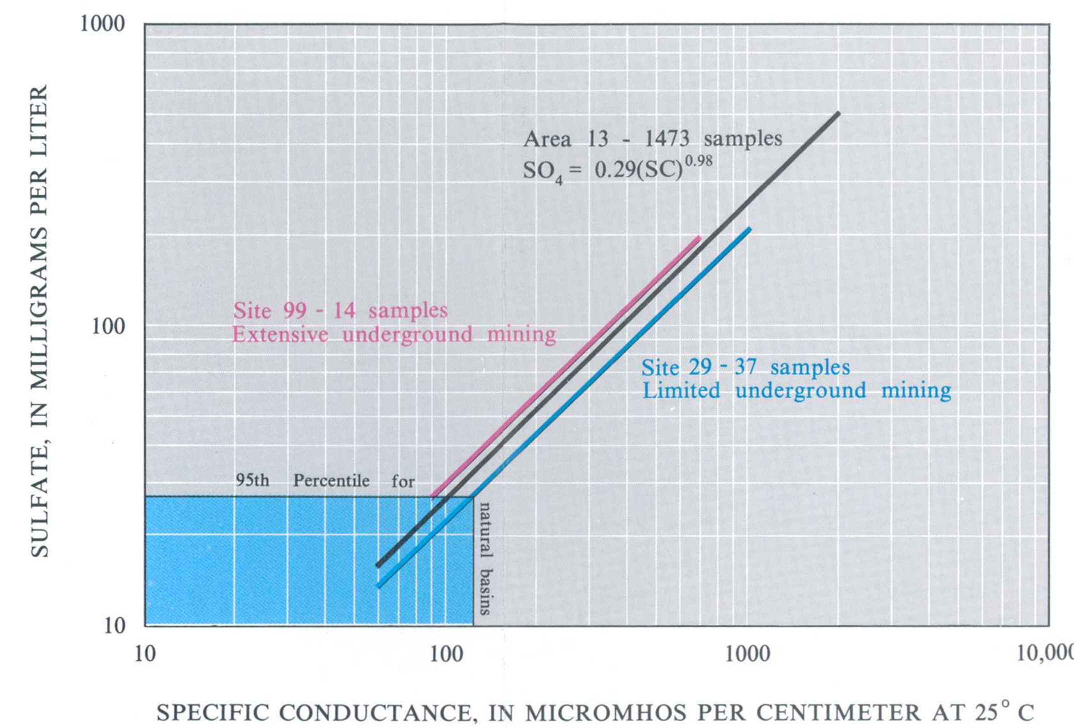


Figure 6.4-2 Relation of the sulfate concentrations and specific conductance values.

Table 6.4-1 Comparison of percentiles of sulfate concentrations in streams draining undisturbed and surface-mined basins.

	MINIMUM	5	25	50	75	90	MAXIMUM
				PERCENTILE			
Undisturbed	4.8	5.5	16	18	20	27	32
Surface-mined	15	15.8	110	230	310	440	580

Iron Concentrations High in Area 13

In several basins where mining is more intense total iron concentrations are generally greater than in basins where mining is less intense.

Iron is a common element in rocks and in soils rich in organic material. Surface mining exposes rocks and soils to weathering, accelerating the oxidation and dissolution of iron compounds. In addition to dissolved iron, large amounts of iron compounds are transported in waters in particulate form (Hem, 1970).

Dissolved and total iron (suspended plus dissolved) are important water-quality constituents to consider in selecting water supplies for domestic and industrial uses. Dissolved iron concentrations in excess of 300 μg/L cause staining, impart an undesirable taste to water, and require treatment for most uses (U.S. Environmental Protection Agency, 1977). Dissolved iron can precipitate to produce "yellow boy", an insoluable precipitate. This precipitate flocculates and settles on stream beds, where it adversely affects bottom aquatic life.

In general, total iron concentrations vary randomly in streams throughout Area 13. However, in several basins where mining is more intense, iron concentrations are generally higher than in partially mined or unmined basins. Basins in Floyd and Pike Counties, Kentucky, and Buchanan County, Virginia, which have been mined, have median total iron concentrations in excess of 1,000 μg/L. Median values from partially-mined or unmined-basins in the area normally do not exceed 1,000 μg/L (sites 17, 122, 123, 124, and 125). However, high concentrations of iron may be found in some undisturbed basins. Site 28 in a undisturbed basin had an observed maximum total iron concentration of 51,000 μg/L; five percent of the 39 observations exceeded 4,900 μg/L, and the median concentration was 270 μg/L.

Total iron concentrations at selected sites in Area 13 (fig. 6.5-1) vary from 0 to 510,000 μg/L. Ninety percent of the determined concentrations vary from 75 to 11,000 μg/L and have a median value of 880 μg/L. More than 75 percent of the values exceed the 300 μg/L recommended limit for a domestic water supply (Enviromental Protection Agency, 1976). A statistical summary of total iron concentration at selected sites in Area 13 is given in section 10.9.

The Act has specified a limit of 7,000 μg/L for total iron concentration for effluents from mining operations. Total iron concentration exceeds 7,000 μg/L at 35 sites in Area 13 (fig. 6.5-1). Site 96 has a median concentration greater than the 7,000 μg/L limit. Fifty-eight or 46 percent of the sites, have median total iron concentrations greater than 1,000 μg/L, the maximum limit recommended by U.S. Environmental Protection Agency (1976) for freshwater aquatic life. Data show that in most streams in Area 13, the dissolved portion of the total iron is a small fraction of the whole. However, in some cases the dissolved fraction of total iron may be substantial (table 6.5-1).

Iron concentration may be estimated by developing a relation between iron and other independent parameters such as discharge and specific conductance. Analysis of the data in Area 13 show that no significant correlation between total iron concentrations and streamflow or specific conductance exists. However, significant correlation, 95 percent confidence limit, exists between total iron and suspended-sediment concentration at selected sites (fig. 6.5-2). An increase in the iron load occurs with an increase in suspended-sediment concentration. Understanding the suspended-sediment transport mechanism at a site is useful in estimating iron yields. Because runoff from one storm may transport most of the annual sediment load at a site (see section 6.7), sediment and iron transport processes cannot be defined from infrequent random sampling.

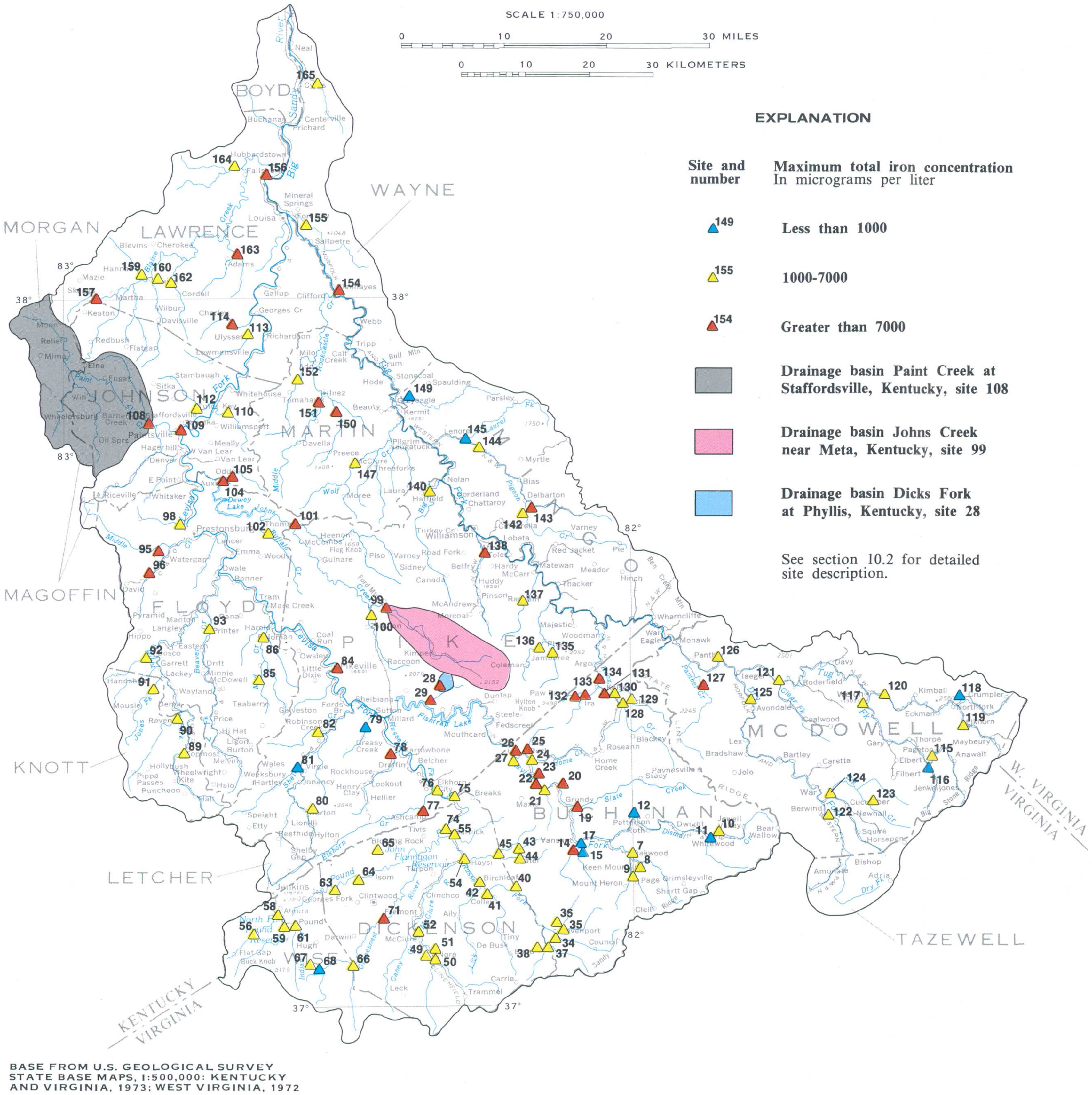


Figure 6.5-1 Range of total iron concentrations at selected sites in Area 13.

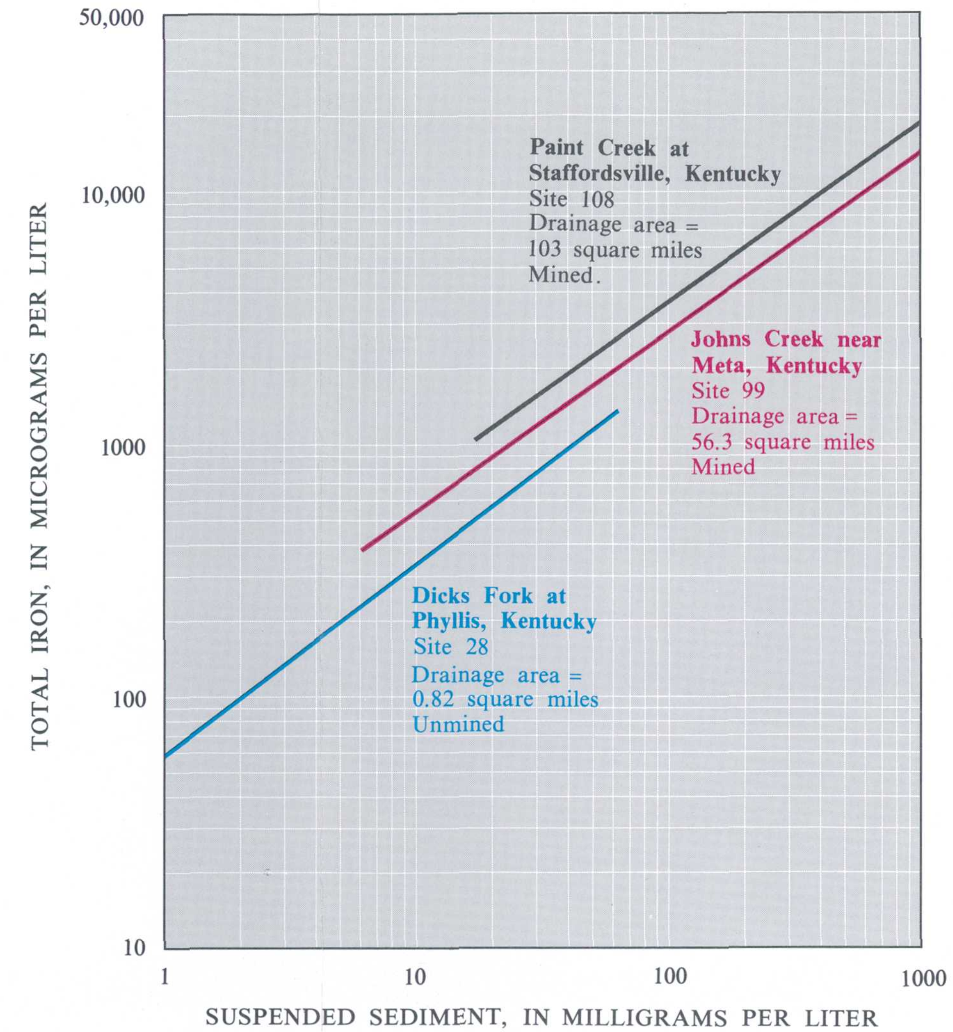


Figure 6.5-2 Relation of the total-recoverable iron concentrations and suspended-sediment values at selected sites.

Table 6.5-1 Dissolved and total iron concentrations during variable flows at selected sites.

SITE	DATE	pH (units)	STREAM-FLOW (ft^3/s)	DISSOLVED IRON (ug/L)	TOTAL RECOVERABLE IRON (ug/L)	PERCENT DISSOLVED OF TOTAL
28 - unmined						
	6-12-79	7.1	5.21	10	810	1.28
	7-26-80	6.9	1.4	0.0	2,000	0.0
	8-15-80	7.1	.83	40	3,100	1.29
	3-25-80	7.8	26	10	1,500	0.7
	5-06-80	7.1	2.05	20	1,500	1.3
	7-17-80	6.8	.10	10	1,000	1.0
	9-09-80	6.9	.54	80	1,400	5.7
99 - mined						
	6-04-79	7.2	53	3,400	8,700	39
	8-13-79	5.9	3.91	18,000	24,000	75
	3-28-80	7.8	23.5	2,700	13,000	20
	5-06-80	6.8	7.43	4,900	16,000	30
	7-17-80	7.3	5.3	70	2,000	4.0
	9-08-80	6.9	1.17	3,300	13,000	25

Manganese Concentrations are Generally High

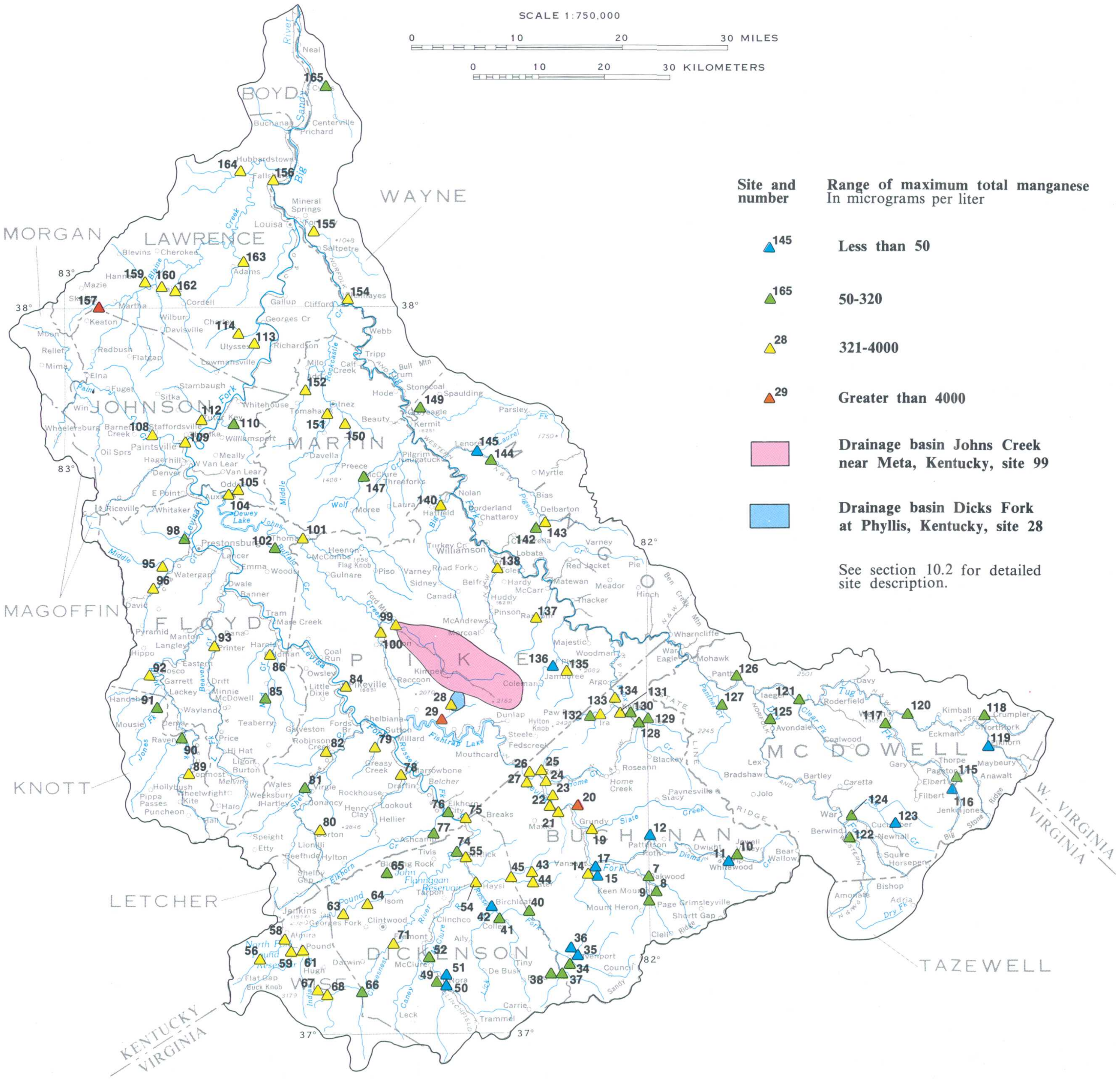
About five percent of the total manganese concentrations in Area 13 exceed the limits established by the Act.

Manganese is one of the most common elements in soils and rocks. Soils rich in organic matter are one of the main sources of manganese in natural waters. Although dissolved manganese is an essential element for plant and animal metabolism, concentrations in excess of 50 μg/L will impart an objectionable taste to water and will stain fabrics (U.S. Environmental Protection Agency, 1977).

The U.S. Environmental Protection Agency (1977) recommends a maximum limit of 50 μg/L for manganese in water for domestic water supply. The Act specifies 4,000 μg/L as the maximum permissible concentration of total manganese in effluents from mining operations. About 75 percent of the observed values in Area 13 exceed the Enviromental Protection Agency standard and about 5 percent of the values exceed the 4,000 μg/L standard set by the Act.

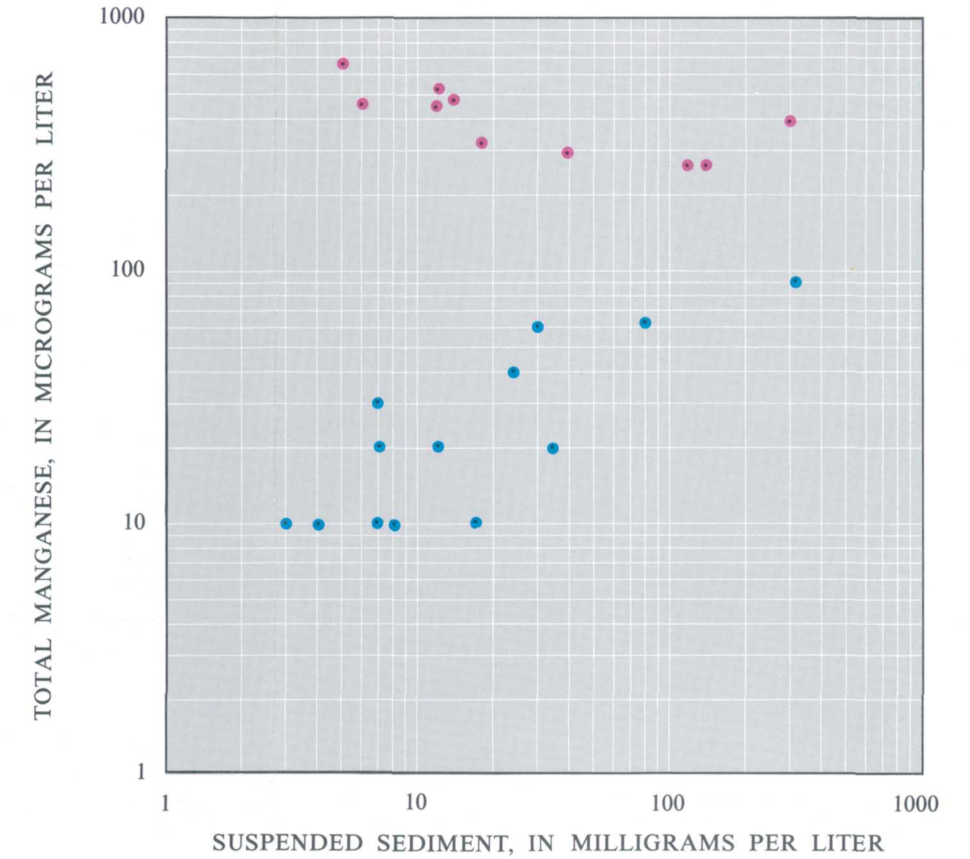
Manganese concentrations vary throughout Area 13 (fig. 6.6-1). Total manganese concentrations in samples from 125 sites in Area 13 ranged from 0 to 17,000 μg/L, and had a median value of 150 μg/L. The maximum permissible concentration of 4,000 μg/L, as set by the Act, was exceeded at only 3 sites (sites 20, 29, and 157). Maximum total manganese concentrations vary from 30 to 17,000 μg/L, minimum concentrations vary from 0 to 720 μg/L, and median concentrations ranged from 10 to 2,700 μg/L. Dissolved manganese concentrations in streams vary randomly throughout Area 13. The dissolved portion may be a substantial part of the total manganese concentration. Dissolved manganese fractions varying from 0 to 100 percent have been observed in Area 13 (table 6.6-1). A summary of total manganese is given in section 10.10.

Figure 6.6-2 is a plot of suspended sediment and total manganese concentrations. In general, no significant relation between these constituents could be found at sites in Area 13. However, figure 6.6-2 does show that the total-manganese concentrations at a mined site (site 99) are greater than the concentrations at an undisturbed site (site 28).



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972

Figure 6.6-1 Range of total manganese concentrations at selected sites in Area 13.



EXPLANATION

- Site 28 Dicks Fork at Phyllis: undisturbed
- Site 99 Johns Creek near Meta: underground mine

Figure 6.6-2 Relation of the total recoverable manganese concentrations and suspended-sediment values at selected sites.

Table 6.6-1 Dissolved and total manganese concentrations during variable flow at selected sites

DATE	DISCHARGE (ft^3/s)	DISSOLVED MANGANESE (ug/L)	TOTAL MANGANESE (ug/L)	SUSPENDED SEDIMENT (mg/L)
Site 28				
3 -3-77	.46	0.0	0.0	9.0
3-16-77	1.1	0.0	10	17
5-15-77	.20	10	20	12
6-24-77	.75	10	20	34
7-21-77	.15	40	30	7.0
9-22-77	.35	10	20	7.0
10-20-77	.46	10	10	3.0
12- 1-77	2.4	0.0	10	8.0
12-13-77	.96	0.0	10	7.0
1-25-78	24	0.0	80	62
3-23-78	.90	10	10	4.0
4-17-78	.34	0.0	10	0.0
5-10-78	4.1	0.0	10	4.0
7-10-78	.07	0.0	0.0	3.0
8- 1-78	0.0	10	10	1.0
7-26-79	7.2	9.0	90	34
8-15-79	.19	5.0	10	8.0
3-25-80	5.1	0.0	40	24
5- 6-80	.40	0.0	10	7.0
9- 9-80	.10	10	60	30
Site 99				
5- 9-79	53	430	460	12
7-11-79	36	60	510	12
8-15-79	11	370	390	18
10- 5-79	16	450	450	13
11-21-79	26	660	660	5.0
1-14-80	101	260	390	298
2-19-80	117	270	290	39
3-26-80	225	170	260	137
5- 7-80	14	450	450	6.0
9-10-80	25	170	260	118

Suspended-Sediment Yields Greater in Disturbed Areas

Watersheds affected by surface mining can have annual yields about 100 times greater than undisturbed basins.

Surface mining drastically alters the land surface. The removal of vegetative cover and subsequent exposure of unconsolidated material to weathering increases erosion and the transport and deposition of large amounts of sediment. In areas where erosion is uncontrolled, river channels and lakes are often clogged with deposited sediment. In general, most land disturbances in a basin tend to increase suspended-sediment yields.

Suspended-sediment discharge is a function of several parameters including land use, climate, basin characteristics, soil, and water discharge. A significant relation exists between water discharge and suspended-sediment discharge (fig. 6.7-1 and fig. 6.7-2). It is not uncommon for a large portion of the annual suspended-sediment load to be transported in a few days during floods. For example, 87 percent of the 1977 annual yield for site 28 occurred during the April 1977 flood. For this reason, intensive sampling during high-flow periods is required to estimate the annual suspended-sediment yield.

Comparison of the suspended-sediment discharge ratings shows that the yields from a surface-mined basin, site 225, are about 100 times greater than that from an undisturbed basin, site 28 (fig. 6.7-2). This relation also shows that the yields from a surface-mined basin are about 10 times greater than in a basin with underground mines (sites 29 and 99).

Figure 6.7-3 is a graphical representation of data from Curtis, and others (1977). The figure shows that as the percent of a basin disturbed by mining increases so does the suspended-sediment yield. In basins where underground mining predominates suspended-sediment yields varied from 740 to 3,500 (tons/mi^2)/yr. In basins where surface mining predominated, annual suspended-sediment yields ranged from 3,900 to 21,000 (tons/mi^2)/yr. The yields from basins disturbed by surface mining were 10 to 100 times greater than those at undisturbed basins.

In Area 13, over one-half of the suspended sediments are silts and clays. Particle size analysis of suspended-sediments from selected sites in the basin show that generally a mined basin yields a greater percentage of coarse particles than the unmined basin.

Instantaneous suspended-sediment yields measured in Area 13 vary from 0 to 12,300 (tons/d)/mi^2 with a median of 0.44 (tons/d)/mi^2 and a mean of 86.6 (tons/d)/mi^2. Ninety percent of the values vary from 0.005 to 261 (tons/d)/mi^2. Fifty-six (fig. 6.7-4) of the 125 sites used in the section have multiple samples.

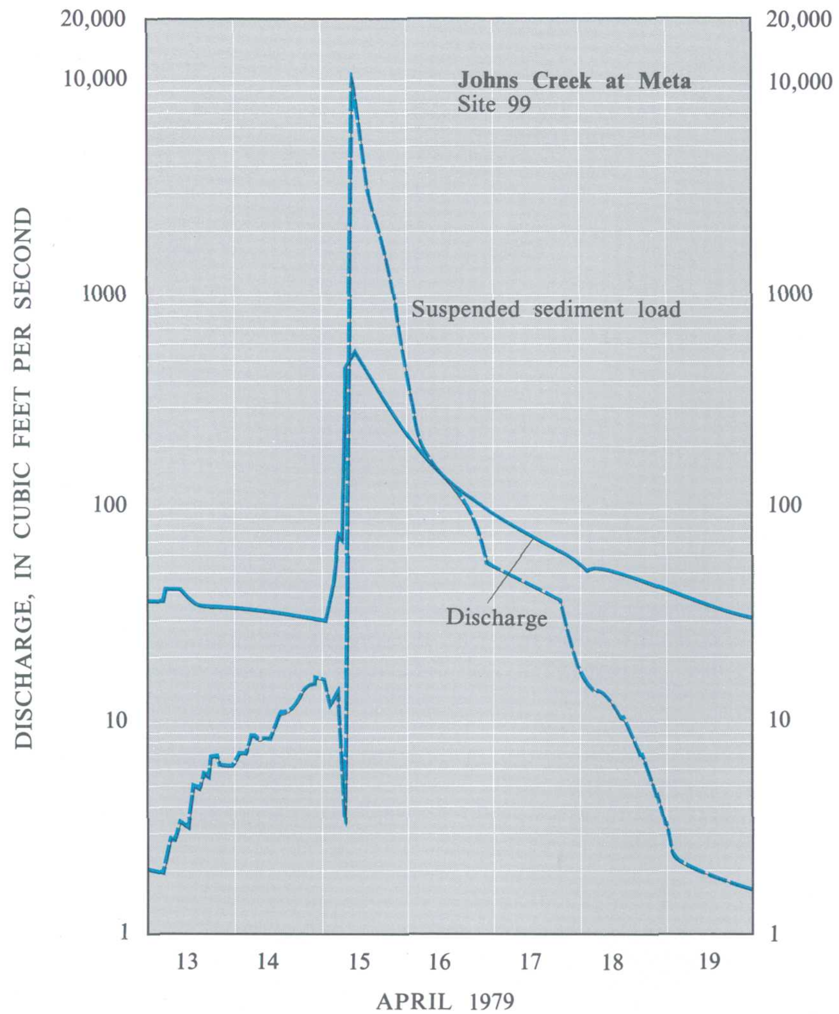


Figure 6.7-1 Comparison of stream discharge and suspended-sediment load.

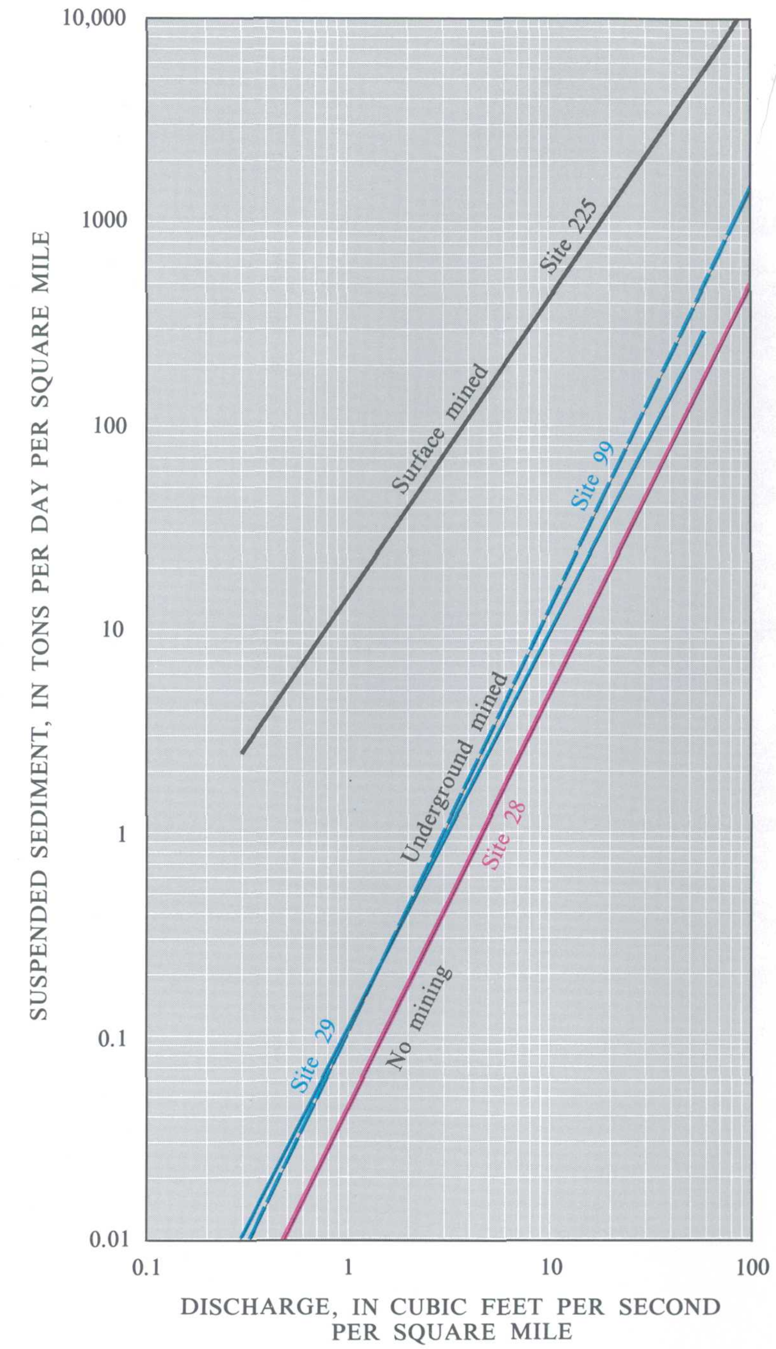


Figure 6.7-2 Relation between stream discharge and suspended-sediment loads at mined and unmined sites.

