Coal Reserves of Eastern Kentucky

GEOLOGICAL SURVEY BULLETIN 1120

Prepared in cooperation with the Kentucky Geological Survey and the U.S. Bureau of Mines

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By J. W. HUDDLE, E. J. LYONS, H. L. SMITH, *and* J. C. FERM

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UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1963

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C.

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COAL RESERVES OF EASTERN KENTUCKY

By J. W. Huddle, E. J. Lyons, H. L. Smith, and J. C. Ferm

ABSTRACT

Estimated original reserves of high-volatile bituminous coal in the Eastern Kentucky coal field, in billions of short tons, are given below. These include remaining reserves for Floyd, Harlan, Knott, Letcher, and Pike Counties as estimated by the U.S. Bureau of Mines.

Thickness of beds (inches)	Measured reserves	Indicated reserves	Inferred reserves	Total reserves
14-28	1.4	4.7	6.6	12.7
28-42	3.2	5.4	4.2	12.8
More than 42	4.5	2.5	1.0	8.0
Total reserves	9.1	12.6	11.8	33.5

Small-scale mining started in Kentucky before 1800 and large-scale mining began early in the 20th century. Prior to 1956 approximately 1.7 billion tons of coal were mined in eastern Kentucky, and, assuming 50-percent recovery, an equal amount was lost in mining. Recorded production from the principal producing counties, in millions of tons, is as follows: Harlan 424, Pike 281, Letcher 207, Perry 193, Floyd 178, and Bell 108. Production from the 32 remaining counties is 309 million tons.

Remaining coal reserves in eastern Kentucky on January 1, 1956, are estimated at approximately 33 billion tons in beds more than 14 inches thick, including 20 billion tons in beds more than 28 inches thick. Approximately 73 percent of the remaining coal reserves are in 10 contiguous counties, Pike, Harlan, Knott, Perry, Leslie, Letcher, Breathitt, Floyd, Martin, and Magoffin, which are in the middle and southeastern parts of the field. Each of the other 28 counties in the coal field have less than 1 billion tons of remaining reserves.

Physiographically the Eastern Kentucky coal field is a part of the Appalachian Plateau province, and the western boundary of both the coal field and the plateau in Kentucky is the westward-facing Pottsville escarpment. Local relief ranges from a few hundred feet in northeastern Kentucky to more than 2,000 feet in southeastern Kentucky. Five main streams and large numbers of secondary and tertiary tributaries have cut the plateau into a fine-textured topography composed of narrow sinuous ridges and steep-sided valleys. This dissection of flat-lying coal-bearing rocks produces many miles of outcrops and permits drift, contour open-pit, and auger mining.

The coal-bearing rocks of eastern Kentucky are the Lower, Middle, and Upper Pennsylvanian, the Lee, Breathitt, and Conemaugh formations, respectively. The Lee formation consists of a lower shale, siltstone, and coal-bearing member

and an upper cliff-forming sandstone member. It is exposed along the Pottsville escarpment, in Pine and Cumberland Mountains, and in the structural uplift along the Irvine-Paint Creek fault. The Breathitt formation consists mainly of shale, siltstone, and sandstone. Principal key beds in the Breathitt formation are the Upper Elkhorn No. 3 and Fire Clay coal beds, and the Magoffin and Vanport limestone members. The Breathitt is the surface formation in most of the Eastern Kentucky coal field, being absent only where it has been removed by erosion, especially just east of the Pottsville escarpment, or covered by the Conemaugh in northeastern Kentucky. Both the Lee and Breathitt formations thicken rapidly toward the southeast. The Conemaugh formation, distinguished by red and green beds, is composed mainly of shale, siltstone, and sandstone, but also contains a few thin limestone and coal beds. Of the estimated 33.5 billion tons of coal reserves for eastern Kentucky, 1.5 billion are in the Lee formation, 32 billion in the Breathitt formation, and 22 million in the Conemaugh formation.

The Eastern Kentucky coal field is a part of the Appalachian coal field which extends from Pennsylvania to Alabama and includes parts of Ohio, West Virginia, Virginia, and Tennessee. The rocks in the eastern Kentucky region are in the relatively undisturbed western part of the Appalachian geosyncline between the closely folded Appalachian Mountains and the Cincinnati arch.

Three broad gentle northeastward-trending synclines partially control the pattern of coal-bed outcrops. The Irvine-Paint Creek fault separates the Pittsburg-Huntington syncline in the northeastern part of the field from the Eastern Kentucky syncline in the central part; and the Pine Mountain fault separates the Eastern Kentucky and the Middlesboro synclines. The youngest rocks, the Conemaugh formation, occur only in the Pittsburg-Huntington syncline, and progressively older rocks cap the highest hills in the synclines to the southeast. The youngest extensive coal in the Eastern Kentucky syncline is the Skyline (Richardson) coal bed and an older bed, the High Splint (Hazard No. 7), is the youngest extensive bed in the Middlesboro syncline.

Different coal-bed names have been used in individual drainage basins within the three synclines, and their correlation is uncertain. For convenience in discussing the coal beds, the Eastern Kentucky coal field is divided into six coal reserve districts, the Princess, Licking River, Big Sandy, Hazard, Southwestern, and Upper Cumberland, whose boundaries are along drainage divides, county lines, and geologic features. Within each of these districts coal-bed names are mainly local and the usage reasonably consistent. Most of the estimated coal reserves are in the Big Sandy, Hazard, and Upper Cumberland reserve districts.

More than 190 local names, many of which are synonyms, have been applied to coal beds in eastern Kentucky, but there are 33 recognized coal beds which are tentatively correlated throughout the Eastern Kentucky coal field. The beds containing the largest estimated original reserves are:

	Billions of short tons		*Billions of short tons*
Upper Elkhorn No. 3	4.9	Amburgy 2.3	2.3
Fire Clay	4.2	Upper Elkhorn No. 2	2.2
Upper Elkhorn No. 1	2.7	Hazard No. 7	1.8
Fire Clay Rider	2.7		

More than one-third, about 11.7 billion tons, of the original reserves are in the Lower and the three Upper Elkhorn coal beds.

Part 1. PREPARING THE ESTIMATES

By J. W. Huddle, E. J. Lyons, H. L. Smith, and J. C. Ferm

The Eastern Kentucky coal field is part of the Appalachian coal region, which extends from Pennsylvania through Ohio, West Virginia, Maryland, Virginia, Kentucky, and Tennessee to Georgia and Alabama (see insert on pl. 1). The part of the Appalachian coal region within Kentucky includes approximately 10,600 square miles and contains large reserves of coking coal and coal that can be blended to form satisfactory grades of metallurgical coke. All the coal-bearing rocks in eastern Kentucky are of Pennsylvanian age. About 190 names, many of which are synonymous, have been given to the various coal beds, but precise correlation between all beds and areas has not been established, largely owing to lack of detailed geologic mapping.

This estimate of the coal reserves of eastern Kentucky was prepared by the U.S. Geological Survey in cooperation with the Kentucky Geological Survey and the U.S. Bureau of Mines. It shows only the general order of magnitude of the coal reserves in eastern Kentucky, outlines areas favorable for further exploration and study, and gives references to detailed published information. The estimate is believed to be conservative, and undoubtedly detailed mapping, exploration, and development will locate additional coal reserves.

NATURE AND SCOPE OF THE REPORT

Since the extensive use of bituminous coal began, both public and private agencies have been interested in the amount of coal available and have made estimates of coal reserves. A general program of reappraisal of the reserves of the United States was begun about 1947 by State and federal agencies because the older estimates were considered inadequate for modern use. Recent revised estimates of the coal reserves of 13 individual States and of the entire United States have been published. This report on the coal reserves of eastern Kentucky is a part of the national program of the U.S. Geological Survey and a continuation of a special study of coking coal reserves started by the U.S. Bureau of Mines.

Some parts of the Eastern Kentucky coal field were excluded from this estimate (pl. 2). These include areas where the coal has been removed by erosion, areas known to have coal less than 14 inches in thickness, and areas where little or no information was available. A few of the omitted areas have reported small coal production, but their reserves probably are not large. The area excluded amounts to about 13 percent of the total area of the Eastern Kentucky coal field, and most of it, except for that part along the Pine Mountain fault, is in the western third of the field.

The report is divided into four parts: part 1 deals with the definition of terms and the methods used in preparing the coal reserve estimates; part 2 is a summary of the topography, climate, water resources, general geology, and coal reserves of the entire Eastern Kentucky coal field; part 3 consists of six reports which summarize the available data about the coal beds of six reserve districts; and part 4 includes all the tabulated data on coal reserves.

SOURCES OF DATA

The estimate of coal reserves presented in this report is based on data from the following sources, in approximately the percentages given: Field reconnaissance, 52 percent; coal-company data supplied to the U.S. Bureau of Mines or to the U.S. Geological Survey, and geologic literature published before 1951, 30 percent; mapping from 1949 to 1955 by the U.S. Geological Survey, 16 percent; mapping from 1950 to 1953 by the Kentucky Geological Survey, 2 percent (pl. 2).

Field reconnaissance, which consisted of visits to mines and accessible outcrops to determine the thickness, character, altitude, and stratigraphic position of the coal beds, averaged about 2 weeks for a 7½-minute quadrangle. Supplemental information was obtained from geologic reports and company records.

A second important source of information was the published maps and reports and record data supplied by the U.S. Bureau of Mines. Estimates for Floyd and parts of Knott, Letcher, and Harlan Counties were derived entirely from U.S. Bureau of Mines data, and for Pike County principally from U.S. Bureau of Mines data and a report of the U.S. Geological Survey by Hunt and others (1937). Estimates for parts of Elliott and Lawrence Counties were prepared entirely from the reports of Phalen (1908) and Crandall (1884). Information about the southeastern part of Clay County and the adjoining parts of Leslie and Knox Counties was obtained largely from private sources. Appraisals of the coal reserves of the Hyden, Cornettsville, Blue Diamond (Troublesome), and Buckhorn quadrangles and for parts of the Bays, Dingus, and Cannel City quadrangles were taken directly from reports of the U.S. Geological Survey prepared between 1950 and 1954. A report of the Kentucky Geological Survey (Hauser, 1953) furnished data on which the estimates of the Paintsville quadrangle are based.

ACKNOWLEDGMENTS

The authors wish to express their appreciation for the cooperation and courtesies extended by many individuals and corporations who contributed information used in compiling this report. The coal

mining companies operating in eastern Kentucky were most generous in permitting the use of mine maps, information on drill holes, and other data. Thanks are due to officers and representatives of those companies, who are too numerous to list here, but without whose cooperation this report could not have been prepared. Grateful acknowledgment is expressed to James J. Dowd, of the U.S. Bureau of Mines, and his associates, by whom much of this information was collected. A. D. Sisk and W. H. Roll, of the Kentucky Department of Mines and Minerals, and Phil M. Miles and J. R. Hutchins, of the Department of Economic Development of Kentucky, were very helpful in supplying information. H. R. Wanless generously permitted the U.S. Geological Survey and the Kentucky Geological Survey to use his extensive field notes on the Pennsylvanian rocks of eastern Kentucky.

In addition to the authors and contributors to this report, many other Survey employes contributed to various phases of the work. W. L. Adkison, M. J. Bergin, R. P. Briggs, R. J. Burnside, J. E. Johnston, Chabot Kilburn, P. T. Stafford, S. W. Welch, and A. D. Williamson did reconnaissance mapping. J. L. Snider, L. E. Shirley, J. A. Van Lieu, E. D. Patterson, W. E. T. Brown, and R. C. Stearns served as field assistants. Mary Beth Graves, J. R. Perkins, W. B. Purdom, R. A. Rivers, Virginia Anderson, and Jane Welch assisted in office compilation. Charlotte Creager and Myrtle Shorter prepared the production tables.

METHODS OF PREPARING COAL RESERVE ESTIMATES

The term "reserve" is used to include deposits of coal which are currently minable as well as those deposits which are potentially minable and are described or classified as indicated or inferred. The objective of a reserve study is to estimate the total number of tons of coal in a certain bed or beds in a specified area. Any such estimate is based on assumptions about the thickness, extent, and correlation of the coal beds as well as on the establishment of cutoff points relating to minimum thickness, maximum overburden, and accuracy or reliability of the information concerning the coal beds. An estimate, therefore, is of value only to the extent that definitions are given and methods explained. In order to get comparable results in preparing estimates on coal reserves, the U.S. Geological Survey has adopted a set of standard definitions, procedures, and assumptions which were prepared jointly by members of the Geological Survey and the Bureau of Mines and include recommendations of the National Bituminous Coal Advisory Council. These are discussed in the succeeding paragraphs.

COAL CLASSIFICATIONS

The classification and description of most coal deposits are based on several characteristics of coal which are termed rank, variety, grade, weight, thickness of bed, and thickness of overburden. These characteristics are discussed under separate headings below.

RANK OF COAL

American coals are classified by rank in accordance with the standard classification of the American Society for Testing Materials. (See table 1.) Rank is defined by the percentage of fixed carbon and the Btu content, calculated on a mineral-matter-free basis, and is independent of grade or quality, which is in part a function of ash and other impurities in the coal. The percentage of fixed carbon increases from the lowest to the highest rank of coal as the percentages

TABLE 1.—*Classification of coals by rank*[1]

Legend: FC, fixed carbon; VM, volatile matter; Btu, British thermal units

[From American Society for Testing Materials (1955, pt 5, p. 1023)]

Class	Group	Limits of fixed carbon or Btu, mineral-matter-free basis	Requisite physical properties
I. Anthracitic	1. Meta-anthracite	Dry, FC, 98 percent or more (dry, VM, 2 percent or less).	
	2. Anthracite	Dry, 92 percent or more and less than 98 percent (dry, VM, 8 percent or less and more than 2 percent).	
	3. Semianthracite	Dry, FC, 86 percent or more and less than 92 percent (dry, VM, 14 percent or less and more than 8 percent).	Nonagglomerating.[2]
II. Bituminous[3]	1. Low-volatile bituminous coal.	Dry FC, 78 percent or more and less than 86 percent (dry, VM, 22 percent or less and more than 14 percent).	
	2. Medium-volatile bituminous coal.	Dry FC, 69 percent or more and less than 78 percent (dry, VM, 31 percent or less and more than 22 percent).	
	3. High-volatile *A* bituminous coal.	Dry FC, less than 69 percent (dry VM, more than 31 percent); and moist[4] Btu, 14,000[5] or more.	
	4. High-volatile *B* bituminous coal.	Moist[4] Btu, 13,000 or more and less than 14,000.[5]	
	5. High-volatile *C* bituminous coal.	Moist Btu, 11,000 or more and less than 13,000.[5]	Either agglomerating or nonweathering.[6]
III. Subbituminous	1. Subbituminous *A* coal.	Moist Btu, 11,000 or more and less than 13,000.[5]	Both weathering and nonagglomerating.
	2. Subbituminous *B* coal.	Moist Btu, 9,500 or more and less than 11,000.[5]	
	3. Subbituminous *C* coal.	Moist Btu, 8,300 or more and less than 9,500.[5]	
IV. Lignitic	1. Lignite	Moist Btu, less than 8,300	Consolidated.
	2. Brown coal	Moist Btu, less than 8,300	Unconsolidated.

