PROGRESS REPORT ON THE EFFECTS OF HIGHWAY CONSTRUCTION ON SUSPENDED-SEDIMENT DISCHARGE IN THE COAL RIVER AND TRACE FORK, WEST VIRGINIA, 1975-81

By Sanford C. Downs and David H. Appel

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

The following factors may be used to convert the inch-pound units published herein to the International System of Units (SI).

Multiply inch-pound units	By	To obtain SI units
inch (in.)	25.40	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
acre	0.4047	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
ton, short	0.9072	megagram (Mg)
ton per square mile (ton/mi^2)	0.3502	megagram per square kilometer (Mg/km^2)
ton per square mile per inch [$(ton/mi^2)/in.$]	0.01379	megagram per square kilometer per millimeter [$(Mg/km^2)/mm$]
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer [$(m^3/s)/km^2$]
cubic yard (yd^3)	0.7646	cubic meter (m^3)
degree Fahrenheit (°F)	5/9(°F-32)	degree Celsius (°C)

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ABSTRACT

The effects of highway construction on stream-sediment loads are being studied in the Coal River and Trace Fork basins in southern West Virginia. Preliminary findings are based on information collected from 1973 to 1981. Construction of the four-lane Appalachian Corridor G highway was done during two periods: 1) 1972-75, along Turtle Creek upstream from the measuring sites on the Little Coal River, and 2) 1979-81, along the lower Little Coal River, across the Big Coal River, and into the Trace Fork basin.

Construction has had a negligible effect on runoff and suspended-sediment load in the Coal River and its major tributaries, the Little Coal and Big Coal Rivers. Drainage areas of the mainstem sites in the Coal River basin ranged from 269 to 862 square miles, and average annual suspended-sediment yields ranged from 535 to 614 tons per square mile for the period 1975-81. Suspended-sediment load in the smaller Trace Fork basin (4.72 square miles) was significantly affected by highway construction. Based on data from undisturbed areas upstream from construction, the normal background load at Trace Fork downstream from construction during the period July 1980 through September 1981 was estimated to be 830 tons; the measured load was 2,385 tons. Runoff from the 0.20 square-mile area disturbed by highway construction transported approximately 1,550 tons of sediment. Suspended-sediment loads from the construction zone were higher than normal background loads during storms.

INTRODUCTION

Modern highways are needed to transport an increasing population and natural resources such as coal and timber. In mountainous areas, such as those in West Virginia, great quantities of rock and soil are disturbed by construction of these highways as mountainsides are cleared of trees and the rock is drilled, blasted, and removed. The valleys and hollows are cleared and filled with spoil from the mountainsides. This disturbance of land increases the potential sediment load in streams draining the affected areas. Large increases in sediment in streams can increase water-supply treatment costs and adversely affect wildlife and channel conveyance.

The U.S. Geological Survey, in cooperation with the West Virginia Department of Highways and Department of Natural Resources, has collected streamflow and sediment data in the Coal River basin from 1973 to the present and in the Trace Fork basin from 1980 to the present. The data are being collected to determine the sediment yields associated with highway construction. The study areas are affected by construction of Appalachian Corridor G—a divided four-lane highway connecting southern West Virginia with the Interstate Highway System at Charleston and by other land uses such as coal mining and logging.

After highway construction in the basin started in 1972, streamflow and suspended sediment-data collection at selected sites above and below highway construction was started in the Coal River and Trace Fork basins, so that the differences in the amount of suspended sediment between the sites could be determined. The data-collection sites to define streamflow and suspended sediment in the study area are shown in figure 1. Information for the sites, including type of data, period of record, and land use are given in table 1.

This report describes the preliminary results of the study to determine the effects of highway construction on suspended-sediment discharges in the Coal River and Trace Fork basins resulting from construction of Appalachian Corridor G for the period October 1974 through September 1981 (water years 1975–81)[1]. Data collection is scheduled to end in September 1984.

PHYSICAL SETTING

Surface Drainage

The Coal River basin drains 890 mi^2 in the Appalachian Plateaus physiographic province (Fenneman and Johnson, 1946) in southern West Virginia. The river, which is a tributary to the Kanawha River (fig. 1), has two main tributaries—the Big Coal River and the Little Coal River. The Coal River and its two main tributaries are referred to as the Coal River mainstem in this report. The basin is an area of densely forested mountains ranging in elevation from 570 ft at the mouth at St. Albans to more than 3,600 ft above sea level at the southern boundary of the basin near the Boone-Raleigh County line. Valley walls are moderately steep to very steep. The steep slopes and rough topography are subject to high rates of soil erosion. The basin includes parts of six counties—Boone, Kanawha, Lincoln, Logan, Putnam, and Raleigh—with Boone constituting more than half the total area (Bader and others, 1977).

The Trace Fork basin adjoins the Coal River basin (fig. 1) but is a tributary to Davis Creek, which flows into the Kanawha River. Trace Fork below Dryden Hollow at Ruth (site 2)—the basin outflow site—has a drainage area of 4.72 mi^2. The basin elevation ranges from 650 ft above sea level at site 2 to about 1,250 ft at the southern boundary of the basin. Dryden Hollow, a major tributary to Trace Fork upstream from site 2 (fig. 2), has a channel slope of 218 ft/mi between the basin divide and its confluence with Trace Fork. The stream bed at site 1 (Trace Fork near Ruth) consists primarily of cobble and rock, whereas at site 2, the stream bed is a bedrock shelf.

Geology

Consolidated sedimentary rocks of Pennsylvanian age that underlie the Coal River

[1]All "annual or yearly" references in this report are for water years. A water year is defined as the 12-month period from October 1 of a previous calendar year to September 30 of the referenced year.

Table 1.--Data-collection sites in study area
[Site numbers correspond to those on figure 1]

Site number	Station number	Station name	Drainage area (mi^2)	Streamflow: Period of record (water years)	Streamflow: Type of data	Suspended sediment: Period of record (water years)	Suspended sediment: Type of data	Land use: Highway construction	Land use: Mining
1	03198020	Trace Fork at Ruth	2.82	July 1980 - Sept. 1981	Continuous	July 1980 - Sept. 1981	Daily	No	No
2	03198022	Trace Fork downstream Dryden Hollow at Ruth1/	4.72	July 1980 - Sept. 1981	Continuous	July 1980 - Sept. 1981	Daily	Yes	No
3	03198550	Big Coal River near Alum Creek	445	Oct. 1974 - Sept. 1981	Continuous	Oct. 1974 - Sept. 1981	Daily	No	Yes
4	03199000	Little Coal River at Danville	269	May 1930 - Sept. 1981	Continuous	Aug. 1973 - Sept. 1981	Daily	No	Yes
5	03199400	Little Coal River at Julian	318	Oct. 1974 - Sept. 1981	Continuous	Oct 1974 - Sept. 1981	Daily	Yes	Yes
6	03199700	Coal River at Alum Creek	841	Oct. 1974 - Sept. 1980	Continuous	Oct. 1974 - Sept. 1980	Daily	Yes	Yes
7	03200500	Coal River at Tornado	862	Aug. 1961 - Sept. 1981	Continuous	Dec. 1972 - Sept. 1981	Daily	Yes	Yes

1/ Once-daily precipitation data July 1980 to September 1981.