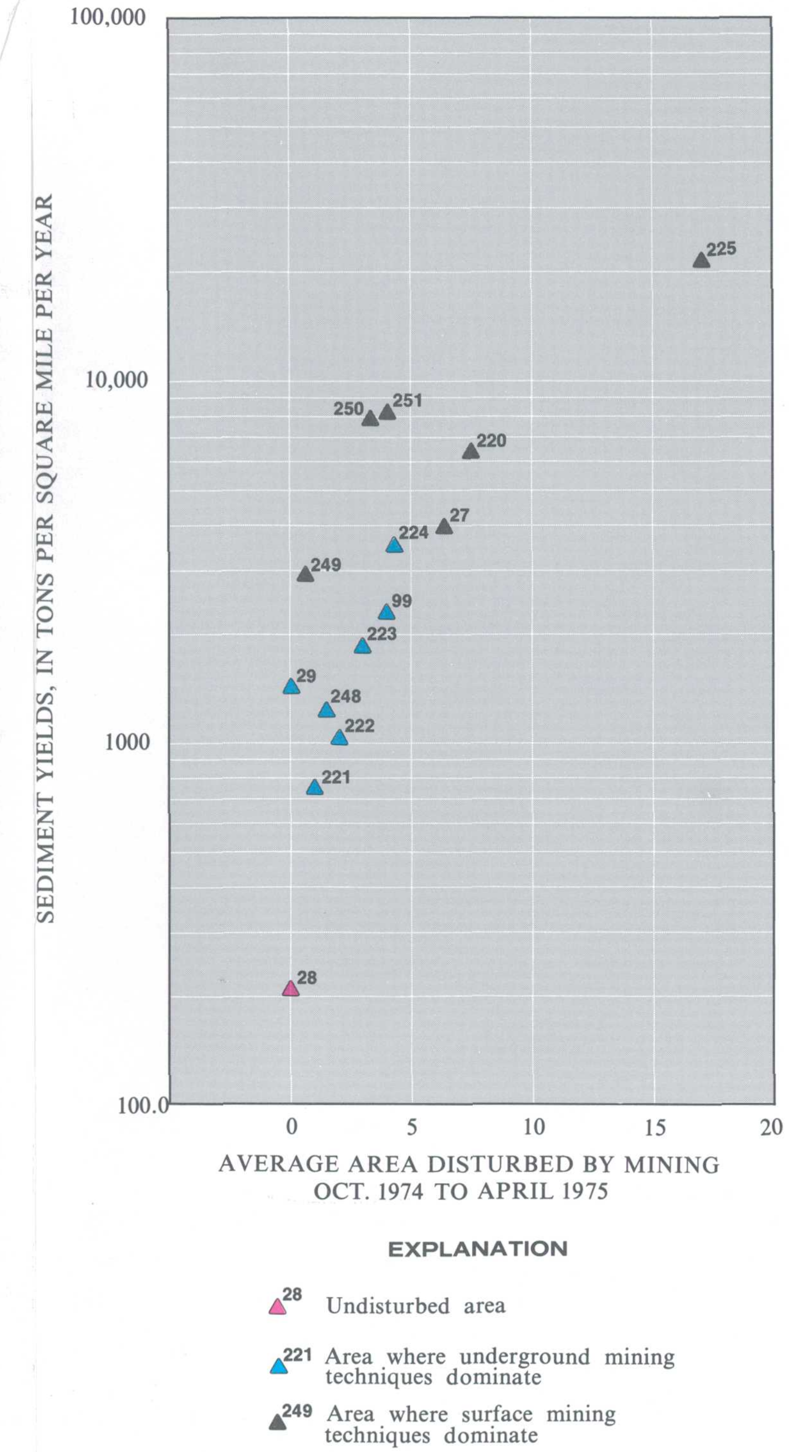
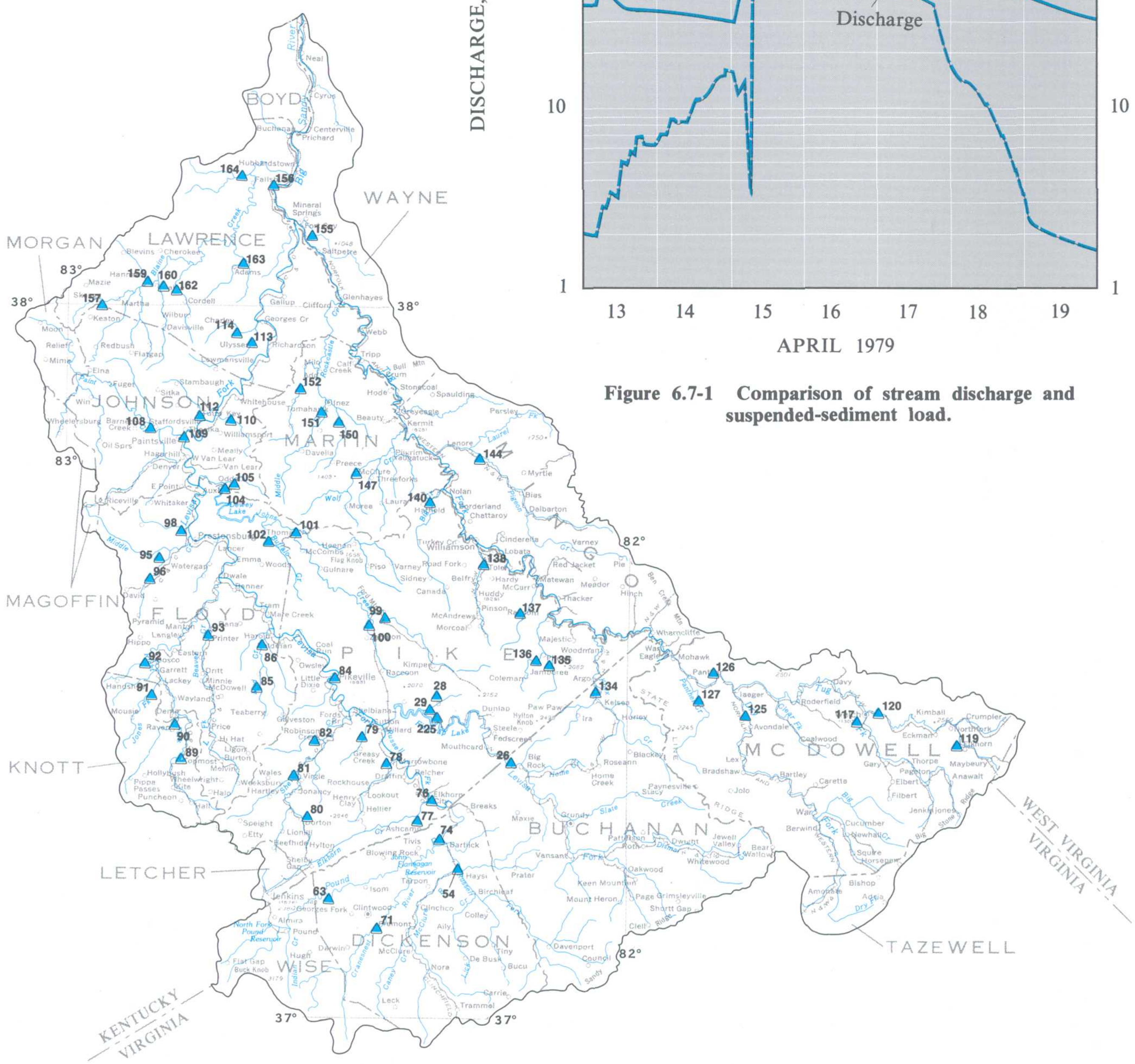


Figure 6.7-3 Relation between percent of land disturbed by mining and yearly sediment yields.



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972

EXPLANATION

117 ▲ **Site and number**

See section 10.2 for detailed site description.

Figure 6.7-4 Suspended-sediment sampling sites with multiple samples.

Concentrations of Trace Constituents Except Mercury and Lead Below Recommended Limits

Maximum concentrations of dissolved mercury and lead at selected sites in Area 13 exceed State and Federal limits for water recommended for domestic use or aquatic life.

Trace constituents are predominantly metals of low solubility that occur in natural water. In low concentrations most of the metals are essential to life. However, in high concentrations some of them are toxic to plants and animals. Trace constituents are present in most soils and under normal weathering conditions they will leach slowly into natural waters. High concentrations of trace metals are commonly associated with waste discharges and mine drainage.

Trace constituents are common in coal and associated rocks. The weathering of exposed pyritic minerals in mine spoils produces sulfuric acid. The acid accelerates the leaching of minerals and dissolution of salts, increasing the dissolved-solids concentration in water. Mine drainage, particularly when acidic, contains concentrations of trace constituents that exceed background levels. When the mine drainage is neutralized, some of the trace constituents are oxidized forming insoluble precipitates that are deposited in stream bottoms and banks in mined areas.

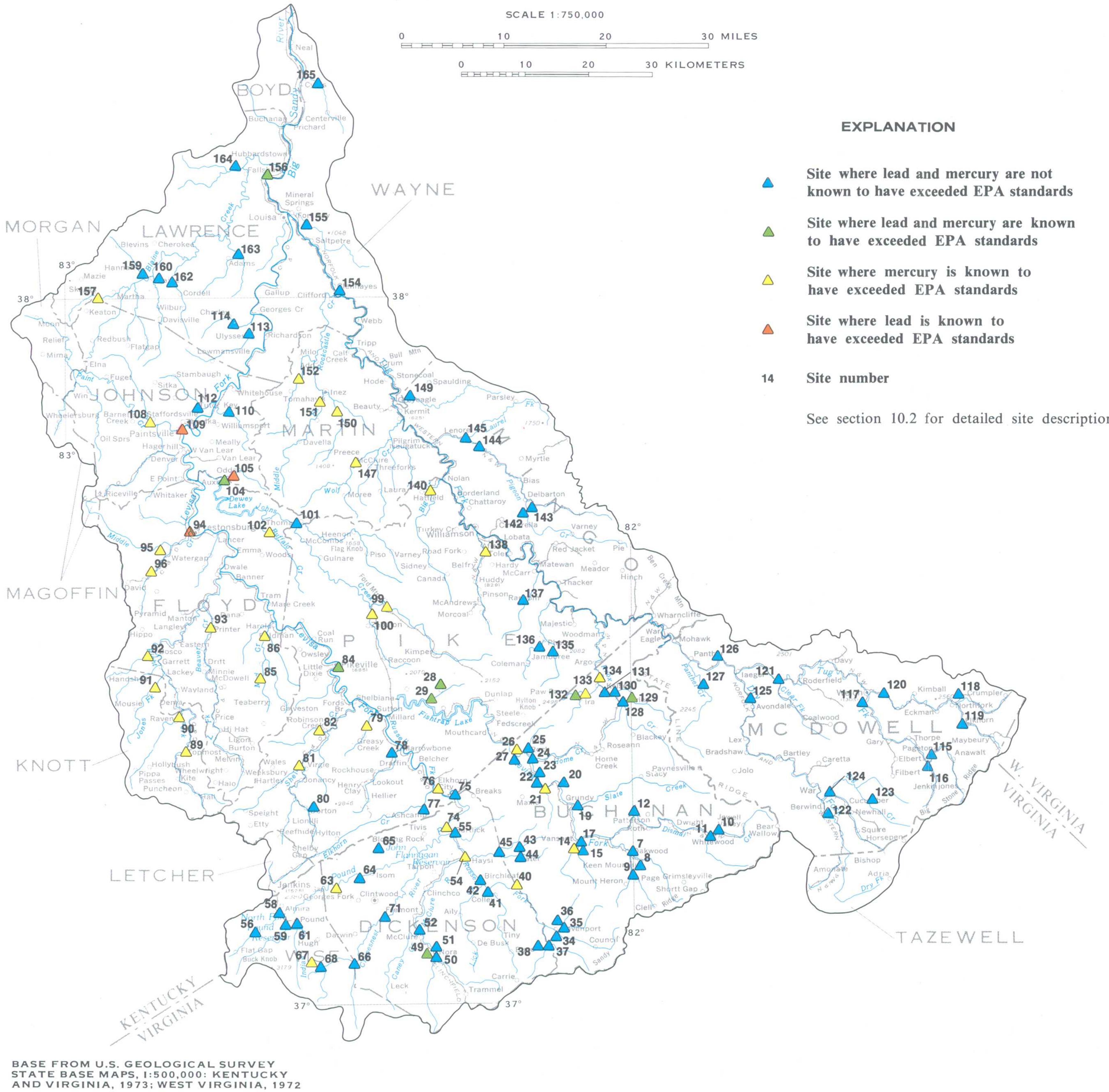
Concentrations of trace constituents in water and stream-bottom sediments at selected sites (fig. 6.8-1) in Area 13 are given in section 10.11. The available data in section 10.11 show that mercury and lead are the only two constituents found to exceed Federal standards.

Concentrations of mercury exceeded the detection limit for mercury of 1 μg/L at 36 sites in Area 13 (fig. 6.8-1). State and Federal recommended limits for aquatic life are 0.05 μg/L (Environmental Protection Agency, 1976). Thus, concentration of mercury may have exceeded the standard for aquatic life at other sites but could not be detected below 1 μg/L. No mercury concentrations were found that exceeded the Environmental Protection Agency (1976) recommended limit for domestic water supplies of 2 μg/L.

Concentrations of lead exceeded the recommended limits for drinking water at 8 sites (Environmental Protection Agency, 1975). The recommended limits for aquatic life for concentrations of lead in water are highly variable dependent upon the species involved (Environmental Protection Agency, 1976).

Stream-bottom sediments at selected sites in Area 13 contain low amounts of trace constituents. Cadmium, iron, manganese, and mercury were the predominant metals in the bottom materials. A summary of the available bottom sediments information is given in section 10.11.

The transport of trace constituents in areas affected by mining is generally associated with the transport of suspended sediment. Relations between suspended-sediment concentrations and many selected trace constituents, such as total recoverable iron and manganese, can be developed. However, the available data in Area 13 are insufficient to define these relations for most constituents. An intensive sampling program through the full range of flow at many sites will be required to describe these relations.



EXPLANATION

- Blue triangle: Site where lead and mercury are not known to have exceeded EPA standards
- Green triangle: Site where lead and mercury are known to have exceeded EPA standards
- Yellow triangle: Site where mercury is known to have exceeded EPA standards
- Orange triangle: Site where lead is known to have exceeded EPA standards
- 14: Site number

See section 10.2 for detailed site description.

Figure 6.8-1 Trace constituents sampling sites.

Aquifers Recharged Directly by Precipitation

Multiple sandstone aquifers are present in the Breathitt and Lee Formations and discharge through fractures to springs and streams.

Almost all ground water in Area 13 originates as precipitation that percolates downward until it enters a zone of saturation, the upper surface of which is called the water table. The water table generally follows the shape of the land surface but is not as deep under valleys as under hilltops. Multiple aquifers can underlie the same area and each aquifer can have its own water table or artesian head. A confined or artesian aquifer occurs below a less permeable bed and the water in a well tapping this aquifer rises above the level where the water is first found in the well. Practically all ground water in Area 13 is artesian. The water in a well tapping an unconfined or water table aquifer stands at the top of the zone of saturation and is the same elevation as the water table. Perched aquifers, located above the main ground-water aquifer and areally limited, are common in the area where hilly terrain is underlain by alternating beds of permeable sandstone and less permeable beds of clay, shale, and siltstone rocks (fig. 7.1-1).

Ground water is stored in and moves through intergranular (primary) and fracture (secondary) openings in rocks. In Area 13 more water moves through fracture openings because they are larger than the intergranular openings. Thus, most of the water from aquifers in Area 13 comes from fracture openings that are best developed in sandstones in the Breathitt and Lee Formations. Along the northern slope of Pine Mountain, solutionally enlarged fracture openings in limestones of pre-Pennsylvanian age permit relatively free movement of ground water to wells and springs. Little is known about the direction of water movement in regional aquifers in Area 13. Generally, movement is downdip along bedding planes or toward structural synclines. Locally, water may move in different directions because of influences of topography and the orientation of the fracture systems. The rate of movement depends on the size and interconnection of water-bearing openings and the hydraulic gradient.

All ground water is in motion from areas of recharge to areas of discharge. Water moves downward from shallow aquifers to deeper aquifers and laterally to the outcrop of the aquifer. Lateral discharge from an aquifer is seen as seeps or springs on hillsides (fig. 7.1-1). The quantity of water recharged to deeper aquifers is controlled by the nature of the underlying rocks and the hydraulic gradient. Water in deeper aquifers also can move downward or laterally to become streamflow. Pumpage from wells or mines can alter the natural hydraulic gradient system so that water levels in nearby wells or streams may be lowered. For example, Epps (1978) reports several areas in Buchanan County with lowered water levels caused by dewatering of underground coal mines.

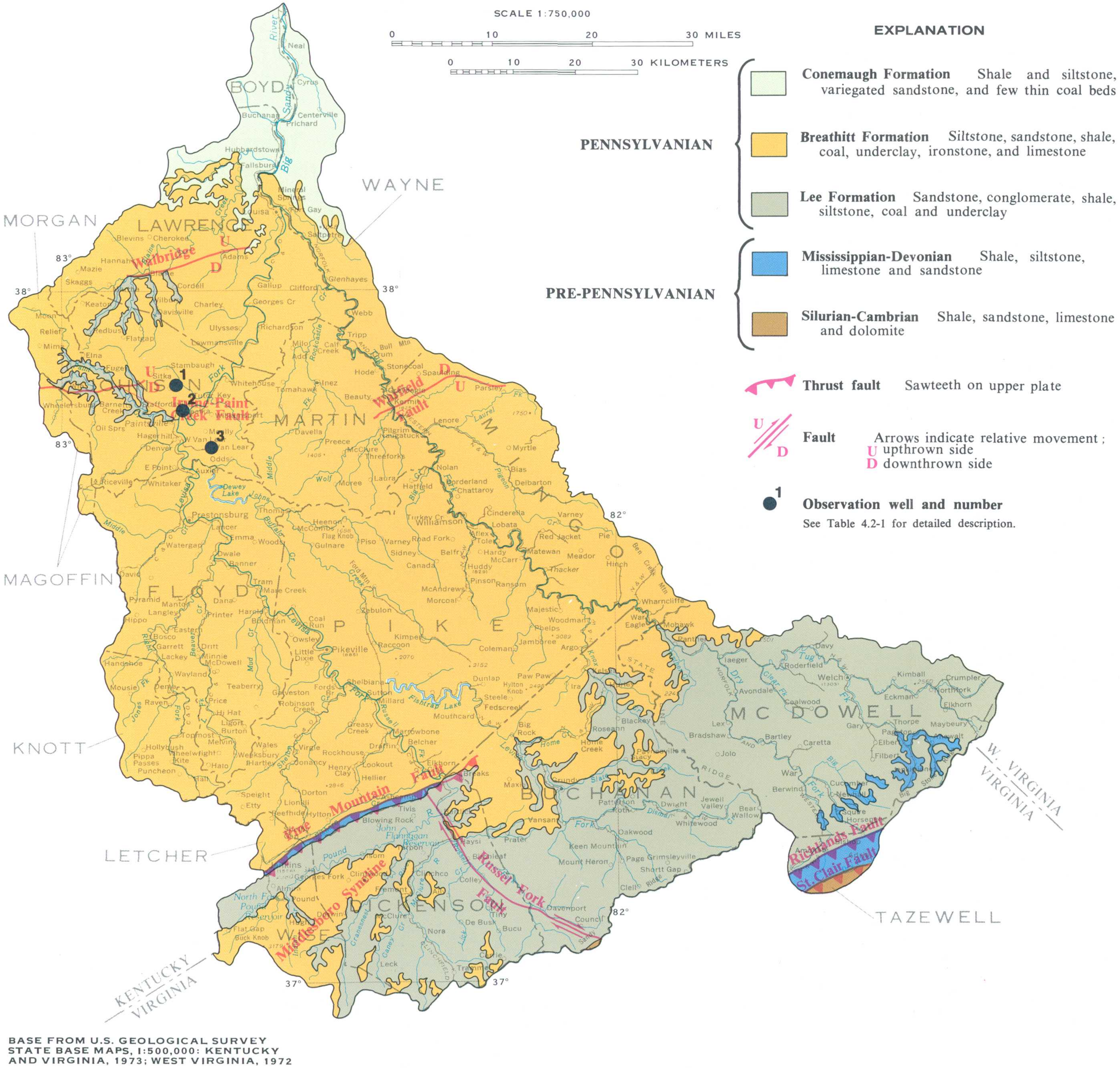


Figure 7.2-1 Observation well sites.

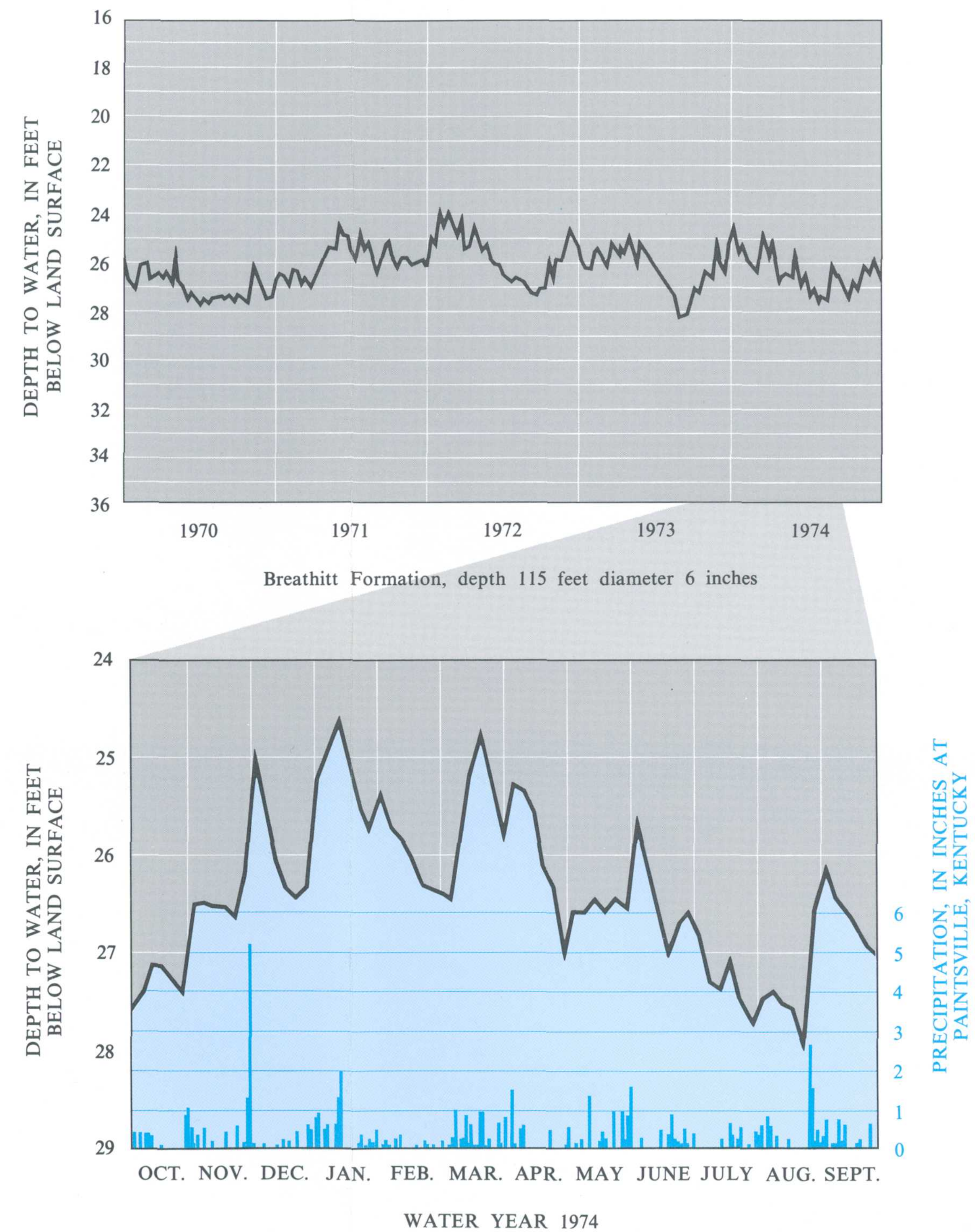


Figure 7.2-2 Typical seasonal water-level fluctuations in Area 13.

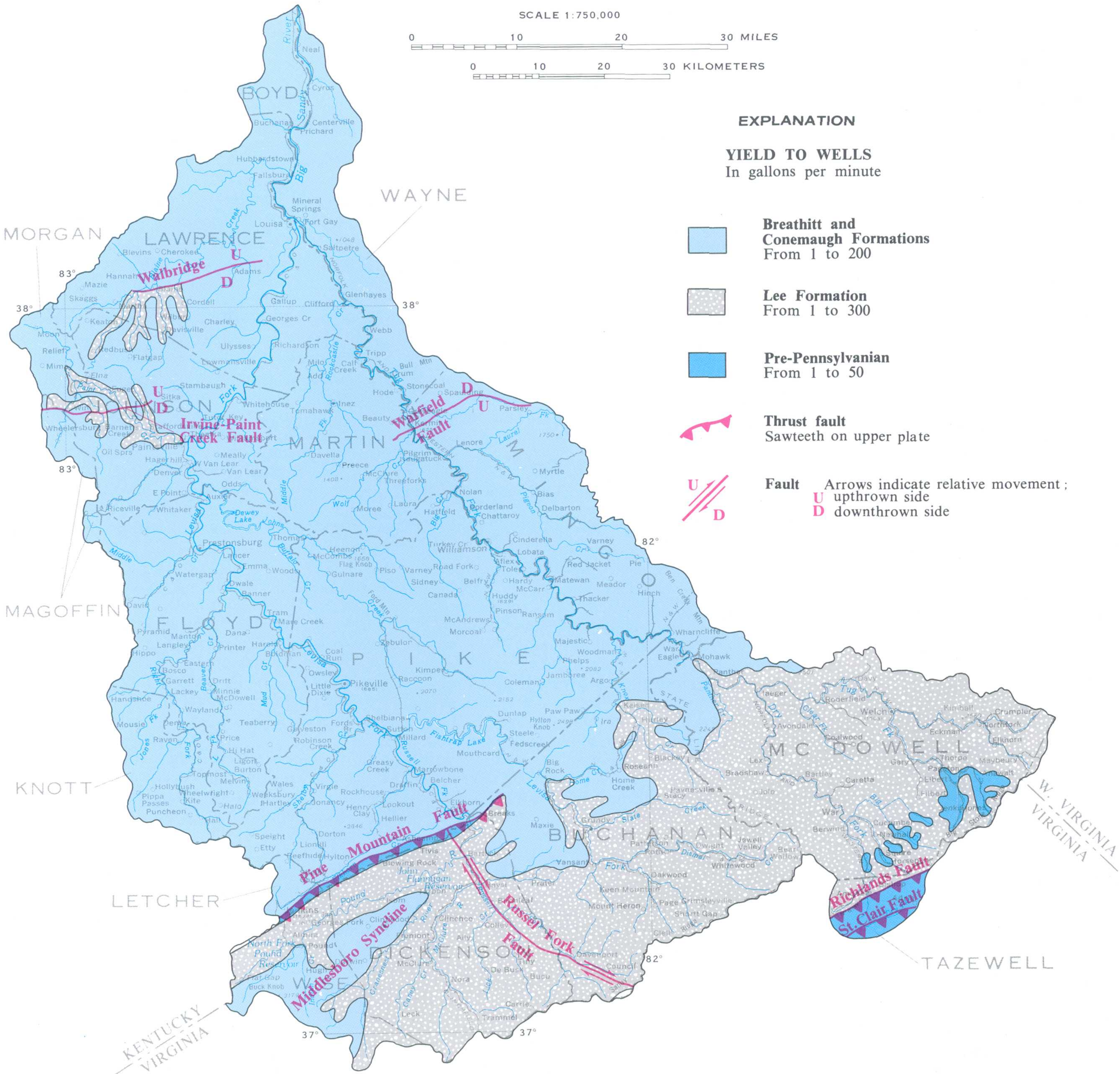
Measured Yields to Wells Range from 1 to 300 Gallons per Minute

The Breathitt and Lee Formations yield 1 to 300 gallons per minute to wells. Yields to wells in the pre-Pennsylvanian rocks are generally less than 50 gallons per minute.

The main source of ground water in Area 13 is the Breathitt and Lee Formations (fig. 7.3-1). Fractured sandstone is the principal aquifer but shale and coal also yield water to some wells. Underground coal mines function as collection galleries and can yield several hundred gallons per minute. Yields usually range from 1 to 50 gal/min from wells 200 feet or less in depth. Fractured sandstones of the Lee Formation near Russell Fork Fault in Buchanan County, Virginia have produced yields up to 300 gal/min. Similar yields may be obtained in the vicinity of other major faults in Area 13 because fractures tend to be larger and more numerous near fault zones.

The principal factors governing well yields are well depth, location, and the lithology of the rocks tapped. In general, deeper wells have greater yields, however, fractures are generally fewer in number and smaller at greater depths. Hence, greater depths may not necessarily produce a corresponding increase in yield. Conversely, shallow wells of less than 200 feet frequently do not yield enough water for a domestic supply. Wells in the valleys of perennial streams may yield as much as 300 gal/min from wells tapping sandstone of the Lee Formation. Deep wells tapping the Lee Formation in the Middlesboro Syncline flow as much as 15 gal/min. Wells more than 200 feet in depth, tapping sandstone of the Breathitt Formation below valleys of major streams yield as much as 200 gal/min. The yields from depths greater than 300 feet are probably from intergranular pore spaces where sandstone particles are poorly cemented (Price and others, 1962).

In pre-Pennsylvanian rocks the major aquifers are limestones that may yield 50 gal/min to wells tapping interconnected solution openings. Springs can flow at more than 20 gal/min from these openings. Typically yields to wells are less than 1 gal/min where limestone is overlain by shale or siltstone of Pennsylvanian age.



BASE FROM U.S. GEOLOGICAL SURVEY
STATE BASE MAPS, 1:500,000: KENTUCKY
AND VIRGINIA, 1973; WEST VIRGINIA, 1972

Figure 7.3-1 General yields to wells.

8.0 QUALITY OF GROUND WATER

Chemical Quality of Ground Water is Highly Variable

Ground water in Area 13 is generally suitable for most uses after proper treatment. High iron concentrations are common. Water ranges from soft to very hard.

The quality of ground water in Area 13 varies considerably, but is generally acceptable for most uses with proper treatment. Most water analyses for the area are from Kentucky. Few analyses are available from rocks of pre-Pennsylvanian age in Area 13. There are not enough chemical analyses available to adequately define the chemical characteristics of ground water in all aquifers throughout Area 13.