[1] This classification does not include a few coals which have unusual physical and chemical properties and which come within the limits of fixed carbon or Btu of the high-volatile bituminous and subbituminous ranks. All these coals either contain less than 48 percent dry mineral-matter-free fixed carbon or have more than 15,500 moist mineral-matter-free Btu.

[2] If agglomerating, classify in low-volatile group of the bituminous class.

[3] It is recognized that there may be noncaking varieties in each group of the bituminous class.

[4] Moist Btu refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.

[5] Coals having 69 percent or more fixed carbon on the dry mineral-matter-free basis shall be classified according to fixed carbon, regardless of Btu.

[6] There are three varieties of coal in the high-volatile *C* bituminous coal group: (1) agglomerating and nonweathering, (2) agglomerating and weathering, and (3) nonagglomerating and nonweathering.

of volatile matter and moisture decrease. Most of the eastern Kentucky coals range in rank from high-volatile B to high-volatile A bituminous coal. High-volatile C bituminous coal has been reported at a few localities, but these occurrences may be due in part to the use of analyses of weathered material.

VARIETIES OF COAL

Varieties of bituminous coal in the Eastern Kentucky coal field are common banded, splint, and cannel (includes true cannel and boghead).

Common banded bituminous coal consists of alternating layers or elongate lenses of bright and dull material with fewer bands or lenses of soft powdery particles of fusain. In some coal beds the bright bands predominate and in others the dull bands predominate. Splint coal, which is characteristic of certain beds, is grayish black, dull, has a compact structure, and is relatively hard and tough. Another variety of dull coal is cannel, which is nonbanded massive dustless and dark gray to black and which has a greasy luster and conchoidal fracture. It ignites easily and burns with a smoky yellow flame. Coal of this variety may be either true cannel or boghead; the two being differentiated, according to the definitions given in the American Society for Testing Materials (1954, p. 111), by the presence of large quantities of spore exines in cannel in contrast with abundant algal remains in boghead. To distinguish true cannel from boghead requires examination of thin or polished sections. Throughout this report the term "cannel" is used in a broad sense to include both the true cannel and the boghead varieties.

Both the common banded and splint varieties of bituminous coal from the Eastern Kentucky coal field are excellent steam coals for generating electrical power, for industrial use, and for space heating, but their rank is such that they can be used for the manufacture of metallurgical coke. The coal mined in Harlan, Letcher, and Pike Counties yielded coke in beehive ovens for many years and now yields coke in byproduct ovens. The quality of the coke produced, however, is improved if the Kentucky coal is blended with low-volatile coal from the Pocahontas mining area in West Virginia and Virginia.

Only a small amount of the estimated reserves is cannel coal, which was once in demand at a high price as fireplace fuel, but which at present has no special market.

GRADE OF COAL

The quality or grade of coal is determined by size designation, calorific value, amount of ash, ash-softening temperature, and amount of sulfur. Too few analyses are available for large areas in eastern Kentucky to permit classification of reserves by grade. The analyses are concentrated for the most part from areas of active mining and are

limited to the outcrop of certain key beds. Definitions used in calculating coal reserves permit the inclusion of beds containing as much as 33 percent ash, but very little of such high-ash coal is included in the estimates contained in this report. Since 1940, analyses of mine, tipple, and delivered samples of eastern Kentucky coals have been published by Rice and Moran (1941), Fieldner and others (1942, 1944). The maximum amount of ash and sulfur reported in these publications was 22.3 percent ash for the top bench of the Lower Elkhorn coal and 4.7 percent sulfur for the Lily coal, but most of the analyses were of coals having less than 10 percent ash and less than 3 percent sulfur.

WEIGHT OF COAL

The weight of bituminous coal in the ground is affected to a marked degree by its ash content and to a lesser degree by its content of fixed carbon, moisture, and volatile matter. Although the weight of bituminous coal in the ground may vary considerably from place to place and bed to bed, the calculation of tonnages of reserves is greatly simplified if an average specific gravity factor is employed. The convenient intermediate figure of 1,800 tons per acre-foot, or 150 tons per acre-inch, is widely accepted for this purpose and has been used uniformly throughout the present report.

THICKNESS OF BEDS

The coal reserve estimates prepared by the U.S. Geological Survey are divided in most instances into three categories, based on the thickness of the coal beds. These categories are termed "thin," "intermediate," and "thick." Coal beds classified as "thin" are 14 to 28 inches thick, "intermediate," 28 to 42 inches, and "thick," more than 42 inches. These thicknesses have been determined primarily by mining practices: 14 inches is approximately the minimum thickness of coal minable by hand methods, and beds thinner than this are excluded from the estimate; 28 inches is the minimum thickness usually considered for machine mining and hand loading; 42 inches is the minimum thickness for completely mechanized mining. Recent developments of new mining equipment would permit changing these limits somewhat, but in order to keep the categories comparable with other recent reserve estimates prepared for other States, these definitions have been retained in this report.

Partings more than three-eighths of an inch thick were omitted in determining the thickness of an individual coal. Beds or parts of beds made up of alternating layers of thin coal and partings were excluded if the partings made up more than one-half of the total thickness. Benches of coal, which lie above or below thick partings and normally would be left in mining, also were omitted.

THICKNESS OF OVERBURDEN

No classification by categories according to thickness of overburden has been made in this report, but almost all the coal lies under less than 1,000 feet of overburden. Some coal in the Black and Little Black Mountains in Letcher, Harlan, and Bell Counties lies under thicker overburden, but the amount is so small that no advantage would be gained by placing it in a separate category. Categories of less than 1,000 feet of overburden were not practicable to calculate because the sinuous line of outcrop and steep topography restrict reserves in these categories to narrow strips difficult to measure.

CLASSIFICATION ACCORDING TO ABUNDANCE AND RELIABILITY OF DATA

Estimates of coal reserves presented herein are divided into three categories termed "measured," "indicated," and "inferred," according to the abundance and reliability of data upon which the estimates are based.

MEASURED RESERVES

Measured reserves are those for which tonnage is computed from coal bed thicknesses actually measured in outcrops, trenches or prospect openings, mine workings, and drill holes. The points of observation must be so closely spaced and the thickness and extent of the coal so well-defined that the computed tonnage of measured reserves may be considered to be accurate within 20 percent of the true tonnage. Although the spacing of the points of observation necessary to demonstrate continuity of a coal bed varies in different places according to the character of the coal beds, geologic structure conditions, and other factors, the points of observation for measured coal are in general no greater than half a mile apart and are at least three in number. Measured coal is considered to extend not more than a quarter of a mile beyond the outermost observation point.

INDICATED RESERVES

Indicated reserves are those for which tonnage is computed partly from specific measurements and partly from projections of visible data for a reasonable distance on geologic evidence. The points of observation are generally about a mile apart but may be as much as 1½ miles apart for beds of known geologic continuity. Areas of indicated coal, in general, are not considered to extend more than three-quarters of a mile from any observation point.

INFERRED RESERVES

Inferred reserves are those for which quantitative estimates are based largely on broad knowledge of the geologic character of the bed or enclosing rocks and for which few measurements of thickness

are available. The estimates are based on an assumed continuity for which there is geologic evidence. In general, inferred coal may be considered to extend as much as 2 miles from the nearest observation point, but in places where continuity is less certain inferred coal may extend less than a quarter of a mile from the observation point.

DISTINCTION BETWEEN ORIGINAL, REMAINING, AND RECOVERABLE RESERVES

Reserve estimates can be presented in terms of original reserves, remaining reserves, or recoverable reserves, but the estimate of original reserves is the basic figure from which the other two estimates are derived.

ORIGINAL RESERVES

Original reserves are those which were in the ground, including the narrow weathered zone along the outcrop, before mining. The estimate of original reserves is subject to change only as new information is gained by additional geologic mapping, exploration, or development of the coal beds.

REMAINING RESERVES

Reserves that are in the ground at the date of appraisal are considered remaining reserves regardless of the feasibility of extraction. The estimate of remaining reserves is obtained by subtracting from the estimate of original reserves the amount of coal that has been produced or lost in mining. These last figures may be obtained either by measuring the mined-out areas and computing the tonnage of coal mined or lost in mining, or by using the recorded production figures and making an allowance for mining losses. The first method method is the more accurate, particularly for small areas or individual beds, but detailed information on mined-out areas is unavailable for much of the coal-bearing area in eastern Kentucky, and it was necessary to use the recorded production figures for such areas. Reliable estimates of the mined-out areas by beds were made and published by the U.S. Bureau of Mines for Pike, Floyd, Knott, Letcher, Harlan, and Perry Counties (Dowd and others, 1951a, 1951b, 1952; Wallace and others, 1953, 1954a, 1954b). U.S. Geological Survey reports by Stafford and Englund (1953), Williamson and Adkison (1953), Johnston and others (1955), Englund (1955), and others also give estimates by beds of coal mined and lost in mining for several areas.

RECOVERABLE RESERVES

Recoverable reserves are those that are in the ground at the date of appraisal and that actually can be produced in the future. This estimate is obtained by subtracting estimated future losses in mining from the remaining reserves. Mining losses vary in different beds

and areas according to the thickness and quality of the coal, the nature of the roof and floor, the amount of overburden, the mining methods employed, and many other factors. Dowd and others (1951a, 1951b, 1952) and Wallace and others (1953, 1954a, 1954b) report the following recovery figures for past mining in eastern Kentucky: Pike County, 55.08 percent; Floyd County, 53.23 percent; Knott County, 53.13 percent; Harlan County, 57.40 percent; Letcher County, 54.10 percent; and Perry County, 56.00 percent. In other parts of the Eastern Kentucky coal field the recovery may be as little as 30 to 40 percent. In a few areas, where conditions are favorable, it may be as great as 80 or 90 percent. As much as 90 percent also may be recovered in strip-mining operations, but the percentage decreases to between 60 and 80 percent when the operation is supplemented with augering. Strippable coal, however, makes up only a small part of the total reserves and only a small part of past production.

Averitt and others (1953, p. 13) estimated a nationwide weighted average of 50 percent recoverability for underground mining. Because the range in eastern Kentucky probably is somewhat similar to that in other parts of the nation, a recoverability factor of 50 percent was used in this report.

METHODS OF RECORDING DATA AND MAKING CALCULATIONS

All the reserve estimates in this report were calculated for individual beds using counties and 15- or 7½-minute quadrangles as areal units. Work sheets were prepared from published or manuscript topographic maps of the 1949–55 series that for the most part had scales of 1:24,000, 1:20,000, and 1:15,840, but a few were prepared from maps that had scales of 1:31,680, 1:48,000, and 1:62,500. The work sheets of the U.S. Bureau of Mines for Pike, Floyd, Knott, Letcher, Harlan, and Perry Counties, from which remaining, measured, and indicated reserves were determined, had a scale of 1:14,400. The outcrop line of a particular coal bed was drawn on a work sheet and the locations of the outcrops, prospects, mines, and drill holes from which data had been obtained were plotted. Where data were sufficient, isopach lines representing coal thicknesses of 14, 28, and 42 inches were drawn to divide the sheet into areas containing coal 14 to 28 inches in thickness, 28 to 42 inches, and more than 42 inches. In addition, the sheet was divided into areas containing measured, indicated, and inferred coal on the basis of spacing and reliability of data. The weighted-average thickness of the coal bed was computed for each area delimited by the two sets of lines.

The areas thus outlined on the work sheets were measured with a planimeter to obtain the acreage underlain by coal in the different

thickness and reliability categories. The tonnage was calculated by multiplying the number of acres by the weighted-average thickness of coal to the nearest inch by the factor 150, the assumed weight of bituminous coal in tons per acre-inch. The calculation and tabulation of the data by quadrangle and county in categories according to thickness and reliability of the information was made by IBM machines. In the machine operations it was necessary to calculate and record all figures to the nearest 10,000 tons in order to preserve small figures obtained in calculating reserves of small areas and in thin beds. This order of accuracy is not implied for the larger figures and totals. For most figures the nearest 1 million tons is all that need be considered, and this position is marked by decimal points in tables 9, 10, 11, and 12.

In reporting in the text on reserves in individual beds in the several reserve districts, the figures have been taken directly from tables 10 and 11, and digits to the nearest 10,000 tons have been preserved to facilitate checking of the reserve district totals against the tables. As use of a decimal point to indicate millions of tons might be confusing in the text, the figures are presented with a conventional comma marking the million position, and additional zeros have been supplied to fill out the number to the unit position. The digits and added zeros to the right of the million position have no significance other than to aid in the proper reading of the larger number.

Because the sources of information and the type of data were not the same for all areas comprising the Eastern Kentucky coal field, the procedures for estimating the reserves differed for different areas. Information obtained from reconnaissance fieldwork or from older geologic literature was interpreted very conservatively to allow for possible errors in correlation. Information obtained from recently completed detailed geologic mapping, or from areas of intensive exploration and development, was interpreted to the fullest extent that the information would permit. The estimates for Pike, Floyd, Knott, Letcher, and Harlan Counties are based on information supplied by the coal companies to the U.S. Bureau of Mines. The Bureau of Mines prepared estimates of measured and indicated reserves of those areas, for which remaining (not original) reserves are given in tables 9 to 11. The estimates of inferred coal for these five counties were prepared by personnel of the U.S. Geological Survey from work sheets of the U.S. Bureau of Mines. For the Paintsville 15-minute quadrangle, Hauser's (1953) figures were revised to conform with the thickness categories used in the rest of the appraisal, but his basic work was accepted unchanged. The southwest quarter of the Dykes 15-minute quadrangle and the northwest quarter of the Cumberland Falls 15-minute quadrangle (see pl. 1) were mapped by John R.

Hutchins, of the Department of Economic Development of Kentucky, and the reserves were calculated by the U.S. Geological Survey personnel.

PAST AND PRESENT ESTIMATES

The only previous estimate of the coal reserves of the entire Eastern Kentucky coal field was made by M. R. Campbell during the period from 1913 to 1929. This estimate has been reprinted by Hendricks (1939) and by Averitt and others (1953). Campbell (1913, p. 534) estimated the Eastern Kentucky coal field to contain 67,806,460,000 short tons of coal in an area of 10,270 square miles. In 1929 he estimated a total of 123,327,000,000 short tons for coal reserves in both Kentucky coal fields, but separate figures for the Eastern and Western coal fields were not published. These older estimates probably were based on an assumed average thickness of coal per 100 feet of coal-bearing strata throughout the estimated areas of the coal fields.

A number of workers have made estimates for various parts of the Eastern Kentucky coal field.

Wentworth (1927) estimated the minable coal in the Middlesboro Basin to be 4,314,000,000 tons.

Eavenson (1934), in a paper discussing the availability of high-volatile coals for gas and metallurgical use in West Virginia, Virginia, and Kentucky, estimated the reserves in several thick coal beds and showed the areas of minable coal for individual beds on maps with a scale of approximately 1 inch equals 16 miles. His estimated reserves for the Lower Elkhorn, Harlan, and Upper Elkhorn No. 3 coal beds in Floyd, Harlan, Knott, Letcher, Martin, and Pike Counties amounted to 1,990,100,000 tons. These reserves include only coal more than 42 inches thick containing less than 6 percent ash and 1 percent sulfur. Eavenson's estimate cannot be compared directly with the estimate given in this report, which includes coal in the 14- to 42-inch category and some coal that has a higher ash and sulfur content.