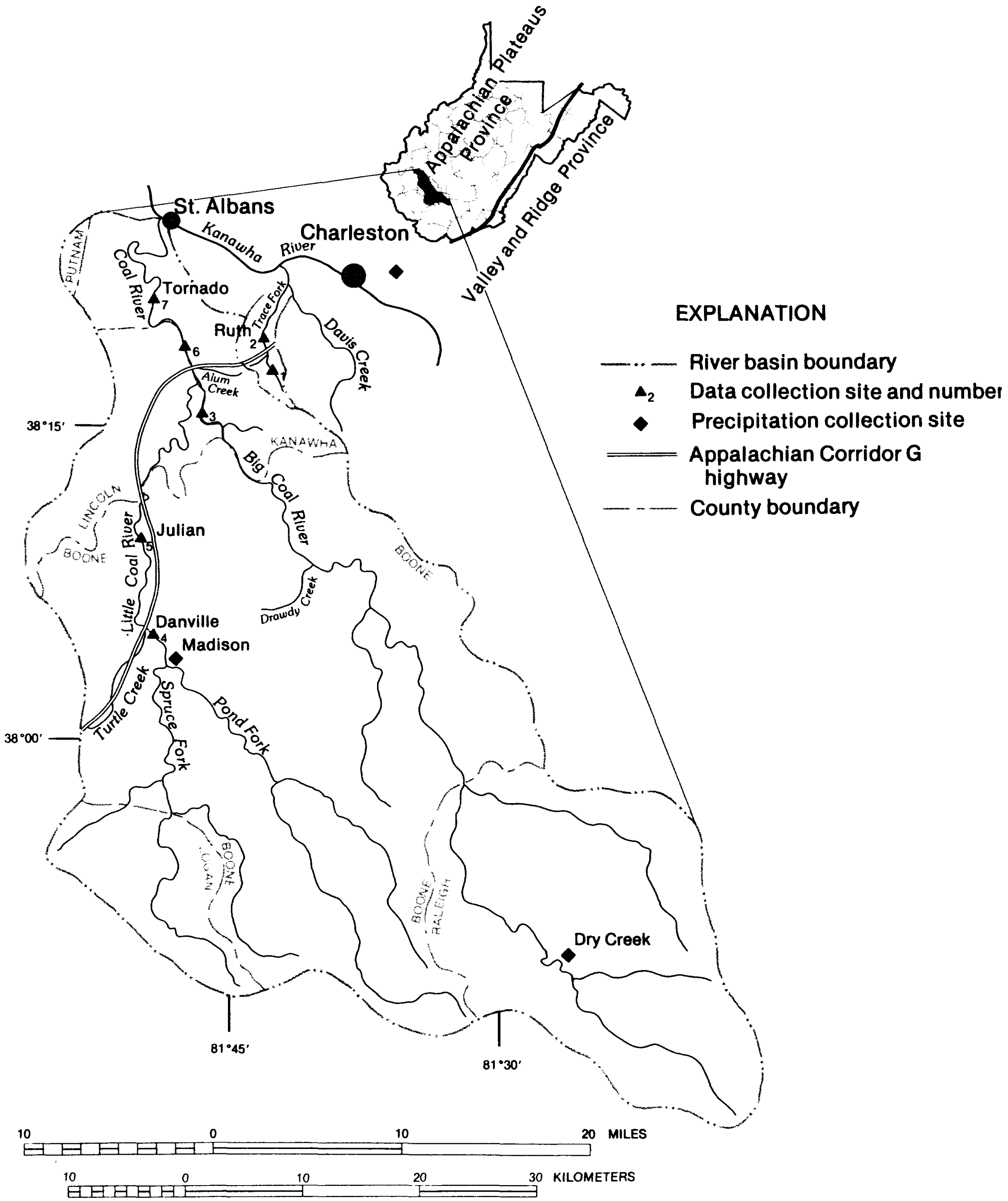

Figure 1. Coal River and Trace Fork study area.

and Trace Fork basins are divided into five stratigraphic units. They are, from the oldest to the youngest: The New River Formation and Kanawha Formation of the Pottsville Group, the Allegheny Formation, the Conemaugh Group, and the Monongahela Group (Cardwell and others, 1968). The consolidated rocks consist chiefly of sandstone, shale, siltstone, coal and underclay. Soils on hilltops and hillsides are classified as deep to moderately deep, well drained channery loams and channery sandy loams. Because of steep land slopes, the soils in the study area are considered to be very erodible.

Shallow deposits of alluvium, typically less than 10 ft thick, are present on the valley floors of the Coal, Big Coal, and Little Coal Rivers and Trace Fork. These deposits generally consist of poorly sorted gravel, sand, silt, and clay. The only alluvium deposit in the study area thick enough to be significant is near the mouth of the Coal River at St. Albans, W.Va.

Climate

Climate in the Coal River basin is continental inland. Warm, humid summers and long winters are typical, and prevailing winds are from the west and northwest (U.S. Department of Commerce, 1977). Average temperatures in January and July are 34° F (1.0° C) and 75° F (24.0° C), (U.S. Department of Commerce, 1973). The average length of the frost-free season is 160 days and occurs from mid-May to mid-October. Precipitation, which averages 42 in. per year, is generally greatest during the spring and summer. October is normally the driest month of the year (table 2).

Convection thunderstorms are common during June and July. These storms may produce intense local rainfall that causes flooding in the narrow valley bottoms (U.S. Department of Commerce, 1977) and increases erosion potential in slope areas. Intense storms are rare over the entire Coal River basin, but they are frequent over small portions of the basin.

Precipitation data in the study area were obtained from National Oceanic and Atmospheric Administration (NOAA) stations at Madison, Dry Creek, and the Charleston Airport. Madison and Dry Creek are in the Coal River basin and Charleston is about 10 mi northeast of the basin (fig. 1). Daily precipitation was also measured by a Geological Survey observer downstream from Dryden Hollow at Ruth in the Trace Fork basin from July 1980 to September 1981. (See Appendix A.)

Annual precipitation recorded at the three NOAA sites from 1975 to 1981 are similar in amount and in areal distribution throughout the study area (fig. 4). Because of central location and similarity of recorded data to all other precipitation stations in the study area, the precipitation data at Madison were used as most representative of ambient precipitation in the Coal River basin. Monthly and annual precipitation data during the study period for Madison are shown in table 2; departure of

Table 2.--Monthly and annual precipitation at Madison, water years 1975-81

[Data in inches]

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
1975	2.12	2.68	4.02	4.80	3.09	6.73	4.38	6.65	4.36	5.34	4.89	5.96	55.02
1976	3.28	2.75	3.39	3.84	2.26	4.25	.98	3.98	3.41	2.44	5.10	7.10	42.78
1977	5.23	1.29	2.65	2.10	1.32	2.94	4.59	1.05	4.39	2.92	8.57	3.05	40.10
1978	5.77	3.24	2.71	5.46	1.47	3.05	3.87	4.76	2.60	5.42	5.60	.31	44.26
1979	2.62	1.80	9.62	6.36	3.33	2.83	4.53	5.84	7.51	7.20	5.32	5.60	62.56
1980	3.38	3.91	3.16	3.21	2.11	4.40	5.29	3.67	3.14	10.10	6.23	2.30	50.90
1981	1.89	3.27	1.98	1.13	3.61	2.37	4.68	5.94	5.68	5.16	1.13	6.24	43.08
Average 1975-81	3.47	2.71	3.93	3.84	2.46	3.80	4.05	4.56	4.44	5.51	5.26	4.37	48.39
Normal 1941-70	2.27	2.96	3.09	3.26	3.14	4.17	3.44	4.00	4.09	4.51	3.37	3.20	41.50

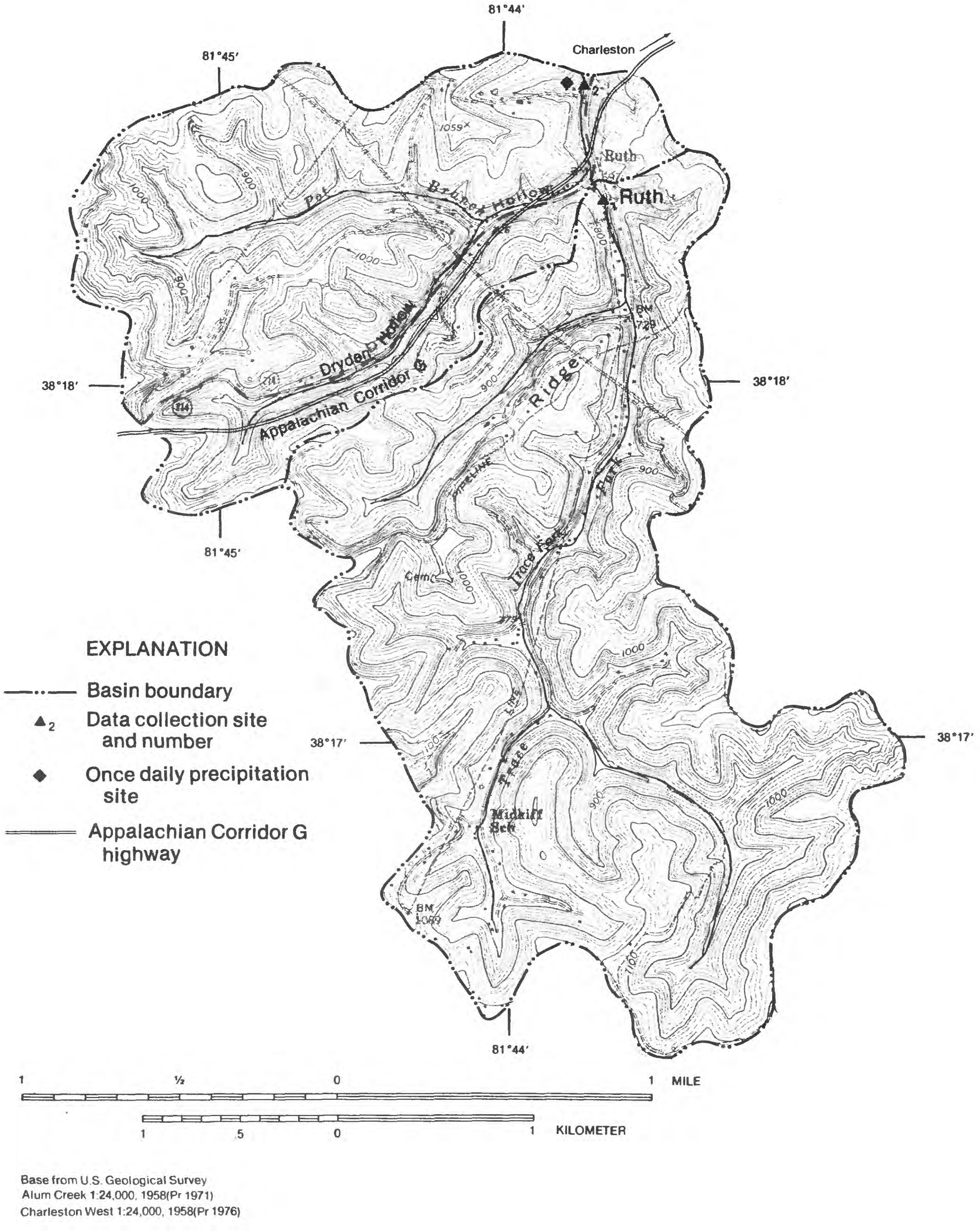

Figure 2. Trace Fork Basin and Appalachian Corridor G highway.

monthly and annual precipitation data from the 1941-70 normal (long-term average) values is shown in figure 5.

