FLUVIAL SEDIMENTATION IN KENTUCKY

By Russell F. Flint

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

Multiply inch-pound units	By	To obtain SI units
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
acre	0.4047	hectare square hectometer (hm^2)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic yard (yd^3)	0.7646	cubic meter (m^3)
ton (short)	0.0972	metric ton (t) megagram (Mg)
ton per day (short ton/d)	0.9072	metric ton per day (t/d) megagram per day (Mg/d)
ton per square mile per year [(ton/mi^2)/yr]	0.3503	metric ton per square kilometer per year [(t/km^2)/a] [(Mg/km^2)/a]
pound per cubic foot (lb/ft^3)	16.02	kilogram per cubic meter (kg/m^3)

ALTITUDE DATUM

The National Geodetic Vertical Datum of 1929 (NGVD of 1929) replaces mean sea level as the datum to which relief features and altitude data are referenced. The NGVD of 1929, derived from a general adjustment of the first-order leveling networks of both the United States and Canada, is referred to as sea level in this report.

DEFINITION OF TERMS

Acre-foot The quantity of water required to cover 1 acre to a depth of 1 foot, and is equivalent to 43,560 cubic feet or about 326,000 gallons.

Association, soil A group of soils geographically associated in a characteristic repeating pattern (Latham, 1969, p. 83).

Bedload Sediment that is transported in a stream by rolling, sliding, or skipping along the bed and very close to it; that is within the bed layer (Colby, 1963, p. vi).

Bed material The sediment mixture of which the stream bed is composed (U.S. Geological Survey, 1977, p. 3-5).

Contributing area of a drainage basin The part of a drainage basin which contributes its surface runoff to that flowing past a downstream gaging station.

Cropland is land in tillage rotation, orchards, and open land formerly cropped (U.S. Department of Agriculture, 1970, p. 251).

Discharge of water or sediment Time rate of movement of volume or weight of water or sediment past a point or through a cross section (Colby, 1963, p. vi).

Depth soil Depth refers to the depth from the surface of the soil to bedrock or other nonsoil material. The depth classes are (1) deep, more than 40 inches; (2) moderately deep, 20 to 40 inches; and (3) shallow, less than 20 inches (Humphrey, 1974).

Drainage class (natural) Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized (Humphrey, 1976).

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Federal land Includes military installations, national forests, national wildlife refuges, hospitals, and other federally-owned land outside of urban and built-up areas (U.S. Department of Agriculture, 1970, p. 251).

Fluvial sediment Sediment that is transported by, suspended in, or that has been deposited in beds by water (Colby, 1963, p. vi).

Forest is land which is at least 10 percent stocked by forest trees of any size capable of producing timber or wood products, or capable of exerting an influence on water regime, lands from which the trees have been removed to less than 10 percent stocking and which have been developed for other use, and afforested (planted) areas.

Fragipan Very compact soil horizons, rich in silt, sand, or both, and usually relatively low in clay. They commonly interfere with water and root penetration. (U.S. Department of Agriculture, 1951, p. 243).

Load The quantity by weight or mass of dissolved or undissolved material which is carried by a stream, without regard to rate of movement.

NASQAN Abbreviation for National Stream-Quality Accounting Network.

Other land is non-federal rural land not classified as cropland, pasture, forest, or urban and built-up. Other land includes farmsteads, farm roads, feedlots, ditch banks, rural and non-farm residences, investment tracts, strip mines, and other miscellaneous uses (U.S. Department of Agriculture, 1970, p. 253)

Pasture is land in grass and legumes in long-term growth that is used primarily for grazing (U.S. Department of Agriculture, 1970, p. 252).

Runoff in inches The depth to which the drainage area would be covered if all the runoff for a given time period were uniformly distributed on it.

Sediment Fragmental material that originates from the disintegration of rock and is transported by, suspended in, or deposited by water or air, or is accumulated in beds by other natural agencies (Colby, 1963, p. vi). It includes organic material and chemical and biochemical precipitates.

Sediment concentration Ratio of dry weight of sediment to the total weight or volume of the water-sediment mixture.

Solum The upper part of a soil profile, including the A and B horizons, in which soil-forming processes occur.

Suspended load That part of the sediment load which is suspended sediment (U.S. Geological Survey, 1977, p. 3-10).

Suspended-sediment yield The suspended-sediment outflow from a drainage basin in a specific period of time and usually expressed in terms of mass or volume per unit of time.

Total sediment yield The total sediment outflow from a drainage basin in a specific period of time. It includes bedload as well as suspended load, and usually is expressed in terms of mass or volume per unit of time.

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ABSTRACT

This report, covering periods 1942-45 and 1951-81, documents the characteristics of sediment being transported from 79 drainage areas within the Commonwealth of Kentucky, and at eight stations on the main stem of the Ohio River. The drainage areas, excluding the Ohio River, range in size from 0.67 square mile on Cane Branch near Parkers Lake to 40,330 square miles on the Tennessee River near Paducah. The drainage areas on the Ohio River range from 62,000 square miles at Greenup Dam to 203,100 square miles at Lock and Dam 53 near Grand Chain, Illinois. Sediment yields and particle size of suspended and bed sediments are discussed for the five major physiographic regions of Kentucky and for the Ohio River stations.

The Blue Grass region had the highest average annual suspended-sediment discharge of 741 tons per square mile. The Eastern Coal Field had the broadest range of average annual yields ranging from 25 tons per square mile at Helton Branch near Greenwood to 21,000 tons per square mile at Millers Creek near Phyllis. For sampling stations, the Jackson Purchase region had the highest median value of annual suspended-sediment yield of 535 tons per square mile.

For particle-size distribution of suspended sediment, the Eastern Coal Field had the highest average for sand at 11 percent, ranging from 1 to 27 percent, and the Blue Grass region had the lowest average at 1.6 percent, ranging from 1 to 3 percent. Average percent silt varied in the regions by only 12 percent with the Western Coal Field, the lowest at 30 percent, and the Mississippian Plateau, the highest at 42 percent.

The bedload discharge was estimated for selected stations to be 5 to 10 percent as much as the suspended-sediment discharge.

All except three of the drainage areas had average annual yields which fell below the average annual erosion rates for cultivated land in Kentucky of 9.93 tons per acre (6,355 tons per square mile). These three exceptions were in the Eastern Coal Field.

INTRODUCTION

A knowledge of the quantity and characteristics of sediment in streams in Kentucky is useful in the development, management, protection, and conservation of water resources. Even though some occurs naturally in streams, excessive sediment has been widely recognized as a major pollutant. Many of man's activities such as agriculture, lumbering, mining, and urban development may increase the sediment in streams and thus impair esthetic and the recreational, municipal, and industrial uses of the water. In its Erosion and Sedimentation Control Manual, the Pennsylvania Department of Environmental Resources (1978, p. 1), emphasizing the role of sediment as a pollutant, states: "Sediment creates an unhealthy habitat for fish, destroys the balanced biological conditions necessary for a diverse aquatic community, and smothers stream organisms. Sediment carries with it fertilizers which accelerate the aging of lakes and ponds and pesticides which have a toxic effect on aquatic organisms . . . . Sediment increases floodcrests, reduces the water-carrying capacity of water courses, fills navigation channels . . ." This list of adverse impacts emphasizes the point of why a knowledge of sediment characteristics of streams is essential to good stream management.

The earliest sediment sampling of Kentucky streams was conducted by the U.S. Army Corps of Engineers during the period December 1878 to December 1879, at the Ohio River at Paducah (U.S. Army Corps of Engineers, 1977). The Corps also collected sediment samples on the Ohio River during the periods April 1929 to May 1929 and June 1942 to April 1944, at Metropolis, Illinois, in May 1943 at Evansville, Indiana, and from November 1942 to March 1945, at Cincinnati, Ohio. These were mainly intermittent, high-flow samplings.

The first U.S. Geological Survey sediment sampling station in Kentucky was a daily sampling station established at Green River at Munfordville in April 1951. By 1982, sediment data had been collected at 58 daily locations and at 33 partial-record stations or at 87 different points in the State. These stations are listed in table 1 and shown in figure 1. The station at Green River at Munfordville has continued in operation as a Federal Index station to the present time.

Purpose and Scope

This study was made in cooperation with the Kentucky Geological Survey for the overall purpose of expanding the knowledge of sediments transported by streams, and to relate this knowledge to the five major physiographic regions of the State. Intermittent and daily collected data were used to determine sediment yields. Sixteen sites were specifically chosen for this study, and data from the 12 partial-record sites of the National Stream-Quality Accounting Network were incorporated in the study. These latter data were collected on a frequency of about once per month. Also, some daily

Table 1.--Drainage area, physiographic region, and period of record for each network sediment station

D, Daily record; P, Partial record; do, ditto

Station number	Station	Drainage area (mi^2)	Contributing area (mi^2)	Period of sediment record	Type of record
	Eastern Coal Field				
03207845	Card Creek at Mouthcard[1]	4.18	Same	1974-75	D
03207875	Feds Creek at Fedscreek[1]	11.6	do	1973-75	D
03207905	Big Creek at Dunlap[1]	9.55	do	1974-75	D
03207925	Island Creek near Phyllis[1]	2.42	do	1974-75	D
03207935	Lick Creek at Lick Creek[1]	6.70	do	1973-76	D
03207940	Millers Creek near Phyllis[1]	1.68	do	1974-75	D
03207962	Dicks Fork at Phyllis[1]	.82	do	1975-79	D
03207965	Grapevine Creek near Phyllis[1]	6.20	do	1973-79	D
03208000	Levisa Fork below Fishtrap Dam near Millard	392	do	1973-75	P
03209300	Russell Fork at Elkhorn City	554	do	1979-81	D
03209500	Levisa Fork at Pikeville	1,232	do	1980-81	D
03210000	Johns Creek near Meta	56.3	do	1974-	D
03210040	Raccoon Creek near Zebulon[1]	14.8	do	1974-75	D
03210160	Caney Fork near Gulnare[1]	3.74	do	1974-75	D
03210310	Brushy Fork near Heenon[1]	20.4	do	1974-76	D
03210420	Buffalo Creek near Endicott[1]	6.21	do	1974-75	D
03211500	Johns Creek near Van Lear	206	do	1974-75	D
03212500	Levisa Fork at Paintsville	2,144	do	1953-54, 60-73,77-	D
03215000	Big Sandy River at Louisa	3,897	do	1979-	P
03216500	Little Sandy River near Grayson	400	do	1979-81	D
03217000	Tygarts Creek near Greenup	242	do	1956-73, 79-82	D
03248500	Licking River near Salyersville	140	do	1979-81	D
03249500	Licking River near Farmers	826	do	1960-67	D
03250100	North Fork Triplett Creek near Morehead	84.7	do	1977-81	P
03277500	North Fork Kentucky River at Hazard[1]	466	do	1979-81	D
03278500	Troublesome Creek at Noble	177	do	1977-81	P
03280000	North Fork Kentucky River at Jackson	1,101	do	1979-81	D
03280600	Middle Fork Kentucky River near Hyden	202	do	1976-81	D
03281000	Middle Fork Kentucky River at Tallega[1]	537	do	1979-81	D
03281100	Goose Creek at Manchester	163	do	1977-81	P,D
03281500	South Fork Kentucky River at Booneville	722	do	1979-81	D
03282500	Red River near Hazel Green	65.8	do	1977-81	P
03400990	Clover Fork at Harlan	222	do	1980-81	D
03401000	Cumberland River near Harlan	374	do	1979-81	D
03402000	Yellow Creek near Middlesboro	60.6	do	1977-81	P,D
03403000	Cumberland River near Pineville	809	do	1979-81	D
03403500	Cumberland River at Barbourville	960	do	1979-81	D
03403910	Clear Fork at Saxton	331	do	1979-81	D

Table 1.--Drainage area, physiographic region, and period of record for each network sediment station--Continued

Station number	Station	Drainage area (mi^2)	Contributing area (mi^2)	Period of sediment record	Type of record
03404000	Cumberland River at Williamsburg	1,607	Same	1953-62, 79-81	D
03404500	Cumberland River at Cumberland Falls	1,977	do	1980-	D
03406500	Rockcastle River at Billows	604	do	1979-81	D
03407100	Cane Branch near Parkers Lake	.67	do	1956-66, 1973-74	D
03407300	Helton Branch near Greenwood	.85	do	1957-58, 65-66	D
03410500	South Fork Cumberland River near Stearns	954	do	1979-81	D
	Blue Grass region				
03251000	North Fork Licking River near Lewisburg	119	Same	1977-81	P
03251500	Licking River at McKinneysburg	2,326	do	1952-73	D
03254000	Licking River at Butler	3,375	do	1974-	P
03287500	Kentucky River at lock 4 at Frankfort	5,411	5,289	1952-73	D
03289500	Elkhorn Creek near Frankfort	473	402	1977-81	P
03290500	Kentucky River at lock 2 at Lockport[1]	6,180	5,984	1973-	P
03291500	Eagle Creek near Glencoe	437	Same	1961-68	D
03297845	Floyds Fork near Crestwood	46.7	do	1979-81	P
03296000	Plum Creek subwatershed No. 4 near Simpsonville	1.55	do	1956-64	D
03297500	Plum Creek at Waterford	31.8	do	1954-61	D
03298500	Salt River at Shepherdsville	1,197	1,190	1952-61, 80-	D,P
03301630	Rolling Fork near Lebanon Junction	1,375	1,370	1974-	P
	Mississippian Plateau region				
03307000	Russell Creek near Columbia	188	173	1977-81	P
03308500	Green River at Munfordville[3]	1,673	1,497	1951-	D
03310300	Nolin River at White Mills	357	237	1977-81	P
03310400	Bacon Creek near Priceville	85.4	54.2	1978-81	P
03314500	Barren River at Bowling Green	1,849	1,362	1952-60	D
03318500	Rough River at Falls of Rough	504	397	1952-56	D
03407500	Buck Creek near Shopville	165	Same	1977-81	P
03438000	Little River near Cadiz	244	150	1977-81	P
03438220	Cumberland River at Grand Rivers	17,598		1974-	P
03609750	Tennessee River at Hwy. 60 near Paducah[1]	40,330		1974-	P

Table 1.--Drainage area, physiographic region, and period of record for each network sediment station--Continued

Station number	Station	Drainage area (mi^2)	Contributing area (mi^2)	Period of sediment record	Type of record
	Western Coal Field				
03310500	Nolin River at Wax	600	378	1959-61	D
03316645	Green River at Rockport	6,183	4,803	1979-81	D
03319500	Rough River at Dundee	770	650	1979-81	D
03320000	Green River at lock 2 at Calhoun	7,566	6,032	1979-81	D
03320500	Pond River near Apex	194	192	1977-81	P,D
03321210	Cypress Creek near Calhoun	142	139	1979-81	D
03321230	Green River near Beech Grove	8,454	6,886	1974-	P
03321350	South Fork Panther Creek near Whitesville	58.2	57.7	1977-81	P
03321430	Panther Creek near Owensboro	324	Same	1979-81	D
03383000	Tradewater River at Olney	255	246	1952-73	D
03384180	Tradewater River near Sullivan[1]	861	833	1980-81	D
	Jackson Purchase region				
03610545	West Fork Clarks River near Brewers	68.7	Same	1977-81	P
03611260	Massac Creek near Paducah	14.6	do	1977-81	P
	Ohio River sediment stations				
03216600	Ohio River at Greenup Dam[1]	62,000	Same	1974-	P
03255000	Ohio River at Cincinnati, Ohio[1,2]	76,580	do	1943-45	P
03277200	Ohio River at Markland Dam[1]	83,170	do	1974-	P
03294500	Ohio River at Louisville[1]	91,170		1979-	D
03303280	Ohio River at Cannelton Dam[1]	97,000		1974-	P
03322000	Ohio River at Evansville, Indiana[1,2]	107,000		1943	P
03611500	Ohio River at Metropolis, Illinois[1,2]	203,000		1942-44	P
03612500	Ohio River at Lock & Dam 53 near Grand Chain, Illinois[1]	203,100		1973-	P

[1]Not included in regional average.
[2]Corps of Engineers sediment station.
[3]Period prior to operation of Green River Lake.

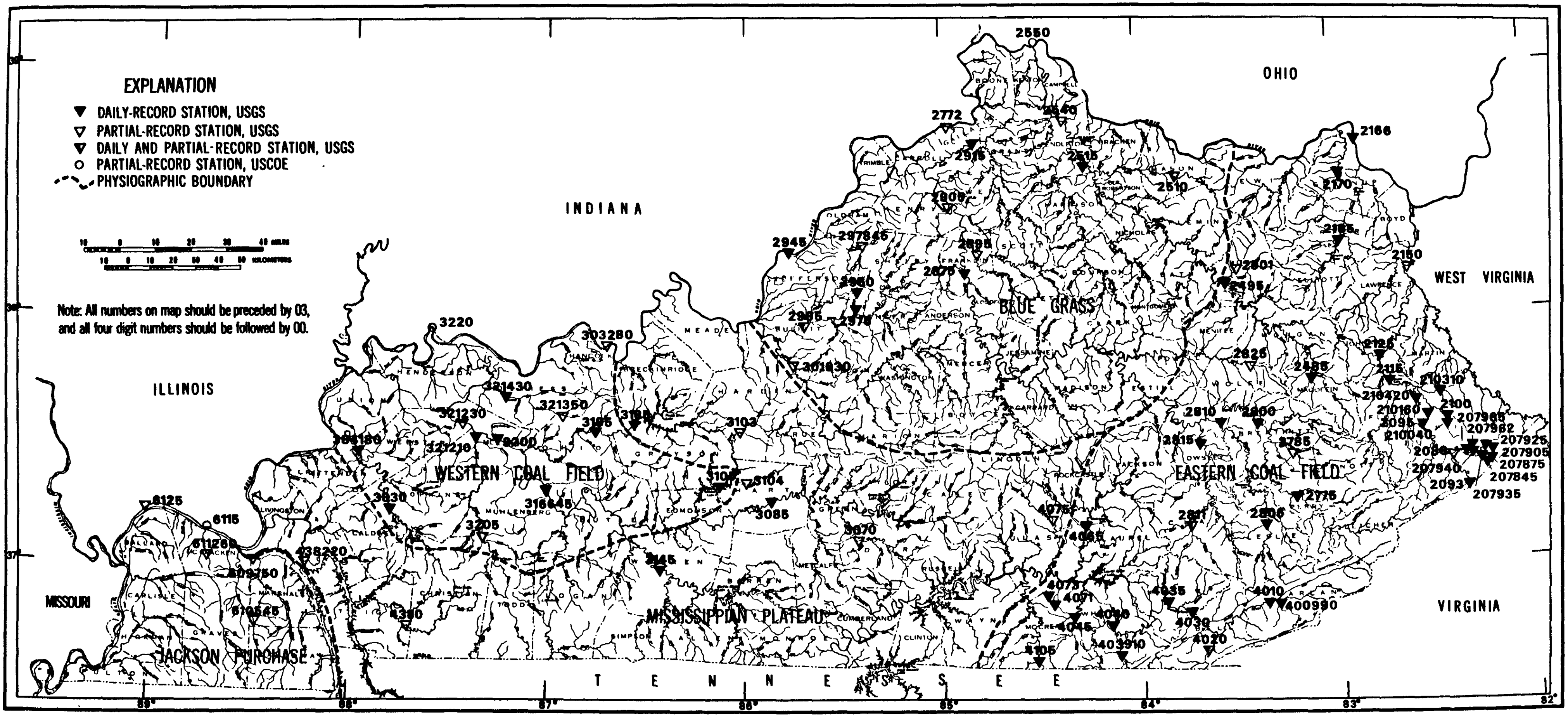

Figure 1.-- Suspended-sediment stations in Kentucky.

stations that were operating at the time this project started in 1977, were used to help define sediment characteristics of each physiographic region. As additional stations became operational, data from them were incorporated into the data base for this project.

The results of this study are presented by physiographic regions except for the Ohio River stations which are discussed in a separate section. The 16 stations which were established especially for this project are discussed in detail. Data for other daily and partial-record stations are found in tables thoughout the report.

Acknowledgements

Appreciation is expressed to several members of the Kentucky State Office of the U.S. Department of Agriculture, Soil Conservation Service, and to many members of that agency's area and field offices throughout the state. Reviews of the report by members of the U.S. Geological Survey both in Kentucky and elsewhere have enhanced the report. Sediment data of the U.S. Army Corps of Engineers were provided by the Louisville and Nashville District offices of the Corps.

FACTORS INFLUENCING SEDIMENT YIELDS

Precipitation

Precipitation is perhaps the most important factor which affects sediment yields in Kentucky. The amount, the distribution areally and seasonally, and the intensity or rate per unit time, all have a bearing upon the detachment and movement of soil materials into and through the stream system.