Hunt and others (1937) estimated the reserves in Pike County at 8 billion tons of coal in beds 12 inches or more thick, minable by drift mines. The estimate was based on the assumption that there were 15 coal beds with a density of 1.3 that averaged 20 inches in thickness across 35 percent of each of the 46 geographic divisions into which the county was arbitrarily divided for the purpose of the estimate. Hunt regarded the estimate as too small rather than too large.

In the period from 1950 to 1955 estimates of the coal reserves of the Hyden (Johnston and Heck, 1950), Cornettsville (Johnston and others, 1955), Buckhorn (Stafford and Englund, 1954), and Blue Diamond (Troublesome) (Williamson and Adkison, 1953) 15-minute quad-

rangles and of the Cannel City (Englund, 1955) 7½-minute quadrangle have been published by the U.S. Geological Survey.

The U.S. Bureau of Mines, in the period from 1951 to 1954, published estimates of the measured and indicated coal in Pike (Dowd and others, 1951a), Letcher (Wallace and others, 1953), Floyd (Dowd and others, 1951b), Knott (Dowd and others, 1952), Harlan (Wallace and others, 1954a), and Perry (Wallace and others, 1954b) Counties as separate county reports. The estimates were reported as remaining reserves in thickness categories for measured and indicated coal for each 15-minute quadrangle, or part of a quadrangle, within the county. These estimates of the U.S. Bureau of Mines have been used in this report with minor changes. The correlations of the coal beds have been modified where later information has made revision of the correlation unavoidable. In a few quadrangles additional information obtained after the U.S. Bureau of Mines prepared their reserve figures has permitted the addition of some measured and indicated coal.

The present estimate of the original reserves of the Eastern Kentucky coal field is approximately 33.5 billion tons, about half of Campbell's 1913 estimate. The present estimate is smaller because (1) more conservative methods were employed to estimate the extent of coal beds underground, (2) no allowance was made for possible coal in deeply buried beds, and (3) about 13 percent of the coal-bearing area had to be omitted for consideration for lack of reliable data as to the thickness of the coal or the number of coal beds present. Campbell attempted by extrapolation to estimate the total amount of coal present in the full thickness of coal-bearing rocks throughout the entire coal-bearing area, and thus obtained a larger total.

Part 2. GEOLOGY AND GEOGRAPHY OF THE EASTERN KENTUCKY COAL FIELD

By J. W. Huddle, E. J. Lyons, and J. C. Ferm

TOPOGRAPHY

The Eastern Kentucky coal field is part of the Appalachian Plateau, a large intricately dissected upland that extends from New York to Alabama. In eastern Kentucky the western margin of the plateau is a westward-facing escarpment, called the Pottsville escarpment (McFarlan, 1943), formed by Lower Pennsylvanian sandstone and Mississippian limestone. At the Tennessee State line the escarpment is about 700 feet high, but northward it becomes lower and is absent in many places.

Differences in landforms and relief provide a basis for division of the Appalachian Plateau into sections, three of which are represented in the Eastern Kentucky coal field (pl. 1). The Cumberland Plateau and the Cumberland Mountain sections extend northward from eastern Tennessee into southeastern Kentucky, and the Kanawha Plateau section extends southward from West Virginia and Ohio into northeastern Kentucky.

The Cumberland Plateau in eastern Kentucky is a broad benchlike upland of relatively low relief. It extends northward, in a belt ranging from 15 to 40 miles in width, along the western border of the coal field from the Kentucky-Tennessee State line to the vicinity of Frenchburg, Ky. The western margin of the plateau is the Pottsville escarpment, characterized by sandstone cliffs, as high as 150 feet, and deep narrow valleys, and narrow ridges. The Cumberland Plateau, to the southeast of escarpment, has been formed by the removal of the less resistent rocks overlying the sandstone. The boundary between the Cumberland Plateau and the adjacent Kanawha Plateau and Cumberland Mountain areas is an irregular line of hills or mountains whose strong local relief contrasts sharply with the weaker relief of the Cumberland Plateau.

The Kanawha Plateau forms the largest part of the Eastern Kentucky coal field. It is a hilly or mountainous upland with narrow crooked valleys whose divides are irregular steep-sided ridges with sharp crests. Most of the land surface slopes moderately to steeply, but a few of the ridge crests that represent the old plateau surface are flat. Flood plains of moderate size have formed on resistant sandstone along some of the major streams, but most of the smaller creeks lack flood plains. The Pottsville escarpment is not as well developed in this section as it is in the Cumberland Plateau area to the south. The local relief of the Kanawha Plateau increases from 300 or 400 feet in the north near the Ohio River to about 2,500 feet in the south where it borders the Cumberland Mountain section along Pine Mountain.

The Cumberland Mountain section has two contrasting types of topography. North of Pine Mountain the rocks are gently dipping sandstone and shale, and the topography is similar to that of the Kanawha Plateau except that the relief, as a whole, is greater. In Pine Mountain and to the south, the rocks dip much more steeply, and the topography is characterized by ridges and valleys that have a strong northeast trend parallel to that of Pine and Cumberland Mountains. This area has the greatest relief in eastern Kentucky, and the highest mountain in the State, with an altitude of 4,145 feet, is near Benham in Harlan County.

CLIMATE

The Eastern Kentucky coal field lies in the belt of temperate humid continental-type climate. The mean annual temperature is about 58° F. The lowest average minimum monthly temperatures are in January, and the highest average maximum monthly temperatures are in July. Temperatures rarely exceed 100° or drop below zero. The frost-free period is approximately 175 days between April 25 and October 15.

Precipitation averages about 4 inches per month but is somewhat less in February, June, October, and November, and somewhat more in January, March, May, July, and September. The mean annual rainfall ranges from 42 inches in the northeastern part of the coal field to about 50 inches in the southeastern part. The lowest recorded annual rainfall is 33.4 inches, measured in 1941 at Paintsville in the central part of the coal field, and the highest is 63.1 inches, measured in 1950 at the same station. During a 24-hour period, rainfall frequently is 3 to 4 inches, occasionally 6 to 10 inches. Thundershowers may occur in any season, but are most frequent between March and September.

DRAINAGE AND WATER RESOURCES

The streams that drain the Eastern Kentucky coal field are tributary to the Ohio River. The principal streams that flow directly into the Ohio River are the Big Sandy River, the Little Sandy River, Tygarts Creek, the Licking River, the Kentucky River, and the Cumberland River. Because of the many valleys and steep slopes, the area is well drained; swamps, marshes, and other poorly drained areas are local and unusual.

The streams that drain the Eastern Kentucky coal field provide the principal water resources of the area. Surface water along the Ohio River is adequate for coal-washing and preparation plants, for many industrial uses, and for public-water systems; but elsewhere in eastern Kentucky the water supply is inadequate for many industrial uses during periods of minimum flow of the streams or after a series of dry years. The mean flow of many of the rivers in eastern Kentucky is relatively large (table 2), but the minimum daily flow during dry seasons is extremely small, and the annual available supply is small.

Large quantities of water would be available on a year-round bsais in most of the area only by use of reservoirs. The only large reservoir within the Eastern Kentucky coal field is that formed by Dewey Dam in Floyd County. This dam controls a drainage area of about 207 square miles and has a pool with a total capacity of 93,300 acre-feet at the altitude of the spillway crest (Wells, 1953, p. 285).

TABLE 2.—*Surface-water discharge at selected eastern Kentucky stations*

[Average flow is given for entire record period to October 1952. Data from U.S. Geological Survey Water Supply Papers]

Gaging station	Drainage area (sq mi)	Mean flow Oct. 1951–Sept. 1952 (cfs)	Average flow (cfs)	Record minimum daily flow	
				Amount (cfs)	Date
Levisa Fork, Fish Trap, Ky	386	566	427	0.1	11/9/39
Levisa Fork, Paintsville	2,143	3,183	2,302	8.4	7/23-25/30
Tug Fork, near Kermit, W. Va	1,185	1,703	1,309	23.0	9/14/39
Little Sandy River, near Grayson, Ky	398	700	500	2.0	10/26/39
Tygarts Creek, Greenup	241	374	316	No flow	8/24/52 9/11-14/52
Licking River, Salyersville	140	253	164	No flow at times	----------
Licking River, Farmer	826	1,457	1,054	.7	10/14/30
North Fork Kentucky River, Hazard	465	707	505	1.0	1/9/41 10/20/51
North Fork Kentucky River, Jackson	1,105	1,934	1,259	No flow	10/16/30
Middle Fork Kentucky River, Tallega	530	963	654	.2	9/17/49
South Fork Kentucky River, Booneville	720	1,478	1,000	.1	10/1-7/30 8/1-4/44
Kentucky River, Lock 14, Heidelberg	2,648	4,934	3,519	4.0	10/20/30
Poor Fork, Cumberland	82.1	169	141	2.1	10/8, 9/41
Cumberland River, near Pineville	822	1,728	1,306	6.1	9/17/39
Cumberland River, Cumberland Falls	1,997	3,990	3,164	8.5	9/19, 20/32
South Fork of Cumberland River, near Stearns	942	1,917	1,810	11.0	10/4/48

Ground water in the Eastern Kentucky coal field is insufficient for large users but can supply individuals and small communities (Baker and Price, 1956, p. 16). The shale, siltstone, and sandstone that underlie most of the coal basin transmit water mainly through joints and cracks. Many of the coal beds are water bearing but the quantity transmitted is small. Some of the sandstone beds are moderately porous, but they are only slightly permeable and yield water slowly. In the Paintsville area Baker (1955) found that most wells yielded less than 10 gallons per minute and only one yielded as much as 100 gallons per minute. Similar small yields were found in the London area by Otten (1948) and in the Prestonsburg area by Price (1956). Fresh water is produced from both the Breathitt and the Lee formations, but some wells in both formations yield water with a high content of dissolved solids and water that is not potable.

TRANSPORTATION

Transportation facilities for hauling coal from mine to market in the Eastern Kentucky coal field include railroads, highways, and waterways (pl. 3). Railroads hauled about two-thirds of the total tonnage produced in 1955. The companies operating within the coal field are the Louisville and Nashville Railroad, the Chesapeake and Ohio Railway, the Norfolk and Western Railroad, the Southern Railway System, the Carolina, Clinchfield, and Ohio (the Clinchfield) Railway, the Kentucky and Tennessee Railway, and the Morehead and North Fork Railroad. Of these, the Louisville and Nashville

and the Chesapeake and Ohio serve the largest area and carry most of the coal shipped.

The Louisville and Nashville Railroad provides service for a large coal-producing area in the southwestern part of the Eastern Kentucky coal field. The Eastern Kentucky division of the railroad extends from Winchester southeastward along the Kentucky River and its tributaries into an important mining area in western Breathitt, Perry, and Knott Counties. The Cumberland Valley division extends from Corbin eastward into Bell, Harlan, Knox, Clay, and Letcher Counties and has a spur line from Barbourville northward to the Manchester area in Clay County. The main line along the western side of the coal field serves principally as an outlet for coal destined for middle western and southern markets.

The Chesapeake and Ohio Railway serves a large area in the northeastern half of the Eastern Kentucky coal field. Its main coal-hauling operation is the Big Sandy division, which extends southward from Catlettsburg along the Big Sandy River and Levisa Fork to the coal-producing region in Johnson, Magoffin, Floyd, Pike, eastern Knott, and eastern Letcher Counties. The Ashland-Lexington division of the railroad serves a relatively small coal-producing area in Boyd and Carter Counties. The main line along the Ohio River provides outlets to coal markets in middle western and eastern seaboard areas.

The Norfolk and Western Railroad serves eastern Pike County adjacent to Tug Fork, and the Southern Railway System serves a small coal-producing area in McCreary and Pulaski Counties. The Kentucky and Tennessee Railway is a short coal-hauling line that connects with the Southern Railway System in McCreary County. The Morehead and North Fork Railroad, another short line extending south from the Chesapeake and Ohio Railway at Morehead, formerly hauled coal but today derives most of its revenue from the transportation of clay and ceramic products. The Carolina, Clinchfield, and Ohio Railway has only a spur line extending into the southeastern part of the coal field to connect with the southern terminus of the Big Sandy Division of the Chesapeake and Ohio Railway at Elkhorn City.

Truck haulage over public highways is the second major method of coal transportation in eastern Kentucky, accounting for the shipment of about one-third of the total production in 1955. Trucks serve as a means for moving coal directly from the mine to the market and also for conveying it from the mines to railroad loading facilities. This last service is important to small underground operations and to strip mines, which in many instances are relatively short-lived and do not justify construction of spur lines.

Waterways are the least important form of transportation in the Eastern Kentucky coal field, principally because the streams in the major coal-producing areas are not navigable. Relatively small tonnages are shipped on the Kentucky and Cumberland Rivers. The Big Sandy is navigable approximately to Louisa in Lawrence County (fig. 3), but the locks were not in operation in 1955.

STRATIGRAPHY

GENERAL DESCRIPTION

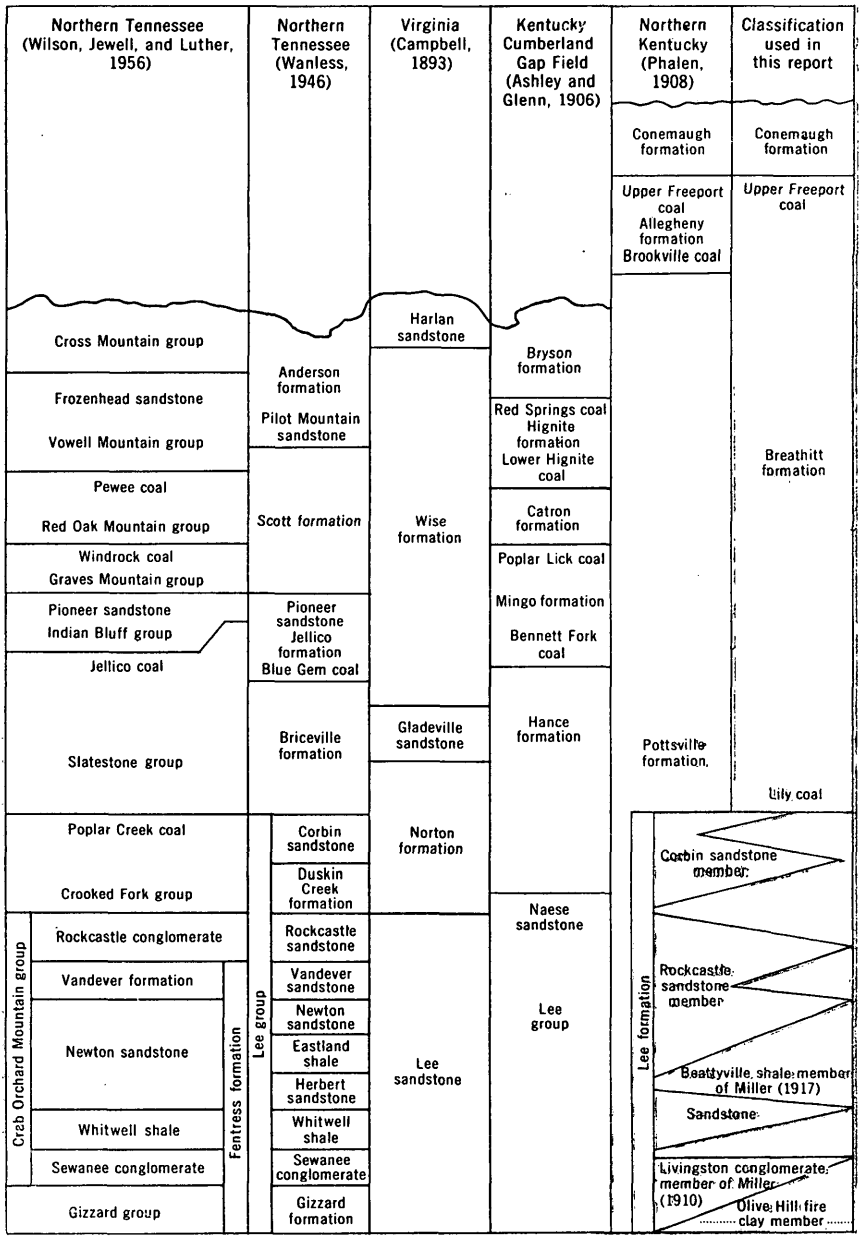
The Pennsylvanian rocks in the Eastern Kentucky coal field are divided into three formations. In ascending order they are the Lee formation of Early Pennsylvanian age, the Breathitt formation of Middle Pennsylvanian age, and the Conemaugh formation of Late Pennsylvanian age. The Monongahela formation of Late Pennsylvanian age has not been recognized in eastern Kentucky, although it is present in Ohio and West Virginia a few miles from the Kentucky State line. The classification of Pennsylvanian rocks used in this report is compared in table 3 with other classifications for eastern Kentucky, Virginia, and Tennessee.