The largest above- and below-normal departures of annual precipitation at Madison from 1975 to 1981 were 21.06 in. in 1979 and 1.40 in. in 1977. The largest above- and below-normal departures of monthly precipitation were 6.53 in. in December 1978 and 2.95 in. in May 1977.

Six storms produced rainfall that exceeded 2.0 in. in 24 hours at Madison from 1975-81. Of the six storms, the most intense produced 2.90 in. and occurred on July 28, 1980; however, other intense local storms may have occurred elsewhere in ungaged areas of the basin during the study period.

The storm on July 28, 1980, produced 1.90 in. of rainfall at the Geological Survey station at Ruth. Only one storm produced more than 2.00 in. in a 24-hour period at Ruth between July 1980 and September 1981; it occurred on July 10, 1980, and produced 2.10 in. of rainfall.

COAL RIVER BASIN

Highway Construction

Major land disturbances in the Little Coal River basin during the study (1975-81) were surface and deep coal-mine operations, logging, and highway construction on Appalachian Corridor G. Land use in Boone County, which is typical of the basin, is 93 percent forest, 3 percent surface mines and quarries, 2 percent residential and industrial, and 2 percent miscellaneous (McColloch and Lessing, 1980).

From 1972 to 1975, Appalachian Corridor G construction occurred along Turtle

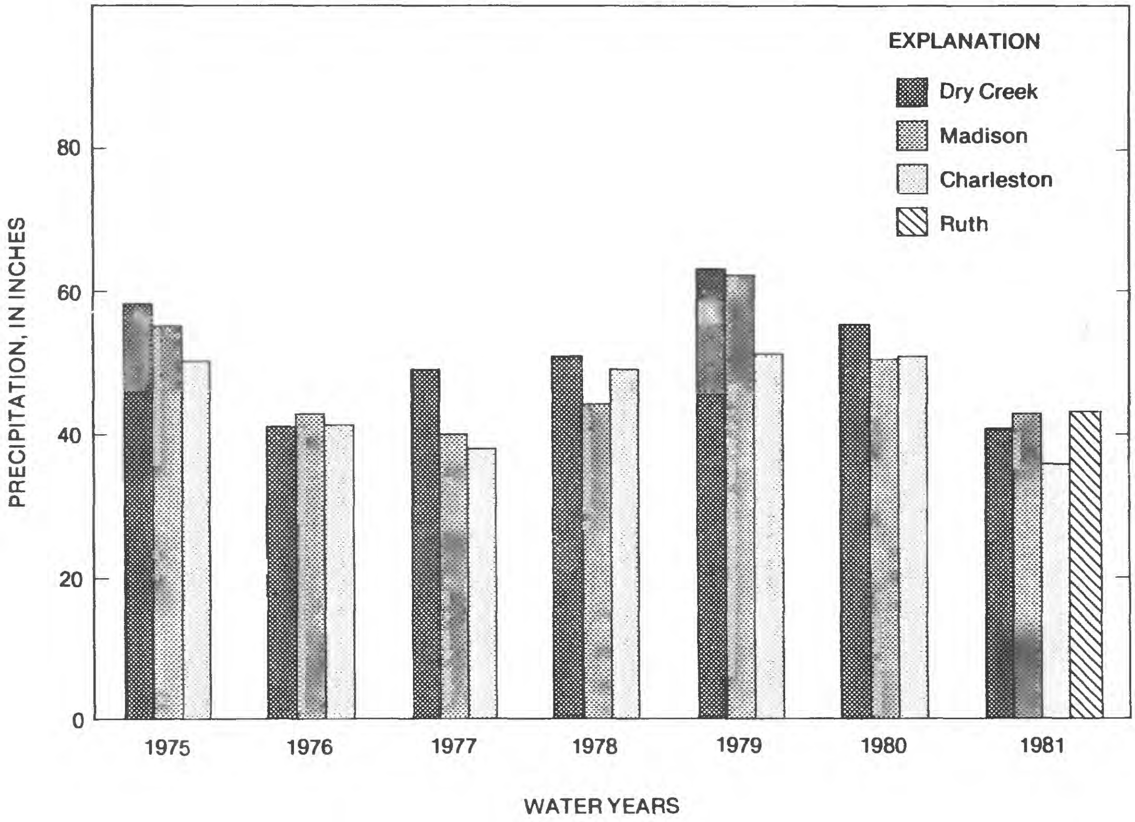

Figure 3. Annual precipitation for rain gages at Dry Creek, Madison, Charleston, and Ruth.

Creek (fig. 1)—a tributary to the Little Coal River downstream from Danville; no highway construction occurred in the Little Coal River basin upstream from Danville. During construction of the Turtle Creek segment, most of the vegetation was removed and approximately 3.5 million yd^3 of material were excavated. Almost 60 percent of the stream channel was relocated to accommodate the new highway (Chisholm and Downs, 1978). Bader and others (1977) estimated that Turtle Creek subbasin load was 34,000 tons of suspended sediment during 1973 and 1974 [a yield of 1,400 $(tons/mi^2)/yr$]. Virtually no logging or surface mining activity occurred in the basin during this period.

From 1975 to 1981, no major highway construction occurred between the Little Coal River gaging stations at Danville and Julian (sites 4 and 5). From January 1979 to September 1981, about 700 acres of right-of-way area were cleared (approximately 0.1 percent of the basin area), and approximately 18 million yd^3 of material were excavated along a 12-mile segment of new highway between Julian and the confluence of the Little and Big Coal Rivers.

Runoff

The gaging stations in the study area (fig. 1) were instrumented for continuous streamflow data collection. Runoff (streamflow) was computed by methods described in Rantz and others (1982) and published annually (U.S. Geological Survey, 1975-81). Runoff data for the study period for Little Coal River at Julian, however, were revised based on streamflow measurements obtained after 1981 and are available from the Geological Survey District office in Charleston, West Virginia.

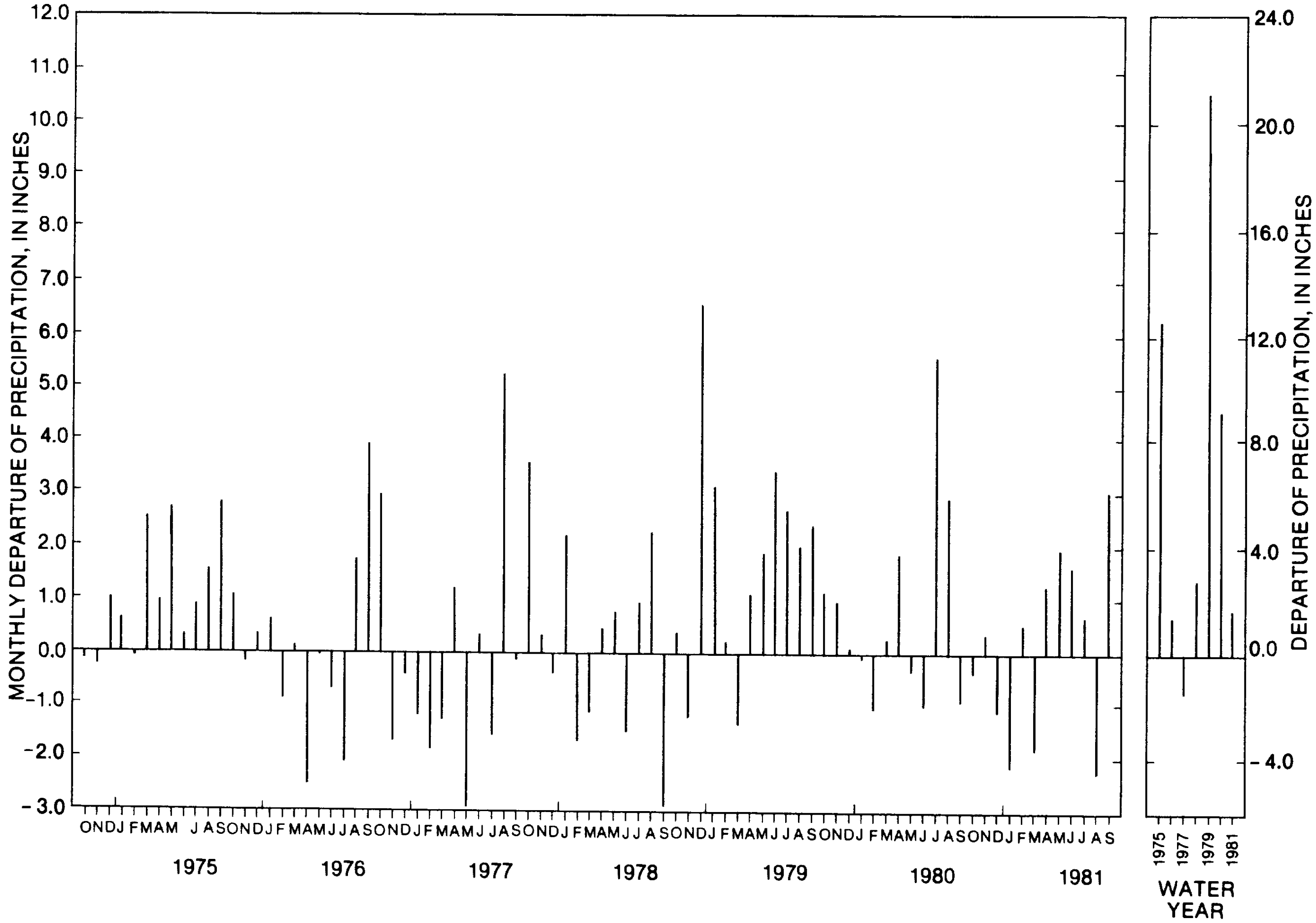

Figure 4. Departure of monthly and annual precipitation from normal [1941-1970] at Madison.