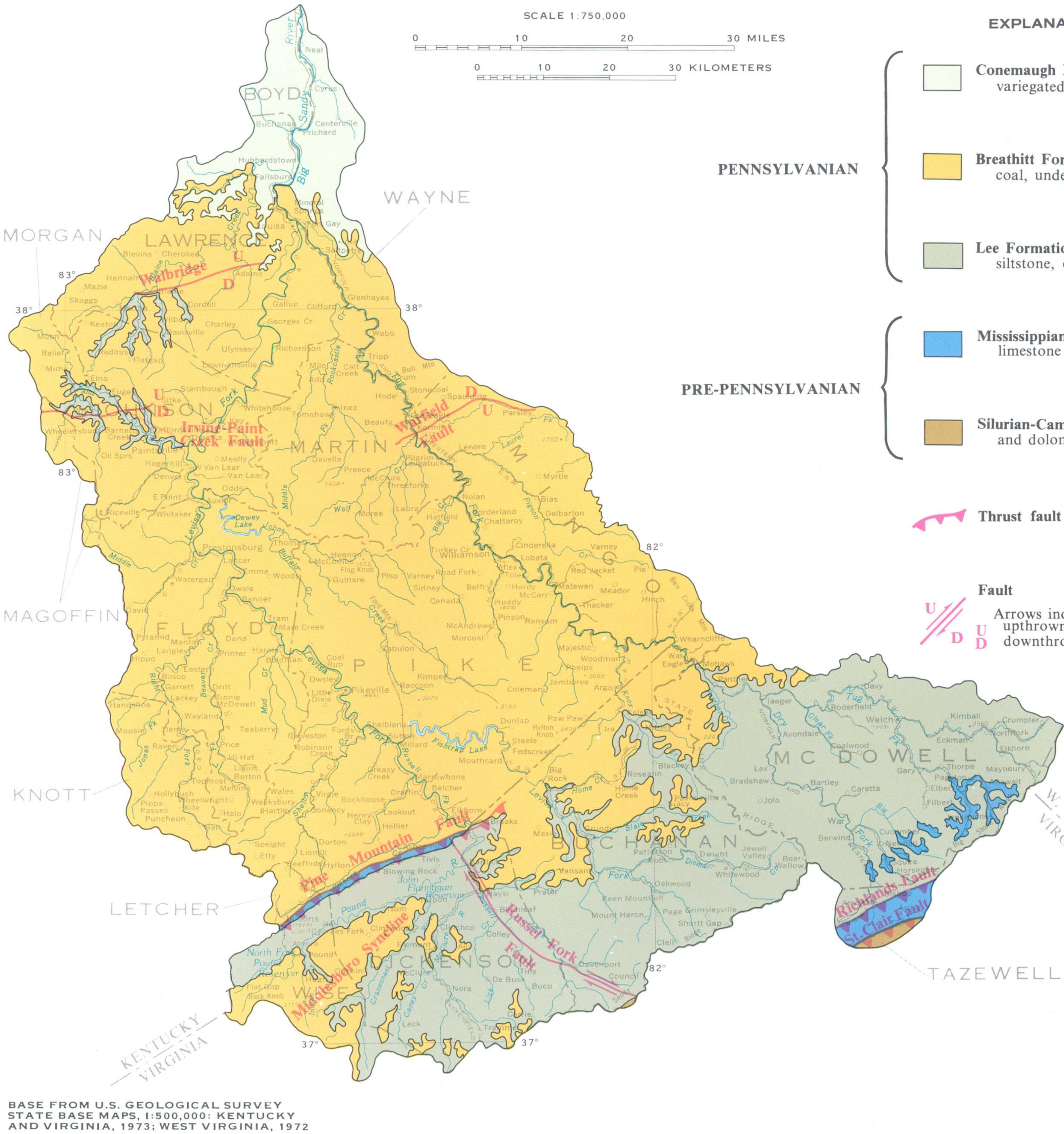
Minimum, median, and maximum values for major chemical constituents are shown in figure 8.0-1. Waters with specific conductance values greater than 10,000 μmhos/cm were not included in the analysis as they were considered to be brines and not suitable for human use. Median values are shown because they are more representative than average values. Ground-water quality data for Kentucky have been compiled by Faust and others (1980).

Iron is the constituent that generally occurs in objectable concentrations in ground water in Area 13. Concentration range from 100 to 157,000 μg/L; the recommended limit for the total iron concentration in water for domestic use is 300 μg/L (U.S. Environmental Protection Agency, 1977). Water from coal mines or water that has drained through beds of black shale is most likely to have high iron concentrations (Price and others, 1962).

Slightly saline water or water having more than 1,000 mg/L dissolved solids (Krieger and Hatchett, 1957) is usually found at depths less than 100 feet below the level of the principal valley bottoms in the central and northern part of Area 13. Elsewhere, slightly saline water typically occurs in wells deeper than 300 feet. Epps (1978) reported chloride concentrations varying from 40 to 800 mg/L from wells 300 to 400 feet below stream level in Buchanan County, Virginia. Saline water is relatively common at shallow depths in the vicinity of oil and gas fields because water can migrate upward through improperly plugged or abandoned oil, gas, and test wells. Hopkins (1970) reported this type of salt water contamination near Keaton in Johnson County, Kentucky. In general, the concentration of dissolved solids increases with depth and brines or water with more than 35,000 mg/L dissolved solids, occurs at depths in most of Area 13.

Hardness, expressed as calcium carbonate ($CaCO_3$), is frequently troublesome in ground water from Area 13. Water from limestone and shale is characteristically hard (more than 120 mg/L $CaCO_3$) and water from sandstone usually is soft (less than 60 mg/L $CaCO_3$). The high values for hardness probably reflect the minerals in the rocks that make up the aquifers of Area 13.

Most shallow waters from rocks of Pennsylvanian age in Area 13 can be classified as calcium-magnesium-bicarbonate or sodium-bicarbonate type. Water from depths below 100 to 300 feet is generally a sodium-sulfate or sodium-chloride type. None of these is unique to either the Breathitt or Lee Formation. All types occur in each formation. The principal factors that govern the chemical quality of ground water are lithology and the amount of time the water has been in contact with the rocks.



EXPLANATION

PENNSYLVANIAN

- **Conemaugh Formation** Shale and siltstone, variegated sandstone, and few thin coal beds
- **Breathitt Formation** Siltstone, sandstone, shale, coal, underclay, ironstone, and limestone
- **Lee Formation** Sandstone, conglomerate, shale, siltstone, coal and underclay

PRE-PENNSYLVANIAN

- **Mississippian-Devonian** Shale, siltstone, limestone and sandstone
- **Silurian-Cambrian** Shale, sandstone, limestone and dolomite

Thrust fault Sawteeth on upper plate

Fault Arrows indicate relative movement; U upthrown side, D downthrown side

Figure 8.0-1 General chemical composition of ground water.

CONEMAUGH-BREATHITT FORMATIONS

Constituents in milligrams per liter unless otherwise specified

Constituent	Range	Median	Number of samples
Iron (Fe)	0.01 - 157	1.0	100
Calcium (Ca)	2.4 - 248	27	118
Magnesium (Mg)	0.5 - 177	7.5	117
Sodium (Na)	1.5 - 742	29	121
Potassium (K)	0.5 - 22	2.4	116
Bicarbonate (HCO_3)	0 - 537	153	102
Sulfate (SO_4)	0.1 - 2,749	13	185
Chloride (Cl)	1 - 2,450	11	238
Specific conductance (micromhos per centimeter at 25°C)	60 - 7,620	378	183
Hardness as calcium carbonate ($CaCO_3$)	3 - 2,190	96	185
pH (Units)	2.6 - 8.8	7.1	167

LEE FORMATION

Constituents in milligrams per liter unless otherwise specified

Constituent	Range	Median	Number of samples
Iron (Fe)	0.01 - 16	0.82	25
Calcium (Ca)	1.3 - 150	22	155
Magnesium (Mg)	0.40 - 57	6.5	155
Sodium (Na)	1.4 - 400	27	153
Potassium (K)	0.8 - 9.2	1.9	153
Bicarbonate (HCO_3)	10 - 388	226	25
Sulfate (SO_4)	0 - 610	12	174
Chloride (Cl)	1.0 - 849	9.4	177
Specific conductance (micromhos per centimeter at 25°C)	39 - 2,970	310	175
Hardness as calcium carbonate ($CaCO_3$)	5 - 580	85	174
pH (Units)	5.5 - 9.0	7.0	173

MISSISSIPPIAN-DEVONIAN ROCKS

Constituents in milligrams per liter unless otherwise specified

Constituent	Range	Median	Number of samples
Iron (Fe)	- - -	-	0
Calcium (Ca)	0.4 - 68	46	18
Magnesium (Mg)	0.10 - 38	8.9	18
Sodium (Na)	2.8 - 310	16	18
Potassium (K)	0.1 - 2.1	1.0	18
Bicarbonate (HCO_3)	- - -	-	0
Sulfate (SO_4)	1.6 - 120	28	18
Chloride (Cl)	2.2 - 210	8.3	18
Specific conductance (micromhos per centimeter at 25°C)	270 - 1,470	330	18
Hardness as calcium carbonate ($CaCO_3$)	1 - 320	145	18
pH (Units)	6.7 - 8.1	7.7	18

NAWDEX, WATSTORE, and OWDC Information

Water data are collected in coal areas by large number of organizations in response to a wide variety of missions and needs.

Within the U.S. Geological Survey there are three activities that help to identify and improve access to the vast amount of existing water data. These activities are:

(1) The National Water Data Exchange (NAWDEX), which indexes the water data available from over 400 organizations and serves as a central focal point to help those in need of water data to determine what information is available.

(2) The National Water Data Storage and Retrieval System (WATSTORE), which serves as the central repository of water data collected by the U. S. Geological Survey and which contains large volumes of data on the quantity and quality of both surface and ground waters.

(3) The Office of Water Data Coordination (OWDC), which coordinates Federal water-data acquisition activities and maintains a "Catalog of Information on Water Data." To assist in identifying available water-data activities in coal provinces of the United States, special indexes to the Catalog are being printed and made available to the public.

A more detailed explanation of these three activities are given in sections 9.2, 9.3, and 9.4.

NAWDEX Simplifies Access to Water Data

The National Water-Data Exchange (NAWDEX) is a nationwide program managed by the U.S. Geological Survey to assist users of water data or water-related data in identifying, locating, and acquiring needed data.

NAWDEX is a national confederation of water-oriented organizations working together to make their data more readily accessible and to facilitate a more efficient exchange of water data.

Services are available through a Program Office located at the U.S. Geological Survey's National Center in Reston, Virginia, and a nationwide network of Assistance Centers located in 45 states and Puerto Rico, which provide local and convenient access to NAWDEX facilities (fig. 9.2-1). A directory is available on request that provides names of organizations and persons to contact, addresses, telephone numbers, and office hours for each of these locations [Directory of Assistance Centers of the National Water Data Exchange (NAWDEX), U.S. Geological Survey Open-File Report 79-423 (revised)].

NAWDEX can assist any organization or individual in identifying and locating needed water data and referring the requester to the organization that retains the data required. To accomplish this service, NAWDEX maintains a computerized Master Water Data Index (fig. 9.2-2), which identifies sites for which water data are available, the type of data available for each site, and the organization retaining the data. A Water Data Sources Directory (fig. 9.2-3) also is maintained that identifies organizations that are sources of water data and the locations within these organizations from which data may be obtained. In addition NAWDEX has direct access to some large water-data bases of its members and has reciprocal agreements for the exchange of services with others.

Charges for NAWDEX services are assessed at the option of the organization providing the requested data or data service. Search assistance services are provided free by NAWDEX to the greatest extent possible. Charges are assessed, however, for those requests requiring computer cost, extensive personnel time, duplicating services, or other costs encountered by NAWDEX in the course of providing services. In all cases, charges assessed by NAWDEX Assistance Centers will not exceed the direct costs incurred in responding to the data request. Estimates of cost are provided by NAWDEX upon request and in all cases where costs are anticipated to be substantial.

For additional information concerning the NAWDEX program or its services contact:

Program Office
National Water Data Exchange (NAWDEX)
U.S. Geological Survey
421 National Center
12201 Sunrise Valley Drive
Reston, VA 22092

Telephone: (703) 860-6031
FTS 928-6031
Hours: 7:45 - 4:15 Eastern Time
or

KENTUCKY
U.S. Geological Survey
Water Resources Division
Room 572, Federal Building
600 Federal Place
Louisville, KY 40202
or

VIRGINIA
U.S. Geological Survey
Water Resources Division
Room 304
200 West Grace Street
Richmond, VA 23220
or

WEST VIRGINIA
U.S. Geological Survey
Water Resources Division
Room 3017, Federal Building
500 Quarrier Street, East
Charleston, WV 25301

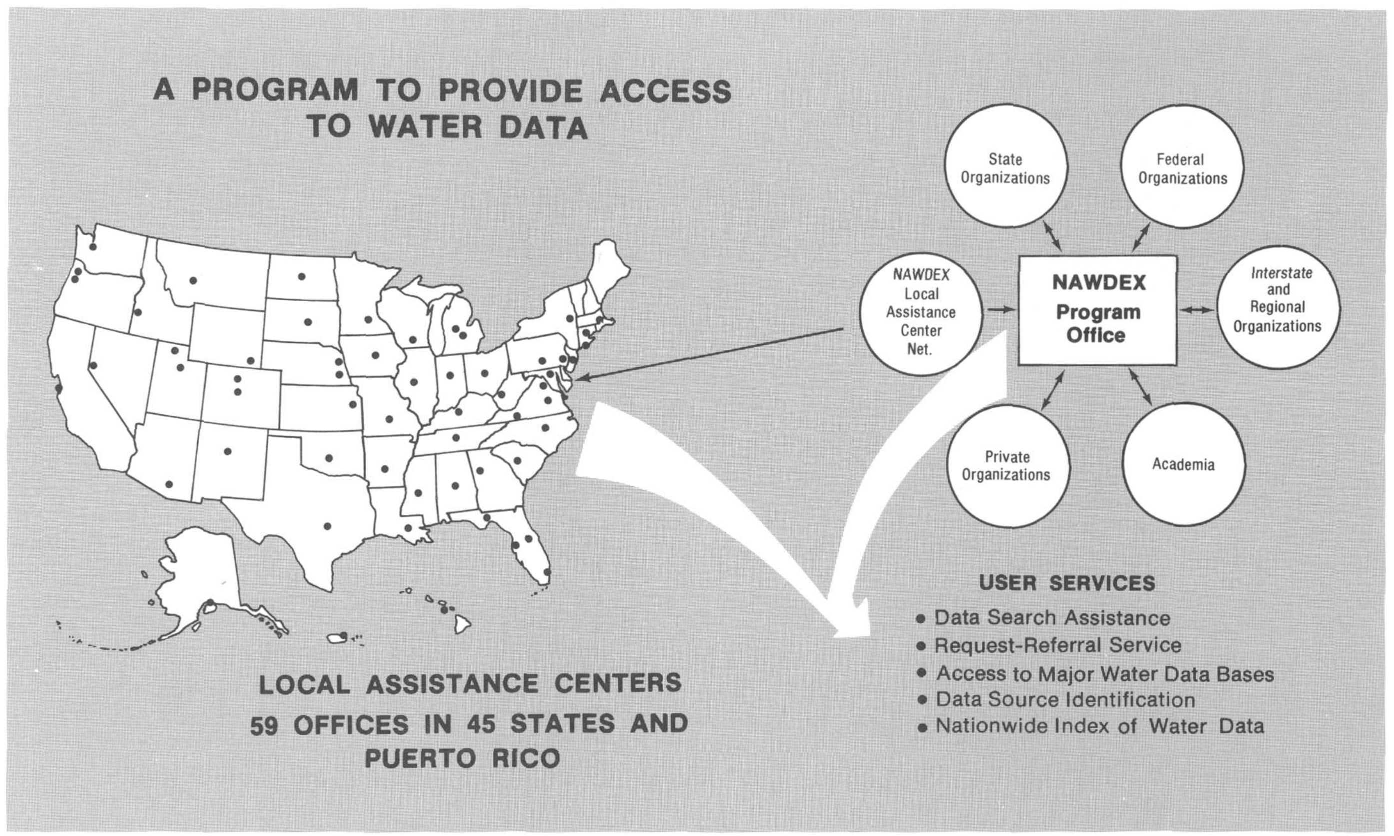


Figure 9.2-1 Access to water data.

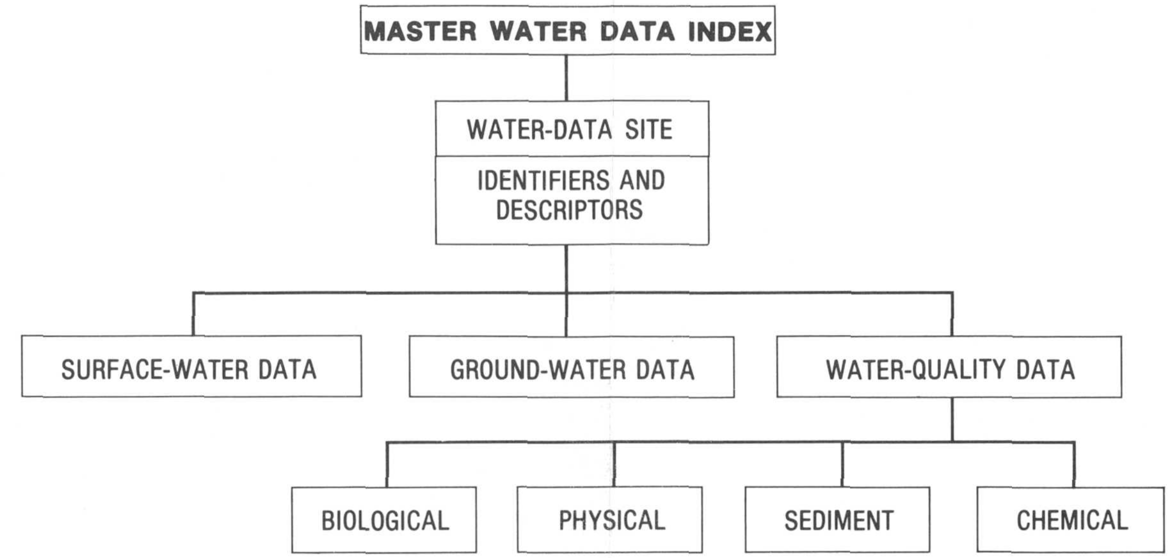


Figure 9.2-2 Master water-data index.

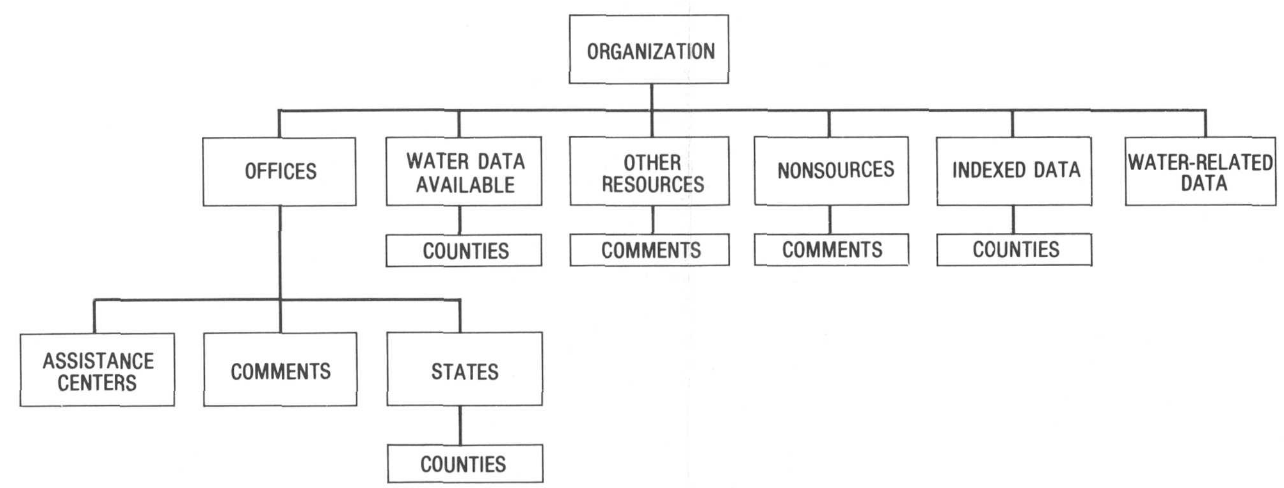


Figure 9.2-3 Water-data sources directory.

WATSTORE Automated Data System

The National Water Data Storage and Retrieval System (WATSTORE) of the U.S. Geological Survey provides computerized procedures and techniques for processing water data and provides effective and efficient management of data-releasing activities.

The National Water Data Storage and Retrieval System (WATSTORE) was established in November 1971 to computerize the U.S. Geological Survey's existing water-data system and to provide for more effective and efficient management of its data-releasing activities. The system is operated and maintained on the central computer facilities of the Survey at its National Center in Reston, Virginia. Data may be obtained from WATSTORE through the Water Resources Division's 46 district offices. General inquiries about WATSTORE may be directed to:

Chief Hydrologist
U.S. Geological Survey
437 National Center
Reston, VA 22092

or

U.S. Geological Survey
Water Resources Division
Room 572, Federal Building
600 Federal Place
Louisville, KY 40202

or

U.S. Geological Survey
Water Resources Division
Room 304
200 West Grace Street
Richmond, VA 23220

or

U.S. Geological Survey
Water Resources Division
Room 3017, Federal Building
500 Quarrier Street, East
Charleston, WV 25301

The Geological Survey currently (1980) collects data at approximately 16,000 streamgaging stations, 1,000 lakes and reservoirs, 5,200 surface-water quality stations, 1,020 sediment stations, 30,000 water-level observation wells, and 12,500 ground-water quality wells. Each year many water-data collection sites are added and others are discontinued; thus, large amounts of diversified data, both current and historical, are amassed by the Survey's data-collection activities.

The WATSTORE system consists of several files in which data are grouped and stored by common characteristics and data-collection frequencies. The system is also designed to allow for the inclusion of additional data files as needed. Currently, files are maintained for the storage of: (1) surface-water, quality-of-water, and ground-water data measured on a daily or continuous basis; (2) annual peak values for streamflow stations; (3) chemical analyses for surface- and ground-water sites; (4) water parameters measured more frequently than daily; and (5) geologic and inventory data for ground-water sites. In addition, an index file of sites for which data are stored in the system is also maintained (fig. 9.3-1). A brief description of each file is as follows:

Station-Header File: All sites for which data are stored in the Daily Values, Peak Flow, Water-Quality, and Unit Values files of WATSTORE are indexed in this file. It contains information pertinent to the identification, location, and physical description of nearly 220,000 sites.

Daily-Values File: All water-data parameters measured or observed either on a daily or on a continuous basis and numerically reduced to daily values are stored in this file. Instantaneous measurements at fixed-time intervals, daily mean values, and statistics such as daily maximum and minimum values also may be stored. This file currently contains over 200 million daily values including data on streamflow, river stages, reservoir contents, water temperatures, specific-conductance, sediment concentrations, sediment discharges, and ground-water levels.

Peak-Flow File: Annual maximum (peak) streamflow (discharge) and gage height (stage) values at surface-water sites comprise this file, which currently contains over 400,000 peak observations.

Water-Quality File: Results of over 1.4 million analyses of water samples that describe the chemical, physical, biological, and radiochemical characteristics of both surface and ground waters are contained in this file. These analyses contain data for 185 different constituents.

Unit-Values File: Water parameters measured on a schedule more frequent than daily are stored in this file. Rainfall, stream discharge, and temperature data are examples of the types of data stored in the Unit Values File.

Ground-Water Site-Inventory File: This file is discussed above, but it is cross-referenced to the Water-Quality File and the Daily Values File. It contains inventory data about wells, springs, and other sources of ground water. The data included are site location and identification, geohydrologic characteristics, well-construction history, and one-time field measurements such as water temperature. The file is designed to accommodate 255 data elements and currently contains data for nearly 70,000 sites.

All data files of the WATSTORE system are maintained and managed on the central computer facilities of the Geological Survey at its National Center. However, data may be entered into or retrieved from WATSTORE at a number of locations that are part of a nationwide telecommunication network.

Remote Job-Entry Sites: Almost all of the Water Resources Division's district offices are equipped with high-speed computer terminals for remote access to the WATSTORE system. These terminals allow each site to put data into or retrieve data from the system within several minutes to overnight, depending upon the priority placed on the request. The number of remote job entry sites is increased as the need arises.

Digital-Transmission Sites: Digital recorders are used at many field locations to record values for parameters such as river stages, conductivity, water temperature, turbidity, wind direction, and chlorides. Data are recorded on 16-channel paper tape, which is removed from the recorder and transmitted over telephone lines to the receiver at Reston, Virginia. The data are recorded on magnetic tape for use on the central computer. Extensive testing of satellite data collection platforms indicates their feasibility for collecting real-time hydrologic data on a national scale. Battery-operated radios are used as the communication link to the satellite. About 200 data relay stations are being operated currently (1980).

Central-Laboratory System: The Water Resources Division's two water-quality laboratories, located in Denver, Colorado, and Atlanta, Georgia, analyze more than 150,000 water samples per year. These laboratories are equipped to automatically perform chemical analyses ranging from determinations of simple inorganic compounds, such as chlorides, to complex organic compounds, such as pesticides. As each analysis is completed, the results are verified by laboratory personnel and transmitted via a computer terminal to the central computer facilities to be stored in the Water-Quality File of WATSTORE.

Water data are used in many ways by decision-makers for the management, development, and monitoring of our water resources. In addition to its data processing, storage, and retrieval capabilities, WATSTORE can provide a variety of useful products ranging from simple data tables to complex statistical analyses. A minimal fee, plus the actual computer cost incurred in producing a desired product, is charged to the requester.

Computer-Printed Tables: Users most often request data from WATSTORE in the form of tables printed by the computer. These tables may contain lists of actual data or condensed indexes that indicate the availability of data stored in the files. A variety of formats is available to display the many types of data.

Computer-Printed Graphs: Computer-printed graphs for the rapid analysis or display of data are another capability of WATSTORE. Computer programs are available to produce bar graphs (histograms), line graphs, frequency distribution curves, X-Y point plots, site-location map plots, and other similar items by means of line printers.

Statistical Analyses: WATSTORE interfaces with a proprietary statistical package (SAS) to provide extensive analyses of data such as regression analyses, the analysis of variance, transformations, and correlations.

Digital Plotting: WATSTORE also makes use of software systems that prepare data for digital plotting on peripheral offline plotters available at the central computer site. Plots that can be obtained include hydrographs, frequency distribution curves, X-Y point plots, contour plots, and three-dimensional plots.

Data in Machine-Readable Form: Data stored in WATSTORE can be obtained in machine-readable form for use on other computers or for use as input to user-written computer programs. These data are available in the standard storage format of the WATSTORE system or in the form of punched cards or card images on magnetic tape.

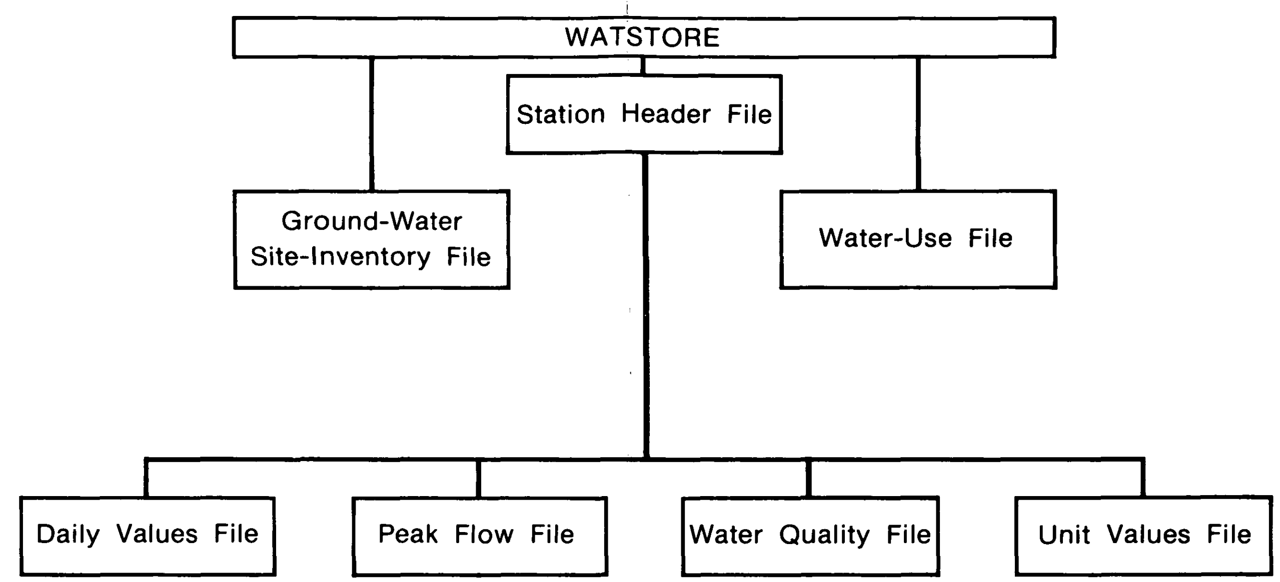


Figure 9.3-1 Index file stored data.

Water Data Indexed for Coal Provinces

A special index, "Index to Water-Data Activities in Coal Provinces of the United States," has been published by the U.S. Geological Survey's Office of Water Data Coordination (OWDC).

The "Index to Water-Data Activities in Coal Provinces of the United States" was prepared to assist those involved in developing, managing, and regulating the Nation's coal resources by providing information on the availability of water-resources data in the major coal provinces of the United States. It is derived from the "Catalog of Information on Water Data," which is a computerized information file about water-data acquisition activities in the United States, and its territories and possessions, with some international activities included.

This special index consists of five volumes (fig. 9.4-1): volume I, Eastern Coal province; volume II, Interior Coal province; volume III, Northern Great Plains and Rocky Mountain Coal provinces; volume IV, Gulf Coast Coal province; and volume V, Pacific Coast and Alaska Coal provinces. The information presented will aid the user in obtaining data for evaluating the effects of coal mining on water resources and in developing plans for meeting additional water-data needs. The report does not contain the actual data; rather, it provides information that will enable the user to determine if needed data are available.

Each volume of this special index consists of four parts: Part A, Streamflow and Stage Stations; Part B, Quality of Surface-Water Stations; Part C, Quality of Ground-Water Stations; and Part D, Areal Investigations and Miscellaneous Activities. Information given for each activity in Parts A-C includes: (1) the identification and location of the station, (2) the major types of data collected, (3) the frequency of data collection, (4) the form in which the data are stored, and (5) the agency or organization reporting the activity. Part D summarizes areal hydrologic investigations and water-data activities not included in the other parts of the index. The agencies that submitted the information, agency codes, and the number of activities reported by type are shown in a table.

Those who need additional information from the Catalog file or who need assistance in obtaining water data should contact the National Water Data Exchange (NAWDEX) (see section 9.2).