The Pennsylvanian rocks consist principally of sandstone, siltstone, and shale and contain small amounts of limestone, ironstone, and coal. North of the Irvine-Paint Creek fault (pl. 4) the lithologic character and the intervals of the Pennsylvanian rocks are similar to those in Ohio, Pennsylvania, and northern West Virginia, whereas south of the uplift the rocks and coal beds are more like those in southwestern Virginia, southern West Virginia, and Tennessee (Wanless, 1939). Southward the rocks thicken greatly and contain more sandstone and conglomerate beds, and the interval between coal beds increases.

COAL BEDS

The coal beds constitute only a small part of the total volume of Pennsylvanian rocks in eastern Kentucky, but, because of their economic importance, an understanding of their extent, continuity, shape, and characteristics is of prime interest. In the Eastern Kentucky coal field coal beds range in thickness from microscopic films to as much as 19 feet, and in area from bodies a few feet across to major beds that extend over most of eastern Kentucky and into adjacent States. The coal beds range in shape from sheets to elongate, rodlike bodies, to disc-shaped or irregular lentils. The thick coal bodies tend to be elongated toward the north and east. Widespread coal beds may be continuous sheets of coal, isolated lentils at the same horizon, overlapping lentils at successive horizons that are not strictly contemporaneous, or semi-isolated tongues and splits

TABLE 3.—*Systems of classification of Pennsylvanian strata used in eastern Kentucky, Virginia, and northern Tennessee*



of coal extending from sheetlike lentils. Continuous sheets of coal may be thin or absent locally because of nondeposition of removal shortly after deposition by decay, fire, erosion, or other causes. In many places channels have been cut in the coal beds and filled with sandstone, shale, or siltstone. Coal beds terminate horizontally by gradual thinning, by grading into other sediments such as black shale, by splitting into several beds, or by ending abruptly in sharp contact with a channel-fill deposit.

Bed characteristics and chemical and physical properties of coal beds also change. Locally, coal beds may have peculiar partings; distinctive benches of laminated, splint, or cannel coal; riders; unusual chemical composition; and unusual roof or floor rocks; but few of these features have a regional extent. Such variations are to be expected because it is unlikely that conditions were identical throughout a coal swamp the size of the Eastern Kentucky coal field during the period of accumulation and formation of the coal. The type, manner, and rate of accumulation of the vegetable matter and inorganic sediments, as well as other factors affecting the formation of the coal, must have changed.

The extent, persistence, termination, and characteristics of coal beds in eastern Kentucky can be determined only where there has been extensive mining, core drilling, prospecting, and careful geologic mapping. In much of the coal field, the extent and continuity of the coal beds have not been determined. Plates 5 through 14 show the probable extent of 12 coal beds. The Upper Elkhorn No. 3 and the Fire Clay coals seem to be extensive and continuous; the Lily seems to be composed of contemporaneous isolated lenses of coal; and the Hazard, Hazard No. 7, and Francis coals and the coal beds in the Lee formation seem to be extensive coal zones composed of overlapping lenses. Additional geologic mapping and prospecting will be required to prove or disprove these speculations.

LEE FORMATION OF EARLY PENNSYLVANIAN AGE

The Lee formation, named by Campbell in 1893, is composed principally of sandstone, conglomerate, siltstone, and shale. Thick orthoquartzitic cliff-forming sandstone and conglomerate beds are the most conspicuous members of the formation. The coal beds are markedly lenticular and discontinuous.

The Lee is well exposed in four general areas: (1) the Pottsville escarpment along the western margin of the coal field, (2) northeast of Paintsville in the Irvine-Paint Creek uplift, (3) Pine Mountain, where the rocks have been upturned by thrust faulting, and (4) Cumberland Mountain along the southeastern border of the coal field.

The thickness of the Lee formation in the Pottsville escarpment along the western edge of the coal field decreases northward from about 670 feet at the Kentucky-Tennessee State line to about 100 feet at the Ohio River. Thick orthoquartzitic cliff-forming sandstone beds—separated by beds of shale, siltstone, and coal—are prominent in the southern part of this area, but northward the sandstone beds grade laterally and vertically into shale and siltstone and become thinner and fewer in number. In the area of the Irvine-Paint Creek uplift, the Lee formation is about 500 feet thick and consists of thick beds of sandstone and interbedded shale and coal. In the Pine and Cumberland Mountains the Lee formation ranges from about 1,000 to 1,500 feet in thickness and is composed almost entirely of sandstone separated by relatively thin zones of shale and coal.

Named members of the Lee formation along the western margin of the coal field include the Olive Hill fire clay of Crider (1913), the Livingston conglomerate of Miller (1910), the Beattyville shale member (Miller, 1917) in the lower part of the formation, and the Rockcastle sandstone and Corbin sandstone members (Campbell, 1889) in the middle and upper parts of the formation, respectively (table 3). The Olive Hill fire clay member occurs in separate lens-shaped bodies, generally less than 3 feet thick, near the base of the Lee formation in the northern part of the coal field in Greenup, Carter, and Elliott Counties. This bed is the source of most of the flint fire clay used in the manufacture of high-refractory brick in eastern Kentucky. The Livingston conglomerate member is a local elongated body of sandstone and conglomerate which occupies a channel in the limestone of Mississippian age near Livingston in Rockcastle County. Similar elongated bodies occupy other channels in the Mississippian limestone at Heidelberg, Ky., and other localities. The Beattyville shale member includes siltstone and fine-grained sandstone and two to four coal beds. Overlying the Beattyville in many parts of the coal field is the Rockcastle sandstone member which is composed of sandstone and conglomerate. This member is as much as 200 feet thick and forms cliffs that are especially prominent in Rockcastle and Pulaski Counties. The Corbin sandstone member, at or near the top of the Lee formation, is a sandstone or conglomeratic sandstone from 100 to 200 feet thick. It is not well indurated, forms rounded outcrops, and weathers to a pinkish color. Although it is not so resistant to erosion as the Rockcastle, the Corbin underlies an extensive upland of low relief in Laurel, Whitley, and McCreary Counties, and in southern Rockcastle County, where the overlying Breathitt has been removed by erosion.

The continuity and correlation of the coal beds of the Lee formation

are not certain, but in many areas three beds that occur in the formation at about the same stratigraphic position relative to each other, probably represent three distinct coal horizons. The names Hudson, Beaver Creek, and Barren Fork have been assigned to these beds for use in this report, but locally other names are used. The composite areal distribution of the coals of the Lee formation is shown in plate 5.

At some places the base of the Lee formation is marked by a disconformity. Along the western margin of the coal field near Heidelberg and Livingston and in the area of the Irvine-Paint Creek uplift, rocks of the Lee formation lie disconformably on sandstone, shale, or limestone beds, which range from Early to Late Mississippian in age. In Pine and Cumberland Mountains the Lee formation and the underlying Bluestone formation of Mississippian age seem to grade and interfinger into each other through a succession of sandstone and shale tongues.

No one criterion can be used at all localities to distinguish between the Lee and older formations. Contrasting types of sediments above and below a sharp contact is characteristic of the relation at most localities. For example, the red and green shales of the Pennington formation of Mississippian age are easily distinguished from the dark-colored shale and siltstone or the sandstone and conglomerate of the Lee formation of Pennsylvanian age. The contact also is sharp and easily recognized where rocks of the Lee formation rest on Mississippian limestone. At many localities, however, the rocks above and below the contact are similar, and it is necessary to use the lowest coal bed, flint clay, or underclay as a guide in finding the base of the Lee formation.

The contact with the overlying Breathitt formation is graditaonal, and the boundary is arbitrary.

BREATHITT FORMATION OF MIDDLE PENNSYLVANIAN AGE

Campbell in 1898 proposed the name Breathitt for the rocks overlying the Lee formation in Breathitt County northwest of Pine Mountain. As used in this report, the Berathitt formation includes all the rocks between the Lee and Conemaugh formations. These rocks have been variously named and subdivided in eastern Kentucky and adjoining States (table 3). Phalen (1908) used Pennsylvania, West Virginia, and Ohio terminology in northeastern Kentucky, dividing the rocks into the Pottsville, Allegheny, and Conemaugh formations. Wanless (1946) used Tennessee nomenclature in southern Kentucky, including, in ascending stratigraphic order, the Briceville, Jellico, Scott, and Anderson formations. These divisions were based partly on key coal and sandstone beds, and partly on general characteristics of the rocks. Wilson and others (1956) abandoned these names and

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proposed new group and formation names for northern Tennessee, basing their subdivisions on selected key sandstone beds and coalbeds. In the Cumberland Gap coal field, Ashley and Glenn (1906) subdivided the post-Lee strata into the Hance, Mingo, Catron, Hignite, and Bryson formations using selected coalbeds as formation boundaries. Campbell in 1893, using the Gladeville sandstone as the key bed, divided the rocks above the Lee formation in Wise County, Va., into, in ascending order, the Norton, Gladeville, Wise, and Harlan formations. The Gladeville has been recognized in Letcher County, Ky., in the area southeast of Pine Mountain, where McFarlan (1943) and Wanless (1946) applied Campbell's names; in Harlab and Bell Counties the Gladeville has not been recognized and the Virginia nomenclature is not used.

None of the proposed systems of subdividing the rocks between the Lee and Conemaugh formations are applicable throughout the entire Eastern Kentucky coal field, but all are included in the Breathitt formation of Campbell and this name is used in this report.

Over most of the Eastern Kentucky coal field the Breathitt formation is at the surface, and its outcrop area is the largest of any of the coal-bearing formations in eastern Kentucky. In the northern part of the coal field in parts of Carter, Boyd, and Lawrence Counties, however, the Breathitt formation is covered by the Conemaugh; in a few areas in the coal field where it has been completely removed by erosion the Lee formation is at the surface.

The upper part of the Breathitt formation has been removed by erosion over most of the outcrop area. The full thickness of the Breathitt is preserved only in northeastern Kentucky, where the overlying Conemaugh formation is present; in this area it is about 475 feet thick. Thickening of the Breathitt formation southward is indicated by the change in thickness of the rocks between two coal beds in the formation, the Upper Elkhorn No. 3 and the Hazard. At the Ohio River this thickness is about 150 feet, increasing to about 300 feet in southern Lawrence and northeastern Morgan Counties, to about 600 feet in central Pike, southern Floyd, Knott, northern Perry, and central Clay Counties. This formation reaches a maximum thickness of about 1,300 feet south of Pine Mountain.

The contact of the Breathitt formation with the underlying Lee is placed at the top of the uppermost cliff-forming sandstone or at the base of a coal bed, variously known as the Lily, Horse Creek, Manchester, Swamp Angel, Zachariah, or River Gem, which lies on or a short distance above the uppermost cliff-forming sandstone. In areas where the cliff-forming sandstone beds are absent or thin, particularly in the northern part of the coal field, the contact is defined by a key bed, such as a coal, ironstone, or sandstone, whose position

relative to the uppermost cliff-forming sandstone has been determined elsewhere.

The Breathitt formation consists of shale, siltstone, sandstone, ironstone, calcareous rocks, and coal. Most of the commercial coal of eastern Kentucky is in this formation. The shale beds are dark or light gray and contain fossil plants—stems, leaves, and fronds—and ironstone at many places. Some of the siltstone and sandstone beds also contain plant fragments, particularly stems and trunks. The sandstone beds are characterized by an abundance of minerals of the clay-mica type and rock fragments. The sandstone beds in the upper part of the formation, particularly in the southeastern part of the coal field, are feldspathic. Ironstone occurs as concretions, usually in shale or claystone, or ranges from separate concretions to nearly continuous beds or layers with a maximum thickness of 3 feet (Crandall, 1884). Calcareous rocks make up a very small part of the formation, but several zones contain large siltstone or sandstone concretions cemented with calcareous material, and at least one zone of limestone, the Magoffin beds of Morse (1931), is widespread. The rocks below the coal beds are shale or clay, siltstone, or sandstone, and in most places contain roots and rootlets. Many of these rocks are slickensided as a result of compaction, due to dewatering of the sediment and compression of roots and rootlets. Marine fossils are present in the calcareous rocks at many localities, and brackish-water and marine fossils occur in some of the noncalcareous rocks which contain plant fossils.

A few beds or zones have distinctive properties and are sufficiently widespread to be useful as key beds throughout the Eastern Kentucky coal field. These are, in about their relative order of importance, the Fire Clay coal, the Magoffin beds (Morse, 1931), the Kendrick shale member (Jillson, 1919), and the Upper Elkhorn No. 3 coal bed and its equivalents.

The Fire Clay coal is characterized by a hard medium-brown flint-clay parting, generally in the lower third of the coal bed. In some places, however, the coal above or below the clay parting is missing, and in a few localities only the parting occurs, underlain by soft clay or shale containing abundant rootlets. The parting is not continuous or constant in its properties but may change in thickness, color, or hardness even in a particular mine. The flint-clay parting in the Fire Clay coal is widespread and most typical in the general drainage area of the Kentucky River, particularly in the Hazard mining district, and is common elsewhere in the Eastern Kentucky coal field except in the northern part. Flint-clay partings are also present in the Amburgy and Hazard coals and their equivalents, but are less characteristic of those beds.