Average annual runoff from gaging stations in the Coal River basin for the period 1975-81 ranged from 20.1 in. at Coal River at Tornado (site 7) to 22.3 in. at Little Coal River at Julian (site 5), or 42 and 46 percent of the precipitation recorded at Madison. The remainder of precipitation was lost to evapotranspiration, interbasin transfer of water (diversion of mine drainage and pumpage), and (or) seepage to deep ground-water reservoirs.

Annual precipitation at Madison and annual runoff at selected gaging stations are given in table 3; the maximum difference in average annual runoffs among the four sites is only 2.2 in. This difference is probably not significant because all or most of the difference may be attributable to a combination of streamflow measurement and computational error and to differences in basin physiography and precipitation distribution. Differences in annual and average annual runoff among the sites (table 3) generally correlate directly with differences in annual precipitation distribution in the study area. Land elevations, overland slopes, and precipitation generally increase from site 7 southward toward sites 3, 5, and 4 (fig. 1). Runoff data for Coal River at Alum Creek (site 6) were not used in this study because drainage areas between sites 6 and 7 differ by only 2.5 percent.

Suspended Sediment

Daily suspended-sediment samples were collected at all sites in the Coal River basin using standard bridge mounted depth-integrating samplers (US-D49, US-DH59). Additional samples were collected manually during low and high flows to obtain data throughout the full range of flow. Sediment transported between sampler intake nozzles and the streambed was not sampled during the study. Suspended-sediment data are published annually (U.S. Geological Survey 1975-81). However, records of suspended-sediment data for the study period at the Little Coal River at Julian (site 5) were revised and will be published in the 1983 Annual Report. Suspended-sediment concentrations, expressed in milligrams per liter, were determined by the dry-weight method outlined by Guy (1969), and daily suspended-sediment loads and yields were computed by techniques described by Porterfield (1972).

Estimates of annual and average annual suspended-sediment loads and yields for mainstem sites in the study area for the period of study are given in table 4. Sediment yields in (ton/mi^2)/in. (tons per square mile per inch of runoff) were also computed for comparison on a unit-runoff basis. Sediment data for the Coal River at Alum Creek (site 6) were not included in table 4 because drainage areas between sites 6 and 7 differ by only 2.5 percent.

Suspended-sediment yields given in table 4 are representative of 6 years of above-normal precipitation and 1 year of below-normal precipitation (fig. 5). Annual yields ranged from 143 to 1,000 tons/mi^2. The maximum annual yield at each site occurred in 1979, when

Table 3.--Annual precipitation at Madison and annual runoff at gaging sites in the Coal River basin, 1975 to 1981
[Data in inches]

Water year	Precipitation at Madison	Runoff			
		Big Coal River near Alum Creek (site 3)	Little Coal River at Danville (site 4)	Little Coal River at Julian (site 5)	Coal River at Tornado (site 7)
1975	55.02	27.31	25.35	26.81	25.28
1976	42.78	13.36	13.81	15.84	13.40
1977	40.10	15.98	16.48	16.79	15.40
1978	44.26	23.14	20.68	22.98	20.45
1979	62.56	30.91	30.23	32.55	28.12
1980	50.90	24.63	25.64	26.02	23.12
1981	43.08	15.07	15.15	15.13	14.92
7 year average	48.39	21.49	21.05	22.30	20.10

annual precipitation in the basin was highest (fig. 3). The lowest annual yields occurred in 1976.

The similarity of the sediment yields for all sites (table 4) indicates that sediment from highway construction areas had negligible impact on the mainstem of the Coal River. This probably results from the masking effects of large sediment loads contributed to the river from other sources in upstream reaches, and from dilution of flow from highway construction areas by the large volume of water in the mainstem.

Sediment yields throughout the Coal River basin were also probably high during 1973-74, when average annual precipitation at Madison (53 in.) was higher than normal. Sediment yields estimated for some of the subbasins affected by mining and logging but not by highway construction within the Coal River drainage (fig. 1) during this period were: Spruce Fork, 1,450 tons/mi^2; Pond Creek, 2,500 tons/mi^2; and Drawdy Creek, 2,500 tons/mi^2 (Bader and others, 1977). Annual sediment yield of the Coal River at Tornado (site 7) was about 800 tons/mi^2. In contrast, the average annual sediment yield at site 7 during water years 1975-81, was only 536 tons/mi^2 (table 4).

Curves representing the suspended-sediment load and streamflow relationships for the four mainstem sites during water years 1975-81 are shown in figure 5.

The positions and the slopes of the curves for sites 3, 4, and 5 are somewhat similar, which indicates that the relations of streamflow and suspended-sediment load at the Big Coal near Alum Creek, Little Coal at Danville, and Little Coal at Julian are nearly the same. The slope of the line of relation for site 7 is nearly the same as those of the other three, but is substantially shifted to the right. This probably reflects sediment disposition as a result of reduced water velocity in a 6-mile long reach of pooled water at site 7. Larger volumes of streamflow are required to transport an equal amount of sediment at site 7 than at sites 3, 4, and 5.

If highway construction significantly affects suspended-sediment yield in the Coal River basin, the relationships between suspended-sediment yield and time and runoff should differ or change. The relations of cumulative annual suspended-sediment yield with time for all four mainstem sites (fig. 6) showed no significant change. The relations between cumulative annual suspended-sediment yield and runoff at sites 3, 4, 5, and 7 are shown in figure 7. Similarly, no significant breaks or changes in slope of the relations for sites on the mainstem of the Coal River occur as would be expected if large amounts of sediment were contributed from the construction area. However, this does not imply that highway construction did not contribute suspended sediment to the Coal River. The curves show that the large volume of sediment contributed from other upstream sources

Table 4.--Annual suspended-sediment load and yield at selected sites in the Coal River basin
[All numbers rounded to three significant figures.]

	Big Coal River near Alum Creek (site 3)			Little Coal River at Danville (site 4)			Little Coal River at Julian (site 5)			Coal River at Tornado (site 7)		
		Yield			Yield			Yield			Yield	
Water years	Load (Tons)	(tons/mi^2)	[(tons/mi^2)/ in. of runoff]	Load (Tons)	(tons/mi^2)	[(tons/mi^2)/ in. of runoff]	Load (Tons)	(tons/mi^2)	[(tons/mi^2)/ in. of runoff]	Load (Tons)	(tons/mi^2)	[(tons/mi^2 in. of runo
1975	286,000	642	23.5	156,000	580	22.9	210,000	660	24.6	488,000	566	22.4
1976	63,800	143	10.7	60,100	223	16.2	67,900	214	13.5	144,000	167	12.5
1977	217,000	488	30.5	148,000	551	33.4	219,000	689	41.0	447,000	519	33.7
1978	362,000	813	35.1	222,000	823	39.8	289,000	909	39.6	715,000	829	40.5
1979	394,000	886	28.7	266,000	988	32.7	318,000	1000	30.8	778,000	903	32.1
1980	236,000	530	21.5	161,000	600	23.4	186,000	585	22.5	468,000	543	23.5
1981	109,000	245	16.3	62,700	233	15.4	76,600	241	15.9	194,000	225	15.1
Average annual	238,000	535	23.8	154,000	571	26.3	195 000	614	26.8	462,000	536	25.7