Further information on the index volumes and their availability may be obtained from:

U.S. Geological Survey
Water Resources Division
Room 572, Federal Building
600 Federal Place
Louisville, KY 40202

or

U.S. Geological Survey
Water Resources Division
Room 304
200 West Grace Street
Richmond, VA 23220

or

U.S. Geological Survey
Water Resources Division
Room 3017, Federal Building
500 Quarrier Street, East
Charleston, WV 25301

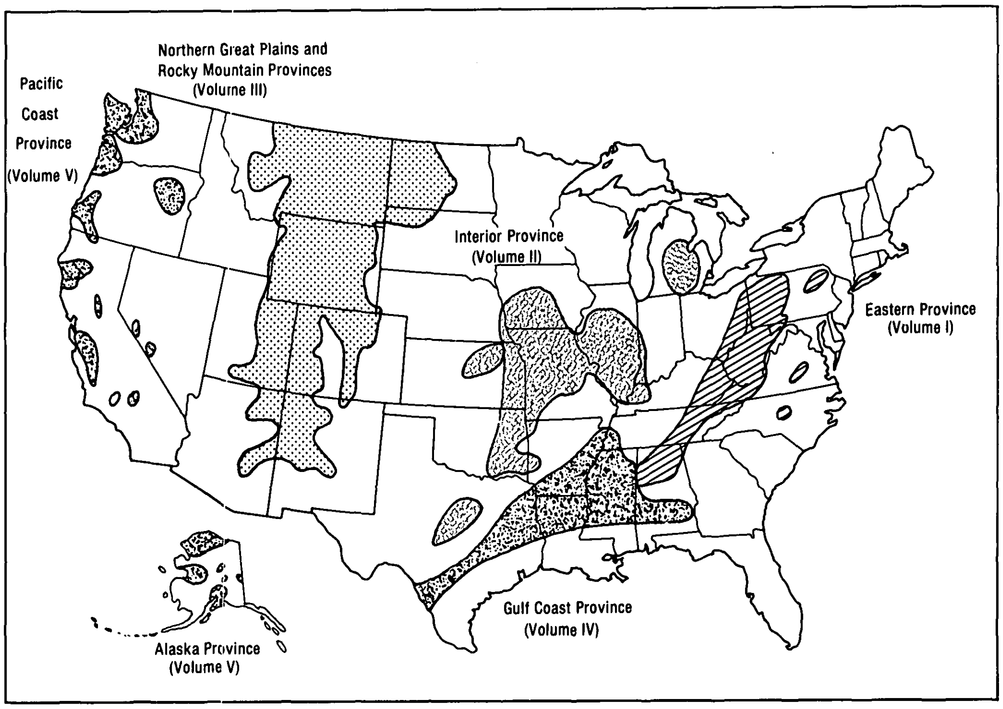
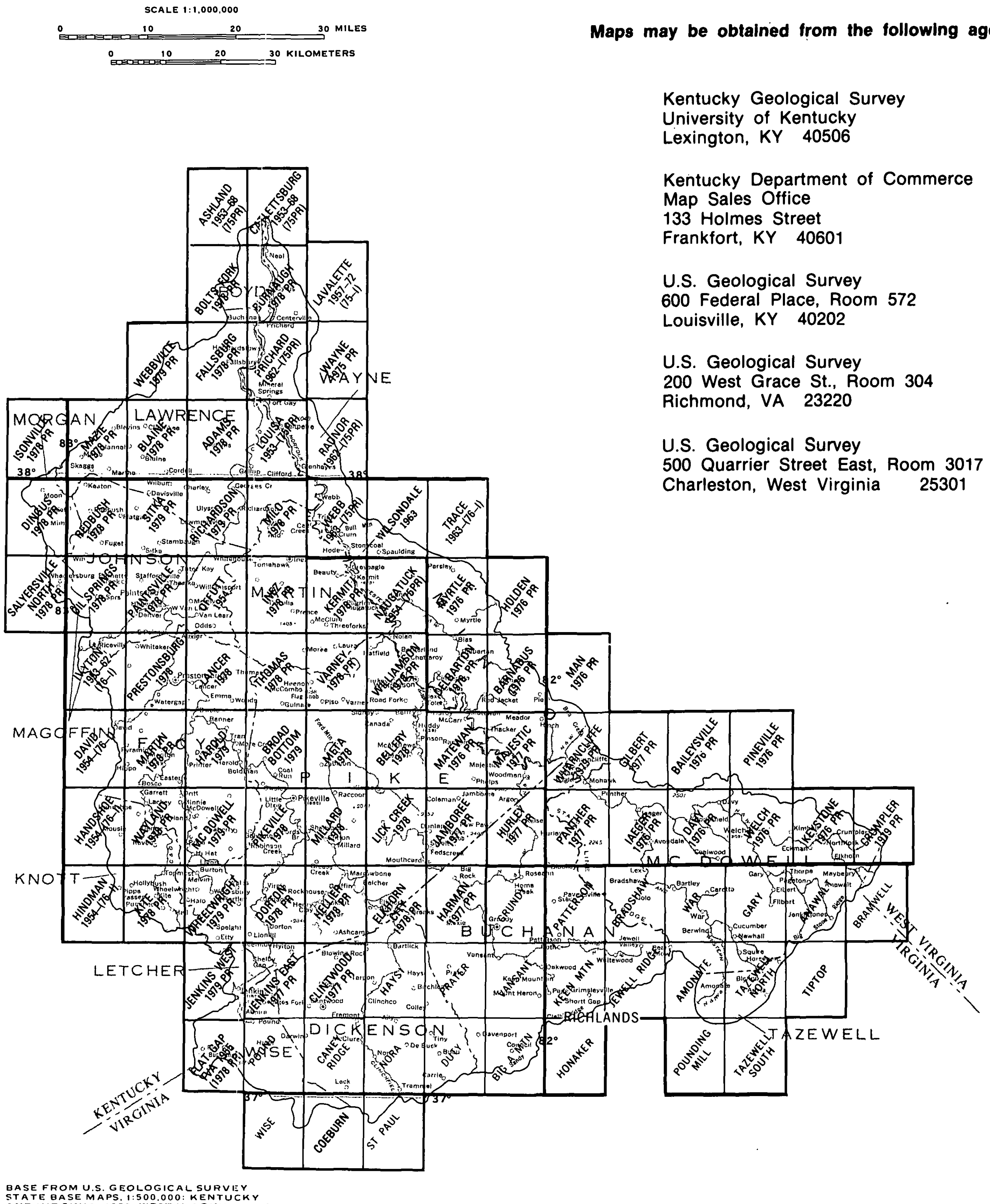


Figure 9.4-1 Index volumes and related provinces.

10.0 SUPPLEMENTAL INFORMATION FOR AREA 13

10.1 Index to Published Geologic Quandrangle Maps



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, 1:500,000: KENTUCKY AND VIRGINIA, 1973; WEST VIRGINIA, 1972

Maps may be obtained from the following agencies:

Kentucky Geological Survey
University of Kentucky
Lexington, KY 40506

Kentucky Department of Commerce
Map Sales Office
133 Holmes Street
Frankfort, KY 40601

U.S. Geological Survey
600 Federal Place, Room 572
Louisville, KY 40202

U.S. Geological Survey
200 West Grace St., Room 304
Richmond, VA 23220

U.S. Geological Survey
500 Quarrier Street East, Room 3017
Charleston, West Virginia 25301

Active surface water sites.

Site Number	Station Number	Station Name	Drainage Area mi^2	Lati- tude	Longi- tude	SW Beg- in Year	SW End Year	Comp- pl- ete Flow	QW Beg- in Year	QW End Year	Bio. Ac- tive Sta- tus	Phy. Ac- tive Sta- tus	Sed. Ac- tive Sta- tus	Chem- Ac- tive Sta- tus
1	03207192	Levisa Fork near Vandyke, Va.		370848	0815448				1978			N		N
2	03207194	Levisa Fork at Vandyke, Va.		370841	0815554				1978			N		N
3	03207196	Pistol Branch at Vandyke, Va.		370841	0815557				1978			N		N
4	03207200	Grassy Creek at Grimsleyville, Va.		371008	0815339				1978			N		N
5	03207210	Levisa Fork near Grimsleyville, Va.		371024	0815628	1978			1978			N		N
6	03207220	Contrary Creek near Keen Mountain, Va.		371138	0815712	1978			1978			N		N
7	03207223	Levisa Fork at Oakwood, VA.	29.0	371243	0820020	1979			1979			Y		Y
8	03207225	Garden Creek at Mount Heron, VA.	11.3	371117	0820008	1979			1979			Y		Y
9	03207228	Right Fork at Mount Heron, VA.	15.7	371116	0820018	1979			1979			Y		Y
10	03207250	Dismal Creek at Whitewood, VA.	27.8	371408	0815127	1979			1979			Y	Y	Y
11	03207280	Laurel Fork at Whitewood, VA.	16.6	371401	0815145	1979			1979			Y	Y	Y
12	03207295	Lower Big Branch near Patterson, VA	2.76	371603	0815949	1979			1979			Y	Y	Y
13	03207300	Dismal Creek near Oakwood, Va.		371422	0820203	1978			1978			N		N
14	03207390	Big Prater Creek near Vansant, VA.	25.1	371301	0820615	1979			1979			Y		Y
15	03207398	Trace Fork Branch near Vansant, VA.	7.33	371305	0820602	1979			1979			Y	Y	Y
16	03207400	Prater Creek at Vansant, VA.	19.8	371305	0820610	1950								
17	03207407	Dry fork at Vansant, VA.	4.32	371325	0820542	1979			1979			Y	Y	Y
18	03207440	Slate Creek near Stacy, VA.		371844	0815841				1978			Y		Y
19	03207450	Slate Creek at Grundy, VA.	41.0	371639	0820548	1979			1979			Y		Y
20	03207505	Looney Creek near Grundy, VA.	2.34	371836	0820746	1979			1979			Y	Y	Y
21	03207520	Poplar Creek near Harman Junction, VA.	6.18	371821	0820921	1979			1979			Y		Y
22	03207530	Bull Creek near Harman Junction, VA.	9.13	371841	0820957	1979			1979			Y		Y
23	03207550	Lynn Camp Creek near Harman Junction, VA.	4.06	371930	0820951	1979			1979			Y		Y
24	03207600	Home Creek near Big Rock, VA.	12.1	372042	0821030	1979			1979			Y		Y
25	03207792	Rocklick Creek at Big Rock, VA.	7.73	372121	0821122	1979			1979			Y		Y
26	03207800	Levisa Fork at Big Rock, VA.	297	372113	0821145	1966		1	1968		N	Y	Y	Y
27	03207805	Conaway Creek at Conaway, VA.	7.40	372045	0821229	1974	1974		1974			Y	Y	Y
28	03207962	Dicks Fork at Phyllis, KY.	0.82	372657	0822016	1975		1	1975			Y	Y	Y
29	03207965	Grapevine Creek near Phyllis, KY.	6.20	372557	0822114	1973		1	1973			Y	Y	Y
30	03207995	Fishtrap Lake Near Millard, KY.	392	372600	0822458	1968		E						
31	03208000	Levisa Fork below Fishtrap Dam, KY.	393	372458	0822515	1938		1	1965			Y	Y	Y
32	03208028	Old Scool House Spring near Council, Va.		370327	0820240				1978			N		N
33	03208038	Curvin Harris Spring near Council, Va.		370437	0820313				1978			N		N
34	03208043	Russell Fork at Davenport, VA.	16.8	370557	0820810	1979			1979			Y		Y
35	03208046	Hurricane Creek near Davenport, VA.	16.5	370634	0820742	1979			1979			Y		Y
36	03208048	Left Fork Hurricane Ck nr Davenport, VA.	8.92	370643	0820740	1979			1979			Y		Y
37	03208064	Indian Creek at Duty, VA.	11.3	370457	0820901	1979			1979			Y		Y
38	03208067	Cane Creek at Duty, VA.	6.95	370450	0821013	1979			1979			Y		Y
39	03208080	Fox Creek near Colley, VA.		370917	0821123				1978			Y		Y
40	03208090	Pawpaw Creek near Colley, VA.	7.07	370956	0821223	1979			1979			Y		Y
41	03208110	Fryingpan Creek near Birchleaf, VA.	26.4	370947	0821519	1979			1979			Y		Y
42	03208150	Lick Creek at Birchleaf, VA.	31.7	371027	0821614	1979			1979			Y		Y
43	03208220	Russell Prater Creek at Prater, VA.	3.11	371256	0821202	1979			1979			Y		Y
44	03208240	War Fork at Prater. VA.	5.48	371248	0821158	1979			1979			Y		Y
45	03208280	Greenbrier Creek at Vicey, VA.	9.13	371247	0821413	1979			1979			Y		Y

see footnote on last page

Active surface water sites -- continued.

Site Number	Station Number	Station Name	Drainage Area mi^2	Latitude	Longitude	SW Begin Year	SW End Year	Complete Flow	QW Begin Year	QW End Year	Bio. Active Status	Phy. Active Status	Sed. Active Status	Chem Active Status
46	03208324	Bentin Chaffin Spring near Trammel, Va.		365959	0821511				1978			N		N
47	03208326	Knot Hollow Spring near Trammel, Va.		370025	0821507				1978			N		N
48	03208350	Roaring Fork near Trammel, VA.		370142	0821759				1978			Y		Y
49	03208370	Open Fork at Nora, VA.	7.68	370409	0822049	1979			1979			Y		Y
50	03208400	McClure River at Nora, Va		370412	0822050	1979			1978			Y		Y
51	03208410	Buffalo Creek near Nora, VA.	3.06	370447	0822059	1979			1979			Y		Y
52	03208420	Caney Creek at McClure, VA.	28.9	370622	0822247	1979			1979			Y		Y
53	03208470	Mill Creek at Clinchco, VA.		370943	0822135				1978			Y		Y
54	03208500	Russell Fork at Haysi, VA.	286	371225	0821745	1925		1	1930		N	Y	Y	Y
55	03208550	Barts Lick Creek at Bartlick, VA.	12.1	371433	0821903	1979			1979			Y		Y
56	03208670	North Fk Pound River at Gilley, VA.	11.6	370615	0824010	1979			1979			Y		Y
57	03208680	North Fork Pound River Lake at Pound, VA.	17.2	370727	0823752	1966			1978	1980				
58	03208700	North Fork Pound River at Pound, VA.	18.5	370732	0823736	1956		1	1969			Y	Y	Y
59	03208795	South Fork Pound River at Pound, VA.	17.4	370716	0823650	1979			1979			Y		Y
60	03208800	Pound River above Indian Ck at Pound, VA.	36.7	370726	0823629	1956		1	1969	1978		N		N
61	03208810	Indian Creek at Pound, VA.	11.1	370707	0823555	1979			1979			Y		Y
62	03208850	Pound River below Bold Camp Creek at Pound, VA.	61.2	370719	0823555	1956		1						
63	03208900	Pound River near Georges Fork, VA.	82.5	370951	0823130	1956		1	1978			Y		Y
64	03208905	Georges Fork near Isom, VA.	7.99	371045	0822858	1979			1979			Y		Y
65	03208922	Cane Creek near Blowing Rock, VA.	2.73	371313	0822702	1979			1979			Y		Y
66	03208935	Cranes Nest River near Duncan Gap, VA.	18.1	370334	0822940	1979			1979			Y		Y
67	03208937	Birchfield Creek near Duncan Gap, VA.	5.29	370315	0823315	1979			1979			Y		Y
68	03208938	Dotson Creek near Duncan Gap, VA.	4.07	370314	0823310	1979			1979			Y		Y
69	03208940	Cranes Nest River near Darwin, VA.		370501	0822924				1978			Y		Y
70	03208945	Lick Fork near Darwin, VA.		370503	0822927				1978			Y		Y
71	03208950	Cranes Nest River near Clintwood, VA.	66.5	370726	0822620	1956		1	1969			Y	Y	Y
72	03208990	John W. Flannagan Reservoir near Haysi, VA.	221	371400	0822056	1964			1978	1980				
73	03209000	Pound River below Flannagan Dam near Haysi, VA.	221	371413	0822036	1925		1	1930			N		Y
74	03209200	Russell Fork at Bartlick, VA.	526	371445	0821925	1956		1	1979			Y	Y	Y
75	03209250	Grassy Creek near Breaks, VA.	15.5	371746	0821849	1979			1979			Y	Y	Y
76	03209300	Russell Fork at Elkhorn City, KY.	554	371814	0822035	1957		1	1961			Y	Y	Y
77	03209402	Elkhorn Creek near Elkhorn City, KY.		371635	0822239	1979			1979			Y	Y	Y
78	03209420	Marrowbone Creek at Wolfpit, KY.		372101	0822524	1979			1979			Y	Y	Y
79	03209430	Greasy Creekl near Sutton, KY.		372336	0822806	1979			1979			Y	Y	Y
80	03209438	Dorton Creek near Dorton, KY.		371652	0823347	1979			1979			Y	Y	Y
81	03209453	Long Fork near Virgie, KY.		372023	0823521	1979			1979			Y	Y	Y
82	03209457	Robinson Creek at Robinson Creek, KY.		372316	0823312	1979			1979			Y	Y	Y
83	03209460	Shelby Creek at Shelbiana, KY.	112	372524	0822957	1965			1965	1979		N	N	N
84	03209500	Levisa Fork at Pikeville, KY.	1237	372835	0823105	1937		1	1960			Y	Y	Y
85	03209530	Mud Creek near Grethel, KY.		372742	0823921	1979			1979			Y	Y	Y
86	03209540	Tollar Creek near Harold, KY.		373128	0823851	1979			1979			Y	Y	Y
87	03209545	Mud Creek at Harold, KY.	51.9	373213	0823840	1975			1978	1979		N	N	N
88	03209575	Bill D Branch near Kite, KY.	3.17	371839	0824858	1975								
89	03209585	Right Fork Beaver Creek at Topmost, KY.		372135	0824722	1979			1979			Y	Y	Y
90	03209590	Caney Fork Beaver Creek near Raven, KY.		372450	0824756	1979			1979			Y	Y	Y
91	03209603	Jones Fork at Betty, KY.		372701	0825033	1979			1979			Y	Y	Y
92	03209607	Saltlick Creek near Bosco, KY.		372940	0825121	1979			1979			Y	Y	Y
93	03209680	Left Fork Beaver Creek at Printer, KY.		373204	0824438	1979			1979			Y	Y	Y
94	03209800	Levisa Fork at Prestonsburg, KY.	1701	374015	0824638	1963		1	1976			Y	Y	Y
95	03209850	Middle Creek near Prestonsburg, KY.		373906	0824954	1979			1979			Y	Y	Y
96	03209870	Left Fork Middle Creek near Goodloe, KY.		373647	0825053	1979			1979			Y	Y	Y
97	03209890	Middle Creek near Prestonsburg, KY.	62.1	373917	0824749	1975			1978	1979		N	N	N
98	03209910	Abbott Creek near Prestonsburg, KY.		374052	0824741	1979			1979			Y	Y	Y
99	03210000	Johns Creek near Meta, KY.	56.3	373401	0822729	1941		1	1974			Y	Y	Y
100	03210060	Rackoon Creek near Zebullon, KY.		373312	0822719	1979			1979			Y	Y	Y
101	03210400	Brushy Fork at Thomas, KY.		374050	0823519	1979			1979			Y	Y	Y
102	03210450	Buffalo Creek near German, KY.		374004	0823818	1979			1979			Y	Y	Y
103	03211000	Dewey Lake near Van Lear, KY.	206	374416	0824350	1948		E						
104	03211500	Johns Creek near Van Lear, KY.	206	374437	0824327	1939		1	1954			Y	Y	Y
105	03211690	Daniels Creek near Odds, KY.		374450	0824218	1979			1979			Y	Y	Y
106	03211800	Levisa Fk ab Paint Ck at Paintsville,KY	1974	374850	0824729				1976			Y		Y
107	03211945	Open Fork Paint Creek near Relief, KY.	25.5	375531	0825944	1975								
108	03212000	Paint Creek at Staffordsville, KY.	103	375005	0825215	1950		1	1965			Y	Y	Y
109	03212500	Levisa Fork at Paintsville, KY.	2143	374855	0824730	1928		1	1948			Y	Y	Y
110	03212510	Greasy Creek near Offutt, KY.		375019	0824218	1979			1979			Y	Y	Y
111	03212515	Rush Fork near Paintsville, KY.	2.10	375117	0824856	1975								
112	03212520	Toms Creek near Tutor Key, KY.		375042	0824546	1979			1979			Y	Y	Y
113	03212530	Georges Creek near Ulysses, KY.		375656	0824013	1979			1979			Y	Y	Y
114	03212535	Right Fork Creek near Charley, KY.		375745	0824149	1979			1979			Y	Y	Y
115	372012081283839	Tug Fork @ Private Br. @ Black Wolf, WV.	27.2	372012	0812838	1978			1978			Y	Y	Y
116	371937081283639	South Fork at HWY 161 Bridge @ Skygusty, WV.	17.5	371937	0812836	1979			1978			Y	Y	Y
117	03212600	Tug Fork at Welch, WV.	85.8	372456	0813525	1943	1963		1972		Y	N	Y	Y
118	372512081252939	North Fork Elkhorn Creek at HWY 17 @ Algoma, WV.	14.4	372512	0812529	1979			1979			Y	Y	Y
119	372310081244139	Elkhorn Creek at HWY 52/20 Bridge at Elkhorn, WV.	11.7	372310	0812441	1979			1979			Y	Y	Y
120	03212700	Elkhorn Creek at Maitland, WV.	69.9	372540	0813305	1948			1979		Y	Y		Y
121	372702081441439	Clear Fork at U.S. 52 Bridge at Clear Fork Junction, WV.	25.3	372702	0814414	1979			1979			Y	Y	Y
122	371537081393239	Dry Fork at HWY 9 Bridgeat Berwind, WV.	51.2	371537	0813932	1979			1979			Y	Y	Y
123	371643081373839	Jacobs Fork at HWY 16 Bridge at Cucumber, WV.	31.7	371643	0813438	1979			1979			Y	Y	Y
124	371724081390839	Big Creek on HWY 16 near Rift, WV.	34.0	371724	0813908	1979			1979			Y	Y	Y
125	03212985	Dry Fork near Avondale, WV.	225	372532	0814722	1979			1979			Y	Y	Y
126	03213000	Tug Fork at Litwar, WV.	502	372905	0815040	1930		1	1960		Y	N		N
127	03213500	Panther Creek near Panther, WV.	31.0	372645	0815215	1946		1	1971		Y	Y		N

see footnote on last page

Active surface water sites -- continued.

Site Number	Station Number	Station Name	Drainage Area mi^2	Latitude	Longitude	SW Begin Year	SW End Year	Complete Flow	QW Begin Year	QW End Year	Bio. Active Status	Phy. Active Status	Sed. Active Status	Chem- Active Status
128	03213572	Knox Creek at Hurley, VA.	27.8	372511	0820110	1979			1979		Y	Y		Y
129	03213575	Lester Fork at Hurley, VA.	12.0	372508	0820118	1979			1979			Y		Y
130	03213578	Guest Fork near Hurley, VA.	13.7	372607	0820154	1979			1979			Y		Y
131	03213581	Race Fork near Kelsa, VA.	7.32	372618	0820245	1979			1979			Y		Y
132	03213584	Paw Paw Creek near Kelsa, VA.	7.49	372607	0820502	1979			1979			Y		Y
133	03213587	Left Fork near Kelsa, VA.	9.16	372602	0820502	1979			1979			Y		Y
134	03213590	Knox Creek at Kelsa, VA.	84.3	372702	0820334	1979			1979		N	Y		Y
135	03213670	Left Fork Peter Creek at Jamboree, KY.		372944	0820814	1979			1979			Y	Y	Y
136	03213680	Right Fork Peter Creek near Phelps, KY.		373017	0820935	1979			1979			Y	Y	Y
137	03213690	Blackberry Creek at Ransom, KY.		373406	0821118	1979			1979			Y	Y	Y
138	03213698	Pond Creek near Toler, KY.		373814	0821513	1979			1979			Y	Y	Y
139	03213700	Tug Fork at Williamson, W.V.	932	374021	0821650	1968			1976				N	
140	03213750	Big Creek near Hatfield, KY.		374334	0822106	1979			1979			Y	Y	Y
141	03213790	Big Creek near Hatfield, KY.		374421	0822025	1975								
142	374148082110239	Pigeon Creek at U.S. 52 Bridge at Delbarton, WV.	23.7	374148	0821102	1979			1979			Y	Y	Y
143	374219082101739	Rockhouse Fork at HWY 65/2 Bridge at Delbarton, WV.	15.6	374219	0821017	1979			1979			Y	Y	Y
144	03213800	Pigeon Creek near Lenore, WV.	93.9	374713	0821544	1949			1979		Y	Y	Y	Y
145	374753082171039	Laurel Fork at HWY 65 Bridge at Lenore, WV.	33.1	374753	0821710	1979			1979			Y	Y	Y
146	03214000	Tug Fork nr Kermit, W.V.	1188	374905	082232	1934		1	1954	1971	N	N		N
147	03214300	Wolf Creek near McClure, KY.		374555	0822855	1979			1979			Y	Y	Y
148	03214400	Wolf Creek at Pilgrim, KY.		374749	0822544	1975								
149	375132082230239	Marrowbone Creek at Private Bridge at Selwyn, WV.	20.7	375132	0822302	1979			1979			Y	Y	Y
150	03214600	Coldwater Creek near Inez, KY.	17.8	375017	0823053	1979			1979			Y	Y	Y
151	03214650	Middle Fork at Inez, KY.	33.3	375114	0823243	1979			1979			Y	Y	Y
152	03214720	Rockhouse Fork near Milo, KY.		375306	0823455	1979			1979			Y	Y	Y
153	03214730	Rockcastle Creek at Clifford, KY.	121	380007	0823112	1965			1965	1975		N		N
154	03214900	Tug Fork at Glenhayes, WV.	1500	380020	0823053	1979			1979			Y	Y	Y
155	380602082340239	Mill Creek @ US. 52 Br. near Salt Petre, WV.	20.5	380602	0823402	1979			1979			Y	Y	Y
156	03215000	Big Sandy River at Louisa, KY.	3892	381016	0823805	1938	1976	E	1950			Y	Y	Y
157	03215250	Right Fork Blaine Creek near Martha, KY.		375956	0825621	1979			1979			Y	Y	Y
158	03215362	Blaine Creek above Cains Creek near Blaine, KY.	64.7	380123	0825207	1975								
159	03215367	Caines Creek near Blaine, KY.		380142	0825145	1979			1979			Y	Y	Y
160	03215380	Hood Creek at Blaine, KY.		380140	0825028	1979			1979			Y	Y	Y
161	03215410	Blaine Creek near Blaine, KY.	119	380400	0824938	1972								
162	03215420	Brushy Creek near Cordell, KY.		380114	0824826	1979			1979			Y	Y	Y
163	03215470	Right Fork Harriot Branch at Evergreen, KY.		380338	0824117	1979			1979			Y	Y	Y
164	03215550	Cat Fork Creek at Fallsburg, KY.		381103	0824118	1979			1979			Y	Y	Y
165	381758082323039	Whites Creek at HWY 19 Bridge near Cyprus, W. VA.	13.2	381758	0823230	1979			1979			Y	Y	Y

see footnote on last page

Active surface water sites -- continued.

Site Number	Station Number	Station Name	Drainage Area mi2	Latitude	Longitude	SW Begin Year	SW End Year	Complete Flow	QW Begin Year	QW End Year	Bio. Active Status	Phy. Active Status	Sed. Active Status	Chem-Active Status
166	373049082091001	Left Fork Creek at Phelps, KY.		373049	0820910				1980		Y	Y		Y
167	373049082091101	Right Fork Peter Creek at Phelps, WV.		373049	0820911				1980		Y	Y		Y
168	373208082033401	Knox Creek near Woodman, KY.		373208	0820334				1980		Y	Y		Y
169	373949082224001	Big Creek near Varney, KY.		373949	0822240				1980		Y	Y		Y
170	373950082224501	Elkins Fork near Varney, KY.		373950	0822245				1980		Y	Y		Y
171	374659082264101	Pigeonroost Fork near Pilgrim, KY.		374659	0822641				1980		Y	Y		Y
172	374701082265401	Wolf Creek near Pilgrim, KY.		374701	0822654				1980		Y	Y		Y
173	374745082251201	Emily Creek at Pilgrim, KY.		374745	0822512				1980		Y	Y		Y
174	3750170823053OO	Coldwater Fork near Inez, KY.		375017	0823053				1980			Y	Y	Y
175	375147082323301	Middle Fork at Inez, KY.		375147	0823233				1980		Y	Y		Y
176	375155082322501	Coldwater Fork at Inez, KY.		375155	0823225				1980		Y	Y		Y
177	375447082332701	Rockhouse Fork at Add, KY.		375447	0823327				1980		Y	Y		Y
178	372501082012301	Lester Fork at Hurley, VA.		372501	0820123				1980		Y	Y		Y
179	372511082011401	Knox Creek at Hurley, VA.		372511	0820114				1980		Y	Y		Y
180	372605082015801	Guest Fork near Hurley, VA.		372605	0820158				1980		Y	Y		Y
181	372649082033101	Pawpaw Creek near Hurley, VA.		372649	0820331				1980		Y	Y		Y
182	371251081374601	Dry Fork near Vallscreek, WV.		371251	0813746				1980		Y	Y		Y
183	371254081375501	Beech Fork near Vallscreek, WV.		371254	0813755				1980		Y	Y		Y
184	371609081400101	Dry Fork at Berwind, WV.		371609	0814001				1980		Y	Y		Y
185	371643081373801	Jacobs Fork at Cucumber, WV.		371643	0813738				1980		Y	Y		Y
186	371651081395201	Jacobs Fork at Rift, WV.		371651	0813952				1980		Y	Y		Y
187	371724081390801	Big Creek near Rift, WV.		371724	0813908				1980		Y	Y		Y
188	371805081412801	War Creek at War WV.		371805	0814128				1980		Y	Y		Y
189	371915081414701	Barrenshe Creek at Yukon, WV.		371915	0814147				1980		Y	Y		Y
190	371936081283601	South Fork at Skygusty, WV.		371936	0812836				1980		Y	Y		Y
191	372002081285501	Tug Fork at Skygusty, WV.		372002	0812855				1980		Y	Y		Y
192	372030081433301	Dry Fork at Bartley, WV.		372030	0814333				1980		Y	Y		Y
193	372038081465301	Little Slate Creek at Raysal, WV.		372038	0814653				1980		Y	Y		Y
194	372056081481301	Bradshaw Creek at Bradshaw, WV.		372056	0814813				1980		Y	Y		Y
195	372153081330801	Sandlick Creek at Gary, WV.		372153	0813308				1980		Y	Y		Y
196	372453081254201	Elkhorn Creek at Northfork, WV.		372453	0812542				1980		Y	Y		Y
197	372455081254601	North Fork Elkhorn Creek at Northfork, WV.		372455	0812546				1980		Y	Y		Y
198	372642081420701	Spice Creek at Roderfield, WV.		372642	0814207				1980		Y	Y		Y
199	372701081441401	Clear Fork at Clear Fork Junction, WV.		372701	0814414				1980		Y	Y		Y
200	372735081421501	Tug Fork at Big Sandy, WV.		372735	0814215				1980		Y	Y		Y
201	372955081544001	Longpole Creek near Panther, WV.		372955	0815440				1980		Y	Y		Y
202	373247082035301	Beech Creek at Devon, WV.		373247	0820353				1980		Y	Y		Y
203	373304082072901	Tug Fork at Vulcan, WV.		373304	0820729				1980		Y	Y		Y
204	373715082093701	Mate Creek at Matewan, WV.		373715	0820937				1980		Y	Y		Y
205	374231082110301	Pigeon Creek at Delbarton, WV.		374231	0821103				1980		Y	Y		Y
206	374235082104801	Rockhouse Fork at Delbarton, WV.		374235	0821048				1980		Y	Y		Y
207	374403082112501	Elk Creek at Bias, WV.		374403	0821125				1980		Y	Y		Y
208	374530082190201	Miller Creek near Nolan, WV.		374530	0821902				1980		Y	Y		Y
209	374625082141201	Trace Fork at Belo, WV.		374625	0821412				1980		Y	Y		Y
210	374725082205501	Pigeon Creek at Naugatuck, WV.		374705	0822055				1980		Y	Y		Y
211	374754082171001	Laurel Fork at Lenore, WV.		374754	0821710				1980		Y	Y		Y
212	375119082245101	Marrowbone Creek at Greyeagle, WV.		375119	0822451				1980		Y	Y		Y
213	375340082260001	Jennie Creek at Crum, WV.		375340	0822600				1980		Y	Y		Y
214	380647082352901	Mill Creek at Fort Gay, WV.		380647	0823529				1980		Y	Y		Y
215	380700082355401	Tug Fork at Fort Gay, WV.		380700	0823554				1980		Y	Y		Y

1. Complete Flow
   - 1 Continuous gaging station.
   - E Discontinued gaging station.
   - blank No activity

2. Active Status for Biological, Physical, Sediment, and Chemical data
   - Y 1 or more paramaters presently being collected.
   - N 1 or more paramaters have been collected.
   - blank No activity

Inactive surface water sites.