The mean annual precipitation in Kentucky varies geographically. According to Conner and Ashby (1979, p. 2), Kentucky's mean annual precipitation varies generally with latitude from about 40 inches in the Covington area in the northernmost part of the State to about 52 inches in the extreme southcentral and southeastern portions of the State. Figure 2, prepared by Conner and Ashby (1979), depicts the areas of equal precipitation throughout the State, based upon the period 1948-77.

The climate of Kentucky is of a continental type. Precipitation is influenced by the movement of storms from west to east over the State. Thunderstorms during the summer months account for a significant portion of the precipitation. The major portion of precipitation, however, is brought to Kentucky by moist tropical air originating over the Gulf of Mexico, and moving in a northeasterly path (Anderson, 1959, p. 124). Snowfall annually averages from 6 to 10 inches in the southwest to 15 to 20 inches in the southeast. (U.S. Department of Commerce, 1977, p. 3-4).

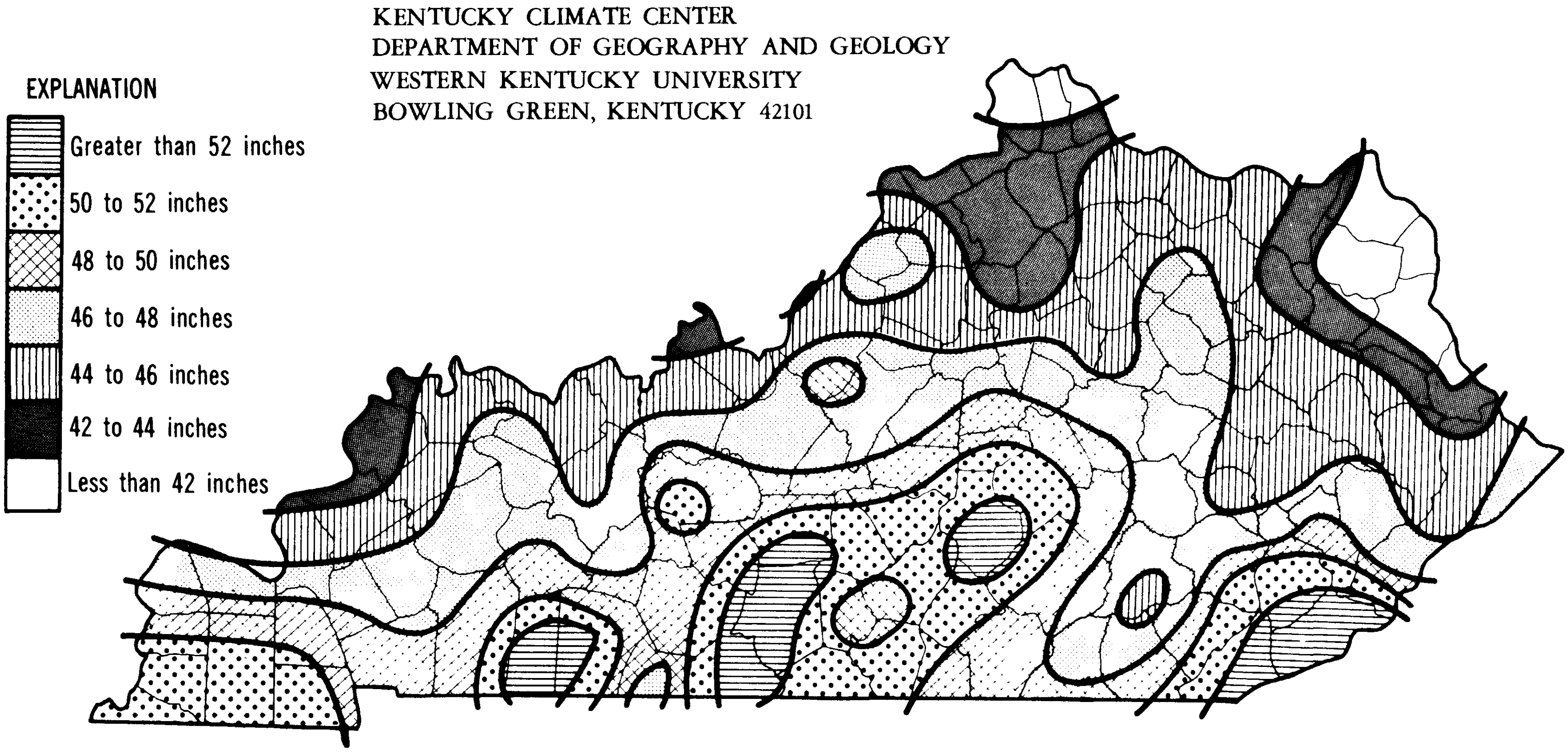

Figure 2.-- Mean-annual precipitation of Kentucky for the period 1948-77.

Topography

Topography is an important factor which affects sediment yields in that it directly influences runoff. The topography of Kentucky is mostly a series of eroded plateaus which decrease in altitude from east to southwest. Altitudes range from 4,145 feet above sea level at Black Mountain near the eastern extreme of Harlan County in the southeastern part of the State to less than 265 feet above sea level near the Mississippi River in the extreme western part of the State.

The State's total land area of 40,109 square miles consists of five major physiographic regions (fig. 1). They are the Eastern Coal Field, the Blue Grass, the Mississippian Plateau (Pennyroyal), the Western Coal Field, and the Jackson Purchase.

The Eastern Coal Field is the most rugged region. There is very little level land, and prime farmland comprises less than 10 percent of most counties. Most of the land is covered by forest. The valleys are deeply incised, and the ridges are sharp crested with exposed bedrock in many places. Most of the population is concentrated along the narrow flood plains of the streams. Economic activity of the region centers mainly around coal production.

The Blue Grass region is in the northcentral part of the State. The Ohio River forms the northern border of this region in Kentucky, although the region actually extends into southern Ohio. The region is bounded on the east by the Eastern Coal Field and on the south and west by the Mississippian Plateau. Gently rolling pastures and cropland make up the inner part of this region while the outer portions are more hilly, rugged, and forested.

The Mississippian Plateau region covers most of the southcentral part of the State. Two narrow extensions of this region reach to the Ohio River, and surround the Western Coal Field on three sides. The region is underlain by Mississippian limestone. Sinkholes have formed on much of the land surface. Fenneman (1938, p. 429) relates, "In its typical development this limestone plateau is without deep or steep valleys. Over large areas, relief is due more to solution than to surface streams."

The Western Coal Field region is an area of good farm land in northwestern Kentucky. It is underlain by rich coal reserves from which about half of the State's coal is produced. About 80 percent of the area is equally divided between cropland and forest (Karan and Mather, 1977, p. 110). Most of the remaining land is in pasture.

The Jackson Purchase region is the smallest of the five physiographic regions. The soils of the region have developed upon either Mississippi River sediments or upon loess which overlies the sediments (Karan and Mather, 1977, p. 110). The area is flat to rolling, and is used generally for growing crops. Loess is easily eroded where it occurs on slopes. It ranges from 30 to 65 feet deep along the Mississippi River in Kentucky to 10 to 15 feet deep near Kentucky Lake (Olive, 1980).

Runoff

Average runoff in Kentucky ranges from less than 15 inches at the extreme east and northeast sections of the State to about 24 inches in the southeast. The statewide average is about 18 inches which is more than twice as much as the average for the 48 contiguous states (Bell, 1963, p. 354). The differences statewide are partly due to the greater amounts of precipitation in the southeast, but runoff variations also depend upon vegetation cover, soil types, topography, and other factors.

The rate of runoff can be an important factor in the amount of sediment transported by streams. A thunderstorm of heavy rainfall of short duration can cause more sediment to be transported than a gentle rainfall of longer duration, even though the volume of runoff may be about the same for the two periods.

Runoff for the project stations is given in table 2. The values were obtained from U.S. Geological Survey 1979-81 water-data reports for Kentucky. In cases where the entire drainage area does not contribute to the runoff, the runoff values are adjusted for the non-contributing area. This is most important when computing sediment yields because runoff and sediment from the non-contributing portion of the drainage are not measured at the sampling stations. Data in table 2 are grouped by physiographic region so that they can be compared within and between regions.

Soils

The soils of Kentucky have been formed from bedrock, alluvium, wind-blown deposits, and to a small extent from glacial materials (Karraker, 1955, p. 3). The most widespread parent materials of Kentucky soils are sandstones, shales, and limestones. Alluvial soils are formed on bottom lands and terraces of streams to which the soil parent materials have been transported by water and redeposited. Aeolian (wind-blown) deposits have provided the materials for some soils in the western part of the State and along the Mississippi and Ohio Rivers. The soils of one area in the Blue Grass region in Boone and Kenton Counties, across the Ohio River from Cincinnati, have been formed from glacial till (Weisenberger, and others, 1973, p. 16, 24).

Soils formed from various parent materials result in many different textural classes. Texture refers to the coarseness or fineness of a soil. Soils are grouped according to percentages of the separates (sand, silt, clay) present, and are named according to the separate which contributes most to the character of the soil class (Millar, and others, 1958, p. 47-48). For example, a clay soil may contain only 40 percent clay, 45 percent sand, and 15 percent silt, but is called a clay, because clay imposes the greatest influence on the soil. Texture is directly related to the total surface area of the separates present in a soil (Millar, and others, 1958, p. 47). If the effects of the separates on a particular soil are balanced, the soil is

Table 2.--Runoff for study areas with adjustments for noncontributing area

Station number	Station	Runoff adjustment factor[1]	Average	Adjusted[2]	1978 water year	Adjusted[2]	1979 water year	Adjusted[2]	1980 water year	Adjusted[2]
					Runoff in inches per year					
	Eastern Coal Field									
03250100	North Fork Triplett Creek near Morehead	--	22.13	--	24.06	--	34.79	--	19.61	--
03278500	Troublesome Creek at Noble	--	21.94	--	22.68	--	29.40	--	17.17	--
03281100	Goose Creek at Manchester	--	22.99	--	31.49	--	31.13	--	19.71	--
03282500	Red River near Hazel Green	--	18.64	--	21.57	--	30.63	--	17.53	--
03402000	Yellow Creek near Middlesboro	--	25.99	--	35.56	--	40.91	--	32.17	--
	Blue Grass Region									
03251000	North Fork Licking River near Lewisburg	--	17.46	--	21.13	--	34.56	--	15.15	--
03289500	Elkhorn Creek near Frankfort	0.85	17.77	20.91	22.32	26.26	31.31	36.84	17.87	21.02
	Mississippian Plateau									
03307000	Russell Creek near Columbia	.92	21.24	23.09	25.24	27.43	47.02	51.11	19.61	21.32
03310300	Nolin River at White Mills	.66	19.17	29.05	26.34	39.91	36.92	55.94	21.12	32.00
03310400	Bacon Creek near Priceville	.63	9.59	15.22	11.67	18.52	20.19	32.05	9.81	15.57
03407500	Buck Creek near Shopville	--	23.13	--	33.15	--	52.54	--	21.47	--
03438000	Little River near Cadiz	.61	19.48	31.93	22.02	36.10	41.05	67.30	22.84	37.44
	Western Coal Field									
03320500	Pond River near Apex	.99	18.83	19.02	18.79	18.98	44.97	45.42	20.61	20.82
03321350	South Fork Panther Creek near Whitesville	.99	23.31	23.55	23.43	23.67	46.68	47.15	24.91	25.16
	Jackson Purchase Region									
03610545	West Fork Clarks River near Brewers	--	19.00	--	17.53	--	37.63	--	12.35	--
03611260	Massac Creek near Paducah	--	18.88	--	14.57	--	35.28	--	13.34	--

[1]Adjustment factor equals ratio of contributing area to total area.
[2]Adjusted runoff equals average divided by adjustment factor.

called a loam. Loams of one textural class or another comprise most of the soils in Kentucky (Karraker, 1955, p. 4-12). Figure 3 shows the textural class of soils according to percentages of sand, silt, and clay present.

The coarseness or fineness of a soil has a significant influence on the detachability and erodibility and thus, on the amount of soil materials (sediment) which reach stream systems. Coarse-grained soils have a tendency to absorb rainfall on level ground, but yield to raindrop impact and gravity on slopes and move intermittently downslope. Fine soils promote surface runoff, but are very erodible when tilled and are frequently transported great distances because of their weight. Loams have a very broad range of water absorption and water-holding capacity, but are easily eroded when rainfall, runoff, topography, and seasonal conditions are conducive.

Particle-size analyses of suspended sediment for streams of this study show that the percentage, by weight, of sand-size particles is exceeded by silt-size particles, and both are exceeded by clay-size particles. The expanse and duration of a storm; the velocity, temperature, and turbulence of the flow; the supply of various sized soil particles; and the percentage of disturbed land in the drainage area all influence the particle-size distribution of suspended sediments in streams. Abrupt changes in particle-size distribution may suggest changes in a watershed in one or more of the factors influencing particle-size characteristics.

Land Use

The type of land use greatly influences the effects of precipitation and runoff on soil surfaces. Forest areas provide a canopy during much of the year which reduces the effects of rainfall. Forests also accummulate a natural litter which reduces raindrop impact, and, to an extent, impede runoff. Even close grown crops and grasses of meadows and pastures give some protection from the forces of erosion. Construction excavations, logging operations, surface mining, and cultivation of row crops expose the land to erosion for at least part of the year and lead to increased stream sedimentation.

Table 3 shows acreages and percentages of various land uses in Kentucky for 1967 and 1977. During this period agricultural uses of Kentucky land decreased by 3.7 percent and urban, built-up lands, and other lands increased by 2.8 percent. This latter category includes land used for surface mining. A current summary of land uses by physiographic region was not available for this report.

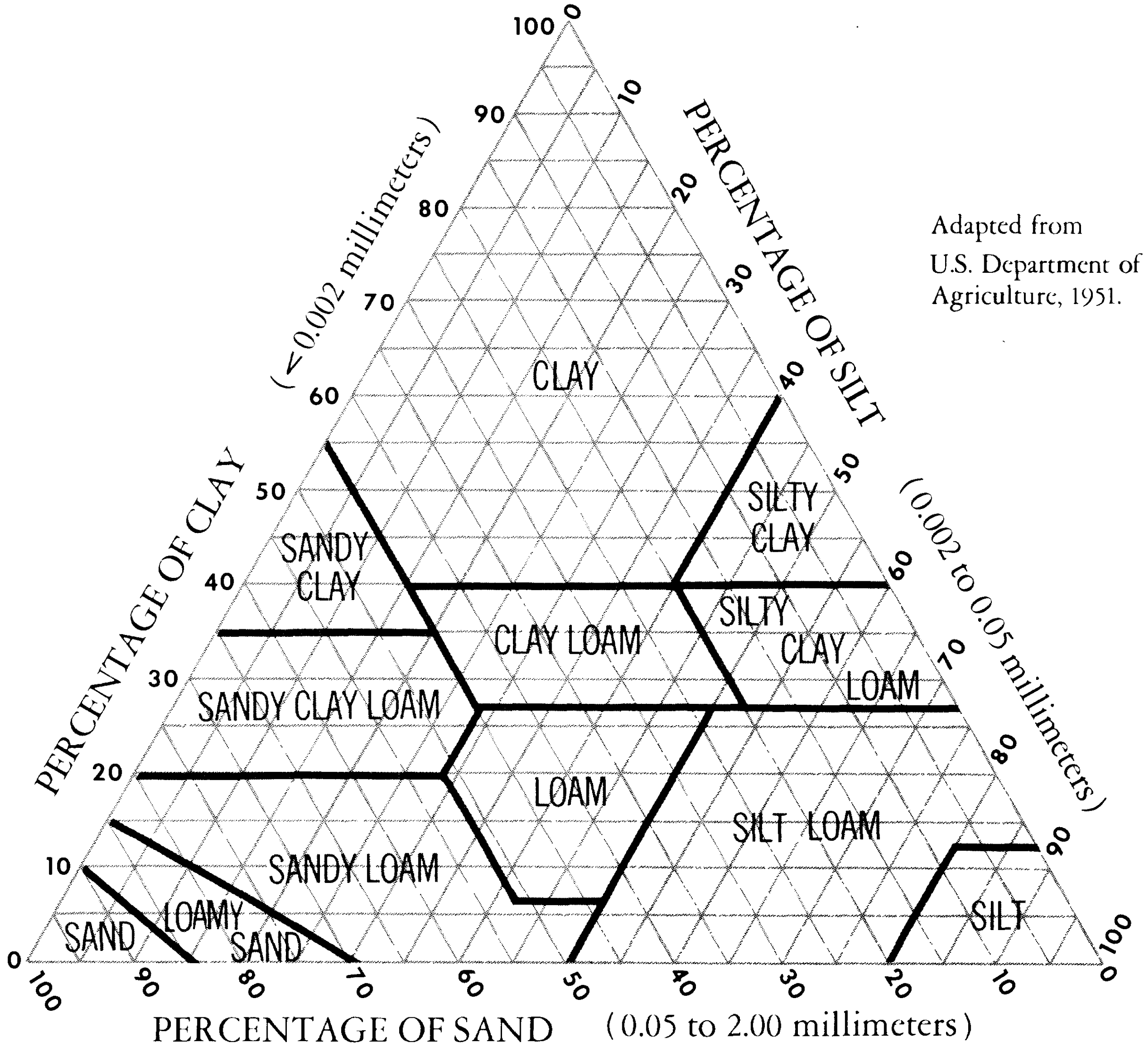

Figure 3.-- Percentages of sand, silt and clay in the basic soil-textural classes.

Ranges of sizes of sand, silt and clay are of the U.S. Department of Agriculture classification. For soil descriptions only.
[References to sand, silt and clay used throughout the report, however, refer to the size ranges of the scale used by the National Research Council and published in the Transactions American Geophysical Union. Volumn 28, Number 6, December 1947.]

Table 3.--Major land uses in Kentucky

(Source: U.S. Soil Conservation Service, 1981, The Kentucky Outlook)

Land Use	1967 (Acres)	1977 (Acres)	Percentage of land uses 1967	Percentage of land uses 1977
Water areas	469,316	608,016	1.8	2.5
Federal land	1,047,416	1,095,000	4.0	4.2
Urban, built-up and other lands	1,596,283	2,338,784	6.2	9.0
Cropland	6,586,739	5,428,000	25.5	21.0
Pasture	5,164,880	5,735,000	20.0	22.1
Forest	10,988,166	10,648,000	42.5	41.2
Total land and water area	25,852,800	25,852,800	100.0	100.0

METHODOLOGY OF STUDY

Collection of Data

At daily suspended-sediment stations, suspended-sediment samples were usually taken at a frequency great enough to develop a continuous sediment-concentration curve. Standard U.S. series depth- and point-integrating samplers were used (Guy and Norman, 1970). Observers collected daily samples at fixed positions in the cross section of the stream and extra samples during storms. These samples were supplemented by samples collected by U.S. Geological Survey personnel during storms. At partial-record stations, samples were taken on monthly to six-week schedules by U.S. Geological Survey personnel.

Cross-sectional samples were taken using the equal-discharge increment (EDI) method or the equal-width increment (EWI) method. Flow distribution curves were used to locate sampling points for EDI measurements. The EWI measurements used 8 to 20 equally-spaced sampling points. Both sampling methods are described by Guy and Norman (1970). Compositing of samples was performed for special purpose analyses such as for particle-size determination.

Early sampling by the U.S. Army Corps of Engineers was done with methods and equipment that were probably the forerunners of techniques and equipment now used. Cross sections were very detailed and numerous samples were taken in each cross section.

Yields at daily suspended-sediment stations throughout Kentucky were based on averages for the period of record for which they were collected. It should be noted that short daily or partial-record stations of one to three years may not be as representative as longer records because short records may not represent long-term hydrologic conditions. Also, not all of the sediment records shown in table 1 were used for obtaining averages for the physiographic regions.

Suspended-sediment yields at all the partial-record sediment stations were computed from an average sediment-transport curve which is a plot of the instantaneous sediment discharge versus instantaneous water discharge. A 20-year flow-duration curve based on the period of 1961-80 water years was used in this study. The method, which will be demonstrated later, of using instantaneous suspended-sediment discharges with flow-duration data to compute suspended-sediment yields has been used by several authors. Miller (1951) first developed the method for the San Juan River basin in Colorado, New Mexico, and Utah. Jordan and others (1964), Hindall and Flint (1970), and Anttila and Tobin (1978) followed similar procedures.

Analysis of Samples

The analyses of the suspended-sediment samples were mainly accomplished by the filtration method. Most particle-size analyses were performed using the sieve-bottom withdrawal tube method. The above methods are described by Guy (1969).

Sand separation analyses were performed on selected suspended-sediment samples in order to determine suspended sand loads. These analyses were made when the weight of sediment was insufficient for a complete particle-size analysis. Bed materials were analyzed by means of the dry-sieve method.