The Magoffin beds are widespread and well known in the central part of the Eastern Kentucky coal field and have been found in a few localities in the southern and southwestern part, whereas in the eastern and northern parts of the field the Magoffin beds apparently have a limited distribution. At most places they consist of a basal bed of silty or argillaceous crinoidal limestone less than 1 foot thick, overlain by dark calcarious shale or siltstone 1 to 5 feet thick, which contains, or is overlain by, individual concretions or a layer of concretionary limestone. The entire unit is represented in some places only by a fossiliferous calcareous shale or siltstone or silty limestone. The Magoffin beds contain marine fossils in all outcrops.

The Kendrick shale member is a widespread marine zone in the eastern and central parts of the coal field, north of Pine Mountain. South of Pine Mountain and in the southwestern part of the coal field, the member has not been widely recognized. The Kendrick consists of a medium- to dark-gray shale, siltstone, or fine-grained sandstone containing silty limestone concretions which average 2 feet in diameter but which reach a maximum diameter of slightly more than 10 feet. Marine fossils are abundant in some localities but are absent in others. Similar fossiliferous marine shale beds containing limestone concretions are not uncommon in other parts of the Breathitt formation in some parts of the coal field, and may be erroneously identified as the Kendrick member.

The Upper Elkhorn No. 3 coal bed has no particularly distinctive properties to aid in its identification but, because it has been mined or prospected over such a broad area, it can be identified throughout much of the coal field by tracing from mine to mine. It is correlated with the Millers Creek, Van Lear, Warfield, Little Caney, Tom Cooper, Darby, Keokee, Rhoda, and "C" coal beds. More coal has been produced from the Upper Elkhorn No. 3 bed, and it contains more remaining coal reserves, than any other coal bed in the Eastern Kentucky coal field. The wide distribution of the coal bed (pl. 8) makes it useful as a key bed, and other coals can be correlated on the on the basis of their stratigraphic relation to the Upper Elkhorn No. 3 coal.

Thirty-seven coalbeds have been identified in the Breathitt formation in the Eastern Kentucky coal field. All these coal beds are not present in any one of the reserve districts, and only three, the Upper Elkhorn No. 3, the Amburgy, and the Fire Clay, have been identified throughout the entire coal field. The correlation of a number of the coal beds between mining areas and districts is tentative, and undoubtedly additional geologic mapping, exploration, and mining will change some of the correlations shown in table 4.

CONEMAUGH FORMATION OF LATE PENNSYLVANIAN AGE

The Conemaugh formation occurs in a small area in Boyd, Carter, and Lawrence Counties. Its maximum thickness is about 500 feet, which does not represent the full thickness of the formation because the upper part has been removed by erosion. The contact between the Conemaugh and the underlying Breathitt is placed at the top of a coal bed or at the base of a sandstone tentatively correlated with the Upper Freeport coal and the Mahoning sandstone member of Pennsylvania.

The Conemaugh formation consists mainly of shale, some of which is red, green, and purple, and siltstone and sandstone. It also contains several marine limestone and chert beds, which are traceable. Only two coal beds were found in the Conemaugh in eastern Kentucky, and neither is of commercial value.

GEOLOGIC STRUCTURE

The major structural features of the Eastern Kentucky coal field are the Allegheny synclinorium, the Irvine-Paint Creek uplift, the Eastern Kentucky syncline, and the Cumberland overthrust block (pl. 4).

The Allegheny synclinorium extends from the vicinity of Pittsburgh, Pa., across West Virginia to Carter, Boyd, and Lawrence Counties, Ky., where it is bordered on the south by the Irvine-Paint Creek uplift (pl. 4). The youngest Paleozoic rocks in the Eastern Kentucky coal field, the Conemaugh formation of Late Pennsylvanian age, are preserved in this synclinorium.

The Irvine-Paint Creek uplift is an eastward-trending zone of folds and faults—including the Irvine-Paint Creek fault, the Paintsville-Warfield anticline, the Johnson Creek fault, and others—which extends entirely across the Eastern Kentucky coal field and divides it into two provinces. Most of the faults are normal and are downthrown on the south. Generally there is an anticline parallel to the fault on the downthrown block. Pairs of structures showing this relation are the Irvine-Paint Creek fault and the parallel Paintsville-Warfield anticline, and the Johnson Creek fault and the anticline south of it.

Between the Irvine-Paint Creek uplift and the Cumberland overthrust block is the Eastern Kentucky syncline (McFarlan, 1943), a broad basin divided by the Paint Creek uplift into an eastern basin centering largely in Martin County and a western one which is most prominent in Breathitt, Perry, and Leslie Counties. The syncline dies out to the southwest.

TABLE 4.—*Correlation of principal coal beds and key beds by districts and subdistricts of eastern Kentucky*

Pennsylvania system		Princess	Licking River	Big Sandy	Hazard	Southwestern	Upper Cumberland	
							Harlan	Middlesboro
Upper	Conemaugh formation	Cambridge limestone member						
		Princess No. 10 coal						
		Princess No. 9 coal						
		Upper Freeport coal						
		Princess No. 8 coal						
		Princess No. 7 coal						
		Princess No. 6 coal						
		Vanport limestone member equivalent						
		Princess No. 5B coal						
		Princess No. 5A coal						
		Black flint			Flint Ridge flint of Morse (1931)			
		Princess No. 5 or Richardson coal	Richardson coal	Richardson coal	Skyline coal			
					Lost Creek limestone of Morse (1931)			
					Hindman coal	Hindman coal		
		Princess No. 4 or Torchlight coal	Sebastian or Fugate coal	Torchlight coal	Francis coal	Francis coal		
			Nickell or Oakley coal		Hazard No. 7 coal	Hazard No. 7 coal	High Splint coal	Red Spring coal

Middle	Breathitt formation	Princess No. 3 or Peach Orchard coal	Index, Prater or Adele coal	Peach Orchard coal	Hazard coal	Hazard coal	Cornett coal	
			Colvin coal Haddix coal Trace Fork coal	Haddix coal	Colvin (?) coal Haddix coal	Haddix coal		
					Saltlick beds of Morse (1931)			
		Magoffin beds of Morse (1931)	Magoffin member	Magoffin member	Magoffin member		Magoffin member	
					Copland coal			
			Upper Hamlin coal	Hamlin coal	Upper Hamlin coal	Upper Hamlin coal	Pardee coal	Lower Hignite coal
			Lower Hamlin coal		Lower Hamlin coal	Lower Hamlin coal	Wax coal	
		Fire Clay rider coal	Fire Clay rider coal	Fire Clay rider coal	Fire Clay rider coal	Fire Clay rider coal		Sterling coal
		Fire Clay coal	Fire Clay coal	Fire Clay coal	Fire Clay coal	Fire Clay coal	Fire Clay coal	Poplar Lick coal
		Whitesburg coal	Upper Whitesburg coal	Upper Whitesburg coal	Upper Whitesburg coal		Upper Whitesburg coal	
			Lower Whitesburg	Lower Whitesburg	Lower Whitesburg	Mills coal	Lower Whitesburg	
		Kendrick shale member of Jillson (1919)	Kendrick shale member	Kendrick shale member	Kendrick shale member			
					Amburgy rider coal			
		Gun Creek coal	Gun Creek coal	Williamson coal	Amburgy coal	Moss coal	Low Splint or Creech coal	Sandstone Parting coal
			Ivyton coal		Upper Elkhorn rider coal		"D" coal	
		Tom Cooper coal	Tom Cooper coal	Upper Elkhorn No. 3 coal	Upper Elkhorn No. 3 coal	Jellico or Straight Creek coal	Darby or "C" coal	Mingo or "Mason" coal
					Elkhorn Leader		Kellioka coal	
				Upper Elkhorn No. 2 coal	Upper Elkhorn No. 2 coal		Collier coal	
								Rich Mountain coal

TABLE 4.—*Correlation of principal coal beds and key beds by districts and subdistricts of eastern Kentucky*—Continued

Pennsylvania system		Princess	Licking River	Big Sandy	Hazard	Southwestern	Upper Cumberland	
							Harlan	Middlesboro
Middle	Breathitt formation	Grassy(?) coal	Grassy coal	Upper Elkhorn No. 1 coal	Upper Elkhorn No. 1 coal	Blue Gem coal	Harlan, "B", or Hance coal	
			"Howard" coal	Lower Elkhorn coal	Lower Elkhorn coal	Bacon Creek coal	Imboden coal	Bennett Fork coal
				Bingham coal Eagle(?) coal Millard coal				
				Hagy(?) coal			Cranes Creek coal	
				Auxier coal				
			Zachariah or Wheelersburg coal	Upper Banner(?) coal	Zachariah coal	Lily coal		
				Elswick coal				
Lower	Lee formation		Mine Fork coal	Mine Fork coal		Barren Fork coal		
			Beattyville coal			Beaver Creek coal		
						Stearns No. 1½ coal		
						Hudson coal		

The Cumberland overthrust block, about 120 miles long and averaging about 25 miles wide, is bordered on the northwest by the Pine Mountain fault, on the northeast by the Russell Fork fault, on the southeast by the Hunter Valley and St. Paul faults, and on the southwest by the Jacksboro fault. The Hunter Valley, St. Paul, and Jacksboro faults are east and south of the area shown on plate 4. The Pine Mountain, Hunter Valley, and St. Paul faults are low-angle trust faults that strike northeastward and dip southeastward. The trace of the Pine Mountain fault is parallel to the northwest face of Pine Mountain. The Russell Fork and Jacksboro faults are nearly vertical, and the displacement is largely horizontal. Southeast of Pine Mountain, within the Cumberland overthrust block, is the Middlesboro syncline whose axis trends northeastward parallel to the long dimension of the block. In the syncline the rocks dip less than 15° in most places, as contrasted with the steep dips of the rocks in Pine and Cumberland Mountains. The Rocky Face fault transects the Cumberland overthrust block in a southeast direction and divides the Middlesboro syncline into two subbasins.

The geologic structure, in general, has little effect on coal-mining operations in eastern Kentucky except in regard to mine drainage. In a few areas, however, particularly near the Rocky Face fault, the Pine Mountain overthrust, and some of the faults of the Irvine-Paint Creek uplift, the coal is too disturbed to mine profitably. Also, in the steeply dipping beds of Pine Mountain, the coal beds are too difficult to mine because of their attitude. Apparently nowhere in the Eastern Kentucky coal field has folding been sufficiently intense to increase greatly the rank of the coal, although, in a general way, the ratio of fixed carbon to volatile matter tends to increase southeastward toward the area of strongly folded rocks in the Appalachian Mountains.

Part 3. RESERVE DISTRICTS OF THE EASTERN KENTUCKY COAL FIELD

BOUNDARIES AND NAMES OF THE DISTRICTS

In the past the Eastern Kentucky coal field has been divided, for purposes of discussion, into major drainage areas—such as, the Big Sandy-Elkhorn drainage, the Licking River drainage, the Kentucky River drainage, and the Cumberland River drainage. This was done because the drainage determined the transportation routes, and the drainage areas outlined in a general way the mining districts within which particular coal beds were mined. The names given to the coal beds, in most instances, were peculiar to one district, although some names were used in several districts.

As mining development continued and transportation facilities were improved, the natural drainage lines became less significant, and the growing areas of coal production became more significant. These more compact areas soon became known as coal-producing districts and were named in many instances for the town or towns that provided the commercial services for the district, such as the Corbin, Hazard, Harlan-Benham, and the Barbourville-Middlesboro producing districts (pl. 15). Some of these extended into adjacent States.

In this report the Eastern Kentucky coal field has been divided into six reserve districts whose boundaries, except along Pine Mountain and the western edge of the field, are county lines (pl. 15). These districts coincide to some extent with drainage areas, because the county lines in many places follow drainage divides. Division on the basis of counties is advantageous because previous reports on coal production and some of the reports on reserves have been published in county units. The one district for which county lines do not determine the boundaries is the Upper Cumberland River reserve district, whose area and extent are delimited by geologic structural features.

The divisions used in the present report are to some extent arbitrary, but drainage, coal-name usage, and coal production, or lack of it, also have been determining factors. Numbering of six the reserve districts has been discretionary from north to south. The six districts are:

1. The Princess district.
2. The Licking River district
3. The Big Sandy district
4. The Hazard district
5. The Southwestern district
6. The Upper Cumberland River district.

COAL BEDS OF THE PRINCESS RESERVE DISTRICT

By JOHN C. FERM

LOCATION

The Princess reserve district occupies an area of about 1,350 square miles in the northern part of the Eastern Kentucky coal field and includes all of Boyd, Carter, Greenup, and Lawrence Counties and the easternmost part of Lewis County. The name of the district is derived from a small mining community in northwestern Boyd County.

Plate 1 shows the location of the district and plate 2 shows the areas within the district for which coal reserve estimates have been prepared. Reserves were not estimated for the western part of the district, as previous reports (Crandall, 1884, and Phalen, 1908) indicate that the coal there is of negligible economic importance.

DRAINAGE AND TOPOGRAPHY

The Princess reserve district lies within the highly dissected Kanawha section of the Appalachian Plateau province and, like the rest of the Eastern Kentucky coal field, the landscape consists mainly of steep-sided hills with narrow ridgetops alternating with narrow, winding valleys. The general character of the terrain, however, is more subdued than in other parts of the coal field. Local relief exceeds 500 or 600 feet in only a few places and some of the major streams have wide alluvial valleys.

All streams flow either directly or indirectly into the Ohio River, which flows northwestward along the northern margin of the district (pl. 1). The three principal tributary streams to the Ohio River in in this district are Tygarts Creek, the Little Sandy River, and the Big Sandy River. Tygarts Creek drains the western parts of Carter and Greenup Counties; the Little Sandy River and its tributaries, East Fork and Little Fork, have a large drainage area which includes most of Carter, Greenup, and Boyd Counties. Lawrence County is drained principally by the Big Sandy River and its tributaries, Levisa Fork, Tug Fork, and Blaine Creek.

TRANSPORTATION

Transportation in the Princess reserve district is provided by an ample network of roads and railroads (pl. 3). In addition to the heavy-duty arterial highways shown on the map, numerous light-duty all-weather roads extend to the remote parts of the district. This road system is very important to the local coal industry, as many of the mines either are located some distance from the railroad or are too small to support rail-loading facilities. Operations which are large enough to require rail transportaion are served by the Chesapeake and Ohio Railway.

SOURCES OF DATA

Data used in preparing coal-reserve estimates were assembled from a number of sources (pl. 2). Estimates for Boyd, Carter, and Greenup Counties were made from field-reconnaissance information supplemented by reports of the Kentucky Geological Survey (Crandall, 1884) and the U. S. Geological Survey (Phalen, 1908).

Data for the Lawrence County estimates were gathered mostly from published literature. Estimates in the northern part, including parts of the Webbville and Louisa 15-minute quadrangles, were made from information in the reports by Crandall (1884, 1905) and Phalen (1908). Data for the Lawrence County part of the Paintsville 15-minute quadrangle were compiled by L. D. Harris from a report by Hauser (1953). Harris and H. L. Smith prepared estimates for the

Lawrence County part of the Inez 15-minute quadrangle from field-reconnaissance data supplemented by published information (Crandall, 1905).