	STATION NUMBER	STATION NAME	DRAINAGE AREA mi2	LATI-TUDE	LONGI-TUDE	SW BEG-IN YEAR	SW END YEAR	COMP-PL-ETE FLOW	QW BEG-IN-YEAR	QW END YEAR	BIO. AC-TIVE STA-TUS	PHY AC-TIVE STA-TUS	SED. AC-TIVE STA-TUS	CHEM-AC-TIVE STA-TUS
216	03207230	Garden Creek at Oakwood, VA.		371242	0820024				1978	1979		N		N
217	03207410	Prater Creek at Mouth, at Vansant, VA.		371353	0820558				1978	1979		N		N
218	03207500	Levisa Fork near Grundy, VA.	235	371752	0820734	1928	1974	E	1945	1974		N		N
219	03207510	Stiltner Creek near Grundy, VA.		371835	0820834				1978	1979		N		N
220	03207845	Card Creek at Mouthcard, KY.	4.18	372254	0821530	1973	1975	E	1974	1975		N	N	N
221	03207875	Feds Creek at Fedscreek, KY	11.6	372407	0821438	1973	1975	E	1972	1975		N	N	N
222	03207905	Big Creek at Dunlap, KY	9.55	372543	0821452	1974	1976	E	1974	1976		N	N	N
223	03207925	Island Creek near Phyllis, KY	2.42	372543	0821817	1974	1975	E	1974	1975		N	N	N
224	03207935	Lick Creek at Lick Creek, KY	6.70	372344	0821808	1973	1976	E	1972	1976		N	N	N
225	03207940	Millers Creek Near Phyllis,KY	1.68	372519	0821953	1973	1975	E	1973	1976		N	N	N
226	03208030	Russell Fork near Council, VA.		370408	0820248				1978	1979		N		N
227	03208039	Ball Creek near Council, VA.		370440	0820345				1978	1979		N		N
228	03208040	Russell Fork at Council, VA.		370440	0820357				1978	1979		N		N
229	03208050	Hurricane Creek at Davenport, VA.		370605	0820812				1978	1979		N		N
230	03208060	Russell Fork near Davenport, VA.		370636	0820927				1978	1979		N		N
231	03208070	Indian Creek near Davenport, VA.		370635	0820930				1978	1979		N		N
232	03208100	Russell Fork near Birchleaf, VA.		370949	0821520				1978	1979		N		N
233	03208200	Russell Fork near Haysi, VA.		371203	0821731				1978	1979		N		N
234	03208300	Russell Prater Creek at Haysi, VA.		371228	0821716				1978	1979		N		N
235	03208328	Knot Hollow Creek near Trammel, VA.		370026	0821607				1978	1979		N		N
236	03208330	McClure Creek near Trammel, VA.		370025	0821614				1978	1979		N		N
237	03208340	McClure Creek at Trammel, VA.		370059	0821745				1978	1979		N		N
238	03208360	McClure Creek at Wakenva, VA.		370230	0821858				1978	1979		N		N
239	30208430	Big Branch at Freemont, VA.		370722	0822310				1978	1979		N		N
240	03208450	McClure River at Fremont, VA.		370731	0822305				1978	1979		N		N
241	03208490	McClure River at Haysi, VA.		371218	0821752				1978	1979		N		N
242	03208830	Bold Camp Creek at Pound, VA.		370709	0823540				1978	1979		N		N
243	03209400	Elkhorn Creek near Elkhorn Creek, KY.	48.8	371630	0822245	1953	1972		1978	1978		N	N	N
244	03209440	Shelby Creek at Dorton, KY.	12.6	371638	0823444	1971	1974	E	1978	1979		N	N	N
245	03209600	Right Fork Beaver Creek at Wayland, KY.	73.9	372635	0824828	1959	1975		1978	1978		N		N
246	03209650	Left Fork Beaver Creek at Drift, KY.		372856	0824509				1978	1979		N		N

see footnote on last page

Inactive surface water sites -- continued.

	STATION NUMBER	STATION NAME	DRAINAGE AREA mi2	LATI-TUDE	LONGI-TUDE	SW BEG-IN YEAR	SW END YEAR	COMP-PL-ETE FLOW	QW BEG-IN-YEAR	QW END YEAR	BIO. AC-TIVE STA-TUS	PHY AC-TIVE STA-TUS	SED. AC-TIVE STA-TUS	CHEM-AC-TIVE STA-TUS
247	03209700	Beaver Creek at Martin, KY.	228	373410	0824528	1953	1972		1961	1971		N		N
248	03210040	Raccoon Creek near Zebulon, KY	14.8	373401	0822705	1974	1975	E	1973	1975		N	N	N
249	03210160	Caney Creek near Gulnare, KY	3.74	373511	0823223	1974	1975	E	1973	1975		N	N	N
250	03210310	Brushy Fork at Heenon, KY	20.4	373958	0822903	1974	1976	E	1973	1976		N	N	N
251	03210420	Buffalo Creek near Endicott, KY	6.21	373758	0823618	1974	1975	E	1973	1975		N	N	N
252	03210500	Johns Creek near Prestonsburg, KY.	197	374155	0824330	1938	1940	E						
253	03211700	Daniels Creek at Mouth near Van Lear, KY.		374450	0824322				1978	1979		N		N
254	03211970	Paint Creek near Elna, KY.		375336	0825742				1966	1966		N		N
255	03211997	Paint Creek above Barnetts Creek near Staffordsville, KY.		375014	0825214				1971	1972		N		N
256	03212900	Dry Fork at Berwind, WV.		371515	0813840	1947	1953							
257	03212950	Dry Fork at Yukon, W. VA.	147	371856	0814301	1949	1968							
258	30213600	Knox Creek near Argo, KY	95.9	372901	0820306	1958	1972							
259	03214500	Tug Fork at Kermit, W.V.	1274	375017	0822435	1915	1934	E	1945	1978		N		
260	03214700	Rockcastle Creek at Inez, Ky.	63.1	375205	08232	1953	1972		1970	1972	N	N		
261	03214995	Big Sandy River Auxiliary at Louisa, KY.	3880	380713	0323638	1938	1976							
262	03215320	Lower Laurel Creek near Flatgap, KY.		375703	0825333				1967	1967		N		N
263	03215370	Blaine Creek at HWY 32 Bridge at Blaine, KY.		380133	0825113				1978	1979		N		N
264	03215430	Blaine Creek below Brushy Creek near Blaine, KY.	151	380312	0824642				1971	1979		N		N
265	03215440	Rich Creek near Adams, KY.		380352	0824507				1971	1972		N		N
266	03215480	Little Blaine Creek at Evergreen, KY.	23.0	380355	0824156				1971	1979		N		N
267	03215490	Blaine Creek near Yatesville, KY.		380632	0824204				1971	1972		N		N
268	03215500	Blaine Creek at Yatesville, KY.	217	380840	0824105	1915	1975	E	1965	1979		N		N
269	03215700	Big Sandy River at Catlettsburg, KY.	4281	382414	0823544				1955	1975		N		N
270	371711082360900	Beefhide Creek near Beefhide, KY.		371711	0823609				1978	1979		N		N
271	372053082252800	Marrowbone Creek near Wolf Pit, KY.		372053	0822528				1978	1979		N		N
272	372210082144900	Little Hackney Creek at Mouthcard		372210	0821449				1977	1979		N	N	N
273	372410082152500	Crooked Branch near Fedscreek		372410	0821525				1977	1979		N	N	N
274	372500082475200	Caney Fork at Mouth near Dema, KY.		372500	0824752				1978	1979		N		N
275	372501082475000	Right Fork Beaver Creek above Caney Branch at Dema, KY.		372501	0824750				1978	1979		N		N
276	372609082205100	Feds Hollow near Phyllis, KY.		372609	0822051				1977	1979		N	N	N
277	372609082502100	Feds Hollow near Phyllis, KY.		372609	0825021				1975	1975		N		N
278	372634082200400	Dicks Fork at Phyllis, KY.		372634	0822004				1975	1975		N		
279	372635082200600	Dicks Fork of Grapevine Creek at Phyllis, KY.		372635	0822006				1975	1975		N		N
280	372645082190700	Hunters Creek at Phyllis, KY.		372645	0821907				1978	1979		N	N	N
281	372656082192000	Honey Fork at Phyllis, KY.		372656	0821920				1977	1979		N	N	N
282	372704082190900	Trace Fork near Phyllis, KY.		372704	0821909				1977	1979		N	N	N
283	372708082180500	Lower Camp Branch near Phyllis, KY.		372708	0821805				1977	1979		N		N
284	372708082180700	Lower Camp Branch near Phyllis, KY.		372708	0821807				1977	1979		N	N	N
285	372709082174500	Grapevine Creek above Upper Camp Branch near Phyllis, KY.		372709	0821745				1977	1979		N	N	N
286	372711082175200	Upper Camp Branch near Phyllis, KY.		372711	0821752				1977	1979		N	N	N
287	373456082435000	Beaver Creek below Arkansas Creek near Martin, KY.		373456	0824350				1977	1979		N	N	N
288	373527082434400	Beaver Creek at Ford near Martin, KY.		373527	0824344				1978	1979		N		N
289	373906082495400	Middle Creek near Prestonsburg, KY.		373906	0824954				1978	1979		N	N	N
290	374709082494600	Jennys Creek at HWY 825 near Hagerhill, KY		374709	0824946				1978	1979		N		N
291	375011082431500	Greasy Creek near Williamsport, KY.		375011	0824315				1978	1979		N		N
292	375043082530000	Toms Creek at Tutor Key, KY.		375043	0825300				1978	1979		N		N
293	375631082375400	Nats Creek at Richardson, KY.		375631	0823754				1978	1979		N		N
294	375806082401400	Georges Creek near Mouth near Ulysses, KY.		375806	0824014				1978	1979		N		N
295	380057082365000	Griffith Creek at Gallup, KY.		380057	0823650				1978	1979		N		N
296	381102082411900	Cats Fork at HWY 3 Bridge near Fallsburg, KY.		381102	0824119				1978	1979		N		N
297	381503082332300	Gragston Creek near Prichard, WV.		381503	0823323				1978	1979		N		N

1. Complete Flow
   - 1 Continuous gaging station
   - E Discontinued gaging station
   - blank No activity

2. Active Statue for Biological, Physical, Sediment, and Chemical data.
   - Y 1 or more paramaters presently being collected.
   - N 1 or more paramaters have been collected
   - blank No activity

FLOYD COUNTY KENTUCKY

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
373928082522601	BILL ADAMS	SPRING	111ALVM	.	1	1951	1951
373945082471401	COMMENWEALTH OF KY	SPRING	324BRTT	.	1	1952	1952
373947082462201	C & O RAILROAD	SPRING	324BRTT	.	1	1952	1952
374229082452101	WILEY WARRIX	SPRING	324BRTT	.	1	1952	1952
371933082432401	INLAND STEEL CO.	WELL		.	1	1953	1953
372318082395101	KY-W.VA GAS CO.	WELL	324BRTT	.	1	1954	1954
372319082390301	MS FANNIE TACKETT	WELL	324BRTT	.	1	1966	1966
372339082392701	CHARLES HAMILTON	WELL	324BRTT	68.00	1	1966	1966
372340082375301	WM. HAMILTON, JR.	WELL	324BRTT	72.00	1	1966	1966
372539082382001	ELVE NEWSON	WELL	324BRTT	100.00	1	1966	1966
372635082474501	BEAVER-ELKHORN WATER DIST.	WELL	324BRTT	100.00	1	1955	1955
372635082481801	BEAVER-ELKHORN WATER DISTRICT	WELL	324BRTT	.	1	1953	1953
372754082391001	A.J. MITCHELL	WELL	324BRTT	81.00	1	1955	1955
372837082364701	JAMES HATCHER	WELL	324BRTT	1620.00	1	1966	1966
373030082495801	INLAND GAS CO.	WELL	324BRTT	78.00	1	1955	1955
373134082400801	T. YATES & E. BOYD	WELL	324BRTT	74.00	1	1966	1966
373202082394901	HENRY BOYD	WELL	324BRTT	55.00	1	1966	1966
373237082471701	KY-W.VA GAS CO.	WELL	324BRTT	135.00	1	1958	1958
373322082393901	AZZLE TACKETT	WELL	324BRTT	50.00	1	1967	1967
373341082391401	AZZLE TACKETT	WELL	324BRTT	.	1	1967	1967
373743082481801	W.M. STEVENS	WELL	324BRTT	57.50	1	1951	1951
373747082500401	EDGAR HALE	WELL	324BRTT	81.00	1	1952	1952
373813082450401	ALEX DEROSETT	WELL	324BRTT	44.00	1	1952	1952
373905082485501	FORKS OF MIDDLE CREEK SCHOOL	WELL	324BRTT	100.00	1	1952	1952
373906082485601	HENRY FRITZ	WELL	324BRTT	48.50	1	1950	1950
373917082480301	CLYDE CLARK	WELL	324BRTT	68.50	1	1950	1950
373919082481701	TOBIA MARSILETT	WELL	324BRTT	99.70	1	1950	1950
373929082500501	INLAND GAS COMPANY	WELL	111ALVM	20.00	1	1958	1958
373939082462401	MAUDE SLOAN	WELL	324BRTT	90.60	1	1951	1951
373950082494701	ABANDONED COAL MINE	WELL	324BRTT	.	1	1950	1950
374003082443701	PRESTONSBURG WATER CO NO1	WELL		.	1	1974	1974
374023082513501	N.P. HOLBROOK	WELL	324BRTT	8.60	1	1950	1950
374035082503101	BRUCE HACKWORTH	WELL	324BRTT	105.00	1	1952	1952
374056082465001	JOHN W. BURKE	WELL	111ALVM	67.70	1	1950	1950
374109082464201	RUSSELL HACKWOOD	WELL	327LEE	144.00	1	1951	1951
374109082474101	GERVIN WADLE	WELL	324BRTT	42.60	1	1950	1950
374110082474901	ERMAN WADLE	WELL	324BRTT	49.00	1	1951	1951
374111082475201	RAYMOND WADLE	WELL	324BRTT	29.00	1	1951	1951
374112082482401	BILL CONLEY	WELL	324BRTT	60.00	1	1952	1952
374113082475101	SHERD WADLE	WELL	324BRTT	12.00	1	1950	1950
374129082520501	ALBERT SPADLIN	WELL	324BRTT	72.00	1	1952	1952
374145082472901	BEE DANIELS	WELL	324BRTT	87.60	1	1950	1950
374237082501401	JOE DEROSSETT	WELL	324BRTT	52.00	1	1952	1952
374303082484901	SAM MUSIC	WELL	324BRTT	71.00	1	1952	1952
374322082505201	JOHN L. WHITAKER	WELL	324BRTT	39.00	1	1952	1952
374337082470801	CLAUDE ROBINSON	WELL	324BRTT	127.00	1	1952	1952
374409082451801	W.H. HORNE	WELL	111ALVM	43.00	1	1952	1952
374415082454401	JAKE HOLLIFIELD	WELL	111ALVM	59.00	1	1952	1952
374415082481901	TOBE AUXIER	WELL	324BRTT	42.00	1	1952	1952
374448082472401	G.L. RAMEY	WELL	324BRTT	44.00	1	1952	1952

Ground-Water Sites with Available Chemical Analyses--continued.

JOHNSON COUNTY KENTUCKY

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
374441082441401	JOHNS CRK PIPE 1	WELL		.	2	1976	1977
374501082425401	J STEPPE WELL#1	WELL		.	1	1976	1976
374610082453001	KENTUCKY WATER COMPANY	WELL	324BRTT	115.00	1	1965	1965
374636082432801	NECC BLDG MINE#1	WELL		.	1	1976	1976
374642082465601	KY WATER COMPANY	WELL	324BRTT	78.00	1	1950	1950
374757082452701	BARN CAVED MINE #1	WELL		.	2	1976	1977
374804082575301	DEWEY HELTON	WELL	324BRTT	75.00	1	1961	1961
374818082455901	E. P. WELCH	WELL	111ALVM	57.00	1	1949	1949
374821082460701	ALBERT SKAUGE	WELL	111ALVM	79.01	1	1949	1949
374823082483201	GUS HAYES	WELL	327LEE	280.00	1	1950	1950
374835082563901	JOHNSON CO. BD.&ED.	WELL	327LEE	385.00	2	1961	1967
374906082552601	VINT DAVIS	WELL	324BRTT	225.00	1	1961	1961
374910082472101	LUCY HALL	WELL	324BRTT	96.00	1	1949	1949
374915082531401	GLEN SALYER	WELL	324BRTT	22.00	1	1961	1961
374930082460801	KY. POWER CO. NO. 1	WELL	111AMOT	.	1	1974	1974
374946082490501	HARRY DAVIS	WELL	327LEE	900.00	1	1950	1950
374952082511901	CHARLEY CONLEY	WELL	324BRTT	51.00	1	1961	1961
375013082483501	UNKNOWN	WELL	327LEE	505.00	1	1966	1966
375016082431501	WALTER PACK	WELL	324BRTT	.	1	1955	1955
375024082473701	POWERLINE MINE #1	WELL		.	2	1976	1977
375028082473401	THEALKA TIPPLE MINE #1	WELL		.	2	1976	1977
375029082460001	LONG BRANCH MINE #1	WELL		.	2	1976	1977
375035082473401	THEALKA RAILROAD SPRING MINE #1	WELL		.	2	1976	1977
375043082461601	TUTOR KEY SPRINGS MINE # 1	WELL		.	2	1976	1978
375052082484401	ALLEN CONSTRUCTION CO.	WELL	327LEE	585.00	2	1966	1966
375101082465401	TUTOR KEY CONCRETE MINE #1	WELL		.	1	1976	1976
375125082472501	LEAPING FROG MINE #1	WELL		.	1	1976	1976
375129082455201	BAKER BR CHURCH#1	WELL		.	2	1976	1977
375129082502401	LITTLE MUDLICK CR #1	WELL		.	1	1976	1976
375129082513901	KY.DEPT. HWY.	WELL	327LEE	345.00	1	1966	1966
375135082514401	PLUNEY BLEVINS	WELL	327LEE	50.01	1	1965	1965
375138082500701	RUSH FK CEM#1	WELL		.	2	1976	1977
375144082483701	WILLIAMS BR SHAFT #1	WELL		.	3	1976	1977
375146082541501	JOHNSON CO. BOARD OF ED.	WELL	324BRTT	385.00	1	1961	1961
375201082544501	FRANK LAMASTER	WELL	327LEE	31.00	1	1950	1950
375205082530501	HOBART MCKENZIE	WELL	327LEE	245.01	1	1966	1966
375208082523201	JAMES MC KENZIE	WELL	327LEE	70.00	1	1949	1949
375244082492501	GOOSE FK CINDER BLOCK MINE#1	WELL		.	1	1976	1976
375557082530701	WALTER MC KENZIE	WELL	324BRTT	36.00	1	1955	1955
375606082533101	JAMES JAYNE	WELL	327LEE	142.01	1	1967	1967
375609082531501	JOHNSON CO.BD.&FED.	WELL	327LEE	330.00	1	1967	1967
375633082581701	FREDDY ISON	WELL	327LEE	239.01	1	1966	1966
375634082583501	J.FYFFE	WELL	327LEE	207.01	1	1966	1966

KNOTT COUNTY KENTUCKY

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
372810082551101	W. BAILEY	WELL	324BRTT	42.00	1	1954	1954

LAWRENCE COUNTY KENTUCKY

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
375806082314601	E149 WILLIAM POPE	WELL	324BRTT	75.00	1	1979	1979
375818082333901	E150 BERNICE BURCHETT	WELL	324BRTT	65.00	1	1979	1979
375824082421901	F. HAYES	WELL	324BRTT	54.00	1	1954	1954
375921082302201	E152 BILL GREYHOUSE	WELL	324BRTT	97.00	1	1979	1979

LETCHER COUNTY KENTUCKY

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
371238082372901	S. ROSE	SPRING	324BRTT	.	1	1961	1961
371004082421801	K. BALLOU	WELL	324BRTT	10.50	1	1960	1960
371016082393301	R. HAY	WELL	324BRTT	140.00	1	1960	1960
371022082405001	M. CRAFT	WELL	324BRTT	20.00	1	1960	1960
371119082361601	R. COOPER	WELL	324BRTT	100.00	1	1960	1960
371131082392001	W. SANDERS	WELL	324BRTT	21.50	1	1960	1960
371132082384401	CONSOLIDATION COAL CO.	WELL	324BRTT	200.00	1	1954	1954
371132082392101	I. MAGGARD	WELL	324BRTT	66.00	1	1960	1960
371144082442501	W. FULTON	WELL	324BRTT	27.70	1	1960	1960
371247082354301	MRS. OULANEY	WELL	324BRTT	11.30	1	1960	1960
371310082392201	K. BENTLEY	WELL	324BRTT	49.00	1	1960	1960
371404082372501	L. BURKE	WELL	324BRTT	152.00	1	1961	1961

MAGOFFIN COUNTY KENTUCKY

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
374753082585501	CUMBERLAND PETROLEUM CO.	WELL	327LEE	624.00	1	1961	1961
374806082590601	CUMBERLAND PETROLEUM CO.	WELL	327LEE	384.00	1	1958	1958
374809082591901	CUMBERLAND PETROLEUM CO.	WELL	327LEE	510.00	1	1953	1953
374818083003401	BRUNDRED OIL CO.	WELL	327LEE	440.00	1	1952	1952
374917083012201	CLAYTON TACKETT	WELL	327LEE	247.01	1	1966	1966

Ground-Water Sites with Available Chemical Analyses--continued.

MARTIN COUNTY KENTUCKY

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
374324082262701	E107 GEORGE PAULEY	WELL	324BRTT	86.00	1	1979	1979
374446082321001	MARTIN CO CC COALBURG SEAM # 1	WELL		.	1	1976	1976
374447082321701	LITTLE BRANCH STOCKTON WELL # 1	WELL		.	1	1976	1976
374512082264501	E108 ERNEST HALE	WELL	324BRTT	71.00	1	1979	1979
374612082283701	E106 ADA STEPP	WELL	111ALVM	60.00	1	1979	1979
374634082364001	ABRAHAM L. FRALEY	WELL	324BRTT	45.00	1	1954	1954
374715082263501	E109 GROVER OSBORNE	WELL	324BRTT	72.00	1	1979	1979
374720082351401	E102 CLELL HOWARD	WELL	324BRTT	55.00	1	1979	1979
374722082242901	E110 HOMER MUNCEY	WELL	324BRTT	59.00	1	1979	1979
374734082312801	E101 COLUMBUS TILLER	WELL	324BRTT	26.00	1	1979	1979
374828082334201	E103 AVERY PREECE	WELL	324BRTT	50.00	1	1979	1979
374842082251601	E111 T J FLETCHER	WELL	324BRTT	63.00	1	1979	1979
374844082251901	E112 T J FLETCHER	WELL	324BRTT	82.00	1	1979	1979
374900082301201	JASPER CASSIDY	WELL	324BRTT	79.00	1	1954	1954
374908082302801	E100 ELMER CASSIDY	WELL	324BRTT	85.00	1	1979	1979
374908082355401	E128 EWART RAMEY	WELL	324BRTT	99.00	1	1979	1979
374941082263601	E126 JAMES SMITH	WELL	324BRTT	126.00	1	1979	1979
374956082285001	E117 VARDIE FIELDS	WELL	324BRTT	73.00	1	1979	1979
375004082252801	E125 JAMES HOWELL	WELL	324BRTT	51.00	1	1979	1979
375028082254701	BEAUTY CONCRETE SLOPE MINE #1	WELL		.	2	1976	1977
375045082360901	E127 ERSEL MILLS	WELL	324BRTT	62.00	1	1979	1979
375051082322201	E104 OTTO BROWN	WELL	324BRTT	73.00	1	1979	1979
375052082321701	E105 OTTO BROWN	WELL	324BRTT	68.00	1	1979	1979
375058082301301	E116 VAN ROBINSON	WELL	324BRTT	48.00	1	1979	1979
375102082262101	E124 JOHN SPAULDING	WELL	324BRTT	35.00	1	1979	1979
375107082391701	E140 LESLIE SPENCE	WELL	324BRTT	90.00	1	1979	1979
375119082371901	E130 HENRY MILLS	WELL	324BRTT	52.00	1	1979	1979
375153082354801	KY-W.VA GAS CO.	WELL	324BRTT	66.00	1	1959	1959
375158082355501	M.C. WARD	WELL	324BRTT	64.00	1	1954	1954
375202082322501	MS. BELVA WARD	WELL	324BRTT	68.00	1	1954	1954
375205082354801	E129 SHIRLEY MOORE	WELL	324BRTT	90.00	1	1979	1979
375247082351501	E147 HARVEY NEWSOME	WELL	324BRTT	61.00	1	1979	1979
375259082273701	B079 BILLY RAY HAMMOND	WELL	324BRTT	57.00	1	1979	1979
375405082345301	E146 ROBERT MAY	WELL	324BRTT	18.00	1	1979	1979
375452082330201	E145 NEBERT BOWEN	WELL	324BRTT	82.00	1	1979	1979
375611082321001	E144 HOMER PACK	WELL	324BRTT	50.00	1	1979	1979

Ground-Water Sites with Available Chemical Analyses--continued.

PIKE COUNTY KENTUCKY

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
371241082335501	TOM J. SMITH	WELL		13.70	1	1960	1960
371241082353101	JOHN PENNELL	WELL	324BRTT	108.00	1	1960	1960
371242082335401	TCM J. SMITH	WELL	324BRTT	46.00	1	1960	1960
371257082324301	K. CABLE	WELL	324BRTT	7.70	1	1960	1960
371301082323701	MS. JOSEPHINE VANOVER	WELL	324BRTT	80.00	1	1960	1960
371404082340201	JOHN STANLEY	WELL	324BRTT	23.00	1	1960	1960
371404082340301	JOHN STANLEY	WELL	324BRTT	34.00	1	1960	1960
371408082310501	CLEMMENT MOORE	WELL	324BRTT	41.70	1	1960	1960
371410082322701	LEE CABLE	WELL	324BRTT	19.00	1	1960	1960
371655082282301	HELLIER COAL&COKE CO.	WELL	324BRTT	.	1	1958	1958
371840082380001	JONNY TACKETT	WELL		12.00	1	1954	1954
372158082331001	UTILITIES ELKHORN COAL CO.	WELL	324BRTT	150.00	2	1953	1958
372307082152001	G.P. BELCHER	WELL	324BRTT	137.00	1	1954	1954
372639082071301	B046 JAMES ADKINS	WELL	324BRTT	65.00	1	1979	1979
372725082091401	E035 ROLAND COLEMAN	WELL	324BRTT	61.00	1	1979	1979
372803082114101	E036 PERRY CASEY	WELL	324BRTT	21.00	1	1979	1979
372826082050401	B043 ORIVILLE BLANKENSHIP	WELL	324BRTT	64.00	1	1979	1979
372833082311201	PIKEVILLE ICE CO.	WELL	324BRTT	110.00	2	1953	1958
372903082121601	E037 KENNETH LOUDERMILK	WELL	324BRTT	120.00	1	1979	1979
372907082110301	KY CARBON CO.	WELL	324BRTT	302.00	1	1965	1965
372917082061401	B040 EMZIE BLANKENSHIP	WELL	324BRTT	100.00	1	1979	1979
372918082261101	CECIL GOFF	WELL		15.00	1	1954	1954
372937082042901	B039 ERNEST PRATER	WELL	324BRTT	60.00	1	1979	1979
372953082081101	E038 JOYCE FIELDS	WELL	324BRTT	32.00	1	1979	1979
373046082090501	E028 LENARD COMPTON	WELL	324BRTT	29.00	1	1979	1979
373047082063501	E030 BERT PRATER	WELL	324BRTT	85.00	1	1979	1979
373134082114601	E040 VER WHITT	WELL	324BRTT	47.00	1	1979	1979
373143082150501	EASTERN COAL CORP.	WELL	324BRTT	50.00	1	1953	1953
373151082150501	B067 VICTOR JAMES	WELL	324BRTT	70.00	1	1979	1979
373154082060601	MAJESTIC COLLIERIES CO.	WELL	324BRTT	280.00	1	1953	1953
373236082173501	B069 RAYMOND D HATFIELD	WELL	324BRTT	77.00	1	1979	1979
373243082130101	E039 WILLIAM F CHURCH	WELL	324BRTT	72.00	1	1979	1979
373250082093001	E029 RUSSELL DOTSON	WELL	324BRTT	105.00	1	1979	1979
373338082153601	B068 HAROLD HELVY	WELL	324BRTT	96.00	1	1979	1979
373348082113101	E041 TIVIS WALLEN	WELL	324BRTT	72.00	1	1979	1979
373424082191001	B064 DAVID B THACKER	WELL	324BRTT	42.00	1	1979	1979
373455082161201	EASTERN COAL CO.	WELL	324BRTT	211.00	1	1953	1953
373508082221201	B061 SARAH HATFIELD	WELL	324BRTT	36.00	1	1979	1979
373533082095901	E034 NORMANS GROCERY	WELL	324BRTT	120.00	1	1979	1979
373544082202401	B063 CLIVE SMITH	WELL	111ALVM	17.00	1	1979	1979
373548082163601	B066 ROGER STANLEY	WELL	324BRTT	155.00	1	1979	1979
373554082122101	B072 VIRGIL STANLEY	WELL	324BRTT	74.00	1	1979	1979
373601082140201	B073 WILLIAM K STACY	WELL	324BRTT	47.00	1	1979	1979
373612082184201	B065 FLOYD BLACKBURN	WELL	324BRTT	51.00	1	1979	1979
373701082213001	B062 BESSIE BLACKBURN	WELL	324BRTT	.	1	1979	1979
373707082143601	EASTERN COAL CO.	WELL	324BRTT	225.00	1	1953	1953
373712082160701	B070 FRED HATFIELD	WELL	324BRTT	43.00	1	1979	1979
373816082173901	E072 J C WILLIS	WELL	324BRTT	25.00	1	1979	1979
373858082215101	E070 PHILLIP ELKINS	WELL	324BRTT	50.00	1	1979	1979
373907082231501	E069 CHARLIE ELKINS	WELL	324BRTT	41.00	1	1979	1979
373909082161301	E073 WALTER R WEST	WELL	324BRTT	.	1	1979	1979
373913082182301	E071 BRUCE HURLEY	WELL	324BRTT	74.00	1	1979	1979
374109082215101	E068 GARY DESKINS	WELL	324BRTT	40.00	1	1979	1979
374232082204701	E067 BILL HARRELL	WELL	324BRTT	.	1	1979	1979

BUCHANAN COUNTY VIRGINIA

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
370439082031601	14E 2 HARRIS, CURVIN	WELL		10.50	1	1978	1978
370449082043601	14E 3 COMPTON, BASIL	WELL		55.00	1	1978	1978
370509082045601	14E 4 COMPTON, HAROLD D	WELL		36.00	1	1978	1978
370558082081101	13E 1 HARRIS, W C	WELL		78.00	1	1978	1978
370602082080901	13E 1 HARRIS, BILLY K	WELL		200.00	1	1978	1978
370923082012601	14F 27 CODELL CONST. CO.	WELL	324NRTN	185.00	1	1980	1980
370949082041501	14F 2 BOYD, ED	WELL	110QRNR	33.50	1	1980	1980
371018082041301	14F 4 DEPT HWAY DESKINS	WELL	324NRTN	385.00	1	1980	1980
371020082042002	14F 3 CORR. UNIT 29 WL2 113-063	WELL	324NRTN	150.00	1	1980	1980
371023082013001	14F 25 JACKIE RAY COAL	WELL	324NRTN	120.00	1	1980	1980
371030082004801	14F 26 VA POCAHONTAS 6 113-99	WELL	324NRTN	305.00	1	1980	1980
371107082050001	14F 23 VA POCAHONTAS 5 113-101	WELL	324NRTN	305.00	1	1980	1980
371121082021801	14F 28 MT. BALDWIN CAMP	WELL	324NRTN	200.00	1	1980	1980
371156082060201	14F 7 FULLER, FOSTER	WELL	324NRTN	175.00	1	1980	1980
371221082055201	14F 6 GOFF, JOHN	WELL	324NRTN	135.00	1	1980	1980
371222082055301	14F 5 DALE, CHARLES	WELL	324NRTN	305.00	1	1980	1980
371232082034001	14F 20 RATLIFF, EARL	WELL	324NRTN	105.00	1	1980	1980
371303082042801	14F 21 STREET, HARRISON	WELL	324NRTN	105.00	1	1980	1980
371337082010801	14F 8 DEPT HWAY OAKWOOD 113-006	WELL	324NRTN	303.00	1	1980	1980
371352082055801	14F 22 VA POCAHONTAS 3 113-44	WELL	324NRTN	200.00	1	1980	1980
371418082052501	14F 24 NOAH HORN DRILLER	WELL	324NRTN	140.00	1	1980	1980
372114082032501	B028 ERNEST C. LOONEY	WELL	324PSLVM	83.00	1	1979	1979
372120082020401	B029 SHERMAN T. JUSTICE	WELL	324PSLVM	80.00	1	1979	1979
372121082015501	B030 J. MARSHALL DAVIS	WELL	111ALVM	22.00	1	1979	1979
372208082003201	B037 BOBBIE E. COOPER	WELL	324PSLVM	180.00	1	1979	1979
372322082024201	B045 DONALD JUSTUS	WELL	324PSLVM	105.00	1	1979	1979
372326082023801	B031 DONALD JUSTUS	WELL	324PSLVM	45.00	1	1979	1979
372354082065101	B049 SHERMAN ADKINS	WELL	324PSLVM	145.00	1	1979	1979
372408082002901	B053 CUBERT COLEMAN	WELL	324PSLVM	.	1	1979	1979
372452082060301	B048 EARL COOK	WELL	324PSLVM	45.00	1	1979	1979
372510082011801	B052 JOHN H LESTER	WELL	324PSLVM	85.00	1	1979	1979
372522082031801	B051 CHARLEY HURLEY	WELL	324PSLVM	68.00	1	1979	1979
372619082051701	B047 WILLIAM PHILLIPS	WELL	324PSLVM	150.00	1	1979	1979
372637082004001	B050 EARL HALL	WELL	324PSLVM	53.00	1	1979	1979
372717082031801	B044 LONNIE DUTY	WELL	324PSLVM	87.00	1	1979	1979
372758082001501	B041 EARL RIFE	WELL	324PSLVM	75.00	1	1979	1979
372821082024701	B042 HOBERT RIFE	WELL	111HLCN	18.50	1	1979	1979

DICKENSON COUNTY VIRGINIA

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
370228082185501	12E 2 LONG, OVIE	WELL		40.00	1	1978	1978
370228082190001	12E 3 PHILLIPS, CLELL	WELL		120.00	1	1978	1978

WISE COUNTY VIRGINIA

Ground-water sites with available chemical analyses--continued.