Determination of Sediment Yield

At daily stations, average suspended-sediment yields were computed by summing the daily suspended-sediment discharges to obtain annual suspended-sediment discharges. The annual suspended-sediment discharges were divided by the number of years and by the square miles of contributing drainage area to obtain sediment yield per square mile per year. The representation of the average annual suspended-sediment yields depends heavily on the length of the record as mentioned earlier. As a general rule, no adjustment was made for sediment trapped by reservoirs. In some cases this, no doubt, is significant. Estimates of reservoir entrapment were made for reservoirs in drainage areas of the Little River near Cadiz and the West Fork Clarks River near Brewers to increase the accuracy of the sediment yields for those basins.

At the partial-record sediment stations, a transport curve was developed from instantaneous sediment discharge and water discharge values. Instantaneous suspended-sediment discharge was determined from the product of the instantaneous water discharge, sediment concentration, and a conversion factor of 0.0027. Using the sediment discharge thus determined, a suspended-sediment instantaneous-transport curve was developed such as the one shown in figure 4. The curves were fitted by eye or by least squares. The average annual suspended-sediment discharge was determined using a flow-duration curve such as that shown in figure 5. An example of the computation of suspended-sediment yield is shown in table 4. The yield determined in table 4 had to be adjusted for a noncontributing area of 70.6 mi^2, thus the yield was increased when the adjusted drainage area was used.

FLUVIAL-SEDIMENT CHARACTERISTICS

Most erosion in Kentucky has probably been caused by the action of raindrop splash, overland flow, either in thin sheet flow or in the concentrated flow of rills and gullies, and from channel flow. Erosion takes place in areas away from stream channels as well in the form of bed and bank erosion in channels. When sediment has been entrained in water it may also become an eroding agent in its own right and produce additional sediment through abrasion of the beds and banks of a stream.

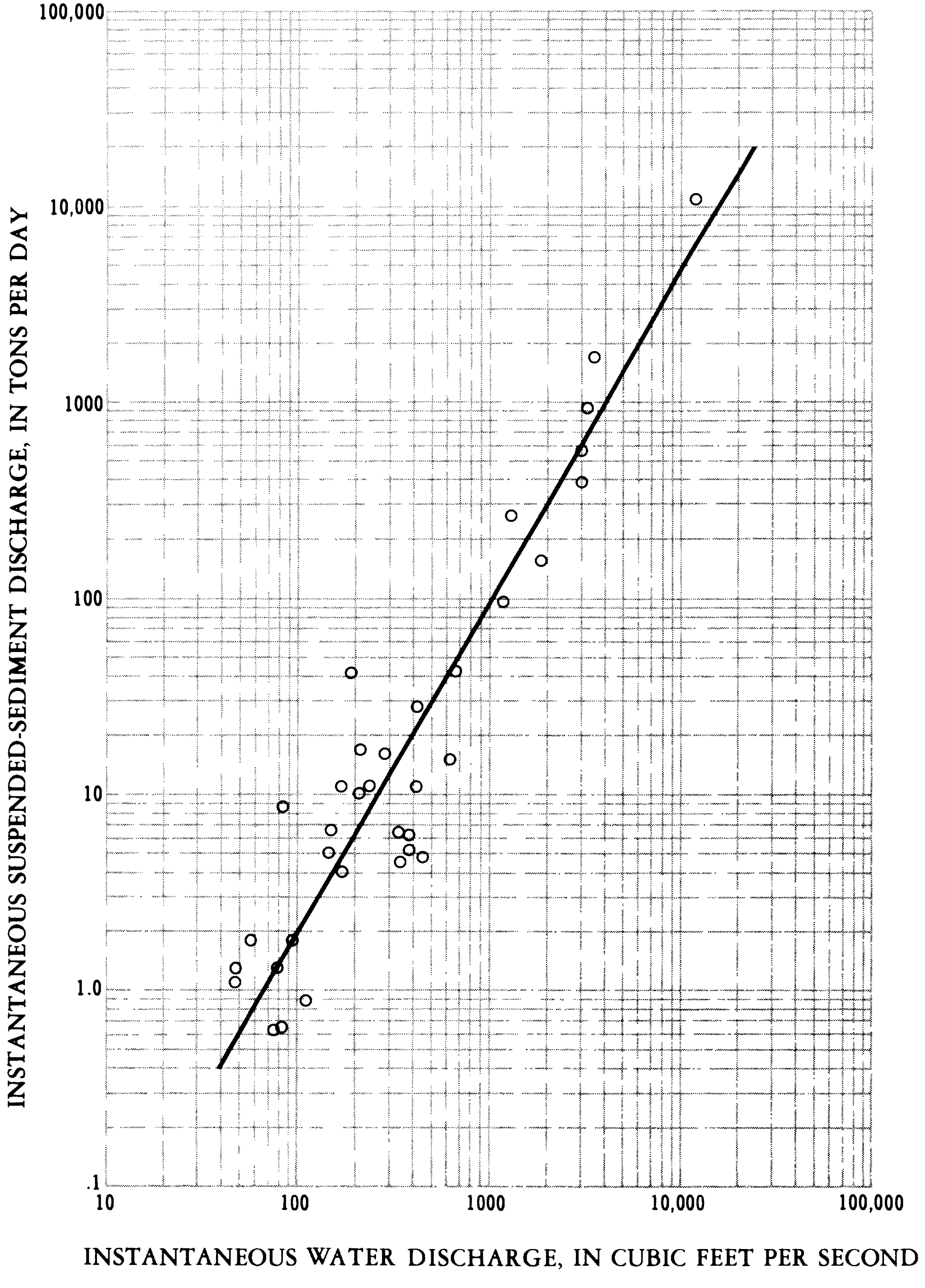

Figure 4.-- Relation of instantaneous suspended-sediment discharge to instantaneous water discharge at Elkhorn Creek near Frankfort, 1977-81.

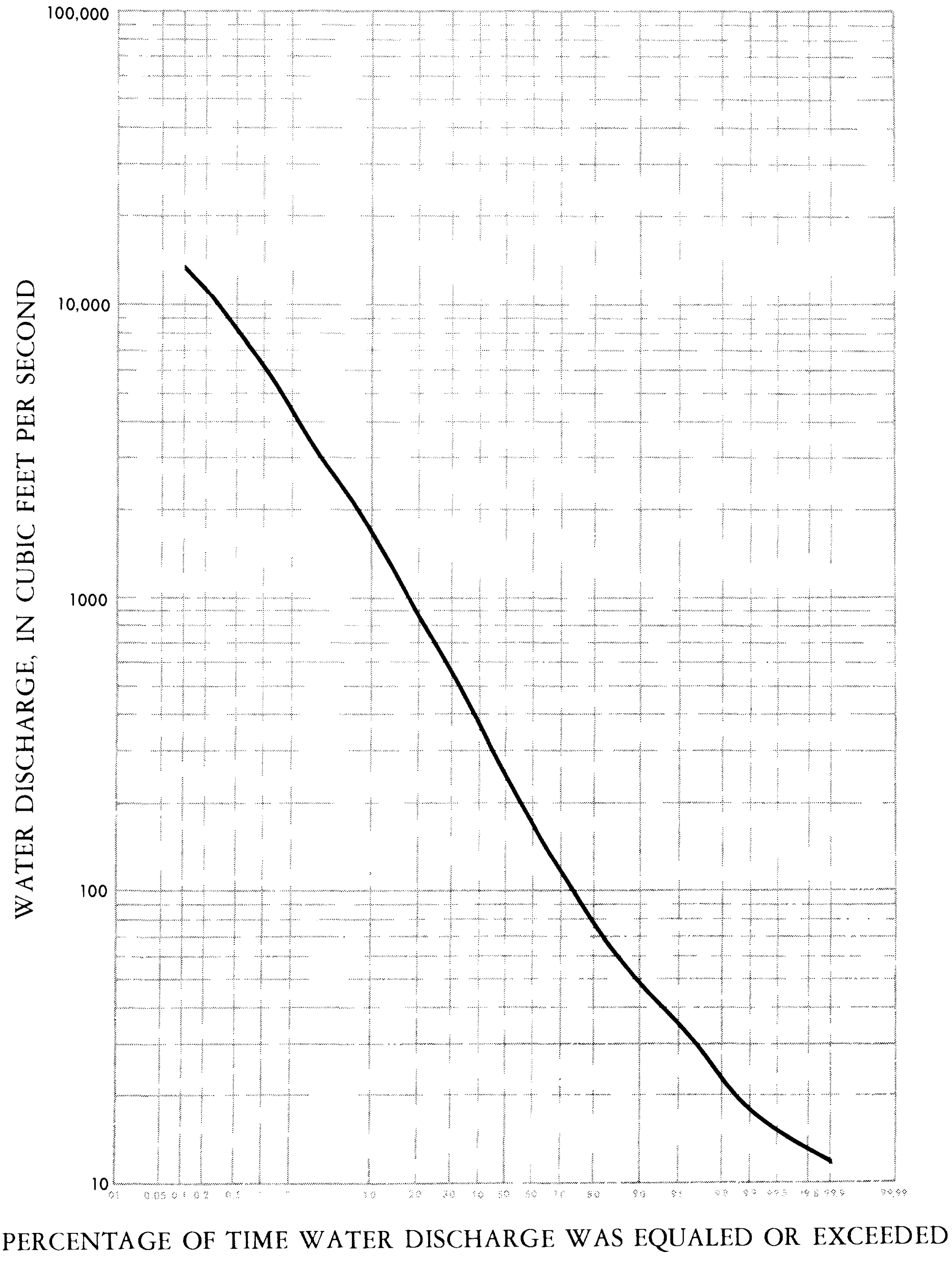

Figure 5.-- Flow duration curve for Elkhorn Creek near Frankfort, 1961-80 water years.

Table 4.--Computation of suspended-sediment discharge, Elkhorn Creek near Frankfort 1978-81 water years

[Drainage area equals 473 mi^2; contributing drainage area equals 402 mi^2]

Percentage of time	Water discharge equaled or exceeded[1] (ft^3/s)	Suspended sediment discharge[2] (tons/d)	Interval between succeeding percentages of time	Average suspended sediment discharge for time interval (tons/d)	Sediment discharge multiplied by time interval
0.00	[3]22,000	18,500	0.10	13,000	1,300
.10	13,000	7,560	.10	6,620	662
.20	11,000	5,690	.10	5,260	526
.30	10,000	4,840	.20	4,180	836
.50	8,300	3,530	.20	3,210	642
.70	7,400	2,900	.30	2,520	756
1.00	6,200	2,150	.40	1,900	760
1.40	5,300	1,640	.60	1,420	852
2.00	4,400	1,200	1.00	996	996
3.00	3,450	793	2.00	630	1,260
5.00	2,530	468	2.00	404	808
7.00	2,100	341	3.00	284	852
10.00	1,650	226	5.00	174	870
15.00	1,150	122	5.00	99	495
20.00	870	76.2	10.00	55	550
30.00	540	33.9	10.00	25	250
40.00	350	16.2	10.00	13	130
50.00	245	8.83	10.00	6.7	67
60.00	165	4.51	20.00	2.8	56
80.00	73	1.12	20.00	.58	12
100.00	9	.03	.00	.00	0
Totals			100.00		12,680

Average suspended-sediment discharge:
Tons per day 126.80
Tons per year 46,282
Tons per square mile per year - 98 for entire drainage area, 115 for contributing area only

[1]Computed from figure 5.
[2]Computed from figure 4.
[3]Maximum daily discharge during period.

The quantity of natural sediments transported or available for transport from a drainage area by streams is affected by the form and intensity of precipitation and by other climatic conditions, character of the soil mantle, plant cover, topography, and land use in the drainage area. The type of movement and the speed of sediment transport is controlled mainly by the size of individual sediment particles. Colby (1963, p. 10) states that fine sediment particles are mainly or entirely carried in suspension and may be moved great distances downstream at about the velocity of streamflow. Coarser particles may be moved in suspension, rolled or skipped along the streambed, or transported alternately by both of these modes. Large sediment particles are moved intermittently for short distances and redeposited on the streambed.

The fine-material load, primarily silt and clay, generally originates in areas away from the stream channel, but some may be contributed from channel bank erosion. Coarser materials such as sand and gravel are more commonly found in the streambed and move intermittently. Bedload consists of that portion of the total sediment load which remains essentially in contact with the streambed surface.

EASTERN COAL FIELD

North Fork Triplett Creek near Morehead

This basin has a drainage area of 84.7 mi^2. About 88 percent of the area is in Rowan County and about 12 percent is in Fleming County. Nearly all of the area is of the Cranston-Berks soil association (Avers and others, 1974). Smaller areas along the stream bottoms are of the Tilsit-Clifty-Morehead and the Latham-Tilsit-Johnsburg soil associations. Both of the latter associations are built upon alluvium near stream channels. All of the soils are silt loams or gravelly silt loams. The slopes are subject to severe erosion and are better suited to pasture, hay, and woodland, and the bottomlands are suitable for hay and cultivated crops. The bottomlands are subject to flooding.

In 1967, the U.S. Soil Conservation Service (U.S. Department of Agriculture, 1970, p. 27) inventoried 72 percent of the land in Rowan County and listed the following percentages of land use: cropland, 14 percent; pasture, 16 percent; forest, 69 percent; and other uses, 1 percent. The drainage area is assumed to be of this distribution.

The 13-year average water discharge from the drainage area is 138 ft^3/s (table 5). Three floods were sampled for suspended sediment during the study period (table 5) with discharges of 25, 27, and 67 times the average discharge. A sample taken during the largest of these floods (Dec. 8, 1978 at 2030 hours) indicated an instantaneous sediment discharge of 14,000 tons/d. Of this amount, 1,120 tons (8 percent) was sand, 8,960 tons (64 percent) was silt, and 3,920 tons (28 percent) was clay. The sediment concentration of the sample was 563 mg/L (milligrams per liter) with a water discharge of 9,190 ft^3/s.

Table 5.--Suspended-sediment data from samples at North Fork Triplett Creek near Morehead

Average discharge: 13 years, 138 ft^3/s (U.S. Geological Survey, 1981, p. 116)

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
Aug. 25	1200	32	28	2.5	0.23
1978					
Mar. 14	1033	3,453	1,400	13,100	25
Apr. 11	0835	37	28	2.8	.27
May 12	0925	130	9	3.2	.94
June 19	1520	5.8	14	.22	.04
July 18	1445	2.9	9	.07	.02
Aug. 30	1350	2.7	11	.08	.02
Oct. 4	1445	1.5	7	.02	.01
Nov. 14	1330	6.2	373	6.2	.04
Dec. 8	1845	3,790	724	7,410	27
Dec. 8	2030	9,190	563	14,000	67
1979					
Feb. 2	1150	49	2	.26	.36
Mar. 13	1300	70	3	.57	.51
Apr. 10	1530	238	10	6.4	1.7
May 30	1010	46	40	5.0	.33
Oct. 3	1745	72	7	1.4	.52
Nov. 5	1725	113	8	2.4	.82
Dec. 20	1150	76	3	.62	.55
1980					
Feb. 5	1220	25	3	.20	.18
Apr. 9	1600	222	12	7.2	1.6
May 29	1425	16	7	.30	.12
July 22	1220	.39	84	.09	<.005
Sept. 16	1325	.19	21	.01	<.005
Oct. 29	1640	1.5	33	.14	.01
Dec. 2	1135	13	6	.21	.09
1981					
Jan. 6	1550	8.4	6	.14	.06
Feb. 18	1400	297	17	.14	2.2
Mar. 24	1140	52	2	.28	.38
May 5	1145	57	9	1.4	.41
July 8	0900	16	11	.50	.12
Aug. 20	0840	1.2	34	.11	.01
Aug. 25	1200	.16	15	.01	<.005

A sample taken less than two hours earlier at 1845 hours had a concentration of 724 mg/L, but a lower water discharge of 3,790 ft^3/s. This illustrates that the peak of sediment concentration preceded the peak of water discharge. The phenomenon of sediment-concentration peaks preceding water-discharge peaks is quite common.

Analyses for the textural composition of the bed material at the station indicated that 16 percent was finer than sand, 29 percent was sand, and 55 percent was gravel. With this high percentage of gravel in the bed material, minimal percentages of sand in the suspended sediment, and with suspended sediment having concentrations mostly less than 1,000 mg/L, the bedload discharge according to Maddock's classification, table 6, is estimated to be in the range of 5 to 12 percent of the suspended-sediment discharge. Samples of suspended sediment of streams in the area have rarely shown more than 10 percent sand.

The sediment transport flow-duration curve computation of suspended-sediment yield gave an average annual yield of 190 $tons/mi^2$.

Troublesome Creek at Noble

There are 177 mi^2 in the drainage area upstream of the sampling site on Troublesome Creek and about 66 percent of this area is in Knott County, about 27 percent is in Perry County, and 7 percent is in Breathitt County. Because Knott County contains about two-thirds of the drainage area, land-use figures for that county are assumed to be representative of the entire area. In 1967 the U.S. Soil Conservation Service (U.S. Department of Agriculture, 1970, p. 26) inventoried 98 percent of the land in Knott County and found the following percentages of land use: cropland, 3 percent; pasture, 3 percent; forest, 89 percent; and other uses, 5 percent.

The suspended-sediment transport curve for the station was defined for discharge of slightly more than 1,000 ft^3/s. The average water discharge (30 years) for the station is 286 ft^3/s. Six of the sediment samples were taken at discharges greater than average (table 7).

The computed average annual suspended-sediment yield is 600 $tons/mi^2$. This may be low due to the limitations of the transport curve which was constructed from a limited range of values.

No suspended particle-size analyses were available, but an analysis of the bed material indicated that 69 percent of the material was gravel, 30 percent was sand, and 1 percent was less than sand. This composition suggests that the magnitude of bedload discharge would be in the range of 5 to 12 percent of the suspended-sediment discharge. An estimate of 5 percent of the suspended discharge is suggested for bedload discharge.

Table 6.--Maddock's classification for determining bedload
[Reprinted by permission from American Society of Civil Engineers, 1975, p. 348]

Concentration of suspended load, in parts per million	Type of material forming channel of stream	Texture of suspended material	Bedload discharge, in terms of suspended sediment discharge, as a percentage
Less than 1,000	Sand	Similar to bed material	25-150
Less than 1,000	Gravel, rock, or consolidated clay	Small amount of sand	5-12
1,000-7,500	Sand	Similar to bed material	10-35
1,000-7,500	Gravel, rock, or consolidated clay	25 percent sand or less	5-12
Over 7,500	Sand	Similar to bed material	5-15
Over 7,500	Gravel, rock, or consolidated clay	25 percent sand or less	2-8

Table 7.--Suspended-sediment data from samples at Troublesome Creek at Noble

[Average discharge: 30 years, 286 ft^3/s (U.S. Geological Survey, 1981, p. 147)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
June 29	2040	764	201	415	2.7
Oct. 13	1030	103	11	3.1	.36
Dec. 7	1300	639	89	154	2.2
1978					
Mar. 22	1920	306	100	83	1.1
Mar. 27	1430	855	112	259	3.0
Dec. 20	1250	92	20	5.0	.32
1979					
Mar. 14	1340	299	64	52	1.0
Apr. 18	1255	192	22	11	.67
May 23	1410	57	54	8.3	.20
Sept. 6	1600	34	12	1.1	.12
Oct. 4	1700	67	31	5.6	.23
Oct. 26	1400	38	35	3.6	.13
Nov. 15	1045	163	12	5.3	.57
1980					
Jan. 29	0940	183	13	6.4	.64
May 8	1450	81	30	6.6	.28
July 17	1300	11	33	.98	.04
Sept. 18	1715	8.7	40	.94	.03
Oct. 2	1230	6.6	27	.48	.02
1981					
Feb. 18	0950	1,070	623	1,800	3.7
May 7	0850	58	6	.94	.20
Aug. 19	1400	14	23	.87	.05

Goose Creek at Manchester

This basin has a drainage area of 163 mi^2. Approximately 76 percent of the drainage area lies in Clay County, and about 24 percent lies in Knox County. About 78 percent of the study area in Clay County is in forest. The average 16-year water discharge is 276 ft^3/s. Sampling during the study period was done for flows that ranged from less than 0.005 to 23 times the average discharge (table 8). Suspended-sediment concentration ranged from 3 to 387 mg/L while instantaneous suspended-sediment discharge ranged from 0.01 to 4,120 tons/d.

Particle-size analyses indicated that 50 percent of the suspended load is clay, 42 percent is silt and 8 percent is sand. Bed-material analyses indicated that 5 percent of the material is finer than sand while 38 percent is sand, and 57 percent is gravel.