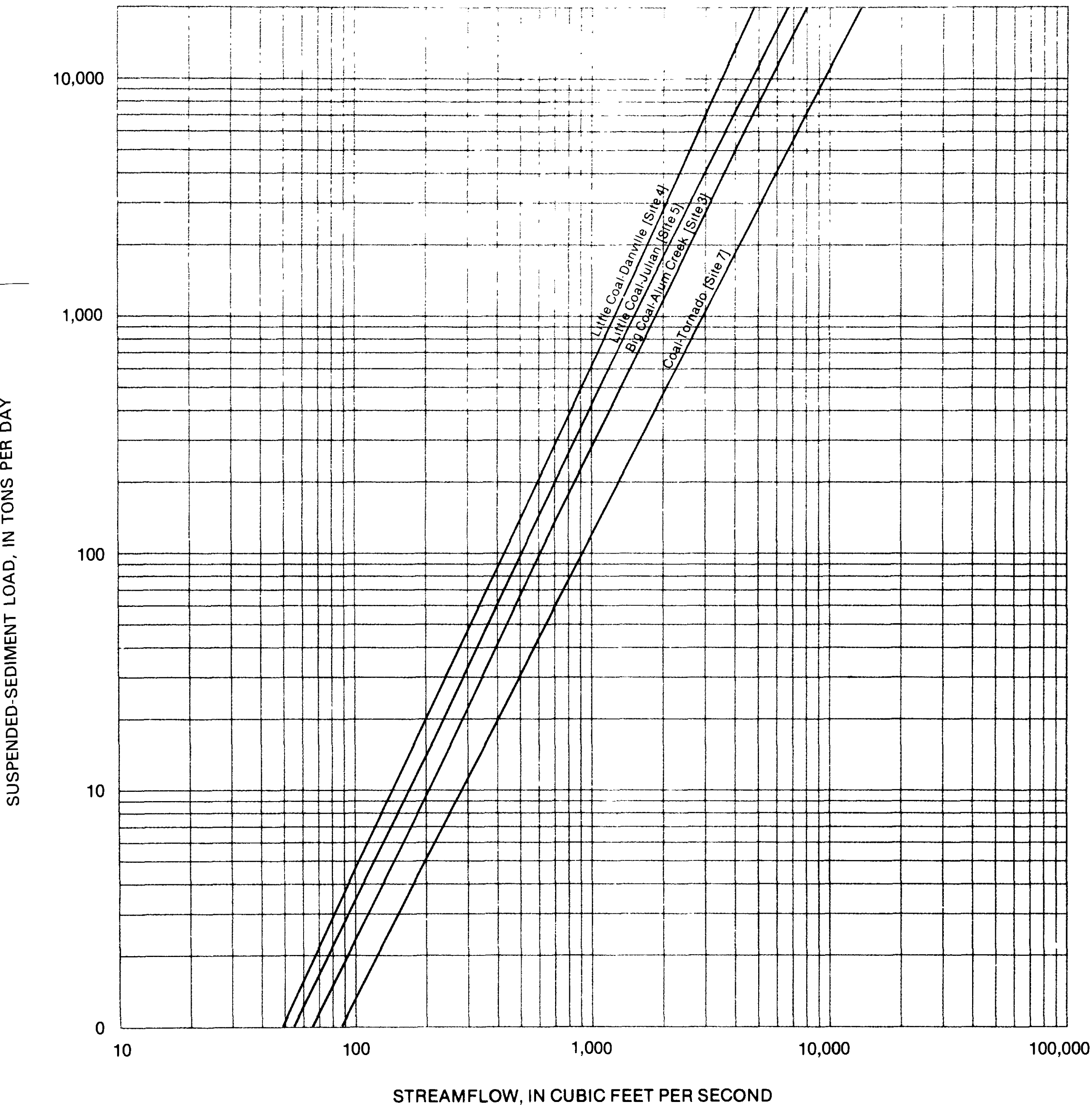

Figure 5. Relation between daily suspended-sediment load and streamflow at sites in the Coal River basin, water years 1975-81.

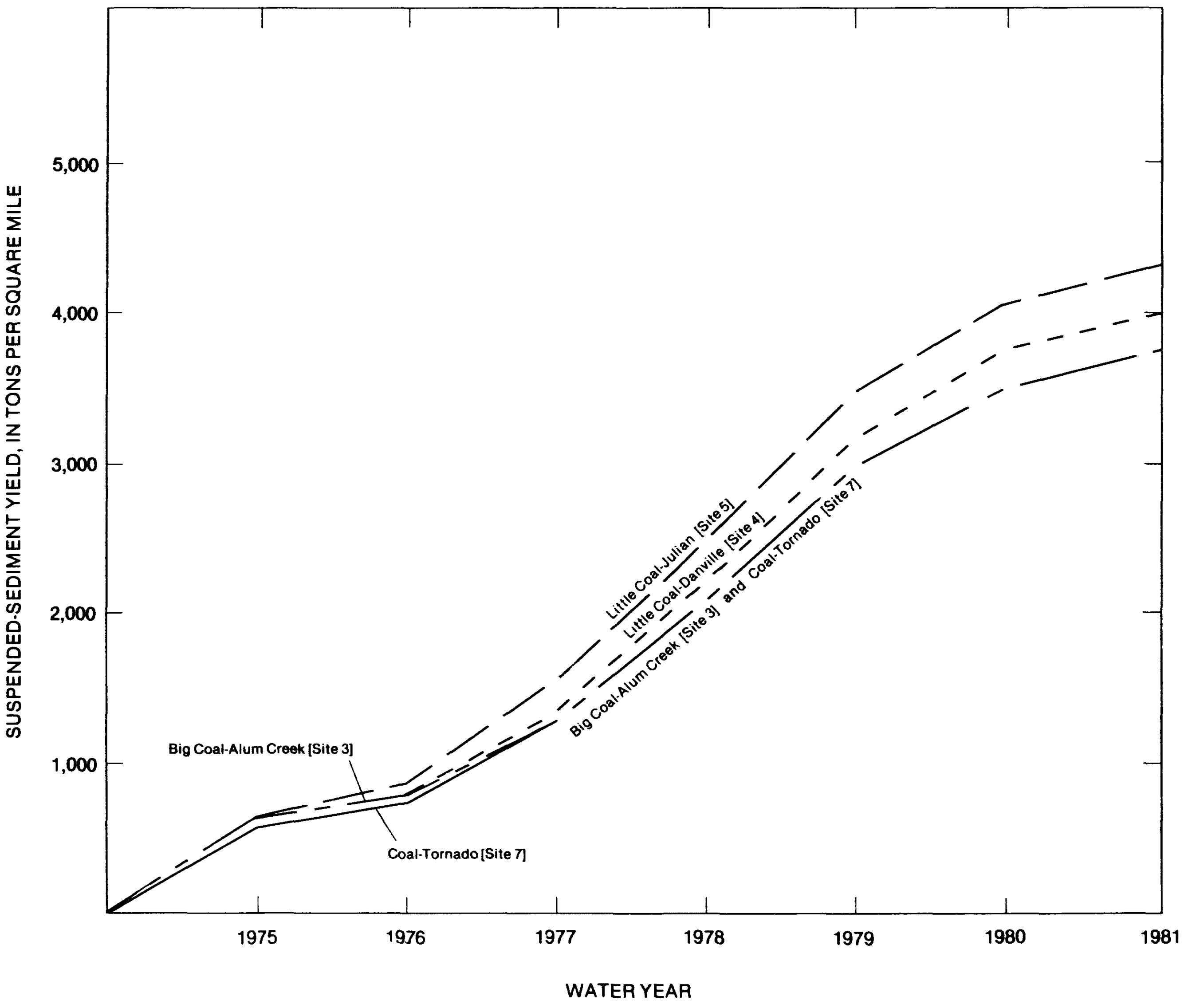

Figure 6. Relation of cumulative annual suspended-sediment yield and time at the sites in the Coal River basin.

and the volume of water in the Coal River simply masks the amount contributed by highway construction. Data were not available to differentiate highway construction-derived sediment yields from the normal annual suspended-sediment yield of the Coal River basin.

TRACE FORK BASIN

Highway Construction

The only major land disturbance in the Trace Fork basin during the study period was the construction of Appalachian Corridor G highway. The highway crosses Trace Fork approximately one-quarter mile downstream from Ruth and parallels the full length of Dryden Hollow, a major tributary to Trace Fork (fig. 2).

From July 1979 to May 1980 about 128 acres of right-of-way area were cleared of vegetation (approximately 4.2 percent of the basin area), and from October 1979 to July 1981 approximately 3 million yd^3 of material were excavated in the 1.6-mile segment of new highway in the basin. Paving of the highway started in the summer of 1982.

No mining, logging, construction, or other major sediment-producing activities in the Trace Fork basin occurred upstream from the confluence of Dryden Hollow during this period (1978-79). This area is relatively undisturbed, except for some single-family houses and unimproved roads.

Runoff

Continuous-streamflow records collected at Trace Fork at Ruth and Trace Fork downstream from Dryden Hollow at Ruth (sites 1 and 2 in figure 2) are published in the Geological Survey report, "Water Resources Data - West Virginia, Water Year 1982" (1983). Runoff from July 1980 to September 1981 at site 1 upstream from the highway-construction area was 17.1 in., whereas runoff at site 2 downstream from construction was 17.9 in. The difference in runoff between the sites (0.8 in.) is within the accuracy of measurement and is considered insignificant. No significant trend or breaks in slope were found in a comparison of cumulative monthly runoff between the two sites. The relation of cumulative monthly runoff at site 1 to that at site 2 is shown in figure 8. This indicates that highway construction had little, if any, effect on runoff.