MINGO COUNTY WEST VIRGINIA

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
373400082083601	E032 MAUDIE HOWARD	WELL	327PSVL	145.00	1	1979	1979
373423082030301	E023 CARLOS CISCO	WELL	327PSVL	63.00	1	1979	1979
373539082015601	E025 HARRY STEELE	WELL	327PSVL	44.00	1	1979	1979
373541082080201	E033 MACK CISCO	WELL	327PSVL	90.00	1	1979	1979
373611082060801	E027 RUTH SNELL	WELL	327PSVL	86.00	1	1979	1979
373636082005601	E022 GEORGE KENNEDY	WELL	327PSVL	57.00	1	1979	1979
373652082032801	E026 JACK STEELE	WELL	327PSVL	96.00	1	1979	1979
373731082045301	E046 CHARLES SMITH	WELL	327PSVL	300.00	1	1979	1979
373806082130001	E066 DANNY HALLEY	WELL	327PSVL	113.00	1	1979	1979
373857082111601	E065 R L COOK	WELL	327PSVL	85.00	2	1979	1980
373902082070701	E047 THOMAS DEAN	WELL	327PSVL	24.00	1	1979	1979
373903082025801	E050 PAUL PERRY	WELL	327PSVL	100.00	1	1979	1979
373918082012701	E049 RICKY STATEN	WELL	327PSVL	40.00	1	1979	1979
373923082053901	E051 JAMES STUMBO	WELL	327PSVL	60.00	1	1979	1979
373950082092301	E048 J P TOTTEN	WELL	327PSVL	40.00	1	1979	1979
374006082072801	E052 RAYMOND JUSTICE	WELL	111ALVM	16.00	1	1979	1979
374019082130201	E064 TOM SAMMONS	WELL	327PSVL	65.00	1	1979	1979
374114082104601	E053 HAWK KENNEDY	WELL	327PSVL	40.00	1	1979	1979
374119082174101	E074 NEWMAN COCHRAN	WELL	327PSVL	56.00	1	1979	1979
374133082044801	E056 JEFF FERRELL	WELL	327PSVL	64.00	1	1979	1979
374150082135501	E075 C R EVANS	WELL	327PSVL	36.00	1	1979	1979
374209082074201	E055 RUSS SHEPARD	WELL	111ALVM	18.00	1	1979	1979
374209082113401	E076 FLORA STEPP	WELL	327PSVL	73.00	1	1979	1979
374212082095301	E054 SHELBY HALL	WELL	327PSVL	35.00	1	1979	1979
374232082163001	E058 JIM RATLIFF	WELL	327PSVL	72.00	1	1979	1979
374253082181901	E059 TOMMY FLETCHER	WELL	327PSVL	60.00	1	1979	1979
374319082073501	E062 WALLACE CAREY	WELL	327PSVL	63.00	1	1979	1979
374335082113401	E057 MARGRET HATFIELD	WELL	327PSVL	80.00	1	1979	1979
374418082100601	E061 WALTER MARTIN JR.	WELL	327PSVL	65.00	1	1979	1979
374424082194801	E060 GLEN BLEVINS	WELL	327PSVL	96.00	1	1979	1979
374454082130201	E063 OLIVER WORKMAN	WELL	327PSVL	81.00	1	1979	1979
374535082131501	E083 IRA CURRY	WELL	327PSVL	82.00	1	1979	1979
374545082183601	E077 WALLACE ROBINSON	WELL	327PSVL	80.00	1	1979	1979
374558082111001	E086 EARL HANSHAW	WELL	327PSVL	95.00	1	1979	1979
374558082162601	E099 JEFF L ROBINETTE	WELL	327PSVL	104.00	1	1979	1979
374610082080201	E084 KENNETH DESKINS	WELL	327PSVL	63.00	1	1979	1979
374631082192301	E078 ALBERT PARSLEY	WELL	327PSVL	85.00	1	1979	1979
374651082101101	E085 MILLARD VANCE	WELL	327PSVL	96.00	1	1979	1979
374702082143701	E087 OLIVER DAVIS	WELL	327PSVL	.	1	1979	1979
374722082155701	E094 WILLIE SHIPMAN	WELL	327PSVL	53.00	1	1979	1979
374735082203201	E079 KENNETH HITCHCOCK	WELL	327PSVL	70.00	1	1979	1979
374819082185801	E098 RAY MEEKS	WELL	327PSVL	.	1	1979	1979
374836082140101	E095 ROY EVANS	WELL	327PSVL	69.00	1	1979	1979
374849082161901	E093 DAVID HALL	WELL	327PSVL	55.00	1	1979	1979
374855082240101	E113 IRA KIRK	WELL	327PSVL	96.00	1	1979	1979
374901082122301	E097 WILLIS NEWSOME	WELL	327PSVL	78.00	1	1979	1979
374912082111101	E096 ANDREW J GILMAN	WELL	327PSVL	50.00	1	1979	1979
374937082142401	E092 GROVER HALL	WELL	327PSVL	56.00	1	1979	1979
375023082130601	E091 OTELIA KING	WELL	327PSVL	68.00	1	1979	1979
375047082214201	E082 JAMES CRANK	WELL	327PSVL	54.00	1	1979	1979
375119082172001	E080 CURTIS WHITT	WELL	327PSVL	43.00	1	1979	1979

Ground-water sites with available chemical analyses--continued.

MINGO COUNTY WEST VIRGINIA

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
375138082225201	E114 EDDIE GILLMAN	WELL	327PSVL	68.00	1	1979	1979
375227082213201	E081 JAMES O FARLEY	WELL	327PSVL	50.00	1	1979	1979
375302082202701	E133 JOE MARCUM	WELL	327PSVL	57.00	1	1979	1979
375356082185001	E134 CLELLEN MESSER	WELL	327PSVL	55.00	1	1979	1979

WAYNE COUNTY WEST VIRGINIA

STATION NUMBER	LOCAL IDENTIFIER	SITE TYPE	GEOLOGIC UNIT	DEPTH OF WELL	NUMBER OF ANALYSIS	BEGINING YEAR	ENDING YEAR
375345082255701	B078 BOBBY WILLIAMSON	WELL	327PSVL	95.00	1	1979	1979
375404082240801	E131 BIRDIE COPLEY	WELL	327PSVL	90.00	1	1979	1979
375437082215801	F132 HOWARD MEADE	WELL	327PSVL	100.00	1	1979	1979
375437082272201	B081 WILLIAM H. FARLEY	WELL	327PSVL	160.00	1	1979	1979
375439082272001	B082 WILLIAM H. FARLEY	WELL	327PSVL	60.00	1	1979	1979
375619082252801	B077 MARIE MARCUM	WELL	327PSVL	84.00	1	1979	1979
375647082282801	B086 W. J. ENDICOTT	WELL	327PSVL	75.00	1	1979	1979
375746082260101	B083 G. F. GILLMAN, JR.	WELL	327PSVL	96.00	1	1979	1979
375807082285901	B085 FRED RATLIFFE, JR.	WELL	327PSVL	62.00	1	1979	1979
375924082280801	B084 ARVEL COPLEY	WELL	327PSVL	94.00	1	1979	1979

Flood-flow data at selected sites

SITE NUMBER	STATION NAME	DRAINAGE AREA	2-YEAR FLOOD	5-YEAR FLOOD	10-YEAR FLOOD	25-YEAR FLOOD	50-YEAR FLOOD	100-YEAR FLOOD	MAXIMUM KNOWN FLOW	1-DAY 10-YEAR	3-DAY 10-YEAR	7-DAY 10-YEAR
		mi^2	Cubic Feet Per Second									
16	Big Prater Creek near Vansant, Va.	19.8	938	1,800	2,600	3,890	5,100	6,540	8,000	---	---	---
218	Levisa Fork near Grundy, Va.	235	10,300	17,000	22,000	28,900	34,500	40,400	52,200	10,800	6,140	3,580
26	Levisa Fork near Big Rock, Va.	297	12,311	26,100	39,300	61,700	83,200	110,000	56,000	16,700	9,630	5,060
28	Dicks Fork at Phyllis, Ky.	.82	---	---	---	---	---	---	113	69.6	34.2	14.5
29	Grapevine Creek near Phyllis, Ky.	6.2	---	---	---	---	---	---	1,650	456	247	123
31	Levisa Fork below Fishtrap Dam, Ky.	386	12,200	17,600	21,100	25,500	78,600	31,700	33,000	15,800	10,300	6,030
54	Russell Fork at Haysi, Va.	286	14,000	23,700	31,100	41,200	49,300	57,800	59,000	16,400	8,480	4,720
58	North Fork Pound River at Pound, Va.	18.5	---	---	---	---	---	---	4,480	---	---	---
60	Pound River above Indian Creek at Pound, Va.	36.7	---	---	---	---	---	---	3,460	---	---	---
62	Pound River below Bold Camp Creek at Pound, Va.	61.2	---	---	---	---	---	---	6,290	---	---	---
63	Pound River near Georges Fork, Va.	82.5	---	---	---	---	---	---	10,900	---	---	---
71	Cranes Nest River near Clintwood, Va.	66.5	2,670	4,790	6,590	9,370	11,800	14,600	18,000	4,190	2,210	1,130
73	Pound River below Flannagan Dam, Va.	221	9,670	15,000	19,000	24,600	29,200	34,100	30,000	9,280	5,270	3,310
74	Russell Fork at Bartlick, Va.	526	---	---	---	---	---	---	50,000	---	---	---
76	Russell Fork at Elkhorn, Ky.	554	---	---	---	---	---	---	54,200	---	---	---
244	Shelby Creek at Dorton, Ky.	12.6	---	---	---	---	---	---	3,000	571	301	175
84	Levisa Fork at Pikeville, Ky.	1,237	28,900	43,300	52,200	62,500	69,700	76,400	85,500	46,100	31,500	18,900
94	Levisa Fork at Prestonsburg, Ky.	1702	---	---	---	---	---	---	69,700	37,000	29,500	20,400
99	Johns Creek near Meta, Ky.	56.3	2,720	4,220	5,290	6,740	7,880	9,070	7,380	2,750	1,780	976
104	Johns Creek near Van Lear, Ky.	206	3,870	6,510	8,530	11,300	13,600	16,100	8,500	6,350	4,860	2,970
108	Paint Creek at Staffordsville, Ky.	103	5,380	9,540	12,900	17,700	21,700	26,100	17,400	6,420	3,310	1,760
109	Levisa Fork at Paintsville, Ky.	2,143	33,700	49,100	59,700	73,500	83,900	94,600	69,700	54,400	44,700	38,900
126	Tug Fork at Litwar, W. Va.	502	12,400	18,200	22,400	27,900	37,300	36,800	54,500	15,400	9,830	6,070
127	Panther Creek near Panther, W. Va.	30.8	1,430	2,590	3,590	5,150	6,540	8,140	6,600	1,540	895	765
139	Tug Fork at Williamson, W. Va.	941	21,500	39,000	53,800	76,600	96,600	120,000	94,000	40,100	22,000	15,200
146	Tug Fork near Kermit, W. Va.	1,185	23,300	38,200	49,500	65,500	78,500	92,400	104,000	44,800	31,600	18,700
156	Big Sandy River near Louisa, Ky.	3,892	48,200	72,100	89,100	112,000	129,000	147,000	89,400	81,100	71,400	49,700
268	Blaine Creek at Yatesville, Ky.	217	6,220	9,490	11,800	15,000	17,500	20,000	21,000	9,070	6,110	3,390

Flow-duration data at selected sites, in downstream order

SITE NUMBER	PERIOD OF RECORD	PERCENT OF TIME INDICATED DISCHARGE (CUBIC FEET PER SECOND) WAS EQUALLED OR EXCEEDED 1	5	10	25	50	70	75	90	95	
218	1942-74	2,700	1,073	670	310	110	39	29	12	6.6	
26	1968-80	3,900	1,450	860	420	200	91	74	33	21	
31	1938-68	4,500	1,800	1,120	490	153	56	44	17	8.7	NO REGULATION
31	1970-78	4,600	2,180	1,250	590	280	109	96	51	18	REGULATED
31	1938-78	4,500	1,900	1,160	526	184	70	55	19	11	HISTORICAL
54	1927-80	3,530	1,240	750	330	130	47	36	12	6.0	
58	1962-64	270	118	75	31	9.0	3.3	2.4	0.6	0.3	NO REGULATION
58	1968-80	245	139	82	32	15	5.7	4.8	3.1	2.6	REGULATED
58	1962-80	245	132	77	32	13	4.9	4.1	2.2	0.8	HISTORICAL
60	1966-78	470	243	150	63	29	14	11	5.9	4.1	
62	1966-78	798	380	230	100	47	25	20	9.8	7.0	
63	1964-80	1,030	487	300	140	67	31	25	11	7.1	
71	1964-80	767	285	180	91	42	18	14	6.1	4.1	
73	1927-63	2,600	1,050	640	270	96	34	26	8.4	4.2	NO REGULATION
73	1967-80	3,000	1,220	710	330	160	78	59	43	33	REGULATED
73	1927-80	2,600	1,110	660	290	120	48	38	12	5.5	HISTORICAL
74	1963-80	5,510	2,940	1,700	720	330	160	130	75	45	
76	1961-64	5,600	2,740	1,790	822	233	99	79	36	23	NO REGULATION
76	1966-78	5,530	3,150	1,840	793	420	188	161	106	75	REGULATED
76	1961-78	5,610	2,980	1,810	804	338	166	144	76	40	HISTORICAL
84	1937-64	13,700	5,210	3,320	1,520	493	188	146	52	28.5	NO REGULATION
84	1966-78	13,300	6,840	3,920	1,720	774	408	348	187	133	REGULATED
84	1937-78	14,100	5,780	2,930	1,600	598	255	202	75.3	39.7	HISTORICAL
94	1966-78	16,700	9,000	5,800	2,280	1,060	503	422	233	165	REGULATED
94	1964-78	16,000	10,000	7,540	2,310	1,020	464	385	201	127	HISTORICAL
99	1941-78	810	272	166	71	20	6.3	4.3	1.4	.60	
104	1940-49	1,900	745	444	183	49	16	11	3.1	1.6	NO REGULATION
104	1951-78	2,560	1,170	635	250	66	21	18	12	9.8	REGULATED
104	1940-78	2,680	1,060	580	233	61	21	17	9.8	6.4	HISTORICAL
108	1950-75	1,500	531	311	112	37	12	8.2	2.8	1.6	
109	1915-16 1929-49	22,800	8,780	6,140	2,310	824	297	223	76	44	NO REGULATION
109	1951-78	22,000	10,800	6,520	3,050	1,090	437	359	155	96	REGULATED
109	1915-16 1929-78	21,000	9,900	6,000	2,840	996	407	330	132	75	HISTORICAL
126	1931-79	4,200	1,950	1,300	640	260	130	100	56	42	
127	1947-80	414	149	90	40	14	4.5	3.4	1.2	.70	
139	1968-79	9,000	4,090	2,700	1,400	680	340	290	160	110	
146	1935-79	12,000	4,990	3,200	1,600	640	280	220	110	77	
156	1934-49	30,200	14,300	9,160	4,140	1,500	565	435	182	129	NO REGULATION
156	1951-77	39,000	18,100	11,400	5,540	2,180	855	681	326	225	REGULATED
156	1937-77	38,600	17,000	10,900	5,230	1,990	788	626	285	183	HISTORICAL
268	1916-75	2,820	999	582	235	67	19.4	14.6	4.5	2.6	

10.7 Dissolved-Solids Concentrations

Summary of dissolved solids, in micrograms per liter.

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
7	4	167	623	322	208	249
8	4	151	529	274	174	209
9	4	90	324	154	114	101
10	4	109	246	168	57.6	159
11	4	112	261	159	69.4	132
12	4	38	84	55	20.1	49
14	4	128	609	301	223	234
15	4	134	315	194	81.8	164
17	4	92	345	185	113	152
19	7	105	479	253	122	205
20	6	357	773	547	180	497
21	6	208	770	396	211	336
22	6	428	1,210	681	292	564
23	5	404	912	599	236	486
24	6	246	705	416	194	323
25	6	178	601	349	171	324
26	231	95	803	328	15	284
27	10	500	943	724	146	722
28	46	39	76	55	7.84	53.5
29	49	58	1,660	263	298	147
34	4	72	211	117	63.6	92.5
35	4	57	145	83	41.7	65
36	4	73	199	114	58.9	91
37	4	110	463	224	164	160
38	4	260	560	379	136	348
40	2	77	90	83.5	9.19	83.5
41	6	148	724	383	208	330
42	4	61	173	110	53.4	104
43	4	169	290	208	56.8	188
44	4	99	224	139	57.8	117
45	4	147	243	190	41.6	184
49	5	157	496	275	145	196
50	3	291	426	359	67.5	360
51	5	44	121	71.2	35.6	50
52	4	71	185	124	51.2	120
54	46	39	485	157	107	117
55	4	73	223	142	62.5	135
56	3	65	227	127	87.6	88
58	5	61	164	95	41.4	75
59	4	271	491	374	99.2	366

Summary of dissolved solids, in micrograms per liter -- continued.

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
60	3	133	380	284	132	338
61	5	222	730	423	207	329
63	16	146	535	293	121	280
64	4	334	858	520	231	444
65	4	24	109	53.2	39.2	40
66	4	162	247	193	37.8	182
67	4	402	662	500	119	468
68	4	401	760	571	149	562
71	18	218	5,170	629	1,140	348
74	16	133	300	190	47.5	178
75	4	225	603	382	160	349
76	29	132	254	185	31.4	186
77	4	169	278	234	48.9	244
78	5	146	297	212	65.0	189
79	4	117	287	201	85.2	200
80	3	242	388	310	73.6	299
81	4	187	392	304	102	319
82	4	301	663	516	173	549
84	34	98	389	211	64.3	208
85	3	110	237	157	69.4	125
86	4	158	286	236	60.1	249
89	4	153	368	263	104	265
90	4	64.0	279	153	90.8	134
91	4	58	133	101	33.2	106
92	4	81	196	119	54	100
93	4	214	430	338	94.9	353
95	4	99	290	181	95.1	168
96	4	140	838	400	318	312
98	2	101	200	150	70	150
99	29	74	524	231	118	203
100	4	82	272	190	94.6	204
101	4	73	276	173	87.8	172
102	4	160	233	200	31.8	204
104	29	50	225	104	35.7	102
105	4	241	602	427	148	433
108	24	86	1,710	406	371	291
109	73	75	379	171	66.2	158
110	4	86	181	121	44.7	109
112	4	193	547	394	159	418
113	3	60	216	129	79.7	110
114	5	89	195	129	42.3	122
115	4	172	345	285	80.7	306

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
116	4	108	269	187	68.6	186
117	10	232	518	389	87.4	400
118	4	238	348	304	50.2	314
119	4	256	358	305	42.0	302
120	11	228	504	363	77.6	369
121	4	196	890	522	285	500
122	4	195	465	333	123	336
123	4	205	686	461	216	476
124	4	149	245	207	41.5	217
125	11	158	484	309	108	307
126	23	126	625	343	118	329
127	10	45	334	151	111	106
128	4	61	154	97.5	39.7	87.5
129	4	158	377	234	99.6	200
130	4	59	132	84.5	32.5	73.5
131	4	133	268	190	57.1	179
132	3	50	72	61.3	11	62
133	4	154	399	234	112	192
134	15	94	271	154	51	135
135	4	108	312	228	88.9	246
136	4	106	259	210	70.7	237
137	4	78	413	280	160	315
138	4	125	331	226	84.7	224
140	3	119	377	238	130	219
142	3	92	276	180	92.2	173
143	4	120	448	245	155	206
144	11	133	482	257	108	231
145	4	35	58	50	10.3	53.5
147	3	280	568	468	163	557
149	4	37	51	45.8	6.4	47.5
150	5	112	425	241	115	237
151	6	112	425	266	120	238
152	3	240	533	411	153	460
154	19	145	467	284	109	235
155	4	44	102	76	23.9	79
156	98	97	447	231	85.5	218
157	4	291	16,800	7,730	7,651	6,915
159	4	64	136	89.8	33.6	79.5
160	4	67	150	99.8	40	91
162	4	72	132	103	32.7	104
163	4	52	106	78	24.5	77
164	4	92	266	156	75.8	134
165	4	100	143	124	18	126

Summary of specific conductance, in micromhos.

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
7	7	248	1,890	779	577	575
8	5	222	658	408	180	350
9	5	122	496	270	158	199
10	6	180	436	308	98.1	315
11	5	165	410	271	106	240
12	6	56	112	84.3	25.1	86.5
14	5	224	977	563	336	565
15	6	195	505	355	151	363
17	6	150	675	394	213	386
19	8	188	699	396	164	385
20	7	556	1,040	785	208	700
21	7	365	1,050	629	257	590
22	7	695	1,390	1,000	314	950
23	6	571	1,050	806	206	796
24	7	434	875	6533	192	680
25	7	265	784	533	199	570
26	260	142	1,130	455	223	411
27	11	670	1,060	896	136	930
28	51	34	120	71	16.9	73
29	51	61	1,600	356	317	227
34	6	126	378	227	104	200
35	6	100	280	174	77.8	152
36	5	115	340	208	101	150
37	5	180	730	401	224	310
38	5	400	950	666	225	600
40	4	115	180	151	33.2	154
41	7	245	1,100	679	335	580
42	6	115	280	201	66.9	208
43	5	260	498	368	106	310
44	6	178	469	312	140	302
45	6	235	580	390	139	365
49	6	226	700	437	192	422
50	4	450	625	561	77.4	584
51	7	60	223	140	69.8	178
52	6	36	310	191	115	204
54	43	46	727	263	173	196
55	5	180	438	297	116	245
56	5	70	430	292	170	405
58	9	93	258	134	53.9	112
59	5	404	744	564	163	537

Summary of specific conductance, in micromhos -- continued.

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
60	3	220	550	423	178	500
61	7	370	940	652	236	783
63	17	194	700	436	162	455
64	5	460	1,160	803	306	690
65	5	23	160	72	54.9	62
66	5	226	460	345	107	303
67	6	440	920	742	193	792
68	5	537	1,010	778	218	770
71	19	210	860	508	175	475
74	16	198	498	312	82.9	296
75	5	330	745	520	163	465
76	48	120	440	295	62.9	293
77	6	301	460	385	66.5	389
78	7	220	490	356	107	330
79	4	160	450	304	143	302
80	5	380	595	480	92.4	515
81	6	290	645	497	148	514
82	7	380	862	657	208	630
84	52	130	585	324	93	340
85	5	175	460	285	127	215
86	6	239	460	361	87	364
89	6	245	525	396	136	416
90	6	85	420	241	142	215
91	7	85	300	194	73.8	206
92	6	92	360	206	104	186
93	6	258	750	507	184	550
95	6	150	440	271	129	230
96	6	220	1,150	595	373	550
98	5	119	320	195	88	165
99	49	10	930	342	198	300
100	6	140	440	300	135	310
101	6	130	382	247	93.1	248
102	6	197	350	264	55	262
104	40	75	300	159	46.5	262
105	6	360	900	617	208	638
108	26	125	2,960	666	605	468
109	86	95	599	269	108	250
110	5	110	310	208	81.4	205
112	6	270	710	508	183	532
113	5	95	320	191	94.9	180
114	7	130	282	194	53.2	210
115	4	280	560	440	121	460
116	4	164	420	298	107	305
117	58	189	780	477	145	473
118	4	370	545	481	76.6	505
119	7	420	540	477	41.5	466
120	31	214	800	537	154	580
121	4	324	1,500	868	484	825
122	4	340	800	565	205	560
123	4	340	1,170	780	366	805
124	4	220	430	328	86.2	330
125	30	27	840	411	224	404
126	30	204	947	561	190	542
127	17	57	600	226	188	130
128	6	98	348	226	117	219
129	5	254	621	412	173	338
130	5	103	300	177	97.2	114
131	5	240	435	327	91.6	290
132	6	77	282	163	83.8	154
133	5	252	608	393	161	320
134	16	178	418	249	83.4	206
135	7	170	420	324	92	321
136	6	170	440	336	108	364
137	6	119	600	340	188	332
138	6	200	530	377	127	365
140	5	180	510	346	136	325
142	4	136	440	257	143	226
143	4	173	1,320	602	544	458
144	132	150	1,000	378	182	309
145	4	46	130	85.5	34.5	83
147	6	295	900	547	264	432
149	4	42	90	66.2	19.6	66.5
150	9	100	600	271	157	225
151	10	120	600	335	164	310
152	6	201	675	410	199	358
154	70	120	804	369	152	330
155	4	83	148	124	30	133
156	127	150	729	377	135	350
157	6	480	26,000	10,000	10,100	7,750
159	6	95	170	130	33.6	128
160	6	105	232	150	53.0	128
162	6	95	220	140	55.3	114
163	6	80	171	121	37.6	120
164	6	145	470	249	115	225
165	4	142	260	206	50.8	212

10.9 pH Values

Summary of pH units.

SITE NUMBER	NUMBER OF OBSERVATIONS	MINIMUM VALUE	MAXIMUM VALUE	MEDIAN VALUE
7	7	5.8	8.2	8.0
8	5	5.9	8.1	7.6
9	5	5.6	8.6	7.6
10	6	5.8	8.3	8.0
11	5	5.8	8.6	8.3
12	6	6.6	8.1	7.2
14	5	6.0	8.5	7.3
15	6	6.4	8.8	7.8
17	6	5.9	8.6	8.2
19	8	6.9	8.7	8.0
20	7	7.0	8.1	7.5
21	7	6.8	8.2	7.6
22	7	7.7	8.2	8.0
23	6	7.2	8.2	7.9
24	7	6.9	8.2	7.7
25	7	7.0	8.1	7.7
26	220	6.2	8.5	7.2
27	12	5.6	8.2	7.5
28	51	6.4	8.4	7.0
29	45	6.5	9.6	7.4
34	6	6.1	7.9	7.6
35	6	6.2	8.0	7.6
36	5	5.9	7.9	7.6
37	5	6.5	8.1	7.9
38	5	6.7	8.3	8.0
40	4	6.6	7.9	7.6
41	7	7.3	8.7	8.2
42	6	7.0	8.0	7.5
43	5	6.7	8.0	7.1
44	6	6.8	8.2	7.2
45	6	6.5	7.7	7.0
49	6	6.7	8.5	7.8
50	4	7.5	8.6	8.0
51	7	6.6	8.3	7.4
52	6	6.2	8.6	7.8
54	44	6.0	8.7	7.5
55	5	6.5	7.3	7.1
56	5	6.0	6.9	6.2
58	9	6.0	7.9	6.6
59	5	6.4	7.7	7.0

Summary of pH units -- continued.

SITE NUMBER	NUMBER OF OBSERVATIONS	MINIMUM VALUE	MAXIMUM VALUE	MEDIAN VALUE
60	3	6.8	7.3	7.0
61	7	6.8	8.4	7.5
63	17	6.3	7.9	7.4
64	5	7.1	8.0	7.7
65	5	6.2	7.4	6.9
66	5	6.9	8.0	7.6
67	6	7.2	7.8	7.7
68	5	6.8	7.6	7.4
71	19	6.5	8.2	7.3
74	16	6.2	8.1	7.4
75	5	6.8	8.0	7.4
76	29	6.9	8.8	7.7
77	6	7.2	8.8	8.1
78	7	7.2	8.6	7.8
79	4	7.0	9.2	7.4
80	5	7.4	8.8	7.7
81	6	7.2	8.4	7.7
82	7	7.0	8.0	7.0
84	37	6.2	8.8	7.5
85	5	7.2	8.2	7.8
86	6	7.0	8.4	7.4
89	6	7.1	7.8	7.4
90	6	6.9	8.2	7.2
91	7	7.0	8.4	7.2
92	6	6.8	7.5	7.0
93	6	7.2	7.8	7.5
95	6	6.8	7.8	7.0
96	6	5.9	7.8	7.1
98	5	6.6	7.6	7.0
99	31	6.4	8.4	7.2
100	6	6.9	7.4	7.2
101	6	7.0	7.7	7.1
102	6	7.0	7.6	7.1
104	33	6.0	8.2	7.1
105	6	7.0	8.2	7.4
108	24	6.1	7.9	7.2
109	71	5.8	7.8	7.1
110	5	6.6	7.8	7.2
112	6	6.8	7.8	7.2
113	5	6.6	8.0	6.9
114	7	6.6	8.8	7.0
115	4	8.0	8.3	8.2

SITE NUMBER	NUMBER OF OBSERVATIONS	MINIMUM VALUE	MAXIMUM VALUE	MEDIAN VALUE
116	4	7.9	8.6	8.3
117	11	5.8	8.5	7.9
118	4	8.0	8.3	8.1
119	4	8.0	8.1	8.0
120	24	6.5	8.7	8.2
121	4	8.0	8.5	8.4
122	4	8.3	8.5	8.4
123	4	8.4	8.7	8.6
124	4	7.8	8.1	7.9
125	13	7.1	9.2	8.3
126	30	6.9	8.7	8.2
127	17	6.6	8.5	7.6
128	6	7.4	8.9	7.6
129	5	7.0	8.3	7.4
130	5	6.9	8.3	7.8
131	5	5.8	8.2	7.8
132	6	7.0	8.5	7.8
133	5	5.8	8.3	7.8
134	16	5.7	8.1	7.4
135	6	7.0	7.6	7.3
136	6	7.4	8.0	7.6
137	6	7.1	8.5	7.5
138	6	7.2	8.0	7.7
140	5	6.6	7.2	7.0
142	4	7.1	8.8	7.6
143	4	6.8	7.6	7.2
144	20	6.1	8.6	7.8
145	4	7.0	7.8	7.3
147	6	6.6	8.0	7.5
149	4	6.8	7.4	7.1
150	9	6.5	8.0	7.3
151	10	6.6	8.0	7.4
152	6	6.8	8.3	7.0
154	25	6.3	8.3	7.8
155	4	6.5	7.3	6.9
156	103	6.2	8.4	7.3
157	6	6.4	7.1	6.8
159	6	6.4	8.2	7.6
160	6	6.7	8.0	7.4
162	6	6.4	8.2	6.9
163	6	6.2	7.6	7.0
164	6	6.8	7.6	7.0
165	4	6.9	7.5	7.2

10.10 Sulfate Concentrations

Summary of sulfate concentrations, in milligrams per liter.