Based upon the character of the suspended load and the bed material, this stream would fall into Maddock's classification of bedload discharge of as much as 5 to 12 percent of the suspended-sediment discharge.

The computed average annual suspended-sediment yield is 240 $tons/mi^2$. The high percentage of forest land in the area probably accounts for low sediment concentrations.

Red River near Hazel Green

This basin has a drainage area of 65.8 mi^2. It lies entirely within northeastern Wolfe County. Approximately 85 percent of the county is in forests of hardwoods and about 3.0 percent in forests of conifers. About 97 percent of the county is either grassland or forest. This station was selected because of limited surface mining in the drainage area. Only a few small mines exist along Gilmore Creek, a tributary of Red River, in the drainage study area. A record of streamflow over a 26-year period shows an average annual discharge of 90.3 ft^3/s. Sampling during the study period represented a range of flow from 0.02 to 13 times the average discharge (table 9). Suspended-sediment concentrations ranged from 2 to 2,940 mg/L with suspended-sediment discharges ranging from 0.05 to 2,140 tons/d.

One sand-separation analysis of suspended sediment indicated 1 percent sand. This is not considered representative because bed-material analyses averaged 38 percent sand and 61 percent gravel. With a channel slope of 6.0 ft/mi, higher discharge samples could have as much as 5 to 10 percent suspended sand, and estimates of bedload discharge could be as high as 10 percent of the suspended-sediment discharge based on Maddock's classification of bedload discharge in table 6.

The average annual suspended-sediment yield is 150 $tons/mi^2$. This value was in fair agreement with that of the North Fork Triplett Creek study area to the north.

Table 8.--Suspended-sediment data from samples at Goose Creek at Manchester

[Average discharge: 16 years, 276 ft^3/s (U.S. Geological Survey, 1981, p. 164)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
June 30	0950	83	23	5.2	0.30
Oct. 13	1445	152	5	2.1	.55
1978					
Mar. 17	1605	540	29	42	2.0
Apr. 6	1500	232	26	16	.84
June 27	1500	18	11	.53	.07
Aug. 4	1545	13	10	.35	.05
Sept. 1	1430	32	33	2.9	.12
Oct. 5	1300	5.0	10	.14	.02
Dec. 10	1050	1,360	133	488	4.9
Dec. 21	1625	1,220	218	718	4.4
1979					
Jan. 21	1515	6,450	194	3,380	23
Feb. 15	1500	398	299	321	1.4
Mar. 8	1755	207	6	3.4	.75
Apr. 3	1300	3,940	387	4,120	14
Apr. 23	1415	126	13	4.4	.46
May 29	1240	82	13	2.9	.30
June 4	1425	1,250	118	398	4.5
July 25	1450	138	36	13	.50
Aug. 13	1255	42	16	1.8	.15
Oct. 5	1645	87	5	1.2	.31
Nov. 16	1545	162	9	3.9	.59
Dec. 17	1450	246	8	5.3	.89
1980					
Feb. 5	1515	89	5	1.2	.32
Apr. 2	1150	264	12	8.6	.96
May 12	1305	34	5	.46	.12
July 25	1245	12	19	.62	.04
Sept. 10	1215	3.3	10	.09	.01
Sept. 18	1340	2.2	23	.14	.01
Oct. 16	1405	.79	5	.01	<.005
Dec. 3	1315	36	8	.11	.13
1981					
Jan. 8	1300	14	3	.11	.05
Feb. 20	1710	900	167	406	3.3
Mar. 31	1730	755	35	71	2.7
Apr. 29	1030	164	17	7.5	.59
May 7	1515	44	4	.48	.16
June 15	1325	68	18	3.3	.25
Aug. 13	1020	10	12	.32	.04
Aug. 19	1045	10	10	.27	.04

Table 9.--Suspended-sediment data from samples at Red River at Hazel Green

[Average discharge: 26 years, 90.3 ft^3/s (U.S. Geological Survey, 1981, p. 173)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
Oct. 15	1415	14	20	0.76	0.16
1978					
Mar. 16	1645	275	83	62	3.0
Apr. 11	1450	42	8	91	.47
May 3	1000	104	13	3.7	1.2
June 6	1145	19	7	.36	.21
July 11	1340	23	40	2.5	.25
Aug. 15	1110	22	28	1.7	.24
Sept. 7	1105	5.3	27	.39	.06
Oct. 3	1100	2.4	17	.11	.03
Nov. 8	1025	3.2	6	.05	.04
Dec. 4	1415	1,200	460	1,490	13
Dec. 5	1300	70	20	3.8	.78
1979					
Jan. 26	1100	143	26	10	1.6
Feb. 23	1045	224	74	49	2.5
May 15	1425	30	14	1.1	.33
June 7	1105	27	16	1.2	.30
Aug. 13	1230	12	6	.19	.13
Nov. 1	1120	34	6	.55	.38
Dec. 6	1515	47	2	.25	.52
1980					
Jan. 7	1525	55	6	.89	.61
Feb. 28	1250	119	12	3.9	1.3
Mar. 24	1330	269	2,940	2,140	3.0
May 5	1400	34	17	1.6	.38
July 14	1430	6.5	36	.63	.07
Aug. 22	1040	24	61	4.0	.27
Sept. 8	1200	3.4	27	.25	.04
Sept. 22	1755	13	65	2.3	.14
Oct. 16	0945	1.7	19	.09	.02
Oct. 22	1150	4.1	16	.18	.05
Dec. 10	1400	145	43	17	1.61
1981					
Jan. 27	1245	36	4	.39	.40
Mar. 4	0950	106	15	4.3	1.2
Mar. 25	1500	105	14	4.0	1.2
May 4	0950	42	8	.91	.47
June 9	1515	147	37	15	1.6
Aug. 19	1625	1.5	13	.05	.02

The total average annual sediment yield, including an estimated 15 tons (10 percent) addition for bedload discharge, would be 160 tons/mi^2 (rounded to the nearest 10 tons).

Yellow Creek near Middlesboro

This basin has a drainage area of 58.3 mi^2. Seventy-six percent of the area is in Bell County, Kentucky, and 24 percent is in Claiborne County, Tennessee. Yellow Creek contains a bypass canal around Middlesboro which accumulates sediment in sufficient quantities to restrict the flow of the canal. This problem is discussed later in the section.

Average water discharge over a period of 40 years at Yellow Creek near Middlesboro is 116 ft^3/s. During the study period, suspended-sediment samples were taken at discharges of 0.04 to 15 times the average discharge as shown in table 10. Suspended-sediment concentrations of samples ranged from 9 to 8,100 mg/L, and suspended-sediment discharges ranged from 0.22 to 26,700 tons/d.

The results of two particle-size analyses of suspended sediment showed 20 percent sand. Analysis of bed material showed 29 percent sand. These values suggest that bedload discharge, in terms of Maddock's classification, may be as much as 10 to 15 percent of the suspended-sediment discharge.

An average annual suspended-sediment yield of 2,380 tons/mi^2 was computed from the suspended-sediment transport curve. By adding an estimated 12 percent for bedload discharge, an average annual total sediment yield of 2,670 tons/mi^2 is indicated. This is not unusual for a drainage area undergoing strip mining (Curtis and others, 1978, p. 18-19). The following analysis was made to estimate the amount per year that might be deposited in the Middlesboro Bypass Canal and which should be part of the overall sediment yield.

Stony Fork and Bennetts Fork basins are heavily mined. The streams in these basins join to form Yellow Creek which empties immediately into the Yellow Creek Bypass Canal. The canal which passes around Middlesboro on the northwest side of town was opened in December 1939 to prevent flooding of Middlesboro. The canal has been cleaned of deposits four times in the period 1968-79. The Corps of Engineers, Nashville District, is charged with keeping the canal open and as near its design capacity as possible. The following table shows sediment removal for various periods of time:

Table 10.--Suspended-sediment data from samples at Yellow Creek near Middlesboro
[Average discharge: 40 years, 116 ft^3/s (U.S. Geological Survey, 1981, p. 349)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
June 29	1635	26	68	4.8	0.22
Sept. 26	1310	36	132	13	.31
Oct. 21	1130	39	11	1.2	.34
1978					
Feb. 1	1500	129	49	17	1.1
Feb. 16	1330	105	16	4.5	.91
Mar. 17	1400	252	61	42	2.2
Mar. 30	1140	149	30	12	1.3
May 10	1310	205	85	47	1.8
June 12	1220	48	27	3.6	.41
Aug. 2	1410	14	94	3.6	.12
Aug. 30	1240	16	79	3.4	.14
Oct. 11	1200	7.1	51	.98	.06
Nov. 27	1215	60	62	10	.52
Dec. 21	1235	613	271	449	5.3
1979					
Feb. 14	1130	62	9	1.5	.53
Mar. 9	1130	148	30	12	1.3
Apr. 3	1320	1,730	1,440	6,730	15
May 3	1245	70	32	6.0	.60
May 30	1305	76	26	5.3	.66
June 7	1220	92	18	4.5	.79
June 28	1210	22	44	2.6	.19
Aug. 17	1450	13	46	1.6	.11
Oct. 15	1220	35	24	2.3	.30
Nov. 26	1350	628	99	168	5.4
1980					
Jan. 15	1245	12	9	.29	.10
Feb. 26	1530	98	20	5.3	.84
Mar. 28	0950	261	90	63	2.2
Mar. 28	1105	437	174	205	3.8
May 9	1000	33	26	2.4	.28
July 18	0945	8.8	75	1.8	.08
Sept. 8	1450	4.1	52	.59	.04
Oct. 21	1100	4.4	31	.37	.04
Nov. 26	1130	16	22	.99	.14
1981					
Jan. 15	1225	9.2	9	.22	.08
Feb. 23	1030	117	122	39	1.0
Mar. 26	1455	129	25	8.7	1.1
May 11	1100	30	40	3.2	.26
June 6	2145	1,220	8,100	26,700	11
June 12	1040	43	61	7.1	.37
Aug. 13	1110	49	28	3.8	.15

Table 11.--Sedimentation in the Middlesboro Bypass Canal

Period covered	Sediment removed (yd^3)	Number of years	Average amount of sediment deposited per year (yd^3/yr)	(tons/yr)	Yield [(ton/mi^2)/yr][1]
12-39 to 4-68	292,000	28.3	10,318	13,929	368
5-68 to 12-74	63,000	6.6	9,545	12,886	341
1-75 to 9-78	84,000	4.8	17,500	23,625	625
10-78 to 6-79	55,000	.8	68,750	92,812	2,455
		40.5			

[1]Specific weight of sediment was estimated at 2,700 lb/yd^3.
Note: Drainage area at the mouth of the canal is 37.8 mi^2.

For the sediment station at Yellow Creek near Middlesboro, which is downstream of the canal about 4.5 miles north of town, the annual average total sediment yield was 2,670 tons/mi^2 or 55,661 tons/yr for the 58.3 mi^2 drainage area. The most recent rate of deposition into the canal was about 2,455 (tons/mi^2)/yr or 92,812 tons/yr (extrapolated from 0.8 year) as shown in table 11. If the assumption is made that the sediment removed from the canal represents a part of the total yield of the basin, it can be added to the total sediment yield at the downstream station on Yellow Creek. This calculation gives a value of 4,260 (tons/mi^2)/yr which is probably a more realistic value for the annual total sediment yield of the basin above Yellow Creek near Middlesboro.

Figure 6 illustrates a typical source area for the sediment originating from Stony Fork and figure 7 shows sediment shoaling and sandbars in the bypass canal. The shoaling results from low velocities in the bypass canal.

Other Sediment Stations of the Eastern Coal Field

In addition to the five project sediment stations previously discussed there were 39 additional sediment stations in the Eastern Coal Field at which daily or partial records of suspended sediment have been collected. Suspended-sediment concentration, discharge, and yields are given in table 12 for all Eastern Coal Field sediment stations.

The highest suspended-sediment yield was determined at Millers Creek near Phyllis, and the lowest was measured at Helton Branch near Greenwood. In considering the yields of basins listed in table 12, the length of record (table 1) for some stations should be noted.

Figure 6.-- Downstream view of Stoney Fork near Hignite Branch showing severely disturbed area near Middlesboro, June 1976.

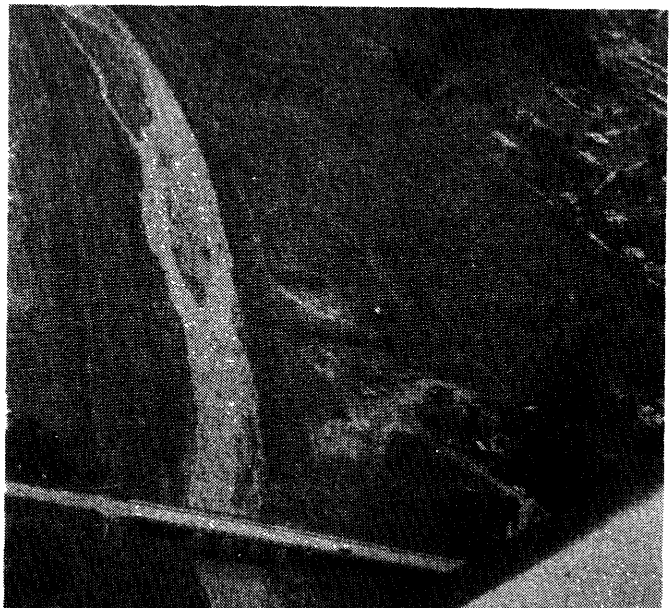

Figure 7.-- View of part of Middlesboro Bypass Canal showing buildup of sand and gravel bars, June 1976.

Table 12.--Summary of sediment-discharge characteristics of streams of the Eastern Coal Field

Station number	Station name	Sediment Concentrations[1] (mg/L) Low	High	Sediment discharge[1] (tons/d) Low	High	Ratio of instantaneous to average water discharge[2] Low	High	Annual suspended-sediment yield[3] (tons/mi^2)
03207845	Card Creek at Mouthcard	1	6,350	0	8,550	--	--	[4]6,220
03207875	Feds Creek at Fedscreek	2	2,460	0	4,270	--	--	[4]732
03207905	Big Creek at Dunlap	2	3,690	.01	884	--	--	[4]1,000
03207925	Island Creek near Phyllis	1	7,350	0	1,010	--	--	[4]1,800
03207935	Lick Creek at Lick Creek	1	12,600	0	6,080	--	--	[4]3,470
03207940	Millers Creek near Phyllis	2	26,800	0	18,600	--	--	[4]21,000
03207962	Dicks Fork at Phyllis	0	1,590	0	310	--	--	[4]204
03207965	Grapevine Creek near Phyllis	0	9,100	0	11,000	--	--	[4]1,360
03208000	Levisa Fork below Fishtrap Dam near Millard	0	1,060	0	455	--	--	[5]1,770
03209300	Russell Fork at Elkhorn City	2	948	.76	11,300	--	--	60
03209500	Levisa Fork at Pikeville	5	1,510	3.8	36,200	--	--	150
03210000	Johns Creek near Meta	0	10,800	0	35,500	--	--	1,270
03210040	Raccoon Creek near Zebulon	3	3,020	.03	2,470	--	--	[4]1,200
03210160	Caney Fork near Gulnare	3	9,770	0	1,580	--	--	[4]2,890
03210310	Brushy Fork near Heenon	10	19,900	.03	10,300	--	--	[4]7,860
03210420	Buffalo Creek near Endicott	1	5,370	0	6,400	--	--	[4]8,120
03211500	Johns Creek near Van Lear	18	1,920	.17	300	--	--	[6]1,440
03212500	Levisa Fork at Paintsville	1	5,600	.25	402,000	--	--	568
03215000	Big Sandy River at Louisa	5	1,390	7	39,800	--	--	450
03216500	Little Sandy River at Grayson	4	580	1.6	4,400	--	--	100
03217000	Tygarts Creek near Greenup	0	1,900	0	31,600	--	--	270
03248500	Licking River near Salyersville	5	2,650	.07	6,360	--	--	340
03249500	Licking River near Farmers	1	1,800	<.5	29,700	--	--	220
03250100	North Fork Triplett Creek near Morehead	2	1,400	.01	14,000	.01	67	190
03277500	North Fork Kentucky River at Hazard	2	640	.11	3,400	--	--	475
03278500	Troublesome Creek at Noble	6	623	.48	1,800	.02	3	600
03280000	North Fork Kentucky River at Jackson	2	4,660	.51	328,000	--	--	750
03280600	Middle Fork Kentucky River near Hyden	1	3,010	0	126,000	--	--	600
03281000	Middle Fork Kentucky River at Tallega	2	2,470	.15	52,100	--	--	[4]260
03281100	Goose Creek at Manchester	0	590	0	5,420	0	23	240
03281500	South Fork Kentucky River at Booneville	2	668	.91	66,000	--	--	370
03282500	Red River near Hazel Green	2	2,940	.05	2,140	.02	13	150
03400990	Clover Fork at Harlan	2	1,520	.17	25,600	--	--	451
03401000	Cumberland River near Harlan	3	1,450	.57	38,400	--	--	350
03402000	Yellow Creek near Middlesboro	9	8,100	.22	26,700	.04	15	[4,7]4,260
03403000	Cumberland River near Pineville	3	2,520	.47	145,000	--	--	420

Table 12.--Summary of sediment-discharge characteristics of streams of the Eastern Coal Field--Continued

Station number	Station name	Sediment Concentrations[1] (mg/L) Low	High	Sediment discharge[1] (tons/d) Low	High	Ratio of instantaneous to average water discharge[2] Low	High	Annual suspended-sediment yield[3] (tons/mi^2)
03403500	Cumberland River at Barbourville	3	2,080	0.89	96,400	--	--	420
03403910	Clear Fork at Saxton	1	2,590	.09	28,000	--	--	300
03404000	Cumberland River at Williamsburg	1	2,170	.27	113,000	--	--	340
03404500	Cumberland River at Cumberland Falls	1	1,920	.79	36,100	--	--	[4]280
03406500	Rockcastle River at Billows	0	317	0	13,100	--	--	55
03407100	Cane Branch near Parkers Lake	1	18,000	<.01	750	--	--	1,500
03407300	Helton Branch near Greenwood	1	90	0	8	--	--	25
03410500	South Fork Cumberland River near Stearns	4	1,980	.48	4,000	--	--	205
				Regional average for all stations				1,690
				Maximum for all stations				21,000
				Minimum for all stations				25
				Median for all stations				435
				Regional average for 28 selected stations				486
				Maximum for 28 selected stations				1,770
				Minimum for 28 selected stations				25
				Median for 28 selected stations				345

[1]Daily values used for daily stations; instantaneous values used for partial-record stations.
[2]Selected partial-record stations only.
[3]Does not include sediment deposited in reservoirs except where noted.
[4]Because of various reasons such as limited record or a large number of samples at similar flow conditions at individual stations, these yields were excluded from the regional average computation for selected stations.
[5]Includes sediment deposited in Fishtrap Reservoirs.
[6]Includes sediment deposited in Dewey Reservoir.
[7]Includes sediment deposited in Middlesboro Bypass Canal.

Table 13 gives the averages of particle-size analyses in percentage of sand, silt, and clay for coal region stations. The average for all analyses is 11 percent sand, 41 percent silt, and 48 percent clay.

Figure 8 is a trilinear diagram of the average of sand, silt, and clay in analyses of most stations of the Eastern Coal Field. Each point represents the average plot for a station. Although most of the stations had low percentages of sand in the suspended sediments, there were exceptions, such as Feds Creek at Fedscreek, which had 56 percent sand, 34 percent silt, and 10 percent clay. This was based on two samples taken during the flood of January 10-11, 1974, in the Fishtrap Lake area. The analyses appear good, but there were no other particle-size analyses at lesser stages; thus, this point is biased toward the high flood condition. The low clay concentrations are not unusual for stations such as Feds Creek where there is little or no surface disturbance in the watershed (Curtis, and others, 1978, p. 26).

BLUE GRASS REGION

North Fork Licking River near Lewisburg

This basin has a drainage area of 119 mi^2 in the Knobs of the Blue Grass region in the headwater area of the North Fork Licking River. About 45 percent of the drainage area is in Mason County, and about 30 percent is in Lewis County where the stream originates. The remainder of the area is in Fleming County.

Mapping of soils is in progress in Mason County, but no modern soil surveys exist for Lewis or Fleming Counties. The Muskingum-Colyer soil association makes up most of the area. Both are upland soils which have been derived from sandstone and shales, (Ligon and Karraker, 1949, p. 7). Both soils have good to excessive internal drainage.