STRATIGRAPHY

The coal-bearing rocks of the Princess reserve district include the Lee, Breathitt, and Conemaugh formations of Pennsylvanian Age. The Lee formation, the oldest of the three, disconformably overlies Mississippian rocks and the contact is an erosion surface with at least 100 feet of relief.

LEE FORMATION

The Lee formation consists mostly of sandstone and siltstone with lesser amounts of clay, shale, coal, "iron ore," and limestone. The most conspicuous units of the formation are the sandstone beds, which attain thicknesses from 100 to 300 feet in the southern part of the district. In other areas, particularly in the northwestern part of the district, the sandstone units are locally absent or are represented by one or two beds 2 to 3 feet thick. Sandstone beds in the Lee formation, regardless of thickness, are generally quartzose, which is the only method of distinguishing the Lee from the lower part of the Breathitt in some areas. In Greenup and Carter Counties the upper contact of the Lee formation is placed at the top of a 2- to 5-foot-thick persistent quartzose sandstone directly underlying the Grassy(?) coal, the lowest stratum of the Breathitt formation. In Lawrence County, the top of the Lee is considered to be the top of the uppermost cliff-forming sandstone member.

The thickness of the Lee is quite variable. Within local areas some of this variation is probably due to differential sedimentation on the uneven, pre-Lee erosion surface. There is a pronounced regional thickening from north to south. In Greenup County, on the Ohio River, the Lee averages about 175 feet in thickness; in Lawrence County it attains a maximum thickness of 350 feet.

BREATHITT FORMATION

The Breathitt formation overlies the Lee and consists mainly of siltstone, sandstone, and shale, in that order of abundance. Minor constituents, other than coal, are clay, "iron ore," limestone, and chert. The sandstone beds of the Breathitt, unlike those of the Lee, are typically nonquartzose or "dirty" and some are feldspathic. The base of the formation in the Princess reserve district is defined as the base of the Grassy(?) coal bed, and the top as the top of the Upper Freeport coal bed. Like the Lee, the Breathitt formation thickens from north to south. In the northern part of the district it is about 475 feet thick; in the southern part it probably averages 800 feet. The main zone of thickening appears to be in the lower

part of the formation below the Princess No. 5 coal bed. The principal coal beds and key beds of the Breathitt formation in the Princess reserve district are shown on figure 1.

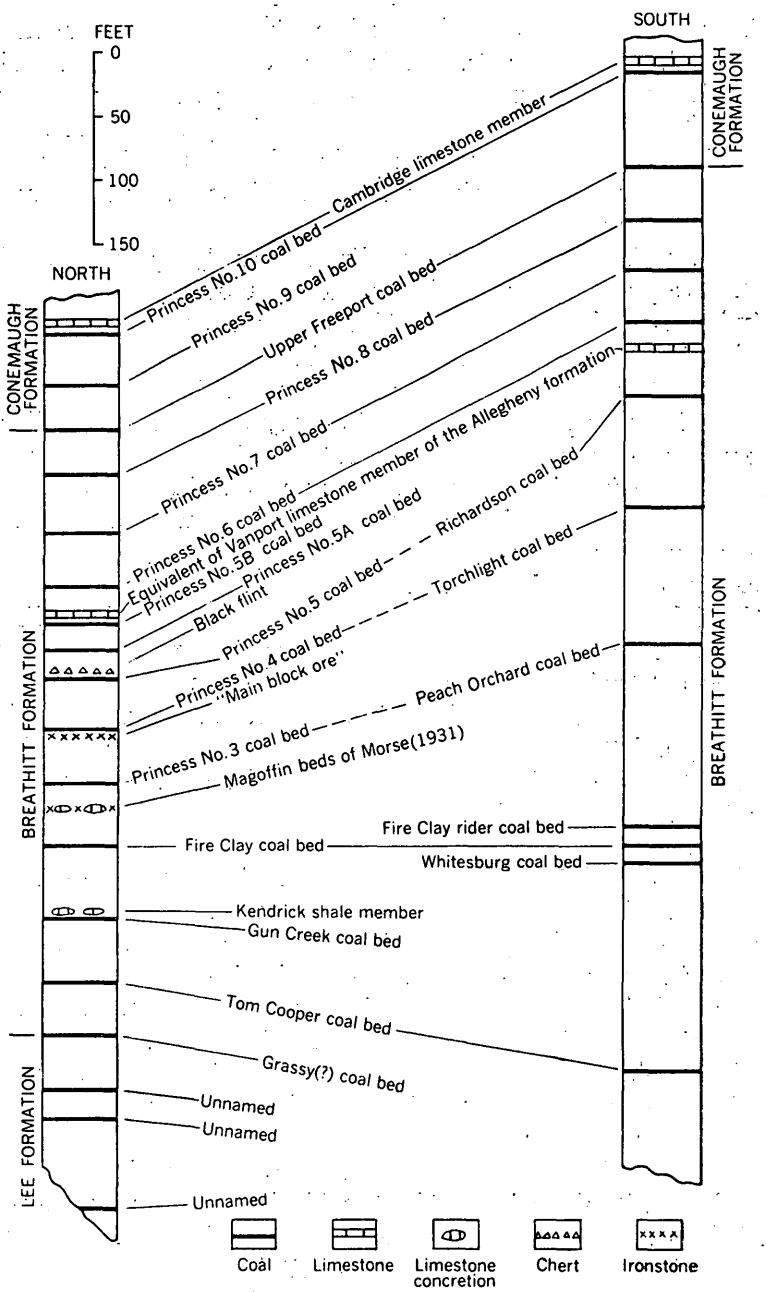

FIGURE 1.—Generalized geologic columns for the Princess reserve district.

Included within the Breathitt formation in the Princess reserve district are six relatively thin units which, because of their lateral persistence and distinctive lithologic character, are of considerable importance in local or regional correlation. These beds, in ascending order, are the Kendrick shale member, flint clay parting in the Fire Clay coal, Magoffin beds, "main block ore," black flint, and the equivalent of the Vanport limestone member of the Allegheny formation. The lower three of these beds are widespread in the southern part of the Eastern Kentucky coal field, but in the Princess reserve district they are less persistent and are lithologically different from their southern equivalents.

The Kendrick shale member, directly overlying the Gun Creek coal, is very irregularly distributed and has been definitely recognized only in Carter County. Ellipsoidal limestone concretions containing marine fossils occur at a few places, but generally the Kendrick is represented by a dark siltstone or sandstone with marine fossils.

The flint clay parting in the Fire Clay coal bed in the Princess reserve district is much less persistent than in districts to the south. At a few localities in Carter and Greenup Counties it is a nonpersistent bed of flint or semiflint clay 1 to 2 inches thick. It has no correlation value within the district, as nearly all the coal beds of the Breathitt formation locally include similar partings.

The Magoffin beds, lying between the Fire Clay and the Princess No.3 coal beds, are fairly widespread in Greenup and Carter Counties, but are not typical of the Magoffin in the Licking River and Hazard reserve districts to the south. Limestone has been found at only one locality, and the position of the Magoffin is generally marked either by a siltstone containing marine fossils or by a thin sandy limonite "ore" bed. The Magoffin beds have not been recognized in Lawrence County.

The next overlying key beds of the Breathitt formation—the "main block ore," the black flint, and the Vanport limestone member equivalent—are reasonably persistent in the Princess reserve district. The oldest of these, the "main block ore," which is generally 35 to 40 feet above the Princess No. 3 coal bed, in most localities consists of a 1-foot bed of silty limonite containing a few marine fossils. In most places the bed itself is not exposed but the position is indicated in large areas of Greenup and Carter Counties by shallow trenches from which the iron ore was formerly mined.

The black flint, lying about 45 feet above the "main block ore," is associated with the Princess No. 5 coal bed and, where best developed, includes two units. The lower unit, a 2- to 3-inch hard blocky flint-like parting containing plant fossils, is within the coal bed itself. The upper unit, a 3- to 4-foot bed of dark hard granular flint containing

marine fossils, lies 2 to 5 feet above the Princess No. 5 coal bed. Both units are extremely resistant to weathering and can be found as ledges or abundant loose float where other beds are not exposed. The lower flintlike parting has a relatively wide areal extent and has been found in many places in southeastern Greenup, northwestern Boyd, and eastern Carter Counties. In Lawrence County, beds probably equivalent to the flintlike partings are present at two localities. The first is a series of ridgetop outcrops extending from Blaine about 5 miles to the east. In this area a thin flinty layer has been found within a 15- to 20-inch coal bed. A second locality is about a mile north of Louisa, where Phalen (1908) reports a 6-inch coal bed that changes laterally to black flint. In contrast, the upper marine flint bed is found only in a small area of about 16 square miles in west-central Boyd County and in Carter County.

The youngest and most persistent key stratum in the Breathitt formation is the Vanport limestone member equivalent of Allegheny age. This bed is 60 to 75 feet below the Princess No. 7 coal bed and 20 to 50 feet above the black flint. In the northern part of the district the Vanport equivalent is a 2- to 5-foot bed of light-gray massive limestone containing marine fossils, but in a few localities the limestone is apparently replaced by fossiliferous chert. A thin limonite bed generally overlies the Vanport equivalent whose stratigraphic position is indicated in some places by shallow abandoned open-pit iron mines. Directly underlying the limestone is a 5- to 20-foot bed of clay, which is mostly of the plastic variety but which contains a few 1- to 4-inch layers of flint clay. This clay bed is apparently more persistent than either the limonite, limestone, or chert, and can be found in many localities where the other rock types are absent. The Vanport limestone member equivalent crops out in a broad area extending through eastern Greenup, eastern Carter, and western Boyd Counties, and is reported by Crandall (1884) to be an excellent marker bed in northern Lawrence County.

CONEMAUGH FORMATION

The Conemaugh formation overlies the Breathitt and represents the youngest Pennsylvanian rocks in the Eastern Kentucky coal field. The lower limit of the formation has been defined (Phalen, 1908, p.15) as the top of the Upper Freeport coal bed and the upper limit as the base of the Pittsburgh coal bed. In Wayne County, W. Va., which adjoins the Princess reserve district on the east, the Conemaugh is reported to be about 500 feet thick (Kerebs and Teets, 1913, p. 114–117), but in Kentucky the upper 100 to 200 feet has been removed by erosion. The Conemaugh formation in the Princess reserve district consists of siltstone, shale—some of which is red—sandstone, a few thin coal beds, and limestone. Several limestone beds are relatively

persistent but, of these, only the Cambridge limestone member was extensively used as a key bed in this study. The Cambridge is in the lower part of the Conemaugh, 110 to 120 feet above the Princess No. 8 coal bed. It has an average thickness of about 2 feet and is generally a silty, fossiliferous limestone. In some localities the Cambridge member contains abundant layers and nodules of fossiliferous chert which, owing to its resistance to weathering, forms conspicuous ledges. The Cambridge crops out in a large area in Boyd and eastern Carter Counties and is reported by Crandall (1884) and Phalen (1908) to be very persistent in the northern part of Lawrence County.

COAL-BED NOMENCLATURE

Coal beds have been found in at least 22 stratigraphic positions in the Pennsylvanian rocks of the Princess reserve district. Of these, however, only 13 individual beds or zones consisting of 2 or more beds have sufficient thickness and areal extent to be included in the reserve estimate. Each coal bed in the Princess reserve district has at one time been given a name, but usually these names have been applied only in a small area and a uniform system of coal-bed nomenclature has not been established. In this report an attempt has been made to simplify the nomenclatural system by using only one name for each bed within the district and, where correlations are reasonably certain, by adopting names from adjoining districts. It has been necessary, however, to continue usage of local nomenclature where (1) no equivalent bed has been recognized in adjoining districts, (2) correlations in adjoining districts have not been definitely established, or (3) local usage has considerable economic significance. The resulting revised nomenclature is shown on figure 1.

The coal beds in the Lee formation are thin and erratic in distribution and, therefore, have not been differentiated or given specific names.

Correlations of beds in the lower part of the Breathitt formation have been established between the Princess and Licking River reserve districts, and Grassy, Tom Cooper, Gun Creek, Whitesburg, Fire Clay, and Fire Clay rider are names introduced from that area. Stratigraphic equivalence of coal beds in the middle part of the Breathitt cannot be definitely demonstrated in different parts of the district and a dual system of nomenclature has been adopted. In the southern part of the district—in Lawrence County and in the Big Sandy reserve district to the south—the three major coal beds in this part of the stratigraphic section are referred to as Peach Orchard, Torchlight, and Richardson. In the northern part of the district—in Boyd, Carter, and Greenup Counties—the approximate equivalents of these beds are the Princess No. 3 and the Princess No. 4

coal beds, and the Princess No. 5 coal zone. This system of numbered beds represents an adaptation of nomenclature first used by Crandall (1884). Most of the coal beds of the upper part of the Breathitt and Conemaugh formations can be traced throughout the district and are designated Princess Nos. 6 through 10, also after Crandall. There is some doubt, however, about the correlation of Crandall's Princess No. 8 bed in Lawrence County. Phalen (1908) refers to this bed as the No. 9, whereas Hudnall and Pirtle (1949) apparently consider it correlative with the Princess No. 7. Lacking conclusive evidence, this report has tentatively accepted Crandall's correlation.

GEOLOGIC STRUCTURE

Geologic structure governs in a large measure, the areal distribution of the coal-bearing rocks (pls. 4–11, 13, 14). The largest and most important structural feature in the district is the Allegheny synclinorium. The axis of this large, northeastward-plunging downwarp extends from the junction of the Elliott, Carter, and Lawrence County lines in the southwest to the Big Sandy River about 9 miles south of Catlettsburg. Outcrop areas of the Conemaugh formation are restricted mainly to the deepest parts of this basin in the southeastern half of Boyd, northern Lawrence, and southeastern Carter Counties. On the northwest flank of the basin the regional dip is toward the southeast. In most of Carter and Greenup Counties the dip seldom exceeds 50 feet per mile which results in broad outcrop areas of both the Breathitt and Lee formations. In southern Carter County the dip locally increases to about 200 feet per mile and the outcrop areas of the Breathitt rocks are narrower. The dip of beds on the southern flank of the synclinorium in Lawrence County is similar to the northwest flank, but the outcrop areas of the Lee and the lower part of the Breathitt are much more restricted than in the northern part of the district. This is due mainly to the increased thickness of the Breathitt rocks, which tends to offset the effect of the dip of beds on the width of outcrop area.

The south flank of the Allegheny synclinorium is broken in southern Lawrence County by the southwestward-trending Walbridge fault. South of the Allegheny synclinorium there is an eastward-plunging anticline, which is a part of the Paint Creek uplift. The lower part of the Breathitt and the Lee are exposed in southwestern Lawrence County along this uplift.

COAL BEDS OF THE LEE FORMATION

In the Princess reserve district the coal beds of the Lee formation are either too thin (less than 28 inches) or not persistent enough laterally to have any commercial importance. Estimated original

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reserves in these coal beds amount to only 9,690,000 tons, and more than half of this is in beds less than 18 inches thick.

Coal beds are locally present in at least three stratigraphic positions in the Lee formation, but no attempt has been made to correlate them, either within the district or with beds in adjoining districts. The outcrop area of coal beds of the Lee includes a large part of western Carter and Greenup Counties, but places within the area where the beds are thick enough to be included in the reserve estimates are widely scattered (pl. 5). In addition to these places, coal beds of the Lee formation are reported at several places in the westernmost part of the district, but, because their potential tonnage is probably very small, they are not included in the reserve estimate.