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
7	6	74	250	159	75	140
8	5	68	240	135	70.1	110
9	5	28	120	61	35.8	47
10	6	51	130	89.5	29.2	89.5
11	5	43	100	67	23.2	62
12	6	12	15	14.2	1.17	14.5
14	5	38	100	57.2	27.5	39
15	6	56	150	101	40.9	95.5
17	6	34	190	101	65.6	85.5
19	8	54	240	133	59.1	125
20	7	200	500	344	122	320
21	7	140	420	250	107	200
22	7	220	670	377	159	320
23	6	230	540	362	127	365
24	7	130	400	246	105	190
25	7	91	330	202	92.2	190
26	262	41	380	159	73.4	140
27	11	280	570	422	78.1	420
28	47	13	27	18.9	2.67	19
29	50	16	980	118	179	47
34	6	30	81	51.5	22.3	45
35	6	20	40	27.8	6.68	26.5
36	5	29	85	52	22.9	41
37	5	48	140	85	42.4	68
38	5	120	270	186	64.3	180
40	4	17	36	26	8.98	25.5
41	7	52	240	148	73.4	160
42	5	34	67	50.6	16	51
43	5	90	160	124	34.6	120
44	6	44	110	72.3	28.5	72
45	6	83	200	138	53.5	125
49	6	76	220	140	61.3	130
50	4	140	190	158	23.6	150
51	6	12	24	19.2	4.67	21
52	6	5.9	50	33.5	17.3	38
54	47	10	230	61	45.5	51
55	5	53	130	88.2	34.3	71
56	5	33	160	113	64.7	160
58	8	30	58	41.1	9.64	38
59	5	150	290	222	57.6	210

Summary of sulfate concentrations, in milligrams per liter -- continued.

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
60	3	65	230	168	90	210
61	7	120	380	254	102	300
63	17	78	330	166	73.7	170
64	5	180	470	310	120	250
65	5	4.8	32	10.7	11.9	5.5
66	5	76	140	101	27.9	88
67	6	220	390	303	69.5	305
68	5	230	470	362	98.6	330
71	19	120	410	209	87.6	190
74	16	57	120	89.4	19.1	92
75	5	140	340	228	76	230
76	31	30	110	86.6	16	85
77	6	58	86	74.3	9.83	78
78	7	67	110	90.1	14.3	92
79	4	39	90	61.8	21.1	54
80	5	29	130	106	43.8	130
81	6	66	130	104	26.4	106
82	7	61	370	270	114	280
84	36	45	218	101	32	100
85	5	44	84	57.6	18.7	45
86	6	69	100	83.3	12.5	79.5
89	6	70	160	112	41.7	110
90	6	25	100	57.5	34.8	47
91	6	20	29	24.7	3.33	25
92	6	8.5	28	16.4	7.06	16.5
93	6	66	170	136	46.2	160
95	6	38	140	59.7	39.7	43
96	6	45	470	210	173	163
98	5	32	53	37.6	8.85	34
99	31	15	300	114	66.8	100
100	6	29	81	58.5	23.3	62
101	6	35	110	62.5	33.4	45.5
102	6	57	110	77.8	19.1	75.5
104	31	16	63	38.9	12.4	42
105	6	120	330	213	84.3	215
108	26	9.5	95	30.9	15.7	31
109	72	25	166	70.4	29	67
110	5	30	76	50	17.6	51
112	6	110	310	193	76.3	200
113	5	24	51	37	12.8	38
114	7	31	70	41.3	13.1	37
115	4	61	130	102	30.8	108

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
116	4	42	98	71	23.4	72
117	10	99	220	170	36.7	180
118	4	71	94	83.2	9.46	84
119	4	76	98	89	9.59	91
120	11	72	140	105	18.9	110
121	4	54	240	151	77	155
122	4	46	91.0	74.8	19.7	81
123	4	70	170	122	41.1	125
124	4	61	100	79	16.4	77.5
125	11	49	120	79.7	20.6	76
126	24	46	198	104	32.2	100
127	10	14	110	44.9	34	28
128	6	27	70	46.3	17.3	44.5
129	5	86	240	147	69.2	120
130	5	26	51	36.6	13.2	29
131	5	73	170	119	43.6	100
132	6	18	53	32.7	12.9	32
133	5	84	275	147	81	100
134	16	45	120	74	23.7	65.5
135	6	40	130	92.2	33	96
136	6	39	97	72.2	20.3	77.5
137	6	27	240	105	88.9	68
138	6	41	100	75	22.9	73
140	3	52	180	107	65.7	90
142	3	34	170	98	68.4	90
143	4	56	250	129	91.8	104
144	11	40	190	91.4	47	85
145	4	12	14	13.2	.96	13.5
147	6	57	190	110	54.4	96.5
149	4	10	13	12	1.41	12.5
150	9	26	200	76.2	53.1	69
151	10	32	200	98.4	57.4	89
152	6	61	335	171	110	145
154	20	53	160	98.8	37.3	83
155	4	22	27	23.5	2.38	22.5
156	99	37	180	94.1	31.2	91
157	6	11	87	50.8	28.3	49.5
159	6	6.5	36	24.6	10.1	26
160	6	19	53	31.5	13.4	26
162	6	19	33	24.8	5.12	25
163	6	21	29	24.5	2.66	24.5
164	6	24	43	33.3	6.06	33.5
165	4	24	38	31.5	6.61	32

Summary of total iron concentrations, in milligrams per liter.

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
7	6	350	2,700	882	904	570
8	5	290	2,800	932	1,050	540
9	5	500	2,200	1,080	777	560
10	6	200	1,700	513	586	280
11	5	290	500	358	91	310
12	6	200	880	437	249	370
14	5	230	67,000	13,800	29,700	670
15	6	170	600	353	186	300
17	6	70	720	310	293	145
19	6	130	18,000	4,420	6,810	1,830
20	5	1,200	510,000	104,000	227,000	2,600
21	5	280	6,100	2,440	2,180	1,800
22	5	1,200	28,000	7,400	11,600	1,800
23	5	1,000	26,000	10,700	11,600	5,300
24	5	210	6,500	3,070	2,790	2,500
25	5	840	59,000	13,200	25,600	1,500
26	21	0.0	27,000	4,530	6,810	2,200
27	3	570	910	740	170	740
28	39	30	51,000	1,960	8,120	270
29	38	150	120,000	6,180	19,900	1,400
34	6	230	1,400	627	432	455
35	6	100	1,300	635	410	605
36	5	390	1,400	734	441	510
37	5	330	2,800	1,110	998	900
38	5	220	2,400	824	898	460
40	3	820	4,300	3,040	1,930	4,000
41	5	240	1,100	752	316	820
42	4	410	1,300	685	419	515
43	5	700	3,700	1,870	1,270	1,500
44	6	780	4,900	1,630	1,600	1040
45	6	440	3,000	1,840	961	1,900
49	5	300	1,500	594	516	330
50	2	310	1,100	705	559	705
51	5	360	1,000	538	269	430
52	5	430	2,200	1,050	703	750
54	15	50	6,700	1,420	1,600	1,200
55	5	500	2,000	1,300	539	1,400
56	5	300	1,100	592	315	580
58	6	310	1,400	620	451	375
59	5	580	4,200	1,780	1,440	1,300

Summary of total iron concentrations, in milligrams per liter -- continued.

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
60	0	.	.	.	.	.
61	6	41	3,200	1,300	1,120	840
63	14	330	3,200	941	745	705
64	5	440	1,800	942	558	670
65	5	360	1,300	764	392	720
66	5	280	1,300	570	418	470
67	6	190	1,500	797	499	625
68	5	290	650	466	136	430
71	16	40	8,000	1,160	1,880	655
74	16	110	3,600	1,160	1,160	655
75	5	360	3,330	1,510	1,130	1,500
76	24	50	4,700	1,000	1,080	585
77	6	280	10,000	3,850	4,790	1,220
78	7	220	19,000	3,760	6,960	490
79	4	180	780	448	252	415
80	5	250	1,400	630	473	430
81	6	310	920	555	239	490
82	7	220	6,700	1,750	2,310	650
84	31	60	41,000	2,340	7,250	780
85	5	580	4,400	1,820	1,550	1,500
86	6	1,400	3,500	2,430	855	2,400
89	6	740	4,000	1,390	1,290	825
90	6	780	3,700	1,680	1,100	1,150
91	6	520	6,000	1,970	2,000	1,300
92	6	1,000	3,500	1,850	914	1,750
93	6	880	4,900	2,410	1,500	2,050
95	6	1,200	8,300	3,150	2,640	2,450
96	6	2,000	24,000	12,800	7,340	13,000
98	5	830	3,700	1,670	1,170	1,400
99	12	330	8,200	1,770	2,200	835
100	6	960	1,900	1,310	315	1,250
101	5	1,200	65,000	15,000	28,000	3,400
102	6	620	3,900	1,640	1,150	1,300
104	16	50	22,000	4,510	5,810	2,450
105	6	540	160,000	27,800	64,800	1,190
108	15	620	56,000	6,910	14,200	1,900
109	67	0	37,000	2,780	7,080	80
110	5	600	2,100	1,090	607	840
112	6	560	2,200	1,190	628	1,100
113	5	770	1,800	1,390	393	1,500
114	6	550	7,700	3,190	2,790	2,250
115	4	290	2,700	1,080	1,130	660
116	4	200	830	520	311	525
117	6	180	6,800	1,920	2,580	720
118	4	80	440	282	149	305
119	4	260	2,100	862	861	545
120	6	170	2,400	840	805	705
121	4	640	3,800	1,620	1,490	1,010
122	4	220	4,100	1,300	1,880	430
123	4	200	2,000	770	845	440
124	4	270	5,200	1,680	2,360	630
125	6	150	5,000	1,190	1,890	430
126	17	190	6,200	1,410	1,620	610
127	6	320	12,000	2,450	4,680	530
128	6	520	4,600	2,140	1,890	1,250
129	5	360	5,400	1,880	2,020	1,300
130	5	940	7,500	3,990	3,270	2,700
131	5	240	2,000	1,140	720	1,400
132	6	570	7,400	3,410	2,930	2,150
133	5	1,200	14,000	4,700	5,450	1,600
134	16	430	13,000	3,750	3,660	2,450
135	6	440	3,800	1,470	1,320	825
136	6	160	1,200	443	410	255
137	6	190	2,100	605	737	320
138	5	360	18,000	4,170	7, 1	860
140	3	1,100	3,200	2,130	1,050	2,100
142	3	150	3,300	1,260	1,770	340
143	4	1,100	40,000	11,800	18,900	2,950
144	6	300	3,100	863	1,100	445
145	4	330	950	550	288	460
147	6	560	5,500	2,440	1,870	2,250
149	4	400	920	672	266	685
150	9	280	14,000	2,880	4,310	1,300
151	10	280	14,000	2,780	4,090	1,350
152	6	440	2,000	1,050	583	975
154	15	40	27,000	4,320	6,770	2,200
155	4	720	4,500	1,960	1,740	1,300
156	25	70	34,000	6,830	8,000	2,900
157	6	800	26,000	7,990	10,600	2,100
159	6	300	6,800	2,500	2,350	1,900
160	6	590	2,900	1,370	846	1,100
162	6	400	4,400	1,900	1,650	1,420
163	6	650	8,800	2,560	3,090	1,350
164	6	610	2,400	1,360	764	1,150
165	4	610	3,200	1,400	1,220	885

10.12 Total-Recoverable Manganese Concentrations

Summary of total manganese concentrations, in micrograms per liter.

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
7	6	50.0	160	107	42.3	100
8	5	70.0	140	104	30.5	100
9	5	10.0	90.0	40.0	31.6	30.0
10	6	20.0	110	61.7	35.4	70.0
11	5	30.0	50.0	42.0	8.37	40.0
12	6	10.0	30.0	18.3	7.53	20.0
14	5	30.0	1,700	380	738	60.0
15	6	20.0	50.0	31.7	11.7	30.0
17	6	0.0	30.0	13.3	10.3	10.0
19	6	10.0	520	167	183	115
20	5	430	17,000	3,940	7,300	860
21	5	320	980	532	271	420
22	5	190	1,200	434	432	230
23	5	130	1,000	484	368	330
24	5	90.0	510	296	154	310
25	5	120	2,200	588	902	210
26	31	0.0	600	213	159	190
27	3	670	2,000	1,320	665	1,300
28	37	0.0	1,300	64.9	217	10.0
29	37	10.0	11,000	1,360	2,150	470
34	6	30.0	90.0	56.7	23.4	50.0
35	6	30.0	50.0	43.3	8.16	45.0
36	5	20.0	50.0	34.0	11.4	30.0
37	5	90.0	210	158	48.2	170
38	5	100	150	134	19.5	140
40	3	20.0	110	66.7	45.1	70.0
41	5	30.0	70.0	46.0	15.2	40.0
42	4	10.0	40.0	25.0	12.9	25.0
43	5	280	500	392	79.5	380
44	6	140	300	203	54.9	190
45	6	270	580	407	114	405
49	5	20.0	90.0	54.0	30.5	50.0
50	2	40.0	50.0	45.0	7.07	45.0
51	5	10.0	30.0	18.0	8.37	20.0
52	5	30.0	80.0	50.0	18.7	50.0
54	15	30.0	610	118	144	70.0
55	5	60.0	290	196	108	250
56	5	720	3,500	2,240	1,110	2,700
58	6	110	1,100	677	336	725
59	5	580	2,100	1,350	719	1,400

Summary of total manganese concentrations, in micrograms per liter -- continued.

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
60	0	.	.	.	.	.
61	6	310	800	565	184	555
63	14	180	870	544	207	525
64	5	340	770	532	215	430
65	5	30.0	140	66.0	51.3	30.0
66	5	50.0	240	152	71.2	170
67	6	120	750	390	284	370
68	5	220	930	456	293	370
71	16	160	790	313	148	270
74	16	40.0	320	126	71.6	110
75	5	320	1,500	840	437	830
76	4	10.0	280	125	71.3	110
77	6	20.0	240	122	96.4	95.0
78	7	40.0	490	126	165	60.0
79	4	180	780	448	252	415
80	5	30.0	750	208	305	100
81	6	50.0	130	71.7	30.6	60.0
82	7	50.0	1,800	1,110	625	1,100
84	30	0.0	980	205	226	130
85	5	60.0	170	104	46.2	110
86	6	190	380	262	65.6	250
89	6	90.0	340	158	96.2	115
90	6	60.0	220	113	59.2	105
91	6	50.0	200	110	55.1	105
92	6	60.0	2,500	665	939	270
93	6	180	310	244	50.4	235
95	6	170	1,100	478	411	270
96	6	420	2,500	1,270	971	900
98	5	180	250	226	27.0	230
99	13	80.0	660	379	144	390
00	6	120	420	240	122	230
101	5	130	1,600	522	612	250
102	6	110	320	205	70.4	190
104	16	0.0	660	213	174	170
105	6	650	3,600	1,280	1,140	895
108	16	140	1,300	441	312	350
109	29	60.0	1,000	294	244	200
110	5	120	270	182	76.3	140
112	6	630	1,300	832	245	730
113	5	110	500	308	188	330
114	6	140	400	292	111	325
115	4	30.0	80.0	60.0	21.6	65.0

SITE NUMBER	NUMBER OF OBSERVATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MEDIAN VALUE
116	20.0	40.0	30.0	8.16	30.0	
117	6	60.0	250	132	69.1	125
118	4	10.0	70.0	40.0	29.4	40.0
119	4	20.0	40.0	30.0	8.16	30.0
120	6	20.0	80.0	40.0	24.5	35.0
121	4	40.0	120	67.5	35.9	55.0
122	4	20.0	100	40.0	40.0	20.0
123	4	20.0	50.0	30.0	14.1	25.0
124	4	20.0	190	75.0	77.7	45.0
125	6	20.0	160	53.3	53.2	30.0
126	19	10.0	630	110	144	70.0
127	6	10.0	230	58.3	84.7	25.0
128	6	30.0	130	71.7	39.2	55.0
129	5	130	290	212	77.6	210
130	5	50.0	180	98.0	55.4	70.0
131	5	70.0	380	200	114	170
132	6	40.0	230	100	72.9	70.0
133	5	70.0	580	268	193	240
134	16	100	1,400	245	320	125
135	6	120	420	253	130	240
136	6	20.0	50.0	38.3	11.7	40.0
137	6	20.0	1,100	297	449	35.0
138	6	40.0	620	205	236	75.0
140	3	150	500	343	178	380
142	3	80.0	140	100	34.6	80.0
143	4	90.0	790	495	314	550
144	6	50.0	120	75.0	25.1	70.0
145	4	20.0	50.0	27.5	15.0	20.0
147	6	110	320	218	74.1	205
149	4	30.0	110	52.5	38.6	35.0
150	8	90.0	570	212	156	165
151	10	40.0	570	193	146	155
152	6	520	2,800	1,280	867	900
154	15	20.0	730	161	189	90.0
155	4	70.0	350	205	124	200
156	32	10.0	1,200	215	257	135
157	6	720	6,200	2,340	2,070	1,550
159	6	260	1,300	647	507	350
160	6	90.0	500	242	158	215
162	5	80.0	2,000	516	832	180
163	6	190	540	345	166	305
164	6	110	3,400	722	1,310	185
165	4	80.0	240	160	65.8	160

10.13 Trace Constituents

Part A, total in bottom material, in micrograms per gram.

SITE NUMBER	ARSENIC NUMBER OF SAMPLES	ARSENIC MIN OR VALUE	ARSENIC MAX	ARSENIC MEAN	CADMIUM NUMBER OF SAMPLES	CADMIUM MIN OR VALUE	CADMIUM MAX	CADMIUM MEAN	CHROMIUM NUMBER OF SAMPLES	CHROMIUM MIN OR VALUE	CHROMIUM MAX	CHROMIUM MEAN
7	1	0	--	--	1	10	--	--	1	10	--	--
8	1	0	--	--	1	10	--	--	1	10	--	--
9	1	0	--	--	1	10	--	--	1	10	--	--
10	1	0	--	--	1	10	--	--	1	10	--	--
11	1	0	--	--	1	10	--	--	1	10	--	--
12	1	0	--	--	1	10	--	--	1	10	--	--
14	1	1	--	--	1	10	--	--	1	10	--	--
15	1	0	--	--	1	10	--	--	1	10	--	--
17	1	1	--	--	1	10	--	--	1	10	--	--
19	1	0	--	--	1	10	--	--	1	10	--	--
20	1	0	--	--	1	10	--	--	1	10	--	--
26	1	0	--	--	1	10	--	--	1	10	--	--
34	1	0	--	--	1	10	--	--	1	10	--	--
35	1	0	--	--	1	10	--	--	1	10	--	--
36	1	0	--	--	1	10	--	--	1	10	--	--
37	1	0	--	--	1	10	--	--	1	10	--	--
38	1	0	--	--	1	10	--	--	1	10	--	--
49	1	0	--	--	1	10	--	--	1	10	--	--
50	1	0	--	--	1	10	--	--	1	10	--	--
51	1	0	--	--	1	10	--	--	1	10	--	--
52	1	0	--	--	1	10	--	--	1	10	--	--
54	1	0	--	--	1	10	--	--	1	10	--	--
63	1	0	--	--	1	10	--	--	1	10	--	--
64	1	0	--	--	1	10	--	--	1	10	--	--
65	1	0	--	--	1	10	--	--	1	20	--	--
71	1	1	--	--	1	10	--	--	1	10	--	--
74	1	0	--	--	1	10	--	--	1	10	--	--
75	1	0	--	--	1	10	--	--	1	10	--	--
77	1	0	--	--	1	10	--	--	1	10	--	
84	8	3	91	16	8	1	10	9	8	2	10	9
85	1	0	--	--	1	10	--	--	1	10	--	--
100	1	0	--	--	1	10	--	--	1	10	--	--
115	1	0	--	--	1	10	--	--	1	10	--	--
116	1	0	--	--	1	10	--	--	1	10	--	--
117	1	0	--	--	1	10	--	--	1	10	--	--
118	1	0	--	--	1	10	--	--	1	10	--	--
119	1	0	--	--	1	10	--	--	1	10	--	--
120	1	0	--	--	1	10	--	--	1	20	--	--
121	1	0	--	--	1	10	--	--	1	10	--	--
122	1	0	--	--	1	10	--	--	1	10	--	--
123	1	0	--	--	1	10	--	--	1	10	--	--
124	1	0	--	--	1	10	--	--	1	10	--	--
125	1	0	--	--	1	10	--	--	1	10	--	--
126	2	0	0	--	2	10	10	--	2	10	10	--
127	1	0	--	--	1	10	--	--	1	10	--	--
134	1	0	--	--	1	10	--	--	1	10	--	--
142	1	0	--	--	1	10	--	--	1	10	--	--
143	1	0	--	--	1	10	--	--	1	10	--	--
144	1	0	--	--	1	10	--	--	1	10	--	--
145	1	0	--	--	1	10	--	--	1	10	--	--
149	1	0	--	--	1	10	--	--	1	10	--	--
150	1	0	--	--	1	10	--	--	1	10	--	--
154	1	0	--	--	1	10	--	--	1	10	--	--
155	1	0	--	--	1	10	--	--	1	10	--	--
156	5	0	18	8	5	2	10	8	5	4	10	9
165	1	0	--	--	1	10	--	--	1	10	--	--

Part A, total in bottom material, in micrograms per gram -- continued.

SITE NUMBER	COBALT NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	COPPER NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	IRON NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN
7	1	20	--	--	1	10	--	--	1	15,000	--	--
8	1	20	--	--	1	10	--	--	1	15,000	--	--
9	1	10	--	--	1	10	--	--	1	6,700	--	--
10	1	10	--	--	1	30	--	--	1	6,000	--	--
11	1	10	--	--	1	10	--	--	1	11,000	--	--
12	1	10	--	--	1	10	--	--	1	10,000	--	--
14	1	10	--	--	1	20	--	--	1	15,000	--	--
15	1	10	--	--	1	20	--	--	1	16,000	--	--
17	1	20	--	--	1	20	--	--	1	14,000	--	--
19	1	10	--	--	1	10	--	--	1	11,000	--	-
20	1	20	--	--	1	10	--	--	1	10,000	--	--
26	1	10	--	--	1	10	--	--	1	8,300	--	--
34	1	10	--	--	1	10	--	--	1	3,500	--	--
35	1	10	--	--	1	10	--	--	1	3,200	--	--
36	1	10	--	--	1	10	--	--	1	7,000	--	--
37	1	10	--	--	1	10	--	--	1	6,800	--	--
38	1	10	--	--	1	10	--	--	1	7,800	--	--
49	1	10	--	--	1	10	--	--	1	5,500	--	--
50	1	10	--	--	1	10	--	--	1	4,700	--	--
51	1	10	--	--	1	10	--	--	1	11,000	--	--
52	1	10	--	--	1	10	--	--	1	6,500	--	--
54	1	10	--	--	1	10	--	--	1	10,000	--	--
63	1	10	--	--	1	10	--	--	1	8,000	--	--
64	1	50	--	--	1	20	--	--	1	20,000	--	--
65	1	10	--	--	1	10	--	--	1	2,300	--	--
66	--	--	--	--	1	10	--	--	--	--	--	--
71	1	10	--	--	1	20	--	--	1	19,000	--	--
74	1	10	--	--	1	10	--	--	1	10,000	--	--
75	1	20	--	--	1	10	--	--	1	7,000	--	--
77	1	10	--	--	1	10	--	--	1	92,000	--	--
84	8	5	50	19	8	1	10	9	--	--	--	--
85	1	10	--	--	1	10	--	--	1	2,500	--	--
100	1	10	--	--	1	10	--	--	1	45,000	--	--
115	1	20	--	--	1	10	--	--	1	9,700	--	--
116	1	10	--	--	1	10	--	--	1	9,900	--	--
117	1	10	--	--	1	10	--	--	1	7,100	--	--
118	1	10	--	--	1	20	--	--	1	13,000	--	--
119	1	10	--	--	1	20	--	--	1	1,200	--	--
120	1	30	--	--	1	60	--	--	1	26,000	--	--
121	1	10	--	--	1	10	--	--	1	6,100	--	--
122	1	10	--	--	1	10	--	--	1	10,000	--	--
123	1	10	--	--	1	20	--	--	1	21,000	--	--
124	1	10	--	--	1	10	--	--	1	9,900	--	--
125	1	10	--	--	1	20	--	--	1	15,000	--	--
126	2	20	20	--	2	20	20	--	2	4,600	19,000	--
127	1	10	--	--	1	10	--	--	1	9,900	--	--
134	1	10	--	--	1	10	--	--	1	14,000	--	--
142	1	10	--	--	1	10	--	--	1	9,700	--	--
143	1	10	--	--	1	10	--	--	1	3,300	--	--
144	1	10	--	--	1	10	--	--	1	6,600	--	--
145	1	10	--	--	1	10	--	--	1	18,000	--	--
149	1	10	--	--	1	10	--	--	1	5,700	--	--
150	1	10	--	--	1	10	--	--	1	5,300	--	--
154	1	20	--	--	1	10	--	--	1	5,600	--	--
155	1	10	--	--	1	10	--	--	1	15,000	--	--
156	5	10	50	26	5	10	16	11	--	--	--	--
165	1	10	--	--	1	16	--	--	1	10,000	--	--

Part A, total in bottom material, in micrograms per gram -- continued.

SITE NUMBER	LEAD NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	MANGANESE NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	MERCURY NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN
7	1	20	--	--	1	580	--	--	1	0	--	--
8	1	20	--	--	1	450	--	--	1	0	--	--
9	1	20	--	--	1	160	--	--	1	0	--	--
10	1	10	--	--	1	230	--	--	1	0	--	--
11	1	10	--	--	1	260	--	--	1	.2	--	--
12	1	10	--	--	1	240	--	--	1	0	--	--
14	1	10	--	--	1	450	--	--	1	0	--	--
15	1	10	--	--	1	350	--	--	1	0	--	--
17	1	20	--	--	1	380	--	--	1	.3	--	--
19	1	20	--	--	1	350	--	--	1	.2	--	--
20	1	10	--	--	1	540	--	--	1	.2	--	--
26	1	10	--	--	1	330	--	--	1	0	--	--
34	1	10	--	--	1	150	--	--	1	0	--	--
35	1	10	--	--	1	120	--	--	1	0	--	--
36	1	10	--	--	1	280	--	--	1	0	--	--
37	1	10	--	--	1	450	--	--	1	0	--	--
38	1	10	--	--	1	500	--	--	1	0	--	--
49	1	10	--	--	1	360	--	--	1	.1	--	--
50	1	10	--	--	1	310	--	--	1	0	--	--
51	1	10	--	--	1	310	--	--	1	0	--	--
52	1	10	--	--	1	280	--	--	1	0	--	--
54	1	10	--	--	1	240	--	--	1	0	--	--
63	1	20	--	--	1	450	--	--	1	0	--	--
64	1	20	--	--	1	2,200	--	--	1	0	--	--
65	1	10	--	--	1	210	--	--	1	0	--	--
71	1	10	--	--	1	600	--	--	1	.3	--	--
74	1	10	--	--	1	220	--	--	1	.2	--	--
75	1	10	--	--	1	680	--	--	1	.2	--	--
77	1	10	--	--	1	300	--	--	1	0	--	--
84	8	0	100	34	--	--	--	--	8	0	1	0
85	1	20	--	--	1	490	--	--	1	0	--	--
100	1	30	--	--	1	610	--	--	1	0	--	--
115	1	20	--	--	1	360	--	--	1	0	--	--
116	1	20	--	--	1	260	--	--	1	0	--	--
117	1	30	--	--	1	310	--	--	1	0	--	--
118	1	20	--	--	1	210	--	--	1	0	--	--
119	1	40	--	--	1	360	--	--	1	0	--	--
120	1	80	--	--	1	840	--	--	1	0	--	--
121	1	20	--	--	1	150	--	--	1	0	--	--
122	1	10	--	--	1	220	--	--	1	0	--	--
123	1	30	--	--	1	390	--	--	1	0	--	--
124	1	10	--	--	1	330	--	--	1	0	--	--
125	1	10	--	--	1	210	--	--	1	0	--	--
126	2	20	50	--	2	210	610	--	2	0	0	--
127	1	10	--	--	1	250	--	--	1	0	--	--
134	1	10	--	--	1	240	--	--	1	0	--	--
142	1	10	--	--	1	240	--	--	1	0	--	--
143	1	10	--	--	1	170	--	--	1	0	--	--
144	1	10	--	--	1	260	--	--	1	0	--	--
145	1	10	--	--	1	290	--	--	1	0	--	--
149	1	10	--	--	1	80	--	--	1	0	--	--
150	1	10	--	--	1	230	--	--	1	0	--	--
154	1	10	--	--	1	720	--	--	1	0	--	--
155	1	10	--	--	1	44	--	--	1	0	--	--
156	5	10	100	48	--	--	--	--	5	0	.2	.1
165	1	10	--	--	1	280	--	--	1	0	--	--

Part A, total in bottom material, in micrograms per gram -- continued.

SITE NUMBER	SELENIUM NUMBER OF SAMPLES	SELENIUM MIN OR VALUE	SELENIUM MAX	SELENIUM MEAN	ZINC NUMBER OF SAMPLES	ZINC MIN OR VALUE	ZINC MAX	ZINC MEAN
7	1	0	--	--	1	71	--	--
8	1	0	--	--	1	58	--	--
9	1	0	--	--	1	20	--	--
10	1	0	--	--	1	30	--	--
11	1	0	--	--	1	30	--	--
12	1	0	--	--	1	30	--	--
14	1	0	--	--	1	60	--	--
15	1	0	--	--	1	70	--	--
17	1	0	--	--	1	80	--	--
19	1	0	--	--	1	40	--	--
20	1	0	--	--	1	110	--	--
26	1	0	--	--	1	30	--	--
34	1	0	--	--	1	17	--	--
35	1	0	--	--	1	12	--	--
36	1	0	--	--	1	22	--	--
37	1	0	--	--	1	27	--	--
38	1	0	--	--	1	3	--	--
49	1	0	--	--	1	26	--	--
50	1	0	--	--	1	32	--	--
51	1	0	--	--	1	31	--	--
52	1	0	--	--	1	22	--	--
54	1	0	--	--	1	40	--	--
63	1	0	--	--	1	60	--	--
64	1	0	--	--	1	110	--	--
65	1	0	--	--	1	9	--	--
71	1	0	--	--	1	80	--	--
74	1	0	--	--	1	40	--	--
75	1	0	--	--	1	50	--	--
77	1	0	--	--	1	30	--	--
84	--	--	--	--	8	20	50	28
85	1	0	--	--	1	50	--	--
100	1	0	--	--	1	80	--	--
115	1	0	--	--	1	70	--	--
116	1	0	--	--	1	40	--	--
117	1	0	--	--	1	60	--	--
118	1	0	--	--	1	70	--	--
119	1	0	--	--	1	160	--	--
120	1	0	--	--	1	180	--	--
121	1	0	--	--	1	20	--	--
122	1	0	--	--	1	50	--	--
123	1	0	--	--	1	80	--	--
124	1	0	--	--	1	20	--	--
125	1	0	--	--	1	40	--	--
126	2	0	0	--	2	37	90	--
127	1	0	--	--	1	30	--	--
134	1	0	--	--	1	40	--	--
142	1	0	--	--	1	30	--	--
143	1	0	--	--	1	10	--	--
144	1	0	--	--	1	20	--	--
145	1	0	--	--	1	50	--	--
150	1	0	--	--	1	10	--	--
154	1	0	--	--	1	30	--	--
155	1	0	--	--	1	20	--	--
156	--	--	--	--	5	10	60	40
165	1	0	--	--	1	20	--	--

Part B, dissolved trace constituents, in micrograms per liter.