The U.S. Soil Conservation Service (U.S. Department of Agriculture, 1970, p. 27) inventoried 97 percent of the area in Mason County and listed the following land uses: cropland, 45 percent; pasture, 41 percent; forest land, 12 percent; and other uses, 2 percent. Although Mason County is low in forest land, Lewis County, where the North Fork Licking River originates, is 79 percent forest land. Due to this higher percentage of forest land, sediment yields in the Lewis County part of the basin should be less than the yields in the Mason County part. Over the entire study area, forest makes up 16 percent of the land area (Beaber, 1970, p. A-5). Mean annual rainfall for the area is 44 inches.

Average water discharge at the station over 34 years is 153 ft^3/s (table 14). Suspended sediment was sampled at magnitudes of water discharge from less than 0.005 to 11 times the average discharge. This is not considered a wide range especially for the higher values of discharge.

Table 13.--Average percentages of sand, silt, and clay in suspended sediment of streams of the Eastern Coal Field

Station number	Station name	Sand	Silt	Clay
03207845	Card Creek at Mouthcard	16	38	46
03207875	Feds Creek at Fedscreek	56	34	10
03207905	Big Creek at Dunlap	22	60	18
03207925	Island Creek near Phyllis	15	41	44
03207935	Lick Creek at Lick Creek	15	41	44
03207940	Millers Creek near Phyllis	7	44	49
03207962	Dicks Fork at Phyllis	18	43	39
03207965	Grapevine Creek near Phyllis	9	46	45
03208000	Levisa Fork below Fishtrap Dam near Millard	12	21	67
03209300	Russell Fork at Elkhorn City	--	--	--
03209500	Levisa Fork at Pikeville	--	--	--
03210000	Johns Creek near Meta	13	45	42
03210040	Raccoon Creek near Zebulon	--	--	--
03210160	Caney Fork near Gulnare	[1]35	--	--
03210310	Brushy Fork near Heenon	22	36	42
03210420	Buffalo Creek near Endicott	--	--	--
03211500	Johns Creek near Van Lear	--	--	--
03212500	Levisa Fork at Paintsville	5	40	55
03215000	Big Sandy River at Louisa	[1]6	--	--
03216500	Little Sandy River at Grayson	--	--	--
03217000	Tygarts Creek near Greenup	3	41	56
03248500	Licking River near Salyersville	5	34	61
03249500	Licking River near Farmers	3	35	62
03250100	North Fork Triplett Creek near Morehead	8	64	28
03277500	North Fork Kentucky River near Hazard	4	52	44
03278500	Troublesome Creek at Noble	--	--	--
03280000	North Fork Kentucky River at Jackson	14	43	43
03280600	Middle Fork Kentucky River near Hyden	3	44	53
03281000	Middle Fork Kentucky River at Tallega	3	32	65
03281100	Goose Creek at Manchester	8	42	50
03281500	South Fork Kentucky River at Booneville	--	--	--
03282500	Red River near Hazel Green	[1]1	--	--
03400990	Clover Fork at Harlan	--	--	--
03401000	Cumberland River near Harlan	27	33	40
03402000	Yellow Creek near Middlesboro	20	42	38
03403000	Cumberland River near Pineville	6	50	44
03403500	Cumberland River at Barbourville	6	44	50
03403910	Clear Fork at Saxton	4	44	52
03404000	Cumberland River at Williamsburg	2	38	60
03404500	Cumberland River at Cumberland Falls	2	40	58
03406500	Rockcastle River at Burrows	--	--	--
03407100	Cane Branch near Parkers Lake	3	32	65
03407300	Helton Branch near Greenwood	2	42	56
03410500	South Fork Cumberland River near Stearns	--	--	--
	Average	11	41	48

[1]Not included in average

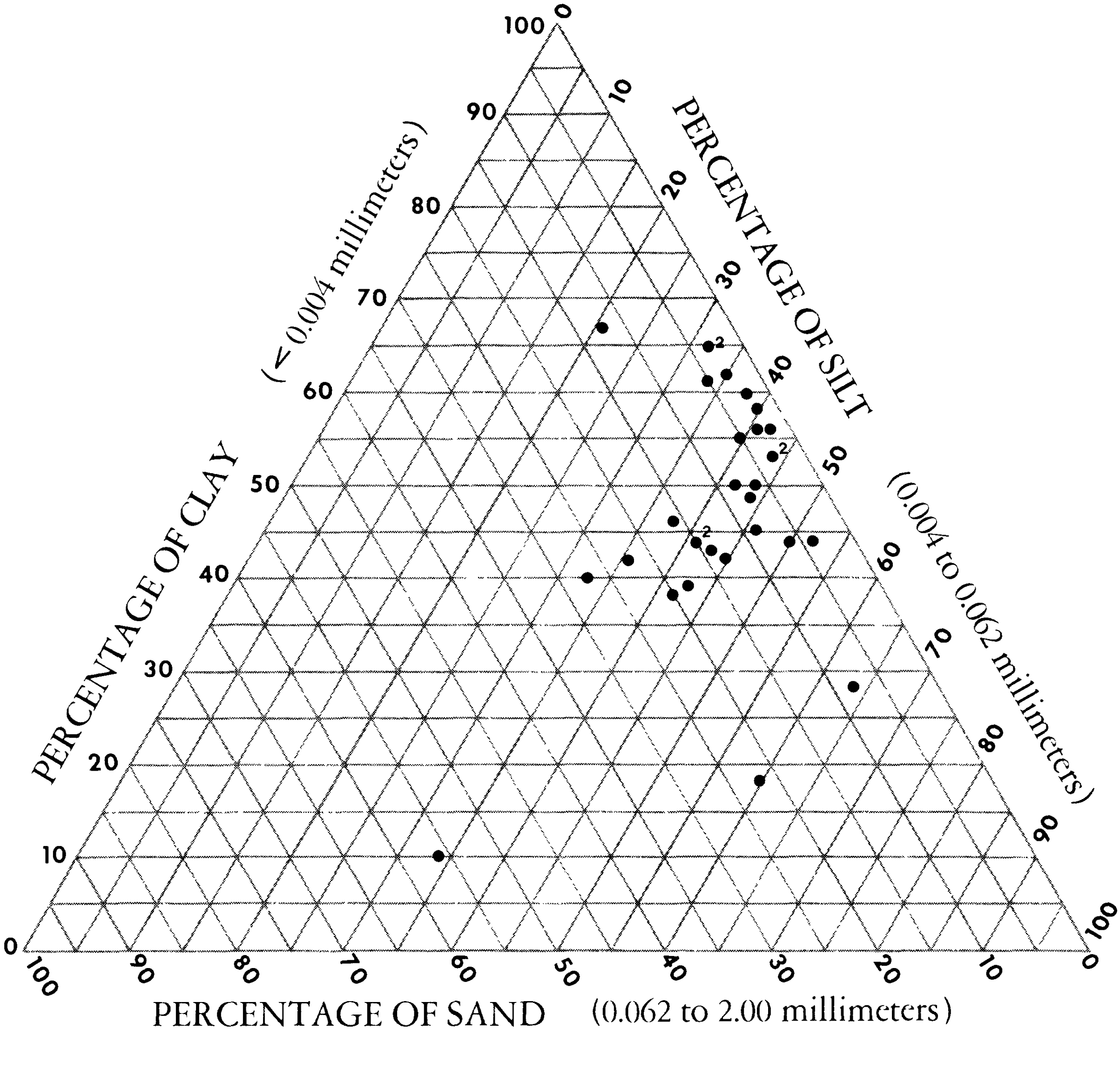

Figure 8.-- Percentage of sand, silt and clay in suspended sediment in streams of the Eastern Coal Field.

Table 14.--Suspended-sediment data from samples at North Fork Licking River near Lewisburg

[Average discharge: 34 years, 153 ft^3/s (U.S. Geological Survey, 1981, p. 119)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
Aug. 30	1330	12	19	0.62	0.08
1978					
Mar. 23	1245	99	26	6.9	.65
Apr. 11	1045	26	28	2.0	.17
May 17	1220	949	523	1,340	6.2
June 21	1120	52	41	5.8	.34
July 19	1045	2.9	34	.27	.02
Aug. 31	1020	1,640	237	1,050	11
Oct. 5	1130	5.2	12	.17	.03
Nov. 15	1135	14	6	.23	.09
1979					
Feb. 7	1120	38	38	3.9	.25
Mar. 15	1300	50	10	1.4	.33
Apr. 12	1210	174	31	15	1.1
May 31	1330	30	32	2.6	.20
June 22	1310	440	292	347	2.9
Aug. 3	1305	65	92	16	.42
Oct. 9	1650	88	13	3.1	.58
Nov. 7	1530	34	11	1.0	.22
Dec. 20	1150	73	9	1.8	.48
1980					
Mar. 3	1305	134	10	3.6	.88
Apr. 1	1200	395	101	108	2.6
June 3	1145	7.5	24	.49	.05
July 21	1100	.61	58	.10	<.005
Sept. 22	1235	.30	44	.04	<.005
Oct. 14	1145	.08	8	.00	<.005
Dec. 1	1330	36	14	1.5	.24
1981					
Jan. 5	1245	12	125	4.0	.08
Apr. 14	1530	62	29	4.9	.41
June 2	1415	67	32	5.8	.44
July 9	1215	36	53	5.2	.24
Aug. 20	1035	.01	999	.01	<.005

Maximum sampled suspended-sediment concentration was 523 mg/L and minimum was 6 mg/L. Maximum instantaneous suspended-sediment discharge was 1,340 tons/d and the minimum was less than 0.01 tons/d.

The suspended sediment in four complete particle-size analyses averaged 66 percent clay, 33 percent silt, and 1 percent sand. One sand-separation analysis showed 3 percent sand. Bed material averaged 9 percent finer than sand, 41 percent sand, and 50 percent gravel.

Considering the particle-size characteristics of the suspended and bed material, the bedload discharge would be as much as 5 to 12 percent of the suspended-sediment discharge according to the classification by Maddock (table 6).

An average annual suspended-sediment yield determined by the sediment-transport flow-duration curve method indicated a yield of 95 tons/mi^2.

Elkhorn Creek near Frankfort

This basin has a drainage area of 473 mi^2 and comprises parts of five counties in the center of the Blue Grass region. About 41 percent of the area lies in Fayette County, 37 percent in Scott County, 12 percent in Woodford County, and the remaining 10 percent lies in Franklin and Jessamine Counties.

Soils of the area are mainly of the Maury-Loradale-Mercer soil association (Weisenberger and Isgrig, 1977, p. 2-4). These soils formed in place from limestone or from alluvium which eroded from upland soils and was deposited along the streams.

Land-use figures are not available for the drainage area, but were estimated from land-use figures published for each county by the U.S. Soil Conservation Service (U.S. Department of Agriculture, 1970, p. 26-27). The following estimated percentages were derived by weighting the percent of each county in the drainage area with the percent of land use in each county. They are cropland, 32 percent; pasture, 53 percent; forest, 11 percent, and other land uses, 4 percent. These figures may vary somewhat from an actual land-use survey, because they are based on averages for each county.

Average water discharge from the drainage area over a period of 43 years was 619 ft^3/s (table 15). Suspended sediment was sampled at discharges which ranged from 0.08 to 19 times the average flow.

Instantaneous suspended-sediment concentration ranged from 3 to 348 mg/L, and instantaneous suspended-sediment discharges ranged from 0.62 to 10,900 tons/d.

Table 15--Suspended-sediment data from samples at Elkhorn Creek near Frankfort

[Average discharge: 43 years, 619 ft^3/s (U.S. Geological Survey, 1981, p. 185)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
June 30	1335	210	30	17	0.33
Aug. 29	1315	169	9	4.1	.27
Oct. 3	1515	1,270	78	267	2.1
Nov. 29	1330	449	4	4.8	.73
1978					
Jan. 10	1300	3,180	109	936	5.1
Mar. 7	1200	339	5	4.6	.55
Apr. 4	1400	379	6	6.1	.61
Apr. 10	1550	234	18	11	.38
June 12	1430	150	16	6.5	.24
July 25	1010	187	84	42	.30
Sept. 6	1430	410	25	28	.66
Oct. 10	1415	80	3	.65	.13
Nov. 28	1230	2,970	72	577	4.8
Dec. 4	2100	11,600	348	10,900	19
1979					
Apr. 13	1045	3,390	185	1,690	5.5
May 7	1505	334	7	6.3	.54
June 26	1355	94	7	1.8	.15
Aug. 3	1400	278	21	16	.45
Sept. 4	1400	209	17	9.6	.34
Oct. 15	1540	611	9	15	.99
Nov. 26	1530	2,950	49	390	4.8
1980					
Apr. 2	1400	1,810	32	156	2.9
Apr. 29	1430	383	5	5.2	.62
June 23	1040	56	12	1.8	.09
Aug. 6	1415	168	24	11	.27
Sept. 22	0915	47	10	1.3	.08
Sept. 22	1445	47	9	1.1	.08
Oct. 28	1515	110	3	.89	.18
Dec. 12	1300	410	10	11	.66
1981					
Jan. 20	1430	76	3	.62	.12
Feb. 24	1455	1,120	32	97	1.8
Apr. 20	1405	658	24	43	1.1
June 24	1245	144	13	5.1	.23
Aug. 19	1535	79	6	1.3	.13
Aug. 20	1420	81	40	8.7	.13

Suspended-sediment particle-size analyses, as in North Fork Licking River, showed that clay was the main constituent. Clay averaged 54 percent, silt 44 percent, and sand 2 percent in the samples.

The main channel at the station is composed of bedrock. The bed material analyzed was that which had been carried from nonbedrock sections and was not present in the entire cross section. No fines were present, but the sample did contain 40 percent sand and 60 percent gravel. Because of the extremely small amount of bed sediment present, the bedload discharge is considered almost negligible, and is probably less than 1 percent of the value for suspended-sediment discharge.

The average annual suspended-sediment yield during the 4-year study period was 115 tons/mi^2.

Other Sediment Stations of the Blue Grass Region

In addition to the two project stations which were in the Blue Grass region, 10 other stations have been operated in the region over the past several years. These stations are listed in table 16 along with the two project stations. Several of the stations have sediment yields as high or higher than the coal region of eastern Kentucky.

Table 17 gives the particle-size distribution for suspended sediment in streams of the Blue Grass region. These analyses on the average had 1 percent sand, 37 percent silt, and 62 percent clay. Figure 9 is a trilinear diagram with the average analysis for each station plotted as a single point. This diagram contrasts with figure 8 and suggests more consistent particle-size distributions in streams of the Blue Grass region than in the Eastern Coal Field. Lower sand percentages in the Blue Grass region are particularly noticeable.

MISSISSIPPIAN PLATEAU REGION

Russell Creek near Columbia

This basin has a drainage area of 188 mi^2 and 15 mi^2 of noncontributing area because of sinkholes. Seventy-eight percent of the drainage area lies in Adair County and 22 percent lies in Russell County.

Soils have been surveyed in both counties, but the survey has not been published for Russell County. The survey of Adair County covers 78 percent of the drainage area.

Table 16.--Summary of sediment-discharge characteristics of streams of the Blue Grass region

Station number	Station name	Sediment concentration (mg/L) Low	High	Sediment discharge[1] (tons/d) Low	High	Ratio of instantaneous to average discharge[2] Low	High	Annual suspended sediment yield[3] (tons/mi^2)
03251000	North Fork Licking River near Lewisburg	6	523	0	1,340	0	11	95
03251500	Licking River at McKinneysburg	1	4,230	0	223,000	--	--	440
03254000	Licking River at Butler	3	791	.84	119,000	--	--	[4]150
03287500	Kentucky River at lock 4 at Frankfort	1	2,420	.53	420,000	--	--	370
03289500	Elkhorn Creek near Frankfort	3	348	.62	10,900	.08	19	115
03290500	Kentucky River at lock 2 at Lockport	7	529	1.3	154,000	--	--	[4]220
03291500	Eagle Creek near Glencoe	0	3,890	0	231,000	--	--	1,100
03297845	Floyds Fork near Crestwood	5	1,570	.03	11,200	--	--	[4]110
03296000	Plum Creek subwatershed No. 4 near Simpsonville	0	955	0	170	--	--	2,940
03297500	Plum Creek at Waterford	0	2,350	0	27,000	--	--	[4]1,500
03298500	Salt River at Shepherdsville	0	3,430	0	139,000	--	--	650
03301630	Rolling Fork near Lebanon Junction	4	857	1.6	20,900	--	--	220
	Regional average for all stations							659
	Maximum for all stations							2,940
	Minimum for all stations							95
	Median for all stations							295
	Regional average for 8 selected stations							741
	Maximum for 8 selected stations							2,940
	Minimum for 8 selected stations							95
	Median for 8 selected stations							405

[1]Daily values used for daily stations; instantaneous values used for instantaneous records.
[2]Selected partial-record stations only.
[3]Does not include sediment deposited in reservoirs, unless so stated.
[4]Because of various reasons such as limited record or a large number of samples at similar flow conditions at individual stations, these yields were excluded from the regional average computation for selected stations.

Table 17.--Average percentages of sand, silt, and clay in suspended sediment of streams of the Blue Grass region

Station number	Station name	Sand	Silt	Clay
03251000	North Fork Licking River near Lewisburg	2	32	66
03251500	Licking River at McKinneysburg	1	36	63
03254000	Licking River at Butler	[1]3	--	--
03287500	Kentucky River at lock 4 at Frankfort	3	44	53
03289500	Elkhorn Creek near Frankfort	2	44	54
03290500	Kentucky River at lock 2 at Lockport	[1]3	--	--
03291500	Eagle Creek near Glencoe	1	34	65
03297845	Floyds Fork near Crestwood	1	42	57
03296000	Plum Creek subwatershed No. 4 near Simpsonville	2	34	64
03297500	Plum Creek at Waterford	1	38	61
03298500	Salt Creek at Shepherdsville	1	33	66
03301630	Rolling Fork near Lebanon Junction	[1]1	--	--
	Average	1.6	37.4	61

[1]Not included in average

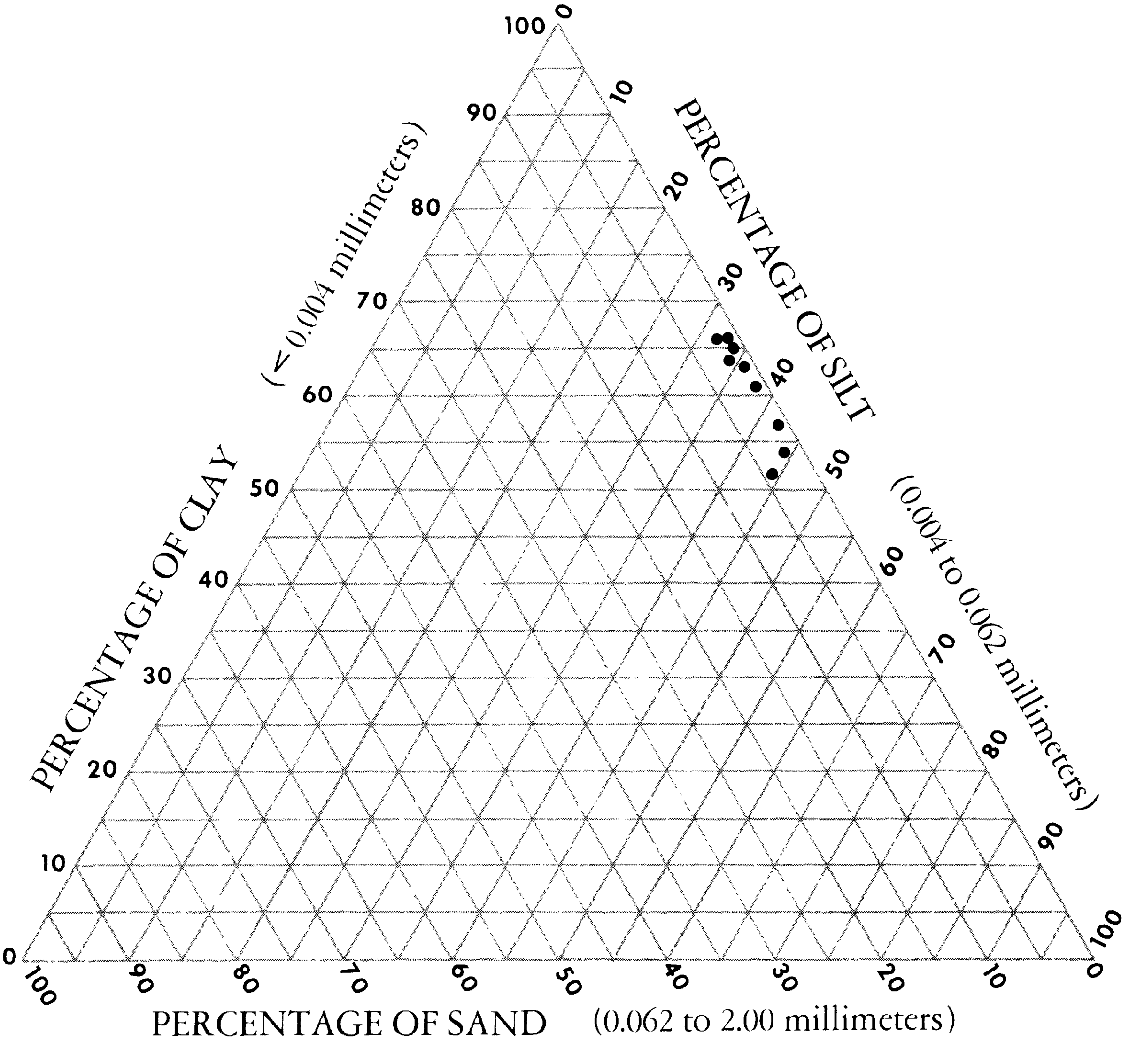

Figure 9.-- Percentage of sand, silt and clay in suspended sediment in streams of the Blue Grass region.