Maximum daily mean and instantaneous peak discharges at sites 1 and 2 during the 15-month period of record were recorded on July 10, 1980. The peak flow at site 1 was 223 ft^3/s and at site 2 was 430 ft^3/s; the maximum daily mean discharges were 32 and 92 ft^3/s.

Suspended Sediment

Collection of suspended-sediment data above and below highway construction in Trace Fork started in July 1980. Site locations are shown in figure 2. Daily suspended-sediment discharge computed for the unaffected Trace Fork at Ruth subbasin (site 1) and the total Trace Fork basin downstream from Dryden Hollow at Ruth (site 2) for the period July 1980 to September 1981 are published in the Geological Survey report, "Water Resources Data - West Virginia, Water Year 1982" (1983). The suspended-sediment load and yield data for the two sites are summarized in table 5.

Cumulative monthly suspended-sediment yields for sites 1 and 2 are shown in figure 9. Major changes in slope between the curves during July and August indicate that the yield measured at site 2 increased at a more rapid rate than that at site 1. Similarly, the data given in table 5 indicate that the sediment load transported at site 2 was about five times greater than that at site 1. To determine how much of the sediment load at site 2 (table 5) was derived from the construction area, it was necessary to estimate the normal background sediment load at site 2. The normal background sediment load can be estimated as follows:

$$Sed_{N2} = (A_2 / A_1) \times Sed_1 \qquad \text{(a)}$$

where:

Sed_{N2} = estimated background sediment load(tons) at site 2,
A_2 = the drainage area (mi^2) at site 2,
A_1 = the drainage area (mi^2) at site 1, and
Sed_1 = the sediment load (tons) at site 1.

The estimated background load (Sed_{N2}) is an indication of the normal sediment load

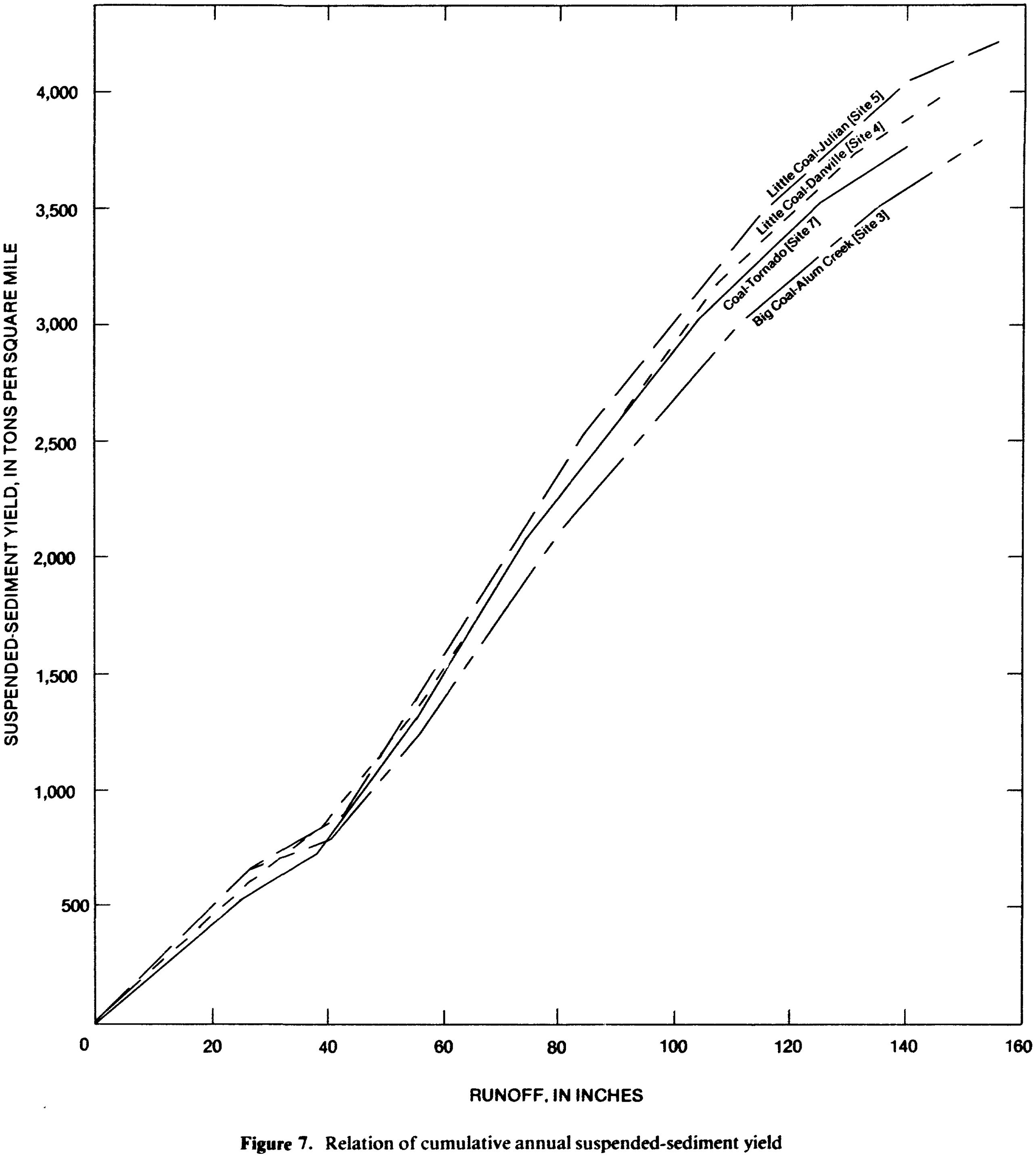

Figure 7. Relation of cumulative annual suspended-sediment yield and runoff at sites in the Coal River basin, water years 1975-81.

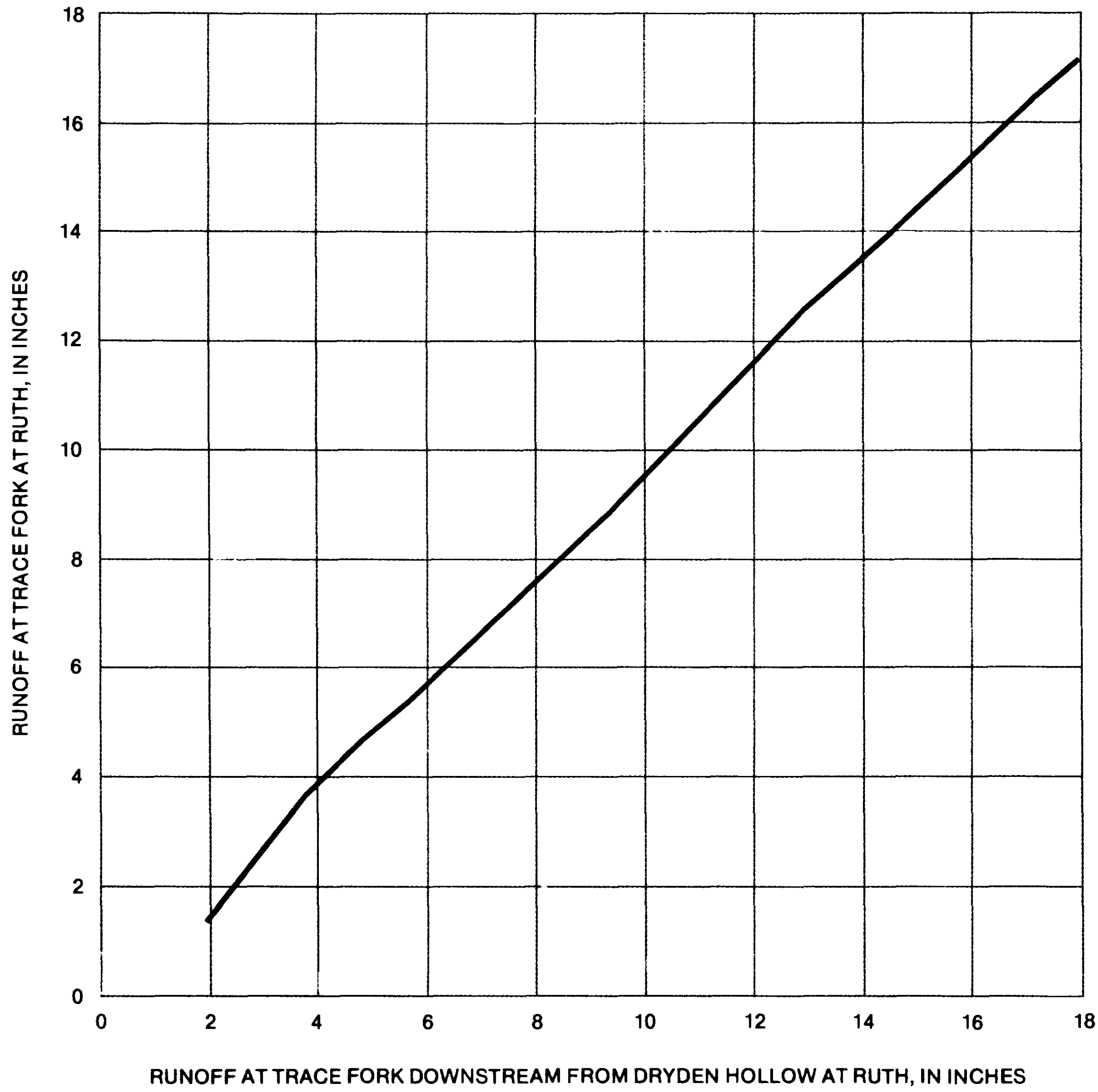

Figure 8. Relation of cumulative monthly runoff between Trace Fork at Ruth and Trace Fork downstream from Dryden Hollow at Ruth, July 1980 to September 1981.