COAL BEDS OF THE BREATHITT FORMATION

Reserves have been estimated for 13 coal beds in the Breathitt formation. Of these beds 7 have been or are being commercially mined and the remaining 6 have been worked on a small scale by local residents for domestic fuel.

Coal beds of commercial importance are not equally distributed in the Breathitt formation. Only two beds of commercial importance, the Tom Cooper and Princess No. 3–Peach Orchard, are in the lower part of the Breathitt. The upper half of the formation has five beds which are being or have been commercially mined. These include the Princess No. 4–Torchlight, the Princess No. 5–Richardson, and the Princess No. 6, No. 7, and No. 8 beds. The Princess No. 7 bed, in the upper part of the formation, is the most important.

Coal beds of the Breathitt formation have a very broad outcrop area in the Princess reserve district, including all of Greenup and Carter Counties east of Tygarts Creek, the northwestern half of Boyd, and all of Lawrence County except a very small area in the northernmost part. Outcrops of the economically important coals above the Princess No. 3–Peach Orchard are limited mainly to the area east of the Little Sandy River and Little Fork in Greenup and Carter Counties, and the northern half of Lawrence County. The Princess No. 3–Peach Orchard bed and underlying coals of the Breathitt crop out in Greenup and Carter Counties east of Tygarts Creek and west of Little Sandy and Little Fork, and in southern Lawrence County.

GRASSY(?) COAL BED

The Grassy(?) coal bed, the basal member of the Breathitt formation, is widely distributed in Greenup and Carter Counties but is too thin to have any commercial value. In most of its outcrop area the Grassy bed is less than a foot thick, but in Carter County in the valley of the Little Sandy River the Grassy locally has thicknesses of 16 to 18 inches (pl. 7).

Total original reserves in the Grassy coal bed are estimated at 22,720,000 tons, all in beds less than 18 inches thick. The Grassy has been mined only on a very small scale for domestic use and, therefore, the original reserves estimate is probably only slightly affected by mining losses.

TOM COOPER COAL BED

The Tom Cooper coal bed, also known as the Millers Creek bed, is one of the important commercial coals of the Princess reserve district, ranking fourth in total original reserve tonnage.

The stratigraphic position of the Tom Cooper bed ranges from about 40 feet above the base of the Breathitt formation in the northern part of the district to at least 100 feet above the base in the southern part. The stratigraphic distance to the overlying Fire Clay coal bed is somewhat more consistent, averaging about 135 feet.

Areas of estimated original reserves in the Tom Cooper bed are in central Greenup and Carter Counties and in southwestern Lawrence County (fig. 10). Within these areas the Tom Cooper bed ranges in thickness from 14 to 60 inches, but the areas of relatively thick coal are found only in two general localities. One forms an arcuate band, 1 to 3 miles wide, extending southwestward from the Little Sandy River at the Carter-Greenup County line and terminating about 2½ miles southeast of Olive Hill. Within this area the Tom Cooper averages about 30 inches in thickness. The second area is located in southern Carter County in the valley of Little Fork. Here the bed is mostly beneath drainage; it contains relatively large acreages of coal averaging about 3 feet in thickness.

Estimated original reserves in the Tom Cooper coal bed total 171,350,000 tons, of which 59,330,000 tons is in beds thicker than 28 inches. Much of the thickest coal seems to have been mined out, but a considerable part of the original reserves probably remains in thinner beds. East of the area of estimated reserves, the Tom Cooper bed is below drainage and may, in some places, be thick enough for commercial mining, but available data are not sufficient to include such areas in the present estimate.

GUN CREEK COAL BED

The Gun Creek coal bed is too thin and discontinuous to be of any commercial importance in the Princess reserve district.

It occurs locally about 50 feet below the Fire Clay coal bed where its stratigraphic position is indicated by a bed less than 12 inches thick. In areas of estimated reserves (pl. 9) the Gun Creek bed has a maximum thickness of only 24 inches and an average thickness of about 18 inches. The coal is generally common banded bituminous,

but at one place in south-central Carter County the bed is composed entirely or in part of cannel coal.

Total original reserves in the Gun Creek coal are estimated as 28,610,000 tons, nearly all in the 14- to 28-inch thickness category. Mining has been on a very small scale, usually for domestic use, and a sizable proportion of the original reserves probably remains.

WHITESBURG, FIRE CLAY, AND FIRE CLAY RIDER COAL ZONE

The Whitesburg, Fire Clay, and Fire Clay rider coal beds in the southern part of the Eastern Kentucky coal field are thick enough and are separated by a sufficiently large stratigraphic interval to be considered as separate beds. In the northern part of the Princess reserve district, some outcrops show only one bed in this stratigraphic position and others show 2 or 3 thin beds 1 inch to 4 feet apart. In these outcrops it is generally not possible to determine whether 1, 2, or all 3 of the beds of this zone are represented. In most localities, however, only one bed is thick enough to be included in this reserve study; this bed is assumed to be the Fire Clay coal. In the southern part of the district the intervals between the coals of this zone are greater, and the Whitesburg, Fire Clay, and Fire Clay rider coal beds can be differentiated at many localities.

The outcrop area of the Whitesburg, Fire Clay, and Fire Clay rider coal zone extends through Greenup, central Carter, and southern Lawrence Counties. Areas where the Fire Clay bed is estimated to be more than 14 inches thick are shown on pl. 10. In the northern part of the Princess reserve district the areas in which the Fire Clay bed attains its greatest thickness are along the westernmost limit of the outcrop in Carter County. At these localities the bed ranges in thickness from 28 to 38 inches, but the acreage is small and the bed generally has numerous partings. The following section, measured in a road cut about 4 miles west of Grayson, illustrates the numerous partings characteristic of the bed.

Ft	*in*	*Description*
Top of exposure.		
1+	---	Sandstone.
	½	Weathered coal.
2	0	Clay.
	1	Coal.
	7	Shale.
1	3	Weathered coal.
	5	Clay (some flint clay).
0	7	Bony coal.
2	0	Underclay and siltstone.
1	2	Coal (mostly bony).
	5	Bone.
	7	Bony coal.
	6+	Clay.
Base of exposure.		

In southern Lawrence County the Fire Clay bed is relatively persistent but exceeds 24 inches in thickness at a few localities. The Whitesburg and Fire Clay rider beds also are in parts of this area, but they are usually thinner and less persistent than the Fire Clay. The

following section, measured in a road cut in the southernmost part of Lawrence County about 2 miles west of Levisa Fork and 5 miles north of the Lawrence-Johnson County line, shows the relative position of each of the three coal beds of this zone.

Ft	in	Description
Top of exposure.		
1	0	Coal (Fire Clay Rider).
	4	Clay.
20	0	Siltstone.
1	3	Coal (Fire Clay).
2	0	Shale.
4	0	Sandstone.
4	0	Siltstone.
	9	Coal (Whitesburg).
	4+	Clay.
Base of exposure.		

Total original reserves in the Fire Clay coal bed in the Princess reserve district are estimated at 136,290,000 tons, of which 27,120,000 tons is in beds more than 28 inches thick. Estimated reserves in the Whitesburg and Fire Clay rider coal beds in Lawrence County are 13,610,000 and 18,010,000 tons respectively, all in the 14- to 28-inch thickness category. The coal beds of the Whitesburg, Fire Clay, and Fire Clay rider coal zone currently are not minable in the Princess reserve district, although in some small areas in western Carter County the Fire Clay bed possibly could be worked in small-scale stripping operations. All beds of this zone, however, are useful principally as a source of fuel for domestic use.

PRINCESS NO. 3 AND PEACH ORCHARD COAL BEDS

The Princess No. 3 coal bed, known locally as the Clod seam, the No. 3 Clod, the Hitchens No. 3, or Top Hill seam, is one of the most persistent and widespread coals in Boyd, Greenup, and Carter Counties. In Lawrence County the Peach Orchard coal bed seems to be the approximate stratigraphic equivalent of the Princess No. 3; but because this correlation is uncertain, both names are retained—Princess No. 3 applying in Boyd, Carter, and Greenup Counties and Peach Orchard in Lawrence County.

The Princess No. 3 is about 200 feet above the Grassy(?) coal bed and about 200 feet below the Princess No. 7. These intervals, although slightly variable, are the most consistent in the Breathitt formation. The outcrop area of the Princess No. 3 extends through eastern Greenup County, the adjoining western part of Boyd County, and eastern Carter County (fig. 13). In most of this outcrop area the Princess No. 3 bed is estimated to be at least 14 inches thick and in many localities is at least 24 inches. The coal attains an average thickness of 28 to 30 inches in several scattered areas that range in size from ¼ to 10 square miles. The most important of these is in eastern Greenup County, between the Little Sandy River and East Fork, about 7 miles southeast of the town of Greenup. A second

relatively large area lies between the Little Sandy River and Little Fork in southern Carter County. There are smaller areas of relatively thick coal in the ridge between Tygarts Creek and the Little Sandy River about 7 or 8 miles southwest of Greenup and in the hilltops about 5 miles west of Grayson.

The Princess No. 3 bed is generally made up of common banded bituminous coal with some thin layers of splint and cannel coal. The most characteristic feature of the bed in Greenup and Boyd Counties is a 9- to 12-inch clay (or clod) parting in the middle of the bed. In most of Carter County the clay parting is absent or is not recognizable.

The Princess No. 3 has been mined in almost all of its outcrop area, either in small commercial truck or wagon mines or in smaller openings for domestic fuel. In parts of southern Carter County the bed has been stripped on a very small scale. Most of the commercial operations in 1954 consisted of a few small truck mines and openings for domestic fuel in Greenup County.

Estimated original reserves of the Princess No. 3 bed are 203,070,000 tons, which places the bed in second rank for total tonnage in the entire district. However, most of the tonnage is in relatively thin beds, with only 33,110,000 tons in beds thicker than 28 inches. Although extensive mining has doubtless removed much of this relatively thick coal, sufficient reserves are probably available to carry on small-scale underground operations for many years and, in the extreme western part of the outcrop area, some areas seem to have sufficient acreage to support small-scale stripping operations. Prospects for commercially minable coal in the Princess No. 3 bed, where it is below drainage in Boyd County, are not promising as the bed seems too thin in this direction.

The Peach Orchard coal bed of Lawrence County, like the Princess No. 3, is very widespread in its outcrop areas in the southern and western parts of the county (pl. 11). In northeastern Lawrence County it is below drainage; in the extreme southwestern part, near the Paint Creek uplift, the Peach Orchard bed is absent because of erosion. The stratigraphic interval between the Peach Orchard and overlying and underlying key beds is variable. In the western part of Lawrence County the Peach Orchard is about 130 feet below the Vanport limestone member equivalent, whereas in the southern part of the county the interval is apparently about 250 feet. This larger interval makes the correlation somewhat doubtful. The interval to the underlying Fire Clay bed is more consistent, averaging about 150 feet. In most of the area of estimated reserves, the Peach Orchard ranges from 14 to 26 inches in thickness, but in a few areas the bed is much thicker. The principal one of these areas where the coal ranges from 30 to 60 inches in thickness lies along the Lawrence-

Martin County line. A somewhat smaller area where the bed is about 30 inches thick is about 5 miles east of Blaine. The Peach Orchard bed in most of Lawrence County is split by 1 to 3 partings, 1 to 15 inches thick. The coal is reported to have a low ash content.

The Peach Orchard bed has been mined extensively in the extreme southern part of Lawrence County east of Levisa Fork and, throughout its outcrop area, has been worked on a smaller scale in truck mines and openings for domestic fuel. The largest operations have long been abandoned, but during 1952 and 1953 a small amount of coal was stripped near the site of the old underground workings near Peach Orchard. Operations during 1954 consisted of truck mines and small workings for domestic fuel.

Total estimated original reserves of the Peach Orchard coal bed in Lawrence County are 146,120,000 tons; of this 21,940,000 tons is in beds more than 42 inches thick, 38,070,000 tons in beds ranging from 28 to 42 inches, and 86,110,000 tons in beds ranging from 14 to 28 inches. Much of the coal in beds more than 42 inches thick has been mined or lost in mining, but a considerable tonnage in the thinner beds is probably still intact.

PRINCESS NO. 4 AND TORCHLIGHT COAL BEDS

The Princess No. 4 coal bed is the least persistent of the commercially minable coals in Boyd, Greenup, and Carter Counties. The bed is economically important only because it contains a relatively thick bench of cannel coal in a few places. Because these cannel layers have a very limited areal extent and are widely scattered, a great variety of local names has been applied to the bed. The most common of these are the Hunnewell cannel and the Boghead cannel, named for places where the bed was formerly mined. In Lawrence County, although no correlative of the cannel coal has been previously reported, the Torchlight coal bed occupies a similar stratigraphic position and, like the Princess No. 4, has a limited areal extent. Cannel coal has not been reported from the Torchlight bed. Because the correlation between these two beds is uncertain, they are described as separate coal beds in this report.

The stratigraphic position of the Princess No. 4 bed in Boyd, Carter, and Greenup Counties is generally about 40 feet above the Princess No. 3, but this interval ranges in thickness from 10 to 70 feet. The stratigraphic interval to the overlying Vanport limestone member equivalent is also variable, ranging from 75 to 150 feet. Areas in which the Princess No. 4 bed is estimated to be more than 14 inches thick form a narrow, discontinuous belt extending from the region on either side of the Boyd-Greenup County line through Carter County to the valley of Little Fork at the Carter-Elliott

County line (pl. 13). Three areas contain thick cannel coal deposits: two are in Greenup County, one in Carter. One of the Greenup County localities, known as the Chinn's Branch cannel district, lies between the Ohio River and East Fork about 5½ miles southeast of Greenup. The second Greenup County locality, once the site of the Hunnewell mines, occupies an area of about one square mile about 2 miles due north of the junction of the Boyd, Carter, and Greenup County lines. The third principal area of cannel development, known as the Boghead mines, is in Carter County about 3½ miles due east of Grayson. In the valley of Little Fork near the Carter-Elliott County line, the Princess No. 4 contains a thin bench of cannel coal but, in thickness and extent, the cannel layer is not comparable to that of the other localities. Elsewhere in the outcrop area the Princess No. 4 bed is an ordinary banded bituminous coal, at most localities less than 18 inches thick.

The cannel coal deposits of the Princess No. 4 bed were among the first coal beds to be mined in the Princess reserve district, but commercial operations ceased at least 30 years ago. Since then sporadic attempts have been made to mine the cannel in small truck mines, but these operations seem to have been short lived.

Total original reserves in the Princess No. 4 are estimated at 70,960,000 tons, but a large proportion of this tonnage, particularly in the area of the old cannel mines, has been mined or lost in mining. Some remaining cannel reserves may exist on the fringes of the main deposits, but only in relatively small amounts.