The most important soils of the drainage area are of the Baxter-Christian-Bewleyville association. These soils occur on rolling land of broad uplands, are mostly well drained, and have a deep root zone and a clayey subsoil (Arms, and others, 1964, p. 3). In the headwaters of the basin, the Frankstown-Bodine-Westmoreland soil association is the most important. These are deep, sloping, well drained, cherty soils on ridge tops, and shallow, steep, somewhat excessively drained soils on hillsides (Arms, and others, 1964, p. 4). Well-drained soils could reduce the rate of direct runoff and could influence stream sediment yields. Arms and others (1964, p. 117), also reported that the uplands of Adair County were covered with a mantle of silt ranging from a thin film to a layer 30 inches in thickness. The thicker deposits are in the central and eastern portions of the county and could be wind-deposited loess.

Land use as of 1967 in Adair County was: cropland, 20 percent; pasture, 34 percent; forest, 44 percent; and other uses, 2 percent (U.S. Department of Agriculture, 1970, p. 26). Corn is the most important feed crop and tobacco is the most important cash crop in Adair County. Livestock raising is important and is the chief reason for the growing of wheat, oats, barley, rye, and soy beans. Several kinds of hay crops are also grown.

The study area has an average water discharge at the station of 294 ft^3/s (41 years) as indicated in table 18. The sediment sampling was done during flows that ranged from 0.02 to 6.8 times the average water discharge.

Suspended-sediment concentrations ranged from 4 to 351 mg/L. About half the drainage area is in forest, about one-third is in pasture, and only about one-fifth is in cropland. The first two factors are conducive to lower sediment yields. Suspended-sediment discharges, as expected, ranged from 0.17 to 851 tons/d.

No particle-size analyses of the suspended sediment were made during the study, however, bed-material analyses were made. These analyses indicate that, on the average, about as much gravel as sand was present and about 5 percent was finer than sand. With sand present in this amount, but with very low suspended-sediment concentrations, Maddock's classification would suggest a bedload discharge of as much as 5 to 12 percent of the suspended-sediment discharge. With an average channel slope of 40.3 ft/mi and with sand and small gravel present in the bed it would be reasonable that bedload discharge would be about 10 percent as much as the suspended-sediment discharge.

Average annual suspended-sediment yield from the contributing area computed by the sediment-transport flow-duration curve method was 170 $tons/mi^2$.

Table 18.--Suspended-sediment data from samples at Russell Creek near Columbia

[Average discharge: 41 years, 294 ft^3/s (U.S. Geological Survey, 1981, p. 244)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
June 28	1910	780	314	661	2.6
Aug. 24	1415	676	351	641	2.3
Oct. 4	1230	31	18	1.5	.11
Nov. 18	1245	117	9	2.8	.40
Dec. 13	1640	265	26	19	.90
1978					
Feb. 2	1525	248	8	5.4	.84
Mar. 1	1243	268	8	5.8	.91
Mar. 16	1553	839	30	68	2.9
Apr. 12	1330	100	13	3.5	.34
May 23	1345	134	24	8.7	.46
July 6	1330	23	14	.87	.08
Aug. 22	0845	96	46	12	.33
Oct. 3	1130	48	17	2.2	.16
Nov. 7	1100	27	5	.36	.09
Dec. 10	1105	2,010	94	510	6.8
Dec. 22	1040	873	47	111	3.0
1979					
Jan. 23	1110	870	24	56	3.0
Mar. 6	1035	453	12	15	1.5
Apr. 13	1045	1,280	102	353	4.4
May 22	1100	81	14	3.1	.28
July 3	1545	50	25	3.4	.17
Aug. 28	1740	296	30	24	1.0
Oct. 10	1230	211	8	4.6	.72
Dec. 12	0900	121	10	3.3	.41
1980					
Jan. 16	1300	272	5	3.7	.93
Mar. 6	1100	704	27	51	2.4
Apr. 17	1130	377	11	11	1.3
June 17	1800	51	24	3.3	.17
July 23	1305	22	16	.95	.07
Sept. 10	1400	7.4	13	.26	.03
Sept. 18	0700	7.4	23	.46	.03
Oct. 16	1150	5.7	11	.17	.02
Dec. 3	1110	32	4	.36	.11
1981					
Jan. 7	1520	22	31	1.9	.07
Feb. 11	1400	1,080	292	851	3.7
Apr. 8	1115	203	7	3.8	.69
June 3	1000	437	57	67	1.5
July 29	1000	616	325	541	2.1
Aug. 18	1530	38	46	4.7	.13

Nolin River at White Mills

This basin has a drainage area of 357 mi^2 and 120 mi^2 of noncontributing area. Fifty-six percent of the area is in Hardin County and 44 percent is in Larue County.

Land-use figures were not available for the Nolin River drainage area but the following percentages were derived from the U.S. Soil Conservation Service (U.S. Department of Agriculture, 1970, p. 26). For Hardin County, 52 percent was cropland, 13 percent was pasture, 32 percent was forest, and 3 percent was used in other ways. For Larue County, 39 percent was in cropland, 22 percent was in pasture, 34 percent was in forest, and 5 percent was in other uses.

The types of crops grown influences sediment yield. In the two-county area, corn was the main grain crop. Oats are grown as a principal hay crop. Burley tobacco is a main cash crop (Arms, and others, 1979, p. 1). Most of the crops are high-erosion crops when compared to close grown crops. Forests cover about one-third of each county. The percentage for pasture appears low because, according to Arms and others (1979, p. 1), livestock enterprises account for a high percentage of farm income.

The average discharge at the station is 504 ft^3/s (21 years). Suspended sediment measurements were made at magnitudes of discharge which ranged from 0.10 to 37 times the average flow (table 19). Maximum suspended-sediment concentrations did not necessarily occur with the higher flows. The range was 4 to 325 mg/L. Suspended-sediment discharges ranged from 0.80 to 13,800 tons/d.

One suspended-sediment particle-size analysis showed 47 percent clay, 43 percent silt, and 10 percent sand. The streambed is made up of limestone bedrock, and bed-material analyses were made for that material which was deposited upon the bedrock. Bed material in two analyses averaged 30 percent gravel, 64 percent sand, and 6 percent finer than sand.

These characteristics and Maddock's table suggest a bedload discharge of as much as 5 to 12 percent of the suspended-sediment discharge. Because of the high percentage of sand in the bed material, and the channel characteristics, most of the material would be capable of entering suspension and would likely be carried in the suspended load. Bedload discharge is considered to be negligible. The average annual suspended-sediment yield figured by the sediment-transport flow-duration curve method was 120 $tons/mi^2$.

Bacon Creek near Priceville

This basin has a drainage area of 85.4 mi^2 and 31.2 mi^2 of noncontributing area. Eighty-nine percent of the area is in Hart County and 11 percent is in Larue County.

Table 19.--Suspended-sediment data from samples at Nolin River at White Mills

[Average discharge: 21 years, 504 ft^3/s (U.S. Geological Survey, 1981, p. 250)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
Aug. 30	1330	243	50	33	0.48
Oct. 3	1340	2,040	159	876	4.0
Nov. 22	1210	1,620	208	910	3.2
Dec. 19	1215	1,180	91	290	2.3
1978					
Feb. 15	1300	510	78	107	1.0
Mar. 16	1100	1,880	108	548	3.7
Apr. 17	1200	272	11	8.1	.54
May 31	1200	300	35	28	.60
July 12	1140	95	10	2.6	.19
Aug. 30	1140	123	30	10	.24
Oct. 10	1145	64	16	2.8	.13
Nov. 14	1025	57	14	2.2	.11
Dec. 4	1415	5,610	312	4,730	11
Dec. 9	1925	18,400	278	13,800	37
1979					
Jan. 2	1220	7,000	260	4,910	14
Feb. 1	1315	620	22	37	1.2
Mar. 7	1200	851	38	87	1.7
Apr. 10	1145	1,700	116	532	3.4
May 30	1150	187	15	7.6	.37
July 9	1200	132	22	7.8	.26
Aug. 30	1800	1,000	325	877	2.0
Oct. 16	1700	485	10	13	.96
Nov. 20	1400	415	16	18	.82
Dec. 17	1700	931	25	63	1.8
1980					
Jan. 21	1430	520	10	14	1.0
Mar. 4	1415	261	4	2.8	.52
June 12	1200	150	38	15	.30
July 30	0900	277	126	94	.55
Sept. 17	1505	51	15	2.1	.10
Oct. 20	1010	88	12	2.9	.17
Dec. 8	0940	74	4	.80	.15
1981					
Feb. 19	1115	992	126	337	2.0
Apr. 16	1330	173	22	10	.34
June 19	1215	305	39	32	.61
Aug. 6	1300	121	41	13	.24
Aug. 17	1330	131	38	13	.26
Sept. 18	1130	81	29	6.4	.16

The headwaters of Bacon Creek are in Larue County and the soils in the headwater area are in the Sonora-Gatton-Riney soil association (Arms and others, 1979, p. 3). These soils are deep, gently sloping, well-drained, and moderately well-drained soils on narrow to moderately broad ridges and side slopes; and deep, well-drained soils on narrow ridges and hillsides.

Land-use figures for the exact drainage area are not available, however, figures for Hart County from the U.S. Soil Conservation Service (U.S. Department of Agriculture, 1970, p. 26), are as follows: cropland, 30 percent; pasture, 24 percent; forest, 42 percent; and other uses 4 percent.

Cropland includes fields for corn, tobacco, small grain, and hay. Raising of beef cattle and hogs are the main livestock enterprises (Arms and others, 1979). Except for hay, close grown crops, and cattle pasture, most of the above agricultural activities have high erosion rates which could increase the sediment yield from this area.

The average water discharge at the station is 60.3 ft^3/s (21 years), as shown on table 20. Sediment sampling was done during flows which ranged from 0.14 to 94 times the average discharge.

Instantaneous suspended-sediment concentration ranged from 1 to 1,680 mg/L and produced suspended-sediment discharges of 0.11 to 5,470 tons/d.

Particle-size analyses of suspended sediment indicated that clay averaged 57 percent, silt 30 percent, and sand 13 percent. Bed-material particle-size analyses indicated 1 percent finer than sand, 56 percent sand, and 43 percent gravel.

Bedload discharge is probably in the range of 5 to 12 percent as much as the suspended-sediment discharge (table 6). When one considers the amount of sand in the bed materials, and a channel slope of 7-8 ft/mi, an estimate of 10 percent seems reasonable. The average annual suspended-sediment yield for the contributing area computed by the sediment-transport flow duration curve method amounted to an average of 100 $tons/mi^2$.

Buck Creek near Shopville

This basin covers 165 mi^2 in the eastern section of the Mississippian Plateau. Fifty percent of the drainage basin lies in Pulaski County, 40 percent in Lincoln County, and the remaining 10 percent in Rockcastle County.

Published soil survey data (Ross, 1974) are only available for Pulaski County. One soil association common to this area is the Dickson-Baxter-Westmoreland (Ligon and Karraker, 1949, p. 8). These soils have formed mostly from limestone, sandstone, and shale. According to Ross (1974, p. 3-8), other important soil associations in the Buck Creek drainage area are the Hartsells-Garman-Mountview, Frederick-Mountview, Frederick-Fredonia-Talbott, and the Bedford-Lawrence-Hartsells. All of these soils are moderately deep to deep, and most are well drained. Both of these soil characteristics could account for slow runoff and low sediment input to

Table 20.--Suspended-sediment data from samples at Bacon Creek near Priceville

[Average discharge: 21 years, 60.3 ft^3/s (U.S. Geological Survey, 1981, p. 252)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1978					
Oct. 11	1245	8.6	39	0.91	0.14
Oct. 11	1340	8.6	32	.74	.14
Nov. 13	1335	9.9	339	9.1	.16
Nov. 15	1600	15	60	2.4	.25
Nov. 17	1600	55	54	8.0	.91
Nov. 26	1500	80	98	21	1.3
Nov. 26	2130	239	550	355	4.0
Nov. 27	0640	318	692	594	5.3
Dec. 3	1330	143	1,680	649	2.4
Dec. 3	2330	403	330	359	6.7
Dec. 4	0635	633	462	790	10
Dec. 4	1815	840	354	803	14
Dec. 7	1400	218	200	118	3.6
Dec. 7	2105	717	498	964	12
Dec. 8	1540	4,470	453	5,470	74
Dec. 8	1930	5,670	336	5,140	94
Dec. 9	1245	3,340	136	1,230	55
Dec. 21	0715	452	689	841	7.5
Dec. 21	1900	324	345	302	5.4
1979					
Jan. 2	1445	489	136	180	8.1
Jan. 31	1415	85	20	4.6	1.4
Feb. 28	1455	187	103	52	3.1
Apr. 12	0950	890	502	1,210	15
Apr. 12	1150	1,200	507	1,640	20
Apr. 13	0820	455	190	233	7.5
May 4	1200	137	80	30	2.3
May 5	1015	143	72	28	2.4
May 21	1025	42	26	2.9	.70
July 2	1115	24	52	3.4	.40
Aug. 21	1400	19	33	1.7	.32
Oct. 8	1100	67	14	2.5	1.1
Nov. 12	1100	96	16	4.1	1.6
Nov. 24	1625	301	234	190	5.0
Dec. 10	1300	48	11	1.4	.80
Dec. 13	1100	618	411	686	10
Dec. 13	1645	994	337	904	16
Dec. 14	0900	296	195	156	4.9
1980					
Jan. 14	1200	99	23	6.1	1.6
Mar. 3	1450	40	12	1.3	.66
Apr. 16	1230	133	41	15	2.2
July 30	1230	40	1	.11	.66
Sept. 17	1655	10	50	1.3	.17
Oct. 20	1410	10	4	.11	.17
Dec. 8	1230	12	4	.13	.20
1981					
Aug. 5	1230	11	54	1.7	.18
Aug. 17	1020	13	52	1.8	.22

streams. Land use estimated by weighting of percent of the study area in each of the three counties is as follows: cropland, 34 percent; pasture, 20.4 percent; forest, 41.4 percent; and other uses, 4.2 percent. This type of land use also tends to decrease sediment yield.

Average water discharge from the Buck Creek study area is 281 ft^3/s (28 years), as shown in table 21. Suspended-sediment sampling was accomplished for flows which ranged from 0.01 to 8.4 times the average flow. This is a limited range.

Suspended-sediment concentrations were consistently low, ranging from 1 to 57 mg/L. Suspended-sediment discharge measurements ranged from 0 to 365 tons/d during the 3-year period.

Two particle-size analyses of suspended sediment averaged 38 percent clay, 52 percent silt, and 10 percent sand. Bed-material particle-size analyses indicated 1 percent finer than sand, 24 percent sand, and 75 percent gravel. With this distribution of particle size in suspended and bed sediments, according to Maddocks classification, the bedload discharge would be 5 to 12 percent of the suspended-sediment discharge.

The average annual suspended-sediment yield computed from the sediment transport flow-duration curve method was 45 $tons/mi^2$.

Little River near Cadiz

This basin has a total drainage area of 244 mi^2 and 94 mi^2 of noncontributing area. This reduces the effective drainage area to 150 mi^2. Eighty-four percent of the area lies in Christian County and 16 percent lies in Trigg County.

According to Froedge (1980, p. 4-14), there are several principal soil associations in the Little River drainage. They are the Zanesville-Frondorf-Weikert in the headwater area, and the Pembroke-Crider, the Hammack-Baxter-Crider, the Nicholson, and the Robertsville-Lawrence in the downstream area. All of these soils are deep, well drained, and loamy. All three of these characteristics help limit stream sediment as runoff is probably slower due to better infiltration.

The Soil and Water Conservation Needs Inventory (U.S. Department of Agriculture, 1970, p. 26) covered 92 percent of the land area in Christian County and 55 percent of the area in Trigg County. Of the inventoried land, the following percentages of land uses were:

	Christian	Trigg
Cropland	51	37
Pasture	17	25
Forest	31	36
Other	1	2
Total	100	100

The Christian County part of the drainage area would be expected to contribute more runoff and sediment than the Trigg County part due to higher percentage of cropland and lower percentage of forest.

Table 21.--Suspended-sediment data from samples at Buck Creek near Shopville

[Average discharge: 28 years, 281 ft^3/s (U.S. Geological Survey, 1981, p. 305)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
June 29	0905	587	37	59	2.1
1978					
Mar. 7	1610	480	34	44	1.7
Mar. 17	0858	587	14	22	2.1
Apr. 11	1600	113	16	4.9	.40
May 16	1420	608	44	72	2.2
June 29	1120	7.8	0	0	.03
Aug. 1	1250	14	10	.38	.05
Sept. 11	1235	15	9	.36	.05
Oct. 11	1350	2.9	5	.04	.01
Nov. 21	1150	86	7	1.6	.31
Dec. 26	1305	326	5	4.4	1.2
1979					
Feb. 20	1415	232	5	3.1	.82
Mar. 9	1355	228	10	6.2	.81
Apr. 3	1440	2,370	57	365	8.4
May 1	1100	75	6	1.2	.27
May 31	1200	34	10	.92	.12
Sept. 10	1350	29	10	.78	.10
Oct. 11	1530	216	6	3.5	.77
Nov. 26	1530	1,520	16	66	5.4
Dec. 20	1345	192	7	3.6	.68
1980					
Feb. 14	1345	83	9	2.0	.30
Apr. 9	1225	613	55	91	2.2
Apr. 15	1615	945	17	43	3.4
May 14	1645	35	3	.28	.12
July 24	1435	1.8	6	.03	.01
Sept. 15	1145	17	6	.28	.06
Sept. 18	1010	17	7	.32	.06
Dec. 4	1330	21	1	.06	.07
1981					
Jan. 19	1410	7.5	16	.32	.03
Feb. 23	1355	469	19	24	1.7
Apr. 1	1510	151	89	36	.54
May 8	1450	50	2	.27	.18
May 20	1345	1,980	63	337	7.0
June 22	1105	69	3	.56	.25
Aug. 19	0800	17	14	.64	.06

Average water discharge at the station is 350 ft^3/s (40 years) as shown in table 22. Suspended-sediment samples were collected during streamflow that ranged from 0.07 to 26 times the average flow. Suspended-sediment concentration ranged from 6 to 1,235 mg/L, and suspended-sediment discharge ranged from 0.62 to 30,700 tons/d.

Particle-size distribution of suspended sediment was 40 percent clay, 56 percent silt, and 4 percent sand.

On the average, the bed material was 3 percent finer than sand, 12 percent sand, and 85 percent gravel. This combination would, according to Maddock's classification of bedload discharge, suggest a bedload discharge of as much as 5 to 12 percent of the suspended-sediment discharge.

In the drainage area of North Fork of Little River, there are four reservoirs (U.S. Geological Survey, 1957 and 1969a) which retain some of the sediment discharged from a combined drainage area of 17,135 acres or 26.77 mi^2. The total surface area of the reservoirs at normal pool is 498 acres. This leaves a sediment contributing area of 16,637 acres or 26 mi^2. This surface area of the reservoirs reduces the total contributing drainage area from 150 to 149 mi^2.

Sediment discharge into these reservoirs was estimated from deposition figures from a survey of Lake Tandy which is one of the four reservoirs. The rate of deposition, including bedload, for Lake Tandy was 0.667 acre-feet per square mile per year (U.S. Soil Conservation Service, 1950, p. 1). Specific weight of deposited sediment was estimated at 55 lbs/ft^3, based upon surveys of Kentucky Lake made by the Tennessee Valley Authority (1966, p. 1-2). The rate of sediment retained by the four reservoirs from the 26 mi^2 was computed to be 20,800 tons/yr (800 $tons/mi^2$).