SITE NUMBER	ALUMINUM NUMBER OF SAMPLES	ALUMINUM MIN OR VALUE	ALUMINUM MAX	ALUMINUM MEAN	ARSENIC NUMBER OF SAMPLES	ARSENIC MIN OR VALUE	ARSENIC MAX	ARSENIC MEAN	CADMIUM NUMBER OF SAMPLES	CADMIUM MIN OR VALUE	CADMIUM MAX	CADMIUM MEAN
28	35	0	70	24	3	0	0	0	1	2	--	--
29	35	0	14,000	494	3	0	2	1	3	0	3	2
31	10	1	18	10	--	--	--	--	--	--	--	--
76	10	0	200	57	--	--	--	--	--	--	--	--
84	11	20	220	68	14	0	4	0	14	0	7	1
94	9	20	170	59	--	--	--	--	--	--	--	--
104	12	0	180	55	--	--	--	--	--	--	--	--
106	9	0	50	28	--	--	--	--	1	0	--	--
108	9	10	50	29	--	--	--	--	--	--	--	--
109	8	20	200	56	11	0	0	0	11	0	0	0
115	--	--	--	--	--	--	--	--	1	2	--	--
116	--	--	--	--	--	--	--	--	1	3	--	--
117	7	50	200	130	--	--	--	--	3	1	4	2
118	--	--	--	--	--	--	--	--	1	2	--	--
119	--	--	--	--	--	--	--	--	1	5	--	--
120	7	20	100	80	--	--	--	--	3	0	4	1
121	--	--	--	--	--	--	--	--	1	2	--	--
122	--	--	--	--	--	--	--	--	1	3	--	--
123	--	--	--	--	--	--	--	--	1	2	--	--
124	--	--	--	--	--	--	--	--	1	3	--	--
125	7	0	200	84	--	--	--	--	3	2	3	3
126	7	0	200	89	--	--	--	--	3	2	3	3
127	7	40	200	103	--	--	--	--	3	1	2	1
142	--	--	--	--	--	--	--	--	1	2	--	--
143	--	--	--	--	--	--	--	--	1	4	--	--
144	7	0	200	80	--	--	--	--	3	0	2	1
145	--	--	--	--	--	--	--	--	1	4	--	--
146	7	0	200	106	--	--	--	--	2	0	3	--
149	--	--	--	--	--	--	--	--	1	4	--	--
154	7	0	200	87	--	--	--	--	3	0	1	1
155	--	--	--	--	--	--	--	--	1	3	--	--
156	--	--	--	--	29	0	9	1	28	0	3	1
165	--	--	--	--	--	--	--	--	1	1	--	--

10.0 SUPPLEMENTAL INFORMATION FOR AREA 13--Continued

10.13 Trace Constituents

Part B, dissolved trace constituents, in micrograms per liter -- continued.

SITE NUMBER	COBALT NUMBER OF SAMPLES	COBALT MIN OR VALUE	COBALT MAX	COBALT MEAN	COPPER NUMBER OF SAMPLES	COPPER MIN OR VALUE	COPPER MAX	COPPER MEAN	LEAD NUMBER OF SAMPLES	LEAD MIN OR VALUE	LEAD MAX	LEAD MEAN
26	--	--	--	--	8	0	3	0				
28	2	1	1	--	3	1	2	2	34	0	60	11
29	3	0	5	2	4	1	38	11	33	0	140	14
31	--	--	--	--	--	--	--	--	10	1	18	9
76	--	--	--	--	--	--	--	--	10	0	19	8
84	14	0	15	2	6	1	4	2	24	0	43	7
94	--	--	--	--	--	--	--	--	9	0	24	18
104	--	--	--	--	--	--	--	--	11	0	32	11
106	--	--	--	--	--	--	--	--	9	0	32	7
108	--	--	--	--	--	--	--	--	8	0	23	8
109	11	0	0	0	--	--	--	--	20	0	40	9
115	1	3	--	--	1	10	--	--	1	10	--	--
116	1	3	--	--	1	10	--	--	1	10	--	--
117	1	3	--	--	1	10	--	--	3	0	10	3
118	1	3	--	--	1	10	--	--	1	12	--	--
119	1	3	--	--	1	10	--	--	1	14	--	--
120	1	3	--	--	1	10	--	--	3	0	10	3
121	1	1	--	--	1	0	--	--	1	10	--	--
122	1	3	--	--	1	10	--	--	1	13	--	--
123	1	3	--	--	1	10	--	--	1	10	--	--
124	1	4	--	--	1	0	--	--	1	10	--	--
125	1	3	--	--	1	10	--	--	3	0	17	6
126	1	3	--	--	1	10	--	--	3	0	10	3
127	1	2	--	--	1	0	--	--	3	0	10	3
142	1	4	--	--	1	10	--	--	1	10	--	--
143	1	4	--	--	1	10	--	--	1	10	--	--
144	1	3	--	--	1	10	--	--	3	0	11	4
145	1	3	--	--	1	10	--	--	1	10	--	--
149	1	3	--	--	1	10	--	--	1	10	--	--
154	1	3	--	--	1	10	--	--	3	0	10	3
155	1	4	--	--	1	10	--	--	1	10	--	--
156	29	0	4	0	29	1	32	5	28	0	120	8
157	--	--	--	--	--	--	--	--	1	200	--	--
165	1	3	--	--	1	10	--	--	1	10	--	--

Part B, dissolved trace constituents, in micrograms per liter -- continued.

SITE NUMBER	MERCURY				SELENIUM				ZINC			
	NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN
26	--	--	--	--	--	--	--	--	9	0	48	16
28	2	0.1	0.5	--	1	0	--	--	2	0	0	--
29	2	0.1	0.5	--	2	0	0	--	3	0	20	8
84	6	0	0.3	0.1	--	--	--	--	6	0	20	9
115	--	--	--	--	--	--	--	--	1	4	--	--
116	--	--	--	--	--	--	--	--	1	4	--	--
117	2	0.1	0.1	--	--	--	--	--	3	4	30	14
118	--	--	--	--	--	--	--	--	1	9	--	--
119	--	--	--	--	--	--	--	--	1	19	--	--
120	2	0.1	0.1	--	--	--	--	--	3	0	4	2
121	--	--	--	--	--	--	--	--	1	0	--	--
122	--	--	--	--	--	--	--	--	1	4	--	--
123	--	--	--	--	--	--	--	--	1	30	--	--
124	--	--	--	--	--	--	--	--	1	0	--	--
125	2	0.1	0.1	--	--	--	--	--	3	0	10	6
126	2	0.1	0.1	--	--	--	--	--	3	4	10	8
127	2	0.1	0.1	--	--	--	--	--	3	0	10	3
142	--	--	--	--	--	--	--	--	1	4	--	--
143	--	--	--	--	--	--	--	--	1	4-	--	--
144	2	0.1	0.1	--	--	--	--	--	3	0	6	2
145	--	--	--	--	--	--	--	--	1	4	--	--
146	2	0.1	0.1	--	--	--	--	--	2	4	10	7
149	--	--	--	--	--	--	--	--	1	5	--	--
154	2	0.1	0.1	--	--	--	--	--	3	0	4	2
155	--	--	--	--	--	--	--	--	1	16	--	--
156	29	0.0	0.5	0.2	24	0	2	0.5	29	0	110	18
165	--	--	--	--	--	--	--	--	1	4	--	--

Part C, total trace constituents, in micrograms per liter.

SITE NUMBER	ALUMINUM NUMBER OF SAMPLES	ALUMINUM MIN OR VALUE	ALUMINUM MAX	ALUMINUM MEAN	ARSENIC NUMBER OF SAMPLES	ARSENIC MIN OR VALUE	ARSENIC MAX	ARSENIC MEAN	CADMIUM NUMBER OF SAMPLES	CADMIUM MIN OR VALUE	CADMIUM MAX	CADMIUM MEAN
7	--	--	--	--	1	1	--	--	1	0	--	--
8	--	--	--	--	1	1	--	--	1	0	--	--
9	--	--	--	--	1	1	--	--	1	0	--	--
10	--	--	--	--	1	1	--	--	1	0	--	--
11	--	--	--	--	1	1	--	--	1	0	--	--
12	--	--	--	--	1	0	--	--	1	0	--	--
14	--	--	--	--	1	2	--	--	1	3	--	--
15	--	--	--	--	1	0	--	--	1	0	--	--
17	--	--	--	--	1	0	--	--	1	0	--	--
19	--	--	--	--	1	2	--	--	1	2	--	--
20	--	--	--	--	1	1	--	--	1	0	--	--
21	--	--	--	--	1	2	--	--	1	2	--	--
22	--	--	--	--	1	1	--	--	1	0	--	--
23	--	--	--	--	1	1	--	--	1	0	--	--
24	--	--	--	--	1	1	--	--	1	0	--	--
25	--	--	--	--	1	1	--	--	1	0	--	--
26	9	0	200	97	2	3	4	--	2	0	1	--
28	34	0	3,200	297	3	0	5	2	2	0	10	--
29	34	30	1,700	2,090	3	0	11	4	2	2	10	--
31	11	100	760	295	--	--	--	--	--	--	--	--
34	--	--	--	--	1	1	--	--	1	0	--	--
35	--	--	--	--	1	1	--	--	1	0	--	--
36	--	--	--	--	1	0	--	--	1	0	--	--
37	--	--	--	--	1	1	--	--	1	2	--	--
38	--	--	--	--	1	1	--	--	1	0	--	--
40	--	--	--	--	1	0	--	--	1	0	--	--
41	--	--	--	--	1	1	--	--	1	0	--	--
42	--	--	--	--	1	0	--	--	1	0	--	--
43	--	--	--	--	1	1	--	--	1	0	--	--
44	--	--	--	--	1	1	--	--	1	0	--	--
45	--	--	--	--	1	1	--	--	1	0	--	--
49	--	--	--	--	1	1	--	--	1	0	--	--
50	--	--	--	--	1	1	--	--	1	0	--	--
51	--	--	--	--	1	1	--	--	1	0	--	--
52	--	--	--	--	1	0	--	--	1	0	--	--
54	--	--	--	--	1	3	--	--	1	0	--	--
55	--	--	--	--	1	1	--	--	1	0	--	--
56	--	--	--	--	1	2	--	--	1	0	--	--
58	--	--	--	--	1	0	--	--	1	0	--	--

Part C, total trace constituents, in micrograms per liter -- continued.

SITE NUMBER	ALUMINUM NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	ARSENIC NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	CADMIUM NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN
59	--	--	--	--	1	1	--	--	1	0	--	--
61	--	--	--	--	1	0	--	--	1	0	--	--
63	--	--	--	--	1	3	--	--	1	0	--	--
64	--	--	--	--	1	1	--	--	1	0	--	--
65	--	--	--	--	1	0	--	--	1	0	--	--
66	--	--	--	--	1	0	--	--	1	0	--	--
67	--	--	--	--	1	0	--	--	1	0	--	--
68	--	--	--	--	1	1	--	--	1	0	--	--
71	--	--	--	--	1	1	--	--	1	0	--	--
74	--	--	--	--	2	1	3	--	2	0	0	--
75	--	--	--	--	1	0	--	--	1	0	--	--
76	11	0	3,100	559	1	2	--	--	1	0	--	--
77	--	--	--	--	1	2	--	--	1	1	--	--
78	--	--	--	--	1	1	--	--	1	0	--	--
79	--	--	--	--	1	1	--	--	1	0	--	--
81	--	--	--	--	1	1	--	--	1	0	--	--
82	--	--	--	--	1	0	--	--	1	0	--	--
83	1	100	--	--	--	--	--	--	--	--	--	--
84	11	50	1,500	571	9	0	14	3	9	0	6	2
85	--	--	--	--	1	1	--	--	1	0	--	--
86	--	--	--	--	1	1	--	--	1	2	--	--
89	--	--	--	--	1	1	--	--	1	1	--	--
90	--	--	--	--	1	1	--	--	1	0	--	--
91	--	--	--	--	1	1	--	--	1	1	--	--
92	--	--	--	--	1	1	--	--	1	2	--	--
93	--	--	--	--	1	1	--	--	1	2	--	--
247	1	100	--	--	--	--	--	--	--	--	--	--
94	9	70	3,000	836	--	--	--	--	--	--	--	--
95	--	--	--	--	1	1	--	--	1	3	--	--
96	--	--	--	--	1	1	--	--	1	2	--	--
99	--	--	--	--	1	1	--	--	1	0	--	--
100	--	--	--	--	1	1	--	--	1	0	--	--
101	--	--	--	--	1	1	--	--	1	1	--	--
102	--	--	--	--	1	0	--	--	1	0	--	--
104	12	80	3,000	882	1	0	--	--	1	0	--	--
105	--	--	--	--	1	2	--	--	1	0	--	--
106	9	180	7,000	1,640	--	--	--	--	1	0	--	--
108	10	30	9,000	1,240	2	0	1	0.5	2	1	3	--
109	9	0	6,000	1,930	--	--	--	--	--	--	--	--
110	1	0	--	--	1	0	--	--	1	0	--	--
112	--	--	--	--	1	1	--	--	1	0	--	--
113	--	--	--	--	1	1	--	--	1	0	--	--
114	--	--	--	--	1	1	--	--	1	1	--	--
117	2	70	80	--	--	--	--	--	2	0	0	--
120	2	40	120	--	--	--	--	--	2	0	0	--
125	2	60	70	--	--	--	--	--	2	0	0	--
126	2	60	80	--	--	--	--	--	2	0	0	--
127	2	120	120	--	--	--	--	--	2	0	0	--
128	--	--	--	--	1	2	--	--	1	2	--	--
129	--	--	--	--	1	1	--	--	1	0	--	--
130	--	--	--	--	1	2	--	--	1	1	--	--
131	--	--	--	--	1	0	--	--	1	0	--	--
132	--	--	--	--	1	1	--	--	1	0	--	--
133	--	--	--	--	1	1	--	--	1	0	--	--
134	--	--	--	--	1	3	--	--	1	0	--	--
135	--	--	--	--	1	1	--	--	1	0	--	--
136	--	--	--	--	1	1	--	--	1	0	--	--
137	--	--	--	--	1	1	--	--	1	0	--	--
138	--	--	--	--	1	2	--	--	1	2	--	--
140	--	--	--	--	1	1	--	--	1	0	--	--
144	2	70	110	--	--	--	--	--	2	0	0	--
146	3	0	350	150	--	--	--	--	2	0	0	--
147	--	--	--	--	1	1	--	--	1	3	--	--
150	--	--	--	--	1	0	--	--	1	0	--	--
151	--	--	--	--	1	0	--	--	1	0	--	--
152	--	--	--	--	1	0	--	--	1	3	--	--
154	2	100	470	--	--	--	--	--	2	0	0	--
156	3	100	100	100	29	0	18	3	27	0	5	1
157	--	--	--	--	1	0	--	--	1	2	--	--
159	--	--	--	--	1	0	--	--	1	0	--	--
160	--	--	--	--	1	0	--	--	1	0	--	--
162	--	--	--	--	1	1	--	--	1	0	--	--
163	--	--	--	--	1	1	--	--	1	0	--	--
164	--	--	--	--	1	1	--	--	1	1	--	--

Part C, total trace constituents, in micrograms per liter -- continued.

SITE NUMBER	COBALT NUMBER OF SAMPLES	COBALT MIN OR VALUE	COBALT MAX	COBALT MEAN	COPPER NUMBER OF SAMPLES	COPPER MIN OR VALUE	COPPER MAX	COPPER MEAN	LEAD NUMBER OF SAMPLES	LEAD MIN OR VALUE	LEAD MAX	LEAD MEAN
7	--	--	--	--	1	1	--	--	1	0	--	--
8	--	--	--	--	1	3	--	--	1	0		--
9	--	--	--	--	1	3	--	--	1	0	--	--
10	--	--	--	--	1	1	--	--	1	0	--	--
11	--	--	--	--	1	1	--	--	1	0	--	--
12	--	--	--	--	1	2	--	--	1	1	--	--
14	--	--	--	--	1	37	--	--	1	29	--	--
15	--	--	--	--	1	2	--	--	1	0	--	--
17	--	--	--	--	1	2	--	--	1	0	--	--
19	--	--	--	--	1	17	--	--	1	25	--	--
20	--	--	--	--	1	3	--	--	1	4	--	--
21	--	--	--	--	1	8	--	--	1	15	--	--
22	--	--	--	--	1	2	--	--	1	3	--	--
23	--	--	--	--	1	1	--	--	1	3	--	--
24	--	--	--	--	1	2	--	--	1	1	--	--
25	--	--	--	--	1	3	--	--	1	2	--	--
26	--	--	--	--	2	3	8	--	2	3	14	--
28	2	2	7	--	3	1	15	6	34	1	54	14
29	3	1	19	8	3	3	31	14	33	0	140	19
31	--	--	--	--	--	--	--	--	10	4	31	18
34	--	--	--	--	1	3	--	--	1	0	--	--
35	--	--	--	--	1	2	--	--	1	0	--	--
36	--	--	--	--	1	3	--	--	1	0	--	--
37	--	--	--	--	1	3	--	--	1	4	--	--
38	--	--	--	--	1	2	--	--	1	2	--	--
40	--	--	--	--	1	4	--	--	1	9	--	--
41	--	--	--	--	1	1	--	--	1	3	--	--
42	--	--	--	--	1	1	--	--	1	4	--	--
43	--	--	--	--	1	3	--	--	1	7	--	--
44	--	--	--	--	1	2	--	--	1	7	--	--
45	--	--	--	--	1	7	--	--	1	8	--	--
49	--	--	--	--	1	2	--	--	1	0	--	--
50	--	--	--	--	1	3	--	--	1	0	--	--
51	--	--	--	--	1	2	--	--	1	0	--	--
52	--	--	--	--	1	2	--	--	1	1	--	--
54	--	--	--	--	1	2	--	--	1	0	--	--
55	--	--	--	--	1	2	--	--	1	5	--	--

Part C, total trace constituents, in micrograms per liter -- continued.

SITE NUMBER	COBALT NUMBER OF SAMPLES	COBALT MIN OR VALUE	COBALT MAX	COBALT MEAN	COPPER NUMBER OF SAMPLES	COPPER MIN OR VALUE	COPPER MAX	COPPER MEAN	LEAD NUMBER OF SAMPLES	LEAD MIN OR VALUE	LEAD MAX	LEAD MEAN
56	--	--	--	--	1	1	--	--	1	4	--	--
58	--	--	--	--	1	1	--	--	1	2	--	--
59	--	--	--	--	1	1	--	--	1	4	--	--
61	--	--	--	--	1	1	--	--	1	0	--	--
63	--	--	--	--	1	3	--	--	1	2	--	--
64	--	--	--	--	1	3	--	--	1	1	--	--
65	--	--	--	--	1	2	--	--	1	0	--	--
66	--	--	--	--	1	1	--	--	1	4	--	--
67	--	--	--	--	1	1	--	--	1	1	--	--
68	--	--	--	--	1	1	--	--	1	3	--	--
71	--	--	--	--	1	7	--	--	1	5	--	--
74	--	--	--	--	2	2	3	--	2	1	5	--
75	--	--	--	--	1	2	--	--	1	1	--	--
76	--	--	--	--	1	5	--	--	11	3	32	20
77	--	--	--	--	1	4	--	--	1	6	--	--
78	--	--	--	--	1	2	--	--	1	0	--	--
79	--	--	--	--	1	3	--	--	1	3	--	--
81	--	--	--	--	1	8	--	--	1	0	--	--
82	--	--	--	--	1	4	--	--	1	3	--	--
84	8	1	23	6	9	1	25	11	19	1	140	33
85	--	--	--	--	1	4	--	--	1	2	--	--
86	--	--	--	--	1	5	--	--	1	5	--	--
89	--	--	--	--	1	4	--	--	1	4	--	--
90	--	--	--	--	1	3	--	--	1	3	--	--
91	--	--	--	--	1	6	--	--	1	6	--	--
92	--	--	--	--	1	6	--	--	1	8	--	--
93	--	--	--	--	1	6	--	--	1	12	--	--
94	--	--	--	--	--	--	--	--	9	9	64	27
95	--	--	--	--	1	11	--	--	1	19	--	--
96	--	--	--	--	1	3	--	--	1	7	--	--
99	--	--	--	--	1	2	--	--	1	18	--	--
100	--	--	--	--	1	4	--	--	1	0	--	--
101	--	--	--	--	1	5	--	--	1	7	--	--
102	--	--	--	--	1	3	--	--	1	3	--	--
104	--	--	--	--	1	6	--	--	11	2	56	18
105	--	--	--	--	1	200	--	--	1	160	--	--
106	--	--	--	--	--	--	--	--	7	4	30	14
108	--	--	--	--	2	5	6	--	10	9	47	19
109	--	--	--	--	--	--	--	--	8	14	200	52
110	--	--	--	--	1	4	--	--	1	3	--	--
112	--	--	--	--	1	5	--	--	1	6	--	--
113	--	--	--	--	1	3	--	--	1	2	--	--
114	--	--	--	--	1	6	--	--	1	8	--	--
117	--	--	--	--	--	--	--	--	2	0	4	--
120	--	--	--	--	--	--	--	--	2	0	2	--
125	--	--	--	--	--	--	--	--	2	2	3	--
126	--	--	--	--	--	--	--	--	2	0	1	--
127	--	--	--	--	--	--	--	--	2	0	0	--
128	--	--	--	--	1	63	--	--	1	16	--	--
129	--	--	--	--	1	3	--	--	1	5	--	--
130	--	--	--	--	1	6	--	--	1	15	--	--
131	--	--	--	--	1	1	--	--	1	2	--	--
132	--	--	--	--	1	1	--	--	1	2	--	--
133	--	--	--	--	1	2	--	--	1	6	--	--
134	--	--	--	--	1	5	--	--	1	5	--	--
135	--	--	--	--	1	2	--	--	1	0	--	--
136	--	--	--	--	1	2	--	--	1	0	--	--
137	--	--	--	--	1	3	--	--	1	2	--	--
138	--	--	--	--	1	19	--	--	1	3	--	--
140	--	--	--	--	1	2	--	--	1	1	--	--
144	--	--	--	--	--	--	--	--	2	0	0	--
146	--	--	--	--	--	--	--	--	2	2	3	--
147	--	--	--	--	1	8	--	--	1	22	--	--
150	--	--	--	--	1	4	--	--	1	5	--	--
151	--	--	--	--	1	2	--	--	1	0	--	--
152	--	--	--	--	1	3	--	--	1	6	--	--
154	--	--	--	--	--	--	--	--	2	0	3	--
156	28	0	17	5	28	2	100	20	27	0	140	23
157	--	--	--	--	1	8	--	--	1	0	--	--
159	--	--	--	--	1	3	--	--	1	5	--	--
160	--	--	--	--	1	6	--	--	1	3	--	--
162	--	--	--	--	1	2	--	--	1	6	--	--
163	--	--	--	--	1	15	--	--	1	8	--	--
164	--	--	--	--	1	32	--	--	1	8	--	--

Part C, total trace constituents, in micrograms per liter -- continued.

SITE	MERCURY				SELENIUM				ZINC			
NUMBER	NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN
7	1	0.1	--	--	1	0	--	--	1	10	--	--
8	1	0.1	--	--	1	0	--	--	1	10	--	--
9	1	0.1	--	--	1	0	--	--	1	20	--	--
10	1	0.1	--	--	1	0	--	--	1	20	--	--
11	1	0.1	--	--	1	0	--	--	1	30	--	--
12	1	0.1	--	--	1	0	--	--	1	40	--	--
14	1	0.2	--	--	1	1	--	--	1	170	--	--
15	1	0.1	--	--	1	0	--	--	1	10	--	--
17	1	0.1	--	--	1	0	--	--	1	40	--	--
19	1	0.1	--	--	1	1	--	--	1	90	--	--
20	1	0.1	--	--	1	1	--	--	1	30	--	--
21	1	0.2	--	--	1	1	--	--	1	60	--	--
22	1	0.1	--	--	1	1	--	--	1	30	--	--
23	1	0.1	--	--	1	1	--	--	1	10	--	--
24	1	0.1	--	--	1	0	--	--	1	20	--	--
25	1	0.1	--	--	1	0	--	--	1	30	--	--
26	2	0.1	0.5	--	2	0	1	--	2	20	40	--
28	2	0.1	0.3	--	1	0	--	--	2	10	10	--
29	2	0.1	0.2	--	2	0	0	--	2	10	260	--
34	1	0.1	--	--	1	0	--	--	1	10	--	--
35	1	0.1	--	--	1	0	--	--	1	70	--	--
36	1	0.1	--	--	1	0	--	--	1	10	--	--
37	1	0.1	--	--	1	0	--	--	1	10	--	--
38	1	0.1	--	--	1	0	--	--	1	20	--	--
40	1	0.2	--	--	1	0	--	--	1	20	--	--
41	1	0.1	--	--	1	0	--	--	1	20	--	--
42	1	0.1	--	--	1	0	--	--	1	20	--	--
43	1	0.1	--	--	1	0	--	--	1	10	--	--
44	1	0.1	--	--	1	0	--	--	1	20	--	--
45	1	0.1	--	--	1	1	--	--	1	20	--	--
49	1	0.1	--	--	1	0	--	--	1	30	--	--
50	1	0.1	--	--	1	0	--	--	1	20	--	--
51	1	0.1	--	--	1	0	--	--	1	10	--	--
52	1	0.1	--	--	1	0	--	--	1	20	--	--
54	1	0.5	--	--	1	0	--	--	1	10	--	--
55	1	0.1	--	--	1	0	--	--	1	10	--	--
56	1	0.1	--	--	1	0	--	--	1	50	--	--

Part C, total trace constituents, in micrograms per liter -- continued.

SITE NUMBER	MERCURY NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	SELENIUM NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN	ZINC NUMBER OF SAMPLES	MIN OR VALUE	MAX	MEAN
58	1	0.1	--	--	1	0	--	--	1	10	--	--
59	1	0.1	--	--	1	0	--	--	1	20	--	--
61	1	0.1	--	--	1	0	--	--	1	20	--	--
63	1	0.5	--	--	1	0	--	--	1	10	--	--
64	1	0.1	--	--	1	0	--	--	1	20	--	--
65	1	0.1	--	--	1	0	--	--	1	20	--	--
66	1	0.1	--	--	1	0	--	--	1	10	--	--
67	1	0.1	--	--	1	0	--	--	1	10	--	--
68	1	0.1	--	--	1	0	--	--	1	40	--	--
71	1	0.1	--	--	1	0	--	--	1	30	--	--
74	2	0.1	0.5	--	2	0	0	--	2	10	20	--
75	1	0.1	--	--	1	0	--	--	1	10	--	--
76	2	0.2	1	--	1	1	--	--	1	50	--	--
77	1	0.1	--	--	1	1	--	--	1	40	--	--
78	1	0.1	--	--	1	2	--	--	1	20	--	--
79	1	0.2	--	--	1	0	--	--	1	10	--	--
81	1	0.2	--	--	1	0	--	--	1	30	--	--
82	1	0.2	--	--	1	0	--	--	1	20	--	--
84	9	0	0.8	0.3	1	1	--	--	8	20	320	66
85	1	0.2	--	--	1	0	--	--	1	50	--	--
86	1	0.3	--	--	1	1	--	--	1	30	--	--
89	1	0.2	--	--	1	0	--	--	1	40	--	--
90	1	0.4	--	--	1	1	--	--	1	20	--	--
91	1	0.3	--	--	1	0	--	--	1	20	--	--
92	1	0.4	--	--	1	0	--	--	1	20	--	--
93	1	0.3	--	--	1	1	--	--	1	20	--	--
95	1	1.7	--	--	1	1	--	--	1	60	--	--
96	1	0.5	--	--	1	0	--	--	1	10	--	--
99	1	0.1	--	--	1	1	--	--	1	10	--	--
100	1	0.2	--	--	1	0	--	--	1	40	--	--
101	1	0.1	--	--	1	1	--	--	1	20	--	--
102	1	0.8	--	--	1	1	--	--	1	10	--	--
104	1	1.9	--	--	1	0	--	--	1	30	--	--
105	1	0.1	--	--	1	0	--	--	1	550	--	--
108	2	0.3	0.3	--	2	0	0	--	2	20	30	--
110	1	0.1	--	--	1	0	--	--	1	20	--	--
112	1	0.1	--	--	1	0	--	--	1	30	--	--
113	1	0.1	--	--	1	1	--	--	1	20	--	--
114	1	0.1	--	--	1	1	--	--	1	20	--	--
117	2	0.1	0.1	--	--	--	--	--	2	20	50	--
120	2	0.1	0.1	--	--	--	--	--	2	20	30	--
125	2	0.1	0.1	--	--	--	--	--	2	20	70	--
126	2	0.1	0.1	--	--	--	--	--	2	10	90	--
127	1	0.1	0.1	--	--	--	--	--	1	10	40	--
128	1	0.1	--	--	1	0	--	--	1	30	--	--
129	1	0.1	--	--	1	1	--	--	1	20	--	--
130	1	0.1	--	--	1	0	--	--	1	30	--	--
131	1	0.1	--	--	1	0	--	--	1	30	--	--
132	1	0.1	--	--	1	0	--	--	1	20	--	--
133	1	0.1	--	--	1	0	--	--	1	50	--	--
134	1	0.5	--	--	1	0	--	--	1	30	--	--
135	1	0.1	--	--	1	1	--	--	1	10	--	--
136	1	0.1	--	--	1	0	--	--	1	20	--	--
137	1	0.1	--	--	1	2	--	--	1	20	--	--
138	1	0.2	--	--	1	5	--	--	1	60	--	--
140	1	0.2	--	--	1	0	--	--	1	30	--	--
144	2	0.1	0.1	--	--	--	--	--	2	10	30	--
146	2	0.1	0.1	--	--	--	--	--	2	20	80	--
147	1	0.8	--	--	1	6	--	--	1	30	--	--
150	1	0.4	--	--	1	2	--	--	1	30	--	--
151	1	0.6	--	--	1	2	--	--	1	10	--	--
152	1	0.2	--	--	1	0	--	--	1	30	--	--
154	2	0.1	0.1	--	--	--	--	--	2	20	30	--
156	29	0	0.6	0.3	24	0	3	1	28	0	300	63
157	1	0.8	--	--	1	0	--	--	1	60	--	--
159	1	0.1	--	--	1	0	--	--	1	20	--	--
160	1	0.1	--	--	1	0	--	--	1	0	--	--
162	1	0.1	--	--	1	0	--	--	--	--	--	--
163	1	0.1	--	--	1	0	--	--	1	20	--	--
164	1	0.1	--	--	1	0	--	--	1	20	-	--

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