Table 5.--Suspended-sediment data for Trace Fork sites

Period of record	Trace Fork at Ruth (site 1)		Trace Fork downstream from Dryden Hollow at Ruth (site 2)	
	Load (tons)	Yield (tons/mi^2)	Load (tons)	Yield (tons/mi^2)
July-Sept. 1980	192.95	68.42	1,346.72	285.32
Oct. 1980-Sept. 1981	303.48	107.62	1,038.30	219.98
Total	496.43	176.04	2,385.02	505.30

from Trace Fork downstream from Dryden Hollow at Ruth (site 2) based on measured loads from the unaffected areas above site 1. The difference between the measured load and the estimated normal background load at site 2 can be directly attributed to highway construction.

The sediment discharge during the 15-month period at site 1 was 496 tons (a yield of 176 tons/mi^2), whereas the discharge at site 2 was 2,385 tons (a yield of 505 tons/mi^2). The background sediment discharge at site 2, computed from equation (a), was 830 tons. Therefore, the probable contribution from the highway construction area (0.20 mi^2) is about 1,555 tons, which is equivalent to about 7,800 tons/mi^2.

Estimates of monthly background suspended-sediment loads at site 2 and the load contribution from the highway construction area are shown in figure 10. The greatest monthly load contributed from the construction area (approximately 760 tons) was discharged in July 1980. However, less than 5 tons per month were discharged from that area in September and December 1980, and in January, March, and September 1981.

The maximum daily suspended-sediment concentration was recorded on July 10, 1980. Precipitation at the Ruth raingage on July 10 was 2.10 in. and was preceded by 1.15 in. on July 9. The July 10 storm was the only storm during the 15-month period that exceeded 2.0 in. in a 24-hour period. The daily mean

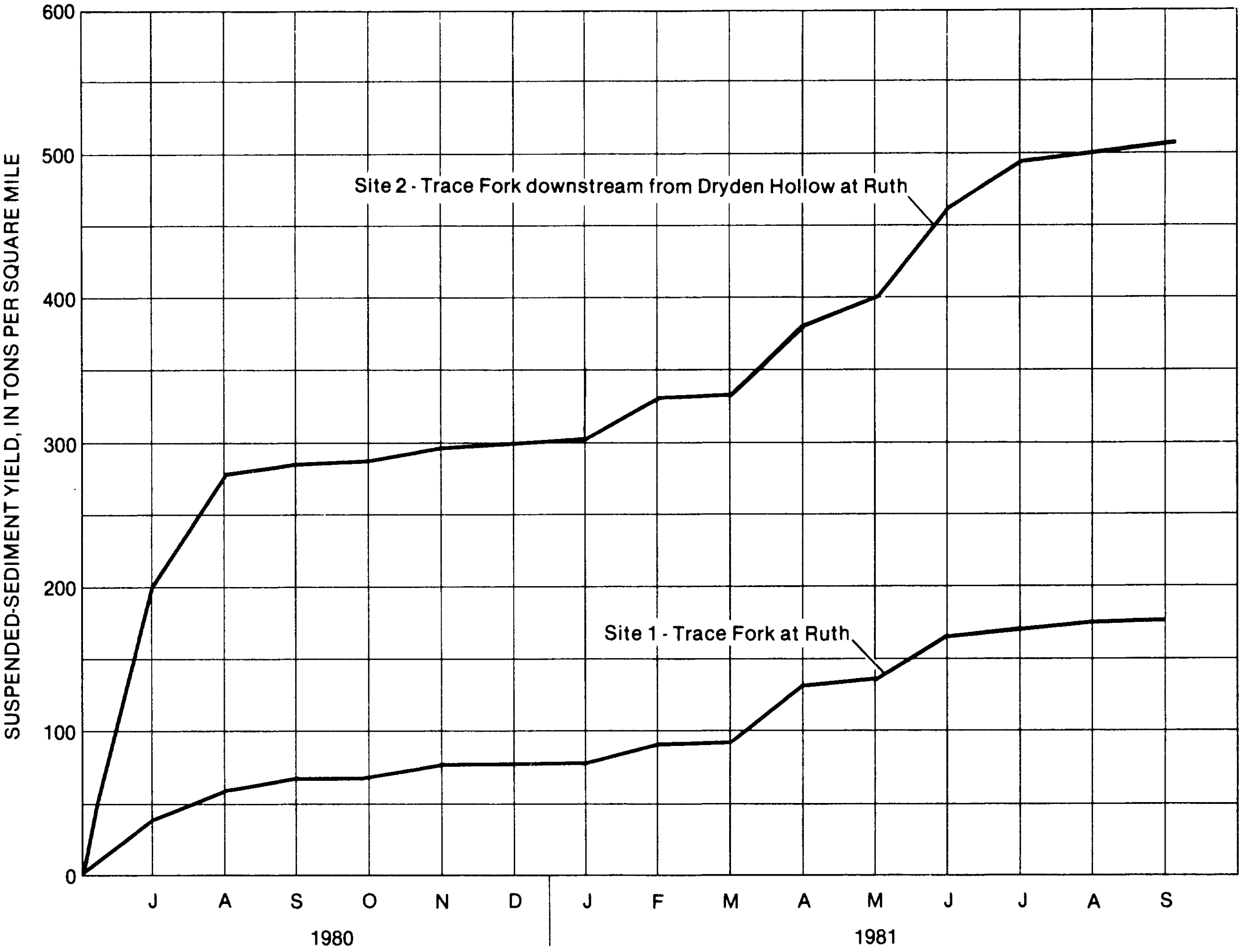

Figure 9. Cumulative monthly suspended-sediment yield for Trace Fork at Ruth and Trace Fork downstream from Dryden Hollow at Ruth.

sediment cocentration at site 1 was 852 mg/L and the daily sediment load was 74 tons. At site 2 the daily mean concentration was 2,500 mg/L and the daily sediment load was 621 tons. The sediment loads discharged on July 10 represented about 15 and 26 percent of the total discharge from the 15-month period at sites 1 and 2. The background sediment load at site 2 on July 10 was estimated to be 124 tons (a yield of 26 tons/mi^2), and the contribution from the highway construction area was estimated to be 497 tons (a yield of 2,480 tons/mi^2).

A total of 5.89 in. of precipitation were measured at Ruth during July 9-13, 1980. The sediment discharge produced at sites 1 and 2 during these 5 days were 104 and 899 tons, or about 21 and 38 percent of the total suspended-sediment discharge during the 15-month study period.

Small or moderate amounts of precipitation can cause high suspended-sediment concentrations, depending on intensity of the storm and degree of soil disturbance. For example, 0.82 in. of precipitation recorded during the storm of September 15, 1981, produced a sediment concentration of 7,520 mg/L and a daily sediment load of 30 tons at site 2.

SUMMARY AND CONCLUSIONS

Large areas in the Little Coal and Big Coal River subbasins within the Coal River basin, and in Trace Fork basin of southern West Virginia have been disturbed by construction of Appalachian Corridor G, a four-lane highway. Highway construction occurred during 1972-75 along Turtle Creek, downstream from Danville in the Little Coal River basin, and in 1979-81, downstream from Julian in the Little Coal River, Big Coal River, and Trace Fork basins. During the latter period, approximately 18 million yd^3 of material were excavated along a 12-mile segment of roadway between Julian and the confluence of the Little and Big Coal Rivers.

From 1975 to 1981 daily suspended-sediment and runoff data were collected at mainstem sites on the Big Coal, Little Coal, and Coal Rivers to determine sediment contribution from highway construction areas in the Coal River basin. Suspended-sediment loads and runoff at the mainstem site were not significantly affected by highway construction. During the study period (1975-81), the average suspended-sediment yield of the Big Coal River at Alum Creek, upstream from highway construction, was 535 (tons/mi^2)/yr. Yields at two sites on the Little Coal River, both upstream from the construction zone, were 571 and 614 (tons/mi^2)/yr. The yield at Coal River at Tornado downstream from construction, the lowermost downstream site in the Coal River basin, was 536 (tons/mi^2)/yr.

Highway construction did contribute suspended sediment to the Little Coal, Big Coal, and Coal Rivers. However, the amount contributed was masked by that already in the rivers from natural runoff, logging, mining, and other sources in upstream areas, and by dilution from the large volume of water in the rivers.

From July 1980 to September 1981 runoff and suspended-sediment data were collected above and below highway construction in Trace Fork basin to determine sediment contribution from construction areas in the basin. Approximately 3 million yd^3 of material were excavated in a 1.6-mile segment of highway along Dryden Hollow, a major tributary to Trace Fork.