The trap efficiency of Lake Tandy was estimated to be 87 percent based on Brune (1953, p. 408) and using the most recent figure of capacity-watershed ratio of 61 (U.S. Soil Conservation Service, 1950, p. 1). This trap efficiency is also used for the remaining reservoirs of the North Fork Little River watershed. The 20,800 tons/yr represented 87 percent of the total sediment inflow of 23,900 tons/yr (920 $tons/mi^2$). The difference of 3,100 tons/yr passed through the reservoirs.

Based upon a sediment-transport curve developed for Little River near Cadiz, the annual suspended-sediment discharge was 70,400 tons. Subtracting the 3,100 tons/yr for sediment which came through the reservoirs results in a total suspended-sediment discharge of 67,300 tons/yr for the area downstream of the reservoirs. The average annual suspended-sediment yield for the 123 mi^2 below the reservoirs then would be 67,300/123 or 550 $tons/mi^2$. No addition was made for bedload discharge.

Table 22.--Suspended-sediment data from samples at Little River near Cadiz

[Average discharge: 40 years, 350 ft^3/s (U.S. Geological Survey, 1981, p. 390)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
June 28	1245	95	135	35	0.27
Aug. 31	1120	30	115	9.6	.09
Nov. 22	1150	1,090	810	2,380	3.1
1978					
Jan. 4	1140	189	6	3.1	.54
Feb. 16	1220	674	53	96	1.9
Mar. 23	1105	686	75	139	2.0
May 2	1330	126	13	4.4	.36
May 17	1335	807	136	296	2.3
June 13	1255	116	134	42	.33
July 25	1040	54	52	7.6	.15
Sept. 7	1220	36	30	2.9	.10
Dec. 4	1530	4,730	1,060	13,500	14
Dec. 28	1400	462	152	190	1.3
Dec. 30	1120	635	852	1,460	1.8
1979					
Mar. 6	1240	1,200	131	424	3.4
Apr. 2	1520	9,220	1,235	30,700	26
May 30	1320	214	24	14	.61
July 9	1320	379	1,090	1,120	1.1
Aug. 23	1130	61	64	11	.17
Sept. 21	1340	2,240	365	2,210	6.4
Oct. 5	1010	282	19	14	.81
Nov. 13	1330	199	11	5.9	.57
1980					
Jan. 2	1125	522	20	28	1.5
Feb. 12	1050	177	25	12	.5
Mar. 18	1225	784	66	140	2.2
July 8	1115	131	41	15	.37
Aug. 19	1200	34	37	3.4	.10
Sept. 16	1504	37	22	2.2	.11
Oct. 1	1115	38	28	2.9	.11
Nov. 11	1150	23	10	.62	.07
Dec. 18	1100	53	11	1.6	.15
1981					
Mar. 31	1130	366	64	63	1.0
May 28	1110	239	57	37	.68
July 21	1045	221	111	66	.63
Aug. 18	1115	112	49	15	.32

Other Sediment Stations of the Mississippian Plateau

In addition to the five partial-record stations which have been discussed, there were four additional locations in the Mississippian Plateau region at which the U.S. Geological Survey has collected either partial-record or daily-record data. All stations of the region are summarized in table 23.

Primary particle sizes of sand, silt, and clay are given in table 24. The average of the analyses is 5 percent sand, 41 percent silt, and 54 percent clay. The trilinear diagram (fig. 10) showing average size analyses of sand, silt, and clay for streams of the Mississippian Plateau shows more variation in all three size classes than for the Blue Grass region (fig. 9), but less scatter (variation) than for analyses of the Eastern Coal Region (fig. 8).

Average annual suspended-sediment yields ranging from 45 to 550 tons/mi^2 were computed. Most of the differences were closely related to land use and soil character from one basin to another. Some of the low yield determinations, notably for Buck Creek near Shopville, may have been somewhat larger if a broader range of flow had been sampled. Bedload discharge was not considered to exceed 10 percent of the amount measured as suspended-sediment discharge.

WESTERN COAL FIELD

Pond River near Apex

This basin has a drainage area of 194 mi^2 and 2 mi^2 of noncontributing area. Forty-four percent of the drainage area lies in Christian County, 38 percent is in Todd County and the remaining 18 percent in Muhlenberg County.

Specific land use for the basin was not available, however, land use was classified separately for the three counties of the area. The following is a land-use estimate based upon percentage of a particular land use within each county weighted according to the percent of the county in the study area. This results in the following distribution for the study area: cropland, 52 percent; pasture, 14 percent; forest, 32 percent; and other uses 2 percent. Corn, soybeans, and tobacco are leading crops and these are very susceptible to erosion as are most row crops. Hay, pasture, and trees provide more protection against soil loss.

Water discharge at the station averaged 269 ft^3/s (40 years) as shown in table 25. Suspended sediment was sampled at discharges which were about 0.005 to 21 times the average discharge. Concentrations ranged from 4 to 1,330 mg/L. Suspended-sediment discharge ranged from 0.01 to 20,500 tons/d.

Table 23.--Summary of sediment-discharge characteristics of streams of the Mississippian Plateau region

Station number	Station name	Sediment concentrations[1] (mg/L) Low	High	Sediment discharge[1] (tons/d) Low	High	Ratio of instantaneous to average discharge[2] Low	High	Average annual suspended sediment discharge[3] (tons/mi²)
03307000	Russell Creek near Columbia	4	351	0.17	851	0.02	6.8	170
03308500	Green River at Munfordville	0	3,180	0	157,000	--	--	[4]340
03310300	Nolin River at White Mills	4	325	.80	13,800	.10	37	120
03310400	Bacon Creek near Priceville	1	1,680	.11	5,470	.14	94	100
03314500	Barren River at Bowling Green	1	1,880	.17	107,000	--	--	290
03318500	Rough River at Falls of Rough	1	2,460	.04	24,100	--	--	450
03407500	Buck Creek near Shopville	2	57	0	365	.01	8.4	45
03438000	Little River near Cadiz	6	1,240	.62	30,700	.07	26	[5]550
03438220	Cumberland River near Grand Rivers	5	169	78	24,300	--	--	45
							Average	234
							Maximum	550
							Minimum	45
							Median	170

[1]Daily values used for daily stations; instantaneous values used for partial record stations.
[2]Selected partial-record stations only.
[3]Does not include sediment deposited in reservoirs, unless so stated.
[4]Prior to construction of Green River Lake.
[5]Includes estimate of reservoir deposits of reservoirs in North Fork Little River.

Table 24.--Average percentages of sand, silt, and clay in suspended sediment of streams of the Mississippian Plateau region

Station number	Station name	Sand	Silt	Clay
03307000	Russell Creek near Columbia	--	--	--
03308500	Green River at Munfordville	2	41	57
03310300	Nolin River at White Mills	10	43	47
03310400	Bacon Creek near Priceville	13	30	57
03314500	Barren River at Bowling Green	1	37	62
03318500	Rough River at Falls of Rough	0	35	65
03407500	Buck Creek near Shopville	10	52	38
03438000	Little River near Cadiz	4	56	40
03438220	Cumberland River at Grand Rivers	--	--	--
	Average	6	42	52

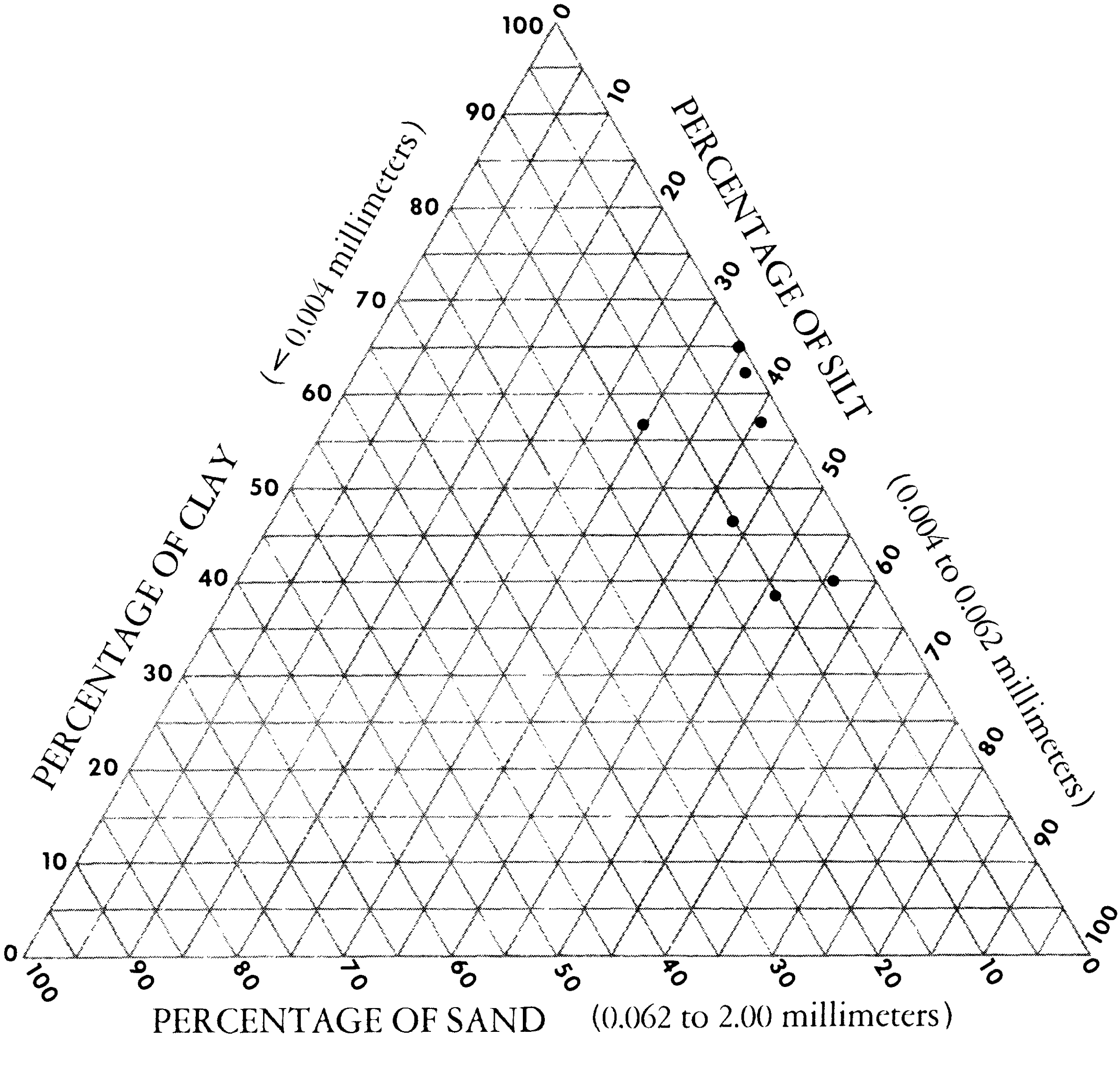

Figure 10.-- Percentage of sand, silt and clay in suspended sediment in streams of the Mississippian Plateau.

Table 25.--Suspended-sediment data from samples at Pond River near Apex
[Average discharge: 40 years, 269 ft^3/s (U.S. Geological Survey, 1981, p. 283)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
June 27	1510	16	260	12	0.06
Aug. 8	1200	5.2	52	.73	.02
Sept. 6	1200	2.9	27	.21	.01
Oct. 3	1240	124	167	56	.46
Nov. 14	1250	43	39	4.5	.16
Dec. 17	1300	300	58	47	1.1
1978					
Mar. 10	1300	941	98	249	3.5
Apr. 21	1230	183	28	14	.68
May 17	1605	963	190	494	3.6
June 1	1230	44	216	26	.16
July 10	1130	2.7	14	.10	.01
Oct. 5	1100	2.4	4	.03	.01
Dec. 13	1300	1,090	128	377	4.1
1979					
Jan. 19	1310	1,220	1,010	3,300	4.5
Feb. 23	1205	5,720	1,330	20,500	21
Mar. 5	1235	955	251	647	3.6
Mar. 15	1320	186	296	149	.69
Mar. 22	1215	490	120	159	1.8
Mar. 30	1020	317	116	99	1.2
May 7	1130	935	93	235	3.5
June 18	1400	11	64	1.9	.04
Aug. 1	1310	30	680	55	.11
Sept. 14	1300	1,890	418	2,130	7.0
Sept. 19	1100	200	89	48	.74
Oct. 26	1230	15	23	.93	.06
Nov. 23	1415	2,700	735	5,360	10
Nov. 27	1500	1,400	269	1,020	5.2
Dec. 7	1245	179	42	20	.67
Dec. 13	1130	4,000	739	7,980	15
Dec. 24	1030	3,000	992	8,040	11
1980					
Jan. 18	1000	215	176	102	.80
Feb. 15	1600	276	756	563	1.0
Feb. 16	1600	610	617	1,020	2.3
Mar. 28	1300	1,170	1,250	3,950	4.3
Apr. 11	1430	201	24	13	.74
June 5	0945	42	86	9.8	.16
July 31	1050	9.1	99	2.4	.03
Aug. 28	1100	.09	41	.01	.005
Nov. 20	1320	70	55	10	.26
Nov. 21	0855	36	40	3.9	.13
1981					
May 19	1200	3,090	1,880	15,700	11
June 11	1125	421	87	99	1.6

Particle-size analyses of suspended sediment consisted mostly of sand separations. Sand ranged from 1 to 10 percent; thus, silt-clay mixtures ranged from 90 to 99 percent. One complete size analysis showed 47 percent clay, 48 percent silt, and 5 percent sand. Two bed-sediment particle-size analyses showed that 30 percent was silt-clay, 53 percent was sand, and 17 percent was gravel. Bedload discharge is estimated to be less than five percent. The channel has a slope of 0.1 ft/mi so that it acts almost as a ponded channel during many ranges of discharge and there is much deposition in the reach. It is sometimes clear of loose sediment but at times has heavy deposits of fine sediment (Bonham, Wilson G., U.S. Geological Survey, oral commun. 1983).

The transport curve for Pond River used with the flow-duration curve, gave an average annual suspended-sediment yield of 500 tons/mi^2. This yield was probably high due to an earlier channelization of the upstream reach which probably continues to feed some sediment into the stream.

South Fork Panther Creek near Whitesville

This basin has a drainage area of 58.2 mi^2 and 0.5 mi^2 of non-contributing area. Sixty-four percent is in Ohio County, 32 percent in Hancock County, and 4 percent in Breckenridge County.

Land-use estimates based on county averages and percent of the study area in a particular county indicated that 52 percent was forest, 17 percent was pasture, 29 percent was cropland, and 3 percent was for other uses. According to Cox (1974 p. 1), the area has been important in farming, but in recent years some of the more hilly farm land has reverted to forest.

Average water discharge at the station was 49.9 ft^3/s (12 years), shown in table 26. Samples were obtained for a flow range of less than 0.005 to 5.3 times the average flow. Suspended-sediment concentrations ranged from 2 to 267 mg/L, while suspended-sediment discharges ranged from less than 0.01 to 190 tons/d. Particle-size determination of suspended sediment was limited to one sand separation analysis which showed 2 percent sand, and a 98 percent silt-clay portion. On the average, 30 percent of the bed material was finer than sand. This is expected because the extremely low velocities aid in settling of fines. Mean velocities of water discharge measurements since March 1977, have never exceeded 1.0 foot per second. This suggests a limited capability of a stream to initiate movement of bed material larger than silt size, however, bed material at this station averaged 30 percent finer than sand, 63 percent sand, and 10 percent gravel. It seems probable that bed material of the finer sizes would be easily moved into suspension by any significant increase in water discharge.

The sediment-transport curve was used to estimate an average annual suspended-sediment yield of 60 tons/mi^2.

Table 26.--Suspended-sediment data from samples at South Fork Panther Creek near Whitesville

[Average discharge: 12 years, 49.9 ft^3/s (U.S. Geological Survey, 1981, p. 299)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
Aug. 10	1300	0.06	48	0.01	.005
Sept. 6	1400	5.2	11	.15	.10
Oct. 9	1340	134	32	12	2.7
Nov. 13	1345	38	27	2.8	.76
Dec. 20	1345	77	24	5.0	1.54
1978					
Mar. 6	1450	82	60	13	1.64
Mar. 15	1605	263	267	190	5.27
Apr. 17	1410	48	20	2.6	.96
May 29	1400	15	15	.61	.30
Aug. 21	1330	.18	2	.01	.005
Oct. 2	1510	.04	13	.01	.005
Dec. 10	1120	137	130	48	2.74
1979					
Mar. 29	1230	76	24	4.9	1.5
May 8	1125	66	26	4.7	1.3
June 20	1320	3.9	58	.62	.08
Aug. 3	1050	51	53	7.3	1.0
Oct. 23	1145	34	16	1.5	.68
Dec. 3	1140	46	13	1.6	.92
1980					
Feb. 27	1500	46	8	.99	.92
Apr. 9	1200	79	24	5.1	1.6
June 3	1010	4.8	30	.39	.10
July 29	1140	12	126	4.1	.24
Sept. 16	0950	.24	27	.02	.005
1981					
Feb. 19	1020	55	47	7.0	1.1
Apr. 15	0855	19	44	2.3	.38
June 2	1005	151	43	18	3.0
July 29	1315	5.2	21	.29	.10
Aug. 17	1645	3.3	92	.82	.07

Other Sediment Stations of the Western Coal Field

Aside from the two stations of this project, there were nine other daily stations in the Western Coal Field. One of these, Tradewater River near Olney, had 21 years of record. The others had from 1 to 5 years of record. All stations and hydrologic data are listed in table 27.

Particle-size analyses are in table 28. Only one station, Tradewater River near Olney, had multiple analyses while the other three, for which size was reported, had one analysis each. Figure 11 is a trilinear plot of these particle-size analyses.

JACKSON PURCHASE REGION

West Fork Clarks River near Brewers

This basin covers 68.7 mi^2 in three different counties. Seventy-five percent of the drainage area is in Calloway County, 19 percent in Marshall County, and 6 percent in Graves County.

The estimated average land use throughout the drainage area, weighted for percentage and land use in each county and percent of the drainage area in each county is: cropland, 43 percent; pasture, 18 percent; forest, 34 percent; and other, 5 percent.

The average water discharge from the drainage area was 96.1 ft^3/s (12 years) as shown in table 29. Suspended-sediment samples were taken at times when the water discharge was 0.01 to 23 times average discharge, a good range of sampling.

Suspended-sediment concentrations ranged from 2 to 1,270 mg/L and suspended-sediment discharges ranged from 0.03 to 6,500 tons/d as shown in table 29.

Particle-size analyses of suspended sediment averaged 50 percent clay, 45 percent silt, and 5 percent sand. Bed material consisted of an average of 2 percent material finer than sand, 58 percent sand, and 40 percent gravel.

The characteristics of the suspended sediment and the bed sediment used with Maddock's table indicates that the bedload discharge would be as much as 5 to 12 percent of the suspended-sediment discharge.

Within the West Fork Clarks River drainage area, there are six floodwater retarding reservoirs on five different streams (U.S. Geological Survey, 1951). These have a combined drainage area of 17.45 mi^2. The combined surface areas at normal pools are 169 acres or 0.26 mi^2. This results in the sediment contributing area of the four reservoirs of (17.45-0.26 = 17.19) 17.2 mi^2.

Table 27.--Summary of sediment-discharge characteristics of streams of the Western Coal Field

Station number	Station name	Sediment concentration (mg/L) Low	Sediment concentration (mg/L) High	Sediment discharge[1] (tons/d) Low	Sediment discharge[1] (tons/d) High	Ratio of instantaneous to average discharge[2] Low	Ratio of instantaneous to average discharge[2] High	Average annual suspended sediment discharge[3] ($tons/mi^2$)
03310500	Nolin River at Wax	5	1,120	1	14,700	--	--	400
03316645	Green River at Rockport	11	1,090	9	82,100	--	--	170
03319500	Rough River at Dundee	5	824	.77	12,600	--	--	180
03320000	Green River at lock 2 at Calhoun	7	610	21	55,400	--	--	160
03320500	Pond River near Apex	4	1,330	.01	20,500	0	21	500
03321210	Cypress Creek near Calhoun	5	1,500	.11	4,940	-	-	180
03321230	Green River near Beech Grove	20	411	16	46,400	--	--	110
03321350	South Fork Panther Creek near Whitesville	2	267	.005	190	0	2.6	60
03321430	Panther Creek near Owensboro	8	1,780	.11	5,770	-	-	230
03383000	Tradewater River at Olney	0	764	0	5,100	-	-	65
03384180	Tradewater River near Sullivan	10	644	.32	4,990	-	-	110
							Average	197
							Maximum	500
							Minimum	60
							Median	170

[1]Daily values used for daily stations; instantaneous values used for instantaneous records.
[2]Selected partial-record stations only.
[3]Does not include sediment deposited in reservoirs.

Table 28.--Average percentage of sand, silt, and clay in suspended sediment of streams of the Western Coal Field

Station number	Station name	Sand	Silt	Clay
03310500	Nolin River near Wax	3	37	59
03316645	Green River at Rockport	1	33	66
03319500	Rough River at Dundee	[1]2	--	--
03320000	Green River at lock 2 at Calhoun	--	--	--
03320500	Pond River near Apex	5	48	47
03321210	Cypress Creek near Calhoun	1	7	92
03321230	Green River near Beech Grove	[1]2	--	--
03321350	South Fork Panther Creek near Whitesville	[1]2	--	--
03321430	Panther Creek near Owensboro	--	--	--
03383000	Tradewater River at Olney	1	21	78
03384180	Tradewater River near Sullivan	1	32	67
	Average	2	30	68

[1]Not included in average

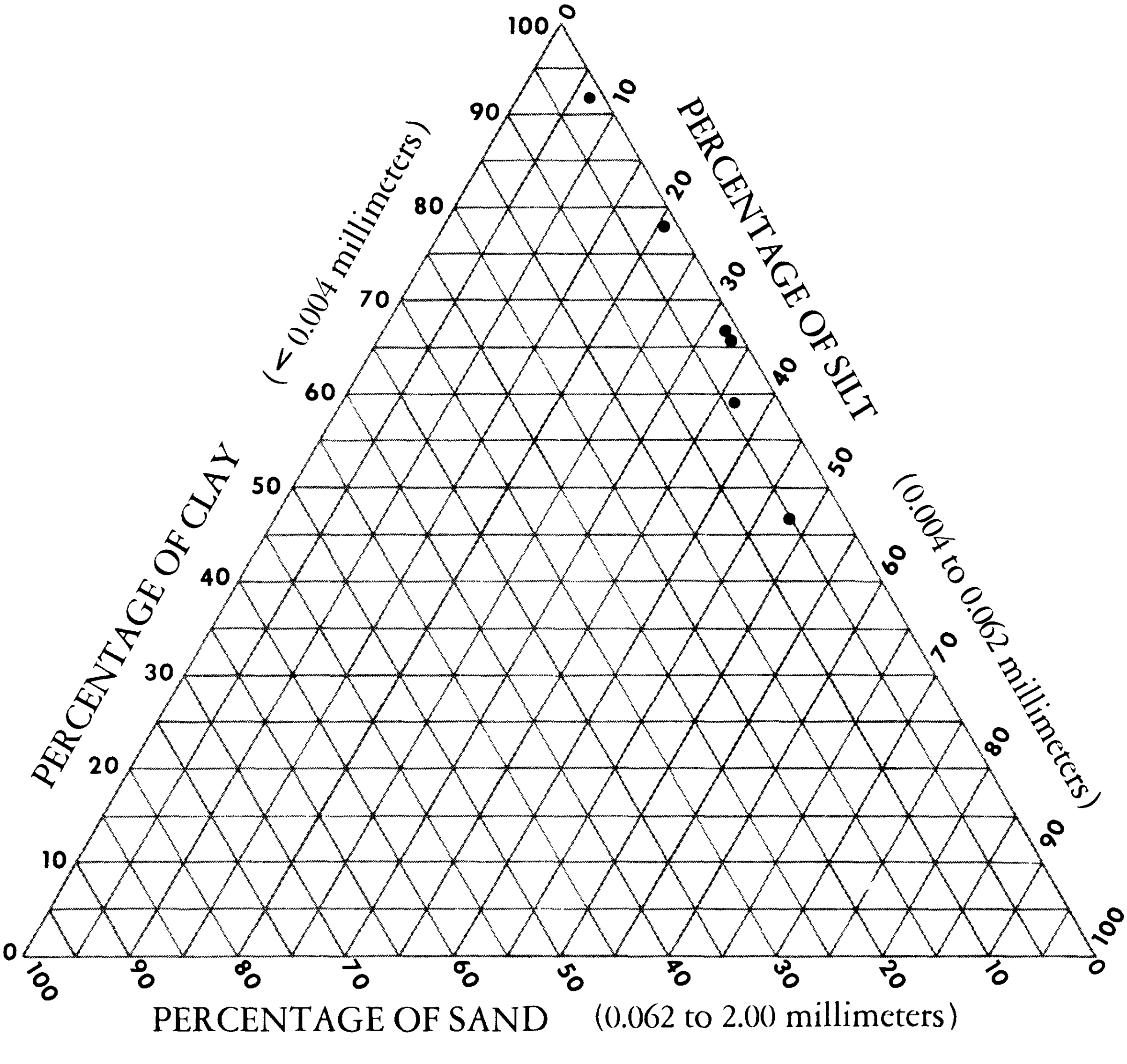

Figure 11.-- Percentage of sand, silt and clay in suspended sediment in streams of the Western Coal Field.

Table 29.--Suspended-sediment data from samples at West Fork Clarks River near Brewers

[Average discharge: 12 years, 96.1 ft^3/s (U.S. Geological Survey, 1981, p. 415)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
June 27	1840	5.3	67	0.96	0.06
Aug. 17	1315	35	122	12	.36
Aug. 31	0940	6.8	58	1.1	.07
Nov. 22	1330	149	83	33	1.6
1978					
Jan. 3	1055	21	6	.34	.22
Mar. 1	1610	202	40	22	2.1
Mar. 20	1330	64	38	6.6	.67
May 11	0900	91	48	12	.95
May 17	1040	73	75	15	.80
June 15	1120	8.5	15	.34	.09
July 26	1030	9.5	15	.38	.10
Sept. 6	1710	5.0	4	.05	.05
Oct. 12	1050	6.7	254	4.6	.07
Oct. 25	1100	6.8	13	.24	.07
Dec. 4	1130	1,500	657	2,660	16
Dec. 7	1340	1,260	193	657	13
Dec. 28	1310	29	27	2.1	.30
1979					
Feb. 2	1305	48	85	11	.50
Mar. 7	1410	102	60	17	1.1
Mar. 16	1110	31	30	2.5	.32
Apr. 2	1425	2,250	1,070	6,500	23
Apr. 11	1335	227	94	58	2.4
May 31	1210	844	1,270	2,890	8.8
July 10	1330	16	114	4.9	.17
Aug. 23	1310	11	99	2.9	.11
Oct. 2	1155	20	9	.49	.21
Dec. 28	1230	55	33	4.9	.57
1980					
Mar. 20	1115	502	516	699	5.2
May 14	1100	13	2	.07	.14
July 9	1520	5.2	9	.13	.05
Sept. 16	1705	1.4	7	.03	.01
Nov. 12	1240	7.7	6	.12	.08
Dec. 23	1150	17	15	.69	.18
1981					
Feb. 4	1300	51	26	3.6	.53
Mar. 31	1440	91	36	8.8	.95
May 14	1210	96	70	18	1.0
May 15	0910	33	26	2.3	.34
May 19	1245	752	670	1,360	7.8
May 27	1045	46	8	.99	.48
July 23	1100	33	48	4.3	.34

In order to compute an estimated tonnage deposited in the six reservoirs as well as the tonnage of sediment outflow, it was assumed that 0.667 acre-feet per square mile of drainage was deposited and that the collective trap efficiency of the 6 reservoirs was 87 percent (this was identical with that of Lake Tandy). Also, it was assumed that each cubic foot of deposited sediment weighed 55 pounds, the same figure used for the Little River reservoirs.

Using the above information, it was calculated that 13,700 tons/yr were collected in the reservoir and that 15,700 tons/yr (910 tons/mi^2) were discharged from the 17.2 mi^2 area. The difference of 2,000 tons/yr passes through the reservoir.

The sediment-transport curve gave a total suspended-sediment discharge of 37,800 tons/yr which included the amount passing through the reservoir. The drainage area below the reservoirs was 68.7-17.4 or 51.3 mi^2. Subtracting the tonnage which came through the reservoir from the average annual sediment discharge computed from the curve gives 35,800 tons/yr or 700 tons/mi^2. No estimate of bedload was made.

Massac Creek near Paducah

This basin has a drainage area of 14.6 mi^2 and is contained completely in McCracken County.

The erosion hazard of the soils of McCracken County is a noticeable characteristic. The annual erosion rate of these soils is about 40 tons per acre or 25,600 tons/mi^2 (James, R. S., Soil Conservation Technician, oral commun., 1982). It is likely that only a small portion of this reaches the stream systems.

Land uses in the watershed are pasture, meadows, cultivated crops and woodland. Dairy farming is quite important in the main branch area of Massac Creek. Some 13 dairy operations are located there (James, R. S., Soil Conservation Technician, oral commun., 1982). Gravel underlying the Granada-Calloway association is also mined although several feet of loess must be removed to reach the gravel (Humphrey, 1976).

Average water discharge at this station was 20.3 ft^3/s (9 years) as shown in table 30. Sediment sampling was accomplished at ranges from 0.01 to 46 times the average flow.

Instantaneous suspended-sediment discharge measurements had concentrations ranging from 8 to 1,330 mg/L, and suspended-sediment discharges ranging from 0.01 to 1,360 tons/d (table 30).

Two particle-size analyses of suspended sediment averaged 62 percent clay and 37 percent silt and 1 percent sand. The bed material consisted of 47 percent gravel, 50 percent sand, and 3 percent finer than sand.

Table 30.--Suspended-sediment data from samples at Massac Creek near Paducah
[Average discharge: 9 years, 20.3 ft^3/s (U.S. Geological Survey, 1981, p. 417)]

Date	Time	Instantaneous discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Instantaneous suspended-sediment discharge (tons/d)	Ratio of instantaneous discharge to average discharge
1977					
June 28	0905	0.43	531	0.62	0.02
Aug. 17	1030	182	1,130	555	9.0
Aug. 30	0915	.73	9	.02	.04
Nov. 21	1550	36	148	14	1.8
1978					
Jan. 4	1415	1.4	20	.08	.07
Mar. 20	0955	10	12	.33	.49
May 9	1010	8.6	32	.74	.42
May 17	0900	1.0	7	.02	.05
June 13	0945	.71	10	.02	.03
July 25	0930	.39	14	.01	.02
Sept. 6	0955	.36	11	.01	.02
Nov. 20	1135	3.4	13	.12	.17
Dec. 7	0850	265	162	116	13
Dec. 11	0955	3.4	56	.51	.17
Dec. 27	0930	2.8	9	.07	.14
1979					
Jan. 30	1220	6.3	49	.83	.31
Mar. 8	0930	10	18	.49	.49
Mar. 11	0850	3.0	39	.32	.15
Mar. 23	1000	935	538	1,360	46
Apr. 2	0925	187	372	188	9.2
Apr. 11	0923	17	21	.96	.84
June 1	0935	1.2	8	.03	.06
Sept. 21	0945	148	1,330	531	7.3
Oct. 3	1445	.53	14	.02	.03
Nov. 13	1010	2.3	15	.09	.11
Dec. 27	1030	7.6	23	.47	.37
1980					
Feb. 14	1230	2.1	28	.16	.10
July 10	1030	.55	15	.02	.03
Sept. 16	1835	.23	13	.01	.01
Oct. 3	1005	.34	24	.02	.02
Nov. 13	1215	.31	8	.01	.02
1981					
Feb. 5	1320	.87	50	.12	.04
Apr. 2	1100	3.1	65	.54	.15
May 6	1010	1.1	8	.02	.05
May 14	1030	139	374	140	6.8
May 15	0945	17	36	1.7	.84
May 18	1320	106	754	216	5.2
May 26	1045	4.4	17	.20	.22
July 21	1200	8.7	115	2.7	.43

Under the above conditions, the bedload discharge could be near the maximum in the 5-12 percent classification. It is estimated from Maddock's classification that the magnitude of bedload discharge is as much as 10 percent of the suspended-sediment discharge.

Average annual suspended-sediment yield from the sediment-transport curve in conjunction with the flow-duration curve was computed to be 370 tons/mi^2.

It is believed that West Fork Clarks River has a higher sediment yield than Massac Creek because the West Fork Clarks River basin is more heavily cultivated, and contains 10 percent more pasture which is not as erodible as cropland.

Sediment Stations of the Jackson Purchase

The two partial-record stations just discussed were the only ones operated by the U.S. Geological Survey in the Jackson Purchase region. Tables 31 and 32 list data for the stations and figure 12 provides a graphic representation of the percentages of sand, silt, and clay.

OHIO RIVER SEDIMENT STATIONS

Four NASQAN stations at which monthly sediment data are collected and one daily sediment station are being operated on the Ohio River where it borders Kentucky. The partial-record station (NASQAN) data are representative of a large range of flow. The daily-station data are collected so that a continuous sediment-concentration curve can be drawn. This amounts to a weekly sample from May to November and twice-weekly samples from December to April. Additional samples are collected during major runoff events. Yields based upon the two frequencies of collection are given in table 33.

As discussed earlier, the U.S. Army Corps of Engineers collected samples on the Ohio River during the 1940's. Data from the Cincinnati and Metropolis stations were used to compute the yields of 550 and 400 tons/mi^2 given in table 33. These are believed to be high because they represented, for the most part, high flows. The Evansville station in table 33 represented one high flow period and a very limited range, thus no reasonable yield figure could be computed.

The daily station at Louisville seems to be very predictable in suspended-sediment discharge. One sampling for unmeasured sediment discharge in June 1981 showed that no appreciable sediment discharge occurred within 3 inches of the streambed for the specific time of sampling. Other samples have been collected, but analyses of the samples were not available at this writing.

Table 31.--Summary of sediment discharge characteristics of streams of the Jackson Purchase

Station number	Station name	Sediment concentration (mg/L)		Sediment discharge (tons/d)		Ratio of instantaneous to average discharge		Average annual suspended sediment discharge ($tons/mi^2$)
		Low	High	Low	High	Low	High	
03610545	West Fork Clarks River near Brewers	2	1,270	0.03	6,500	0.01	23	700
03611260	Massac Creek near Paducah	8	1,330	.01	1,360	.01	46	370
							Average	535
							Median	535

Table 32.--Average percentages of sand, silt, and clay in suspended sediment of streams of the Jackson Purchase region

Station number	Station name	Sand	Silt	Clay
03610545	West Fork Clarks River near Brewers	5	45	50
03611260	Massac Creek near Paducah	1	37	62
	Average	3	41	56

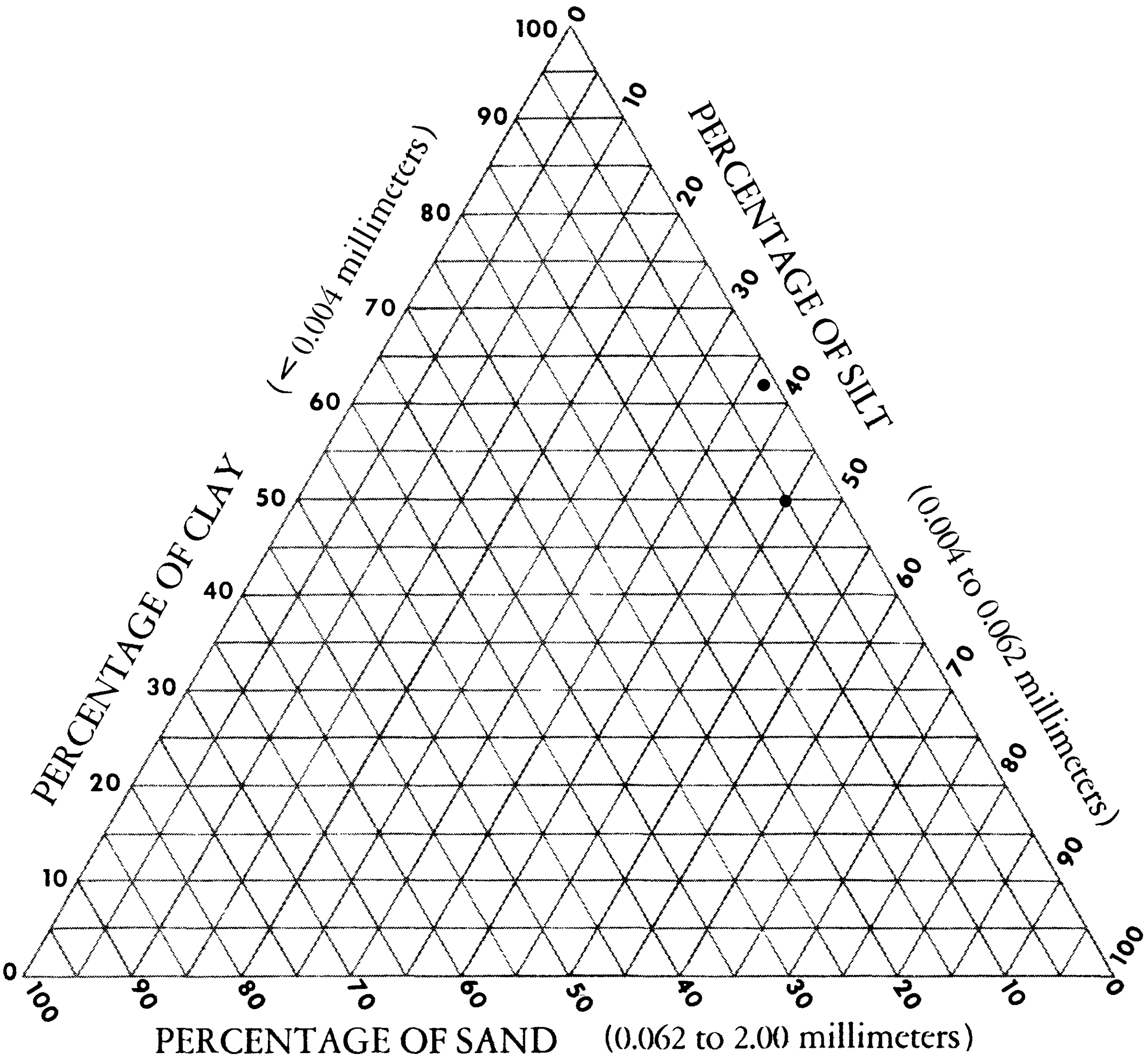

Figure 12.-- Percentage of sand, silt and clay in suspended sediment in streams of the Jackson Purchase.

Table 33.--Summary of sediment-discharge characteristics of streams of the Ohio River sediment stations

Station number	Station name	Sediment concentration[1] (mg/L) Low	High	Sediment discharge[1] (tons/d) Low	High	Average annual suspended-sediment discharge[2] (tons/mi²)
03216600	Ohio River at Greenup Dam	5	615	238	577,853	225
03255000	Ohio River at Cincinnati[3]	141	746	148,000	1,040,000	[4]550
03277200	Ohio River at Markland Dam	7	937	499	918,702	200
03294500	Ohio River at Louisville	1	880	87	923,000	280
03303280	Ohio River at Cannelton Dam	5	979	279	967,447	270
03322000	Ohio River at Evansville, Ind.[3]	221	357	135,000	[4]249,000	--
03611500	Ohio River at Metropolis, Ill.[3]	95	628	56,000	[4]835,000	400
03612500	Ohio River at Lock and Dam 53 near Grand Chain, Ill.	11	474	1,688	594,054	240

[1]Daily values used for daily stations; instantaneous values used for partial-record stations.
[2]Does not include sediment trapped in reservoirs.
[3]U.S. Army Corps of Engineer station.
[4]Not representative of complete range of flow; mostly high flow was sampled.

SUMMARY

This report has presented characteristics of stream sediments in Kentucky and has shown differences as well as similarities in the sediments of the five major physiographic regions.

A comparison of the average annual suspended-sediment yields between regions indicates that the Blue Grass region has the highest yield at 741 tons/mi^2. The lowest yield occurs in the Western Coal Field and is 197 tons/mi^2.

The Eastern Coal Field has the highest range of average annual suspended-sediment yields. That range is from 25 tons/mi^2 at Helton Branch near Greenwood to 21,000 tons/mi^2 at Millers Creek near Phyllis. The lowest was for the Jackson Purchase.

The Eastern Coal Field has the highest average percent sand in suspended sediment at 11 percent and the lowest is the Blue Grass region at less than 2 percent.

Silt in suspended sediment ranges from 42 percent for the Mississippian Plateau to 30 percent for the Western Coal Field. Clay is the highest for streams of the Western Coal Field at 68 percent and lowest for Eastern Coal Field at 48 percent.

Bedload discharge is estimated to be generally in the range of 5 to 10 percent of the suspended-sediment discharge. Sampling of the Ohio River for unmeasured load at Louisville indicated that very little sediment is moving in the 3 inch zone above the bed of the stream during high-water discharge.

The stream-sediment yield for three stations in the Eastern Coal Field exceeds the average annual erosion rate for the State's cropland of 9.93 tons/acre or 6,355 tons/mi^2.

Over one-half of the sediment entering the Middlesboro Bypass Canal in the Eastern Coal region is deposited in the canal.

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