Unit runoff from the disturbed area in the Trace Fork basin was nearly the same as that from the unaffected or undisturbed parts of the basin. Suspended-sediment loads, however, were much higher in Trace Fork downstream from the construction area. Normal background sediment load at Trace Fork downstream from Dryden Hollow, the downstream site, for the 15-month period was estimated to be 830 tons; the measured load was 2,385 tons. Approximately 1,550 tons of suspended sediment were derived from the 0.20 mi^2 of disturbed area associated with highway construction.

The maximum daily mean runoff measured at Trace Fork downstream from Dryden Hollow was 92 ft^3/s and occurred on July 10, 1980, when a high-intensity storm produced 2.10 in. of rain in a 24-hour period. The normal background-sediment load at the downstream site during the storm was estimated to be 124 tons, but the total load measured was 621 tons. Of the total load, approximately 80 percent (497 tons) was contributed by the disturbed area.

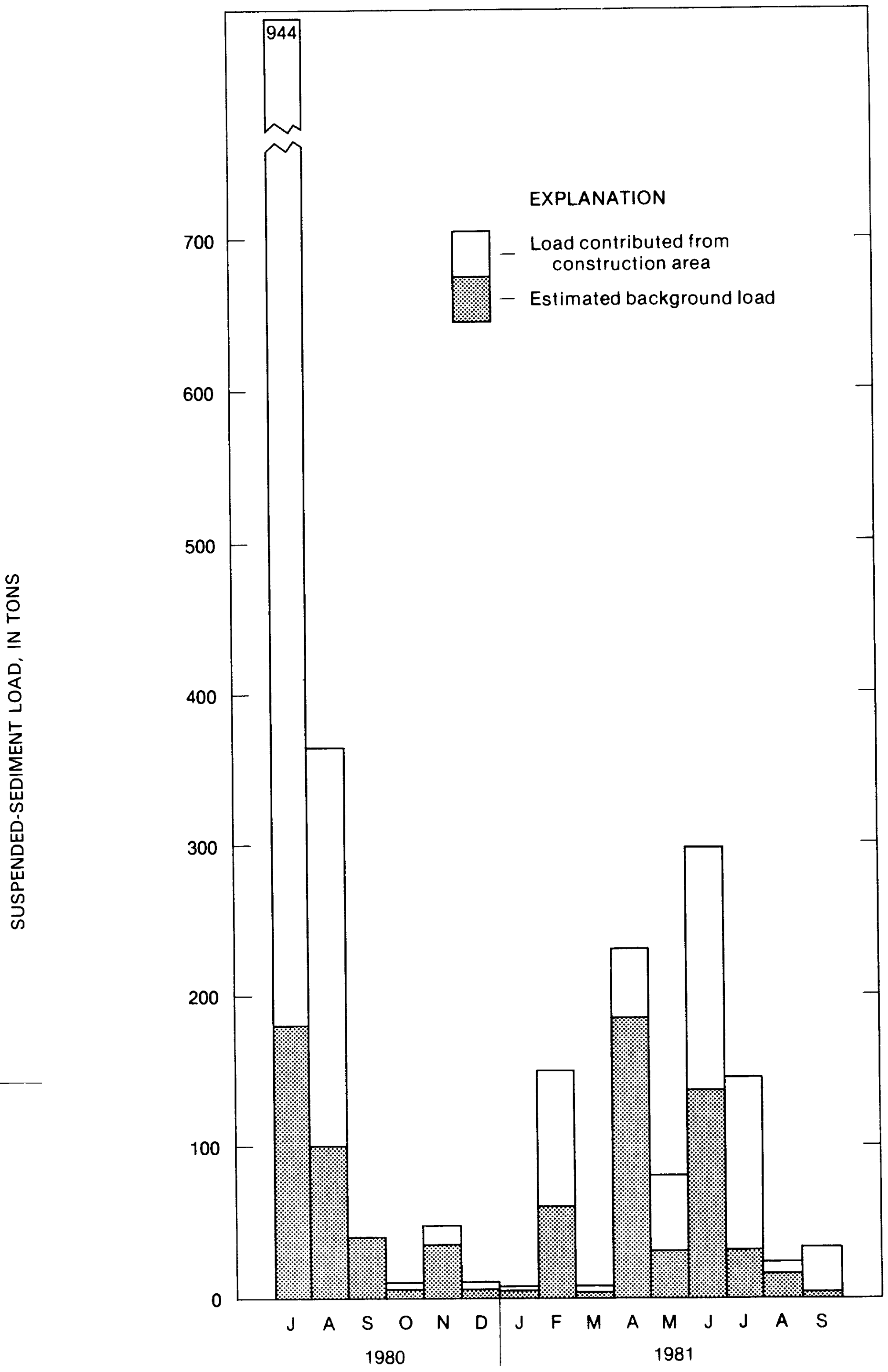

Figure 10. Monthly suspended-sediment load at Trace Fork downstream from Dryden Hollow at Ruth.

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Once-daily precipitation, in inches at Trace Fork downstream from Dryden Hollow at Ruth, West Virginia (site 2) for the year ending September 30, 1980[a]
[From U.S. Geological Survey files.]

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept
1										0.00	0.15	0.00
2										.00	.00	.00
3										.00	.02	1.05
4										.00	.01	.00
5										.00	.60	.00
6										.00	.00	.00
7										.50	.00	.30
8										.00	.40	.00
9										1.15	.00	.00
10										2.10	.15	.90
11										1.40	.00	.00
12										.04	.00	.00
13										1.20	.00	.00
14										.00	.00	.00
15										.00	1.50	.00
16										.00	.02	.00
17										.00	.10	.00
18										.00	.42	.00
19										.00	.74	.00
20										.00		.00
21										.00	.92	.90
22										.08	.60	
23										.20	.20	.68
24										.00	.00	.10
25										.00	.00	.30
26										.00	.00	.03
27										.00	.00	.00
28										1.90	.00	.00
29										.00	.00	.00
30										.00	.00	.10
31										.00	.80	--
Total										8.57	6.63	4.36

Once-daily precipitation, in inches at Trace Fork downstream from Dryden Hollow at Ruth, West Virginia (site 2) for the year ending September 30, 1981[a]
[From U.S. Geological Survey files.]

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept
1	0.03	0.00	0.00	0.00	0.05	0.00	--	--	--	0.60	0.00	0.00
2	.01	.00	.15	.25	1.50	.30	--	--	--	.04	.00	.44
3	.20	.00	.10	.00	.00	.00	--	--	--	.00	.06	.03
4	.05	.20	.00	.00	.00	.20	--	--	--	.02	.00	.34
5	.04	.00	.05	.00	.00	.40	--	--	--	.09	.00	.00
6	.01	.00	.00	.00	.00	.00	--	--	--	.92	.84	.00
7	.00	.00	.00	.30	.00	.05	--	--	--	.00	.32	.00
8	.00	.00	.00	.00	1.00	.00	--	--	--	.00	.60	.16
9	.00	.00	.60	.00	.00	.00	--	--	--	.14	.00	.20
10	.00	.40	.05	.00	.05	.00	--	--	--	.00	.00	.00
11	.00	.00	.00	.10	.00	.00	--	--	--	1.32	.00	.00
12	.00	.00	.00	.10	.80	.00	--	--	--	.00	.30	.00
13	.00	.00	.00	.00	.00	.00	--	--	--	.00	.00	.00
14	.00	.00	.00	.00	.00	.00	--	--	--	.13	.00	.00
15	.00	.80	.00	.05	.00	.00	--	--	--	.00	.00	.82
16	.00	.00	.20	.00	.05	.50	--	--	--	.04	.30	1.00
17	.00	1.20	.00	.00	.15	.05	--	--	--	.00	.00	.00
18	.24	.10	.00	.00	.05	.30	--	--	--	.00	.00	.00
19	.30	.00	.05	.00	.10	.05	--	--	--	.00	.00	.44
20	.00	.00	.00	.00	.10	.00	--	--	--	.00	.00	.00
21	.00	.00	.00	.40	.40	.00	--	--	--	.03	.00	.00
22	.00	.00	.00	.05	.00	.00	--	--	--	.00	.00	.00
23	.00	.20	.00	.00	1.00	.00	--	--	--	.03	.00	.00
24	.00	.70	.20	.00	.00	.15	--	--	--	.00	.00	.00
25	.80	.15	.20	.00	.20	.00	--	--	--	.00	.00	.00
26	.00	.00	.00	.00	.00	.00	--	--	--	.00	.00	.00
27	.00	.20	.00	.00	.00	.30	--	--	--	.00	.00	.00
28	.40	.20	.00	.00	.30	.00	--	--	--	.16	.00	.00
29	.30	.05	.00	.00	--	.00	--	--	--	.70	.00	.00
30	.00	.00	.40	.00	--	.15	--	--	--	.00	.00	.30
31	.00	--	.05	.00	--	.00	--	--	--	.00	.14	--
Total	2.38	4.20	2.05	1.25	5.75	2.45	[b]4.20	[b]4.00	[b]6.20	4.22	2.56	3.73

[a] Readings made once daily by sediment observer.
[b] Estimated from 4 nearby stations.