In Lawrence County the Torchlight coal bed, which is the presumed correlative of the Princess No. 4, occupies a stratigraphic position about 100 feet above the Peach Orchard coal bed and about 120 feet below the Vanport limestone member equivalent. The only area of estimated reserves of the Torchlight bed is located about 5 miles southwest of Louisa, principally between Levisa Fork and Blaine Creek. Within this area the Torchlight bed ranges from 30 to 56 inches in thickness but seems to thin rather abruptly in all directions. Elsewhere in Lawrence County, available data indicate that the bed is too thin to contain appreciable reserves. The Torchlight bed contains both soft banded and splint coal as well as many thin bone and shale partings. The coal from this bed is reported to be locally high in ash.

The Torchlight bed has been mined on a large scale on both sides of Levisa Fork 4½ miles south of Louisa; west of Levisa Fork the bed has been worked in small truck mines and openings for domestic fuel. All large-scale operations have been abandoned for many years, but in 1954 there were a few small seasonally operated mines, some for private use and some for local trade.

Original reserves of the Torchlight bed are estimated at 52,510,000 tons, of which 6,030,000 tons is in beds more than 42 inches thick and 18,370,000 tons in beds 28 to 42 inches thick. Of these original estimated reserves a large part of the coal in the thickest category has been mined out in the valley of Levisa Fork but resources in thinner categories probably remain.

PRINCESS NO. 5 COAL ZONE AND THE RICHARDSON COAL BED

In parts of Boyd, Carter, and Greenup Counties, at least three coal beds occur in the 50-foot interval underlying the Vanport limestone member equivalent. This is the approximate position of the No. 5 coal of Crandall (1884), but currently it is not possible to determine to which particular bed Crandall's designation "No. 5" should apply. In order to retain the existing nomenclature, and also to be consistent with the available facts, these three beds are considered as comprising the No. 5 coal zone; where sufficient data are available to distinguish between them, they are designated in ascending order the Princess No. 5, 5A, and 5B. Of the three beds the No. 5 seems to be the most persistent, and at places where only one bed in this zone is present it is assumed to be the No. 5. In Lawrence County the Richardson coal bed occupies a stratigraphic position equivalent to the Princess No. 5 coal zone, but because correlations are uncertain both names are retained in this report.

The Princess No. 5 coal bed in Boyd, Carter, and Greenup Counties occurs 30 to 75 feet below the Vanport equivalent, but the interval is generally about 50 feet. The interval between the No. 5 and the next underlying persistent key bed, the Princess No. 3, ranges from 60 to 120 feet, averaging about 75 feet. The area where the No. 5 bed is estimated to be 14 inches or more in thickness is relatively large and includes part of northwestern Boyd, southeastern Greenup, and eastern Carter Counties (pl. 14). Within this area the bed ranges from 14 to 72 inches in thickness, but localities where the thickness exceeds 28 inches are small—generally less than one or more square miles—and very widely scattered.

The No. 5 coal bed, in most localities, is a banded bituminous coal with a blocky fracture. The coal itself is reported to be a very satisfactory fuel, but in many places the bed has numerous bone, shale, or clay partings ranging in thickness from $\frac{1}{16}$ inch to 15 inches. In most small mines much of this noncoal material is not removed from the mined coal and the product tends to be high in ash.

The Princess No. 5 bed has been worked chiefly in small truck mines and by farmers for domestic fuel. As a rule, however, the development of this bed has been neglected in favor of the overlying Princess No. 7, which is generally thicker, more persistent, and of better quality.

The Princess No. 5 coal ranks third in total original reserves; it has an estimated 191,260,000 tons in all thickness categories, of which 17,110,000 tons is in beds more than 42 inches thick, 72,880,000 tons in beds 28 to 42 inches in thickness, and 101,270,000 tons in beds 14 to 28 inches. Much of the thickest coal has probably been removed by mining, but because most of the large-scale operations have been limited to the Princess No. 7 a relatively large proportion of the original reserves probably is still intact.

The Princess No. 5A coal bed occupies an intermediate stratigraphic position in the 50-foot interval between the No. 5 and the equivalent of the Vanport limestone member. Its outcrop area is practically coincident with that of the underlying Princess No. 5, but the area in which reserves have been estimated is limited mostly to the northwestern quarter of Boyd County. In most of this area the No. 5A ranges in thickness from 14 to 20 inches, but in a small area about 4 miles southwest of Ashland it has a maximum thickness of 35 inches.

The Princess No. 5A bed is not a commercial coal. Total original reserves are only 61,990,000 tons, of which about 9,110,000 tons is in beds more than 28 inches thick. These original reserves, however, are practically intact, as the bed has been worked only at a few places for domestic fuel.

The Princess No. 5B coalbed is the uppermost bed in the Princess No. 5 zone. Its stratigraphic position is a few feet below the Vanport equivalent and within the clay bed that underlies the limestone. The area of estimated reserves is very small, about 2 by 8 miles, lying mostly in northwest Boyd County but extending a short distance into easternmost Greenup County. Within this area the Princess No. 5B bed ranges in thickness from 14 to 26 inches and averages about 16 inches.

Total original reserves in the Princess No. 5B bed are estimated to be 10,110,000 tons, all in beds from 14- to 28-inches in thickness. If the clays beneath the Vanport limestone member equivalent are commercially developed, the No. 5B bed could be removed with the clay and utilized in the manufacture of ceramic products.

The Richardson coal bed of Lawrence County is tentatively correlated with the Princess No. 5 coal zone of Boyd, Greenup, and Carter Counties. Its stratigraphic position is 20 to 30 feet below the Vanport equivalent where this bed is present. The interval between the Richardson and the underlying Peach Orchard bed ranges from 100 feet in western Lawrence County to 225 feet in the southern part of the county. The Richardson bed, one of the least persistent of the commercial coal beds in the Princess reserve district, ranges in thick-

ness from 14 inches to 14 feet within horizontal distances of less than half a mile.

Areas of estimated reserves in the Richardson bed are fairly widespread in Lawrence County (pl. 14), but areas where the coal is more than 42 inches are much more restricted. At two places in northern Lawrence County the bed has a maximum thickness of about 60 inches. About 6 miles south of Louisa, on either side of Levisa Fork, maximum thicknesses range from 40 to 170 inches, and in southern Lawrence County, along the Martin-Johnson County line, the Richardson ranges from 30 to 85 inches in thickness. Directly adjacent to the above localities the thickness ranges from 14 to 36 inches and probably averages about 20 inches.

Coal from the Richardson bed is common banded bituminous with a few thin splint and semicannel partings and is reported to be of good quality. At some places, however, the bed contains many shale and bone partings, and unless they are removed the coal is rather high in ash.

Most of the commercial development of the Richardson coal bed has been in truck mines, although some of the mines in the valley of Levisa Fork were served by rail. West of Levisa Fork, 5 miles southwest of Louisa the bed has been stripped in a small area but these operations have been abandoned for at least 5 years. In 1954 a few small truck mines were operating, and several small openings were seasonally worked for domestic fuel.

Total estimated original reserves in the Richardson bed are 122,900,000 tons, with 30,590,000 tons in beds more than 42 inches thick, 58,550,000 tons in beds 28 to 42 inches, and 33,760,000 tons in beds 14 to 28 inches. A great deal of the original tonnage in beds more than 42 inches thick probably should be considered mined out or lost in mining, as much of the early development of the bed was limited to the areas of greatest thickness. Most of these operations were underground, however, and in the southern part of the county some thick coal probably could be mined by stripping methods.

PRINCESS NO. 6 COAL BED

The Princess No. 6 coal bed, like the underlying Princess No. 5, is a moderately important commercial coal in this district. Its stratigraphic position, 25 feet above the Vanport limestone member equivalent and 40 feet below the Princess No. 7 coal bed, can be easily recognized in most places, as either one or both of these key strata is generally exposed.

Areas of estimated reserves in the Princess No. 6 bed extend from the Ashland-Catlettsburg area in Boyd County northwestward into southeastern Greenup County, then southward to the Carter County

line. In Carter County the reserve areas of the Princess No. 6 bed occupy a belt 2 to 3 miles wide extending from the northeast corner of the county southward to the junction of the Carter, Elliott, and Lawrence County lines. In Lawrence County, areas of estimated reserves are scattered across the northeastern part of the county from the Carter-Elliott County line on the west to the general vicinity of Louisa on the east. Within these areas of estimated reserves the Princess No. 6 coal ranges in thickness from 14 to 46 inches, but 16 or 18 inches is probably average. The Princess No. 6 bed probably is more than 28 inches thick in two areas. The most important of these is an arcuate band ½ to 2 miles wide lying just south of the Ohio River and extending from the Big Sandy River, about 1 mile south of Catlettsburg, to about 4 miles northwest of Ashland. In this area the Princess No. 6 ranges in thickness from 30 to 46 inches. In the second area, in northeastern Carter County in the ridge at the heads of the eastern tributaries of the Little Sandy River, the bed ranges in thickness from 30 to 44 inches.

The coal from the Princess No. 6 bed is a common banded bituminous variety and generally has a pronounced blocky fracture. The bed, where thick enough to be mined, usually has one or two partings 1 to 8 inches thick, but these can be easily removed and the resulting product is reported to be of good quality.

Commercial development of the Princess No. 6 has been in both truck and railroad mines, with the heaviest development in the area just south of Ashland. Many openings also have been made by farmers for domestic fuel. Operations on this bed in 1954 consisted of several domestic mines and a few small commercial truck mines. In most parts of the Princess reserve district the development of the No. 6 coal has generally been neglected in favor of the thicker overlying No. 7 bed, but as the reserves in this thicker bed are depleted the No. 6 may assume greater economic importance.

Total original reserves in the No. 6 bed are estimated to be 143,170,000 tons, with 13,920,000 tons in beds more than 42 inches thick, 55,030,000 tons in beds 28 to 42 inches, and 74,220,000 tons in beds 14 to 28 inches. Remaining reserves are difficult to estimate but, except in the heavily mined Ashland area, a moderately large proportion of the tonnage would seem to be available for future mining. Possibilities of reserve areas of thick coal in southern Boyd County, where the Princess No. 6 is below drainage, are not promising as the coal seems to thin in this area.

PRINCESS NO. 7 COAL BED

The Princess No. 7 is the most important coal bed in the district, accounting for about 30 percent of the original estimated reserves in

beds thicker than 28 inches. In 1954, the Princess No. 7 bed was the source of about 75 percent of the coal produced in the district.

The Princess No. 7 bed lies about 65 feet above the Vanport limestone member equivalent and about 150 feet below the Cambridge limestone member; these intervals seem to be relatively constant. In all four counties in the district, the Princess No. 7 is a very persistent bed, but areas where the coal is thick enough to be included in the reserve estimate are limited mainly to Boyd and Carter Counties (pl. 6). In Greenup County the Princess No. 7 occurs too near the hilltops to have any considerable acreage, and in Lawrence the bed is reported to be thin except in the northwestern part along the Carter County line. In the areas of estimated reserves the Princess No. 7 bed ranges in thickness from 14 to 62 inches; in a very large part of this area it is about 35 inches thick.

The Princess No. 7 coal is common banded and splint; the splint type is more common in the lower part of the bed. Analyses of the coal show considerable variation, particularly in ash and sulfur content. Ash ranges from 1 to 13 percent but generally averages about 4.5 percent, whereas sulfur ranges from less than 1 percent to nearly 4 percent. The Princess No. 7, in most areas, has one or two partings ranging in thickness from 1 to 5 inches.

The roof rock of the Princess No. 7 is either shale or sandstone in the southern part of the reserve area, but in the northwestern part of Boyd County and adjoining parts of Carter and Greenup the coal in many localities is directly overlain by clay which ranges in thickness from 1 to 5 feet. The clay generally forms a treacherous roof in underground operations because it fails without warning. It has been used in some areas for ceramic products.

The Princess No. 7 bed has been extensively developed in the northern part of the district, with operations ranging in size from small openings for domestic fuel to large railroad mines. Most of the larger operations, which were mainly in west-central Boyd and eastern Carter Counties, are now abandoned. Although many of the largest underground operations have apparently reached the extent of their recoverable reserves, several truck mines were in operation in 1954 and many small openings were worked by farmers to obtain fuel for their own use. Since 1950, strip mining along the western half of the outcrop area has assumed major importance; in 1954 it accounted for more than half the total tonnage produced in the area.

Total original reserves in the Princess No. 7 bed are estimated to be 333,710,000 tons, of which 100,300,000 tons is in beds more than 42 inches thick, 172,850,000 tons in beds 28 to 42 inches, and 60,560,000 tons in beds 14 to 28 inches. Remaining recoverable reserves in beds more than 28 inches thick are considerably less than the original

reserves, because a large proportion of the coal suitable for large-scale underground mining apparently has been mined or lost in mining and areas of strippable coal are being rapidly depleted. Possibly the greatest area of untouched reserves in the Princess No. 7 bed are in Boyd County, where the bed is beneath the surface and has not been prospected.

PRINCESS NO. 8 COAL BED

The Princess No. 8 bed is one of the less important commercial coals of the Princess reserve district. Its stratigraphic position is about 45 feet above the Princess No. 7 and 110 feet below the Cambridge limestone member. It is easily located in most places but in a large part of the outcrop area the bed has not been prospected.

In the areas where reserves have been estimated (pl. 5), the Princess No. 8 ranges in thickness from 14 to 58 inches. Although the bed is not laterally persistent, it is thick enough for commercial mining in two areas. The larger of these, in northern Lawrence County, extends westward for about 8 miles from the Big Sandy River near the mouth of Blaine Creek. In this area the thickness of the Princess No. 8 ranges from 24 to 58 inches and averages about 30 inches. A second, smaller area is in central Boyd County about 9 miles south of Ashland. At this locality the coal attains a maximum thickness of 49 inches, but apparently thins to about 25 inches in a distance of less than a mile. In Greenup and Carter Counties there are two or three very small areas where the Princess No. 8 is known to exceed 28 inches in thickness, but these seem to be too small to have more than local importance.

Where the Princess No. 8 bed has been mined, it generally consists of a single bench of soft blocky coal with many very thin bone or clay partings, which are too thin to be removed in most small operations. Although satisfactory in other respects, the coal tends to be high in ash.

Commercial development of the Princess No. 8 coal bed has been by small truck mines and recently by strip mining. In general the No. 8, like the Princess No. 6, has been neglected in favor of the more persistent No. 7 bed.

Total estimated original reserves in the Princess No. 8 are 141,230,000 tons; of this 5,280,000 tons is in beds more than 42 inches thick, 32,950,000 tons in beds 28 to 42 inches, and 103,000,000 tons in beds 14 to 28 inches. Remaining reserves are probably somewhat less than the original, but because most operations have been rather small a considerable proportion of the original reserves are probably available for future development.

COAL BEDS OF THE CONEMAUGH FORMATION

Coal beds of the Conemaugh formation have no commercial importance in the Princess reserve district and have been worked at only a few places for domestic fuel. Only two of the beds, the Princess No. 9 and No. 10, are included in the reserve estimate.

The stratigraphic positions of the Princess No. 9 and No. 10 are about 45 and 10 feet, respectively, below the Cambridge limestone member. The area of reserve estimates of the No. 9 bed is about 10 square miles, about 9 miles south of Ashland in central Boyd County between East Fork and the Big Sandy River. In this area the bed is about 24 to 30 inches thick and contains an estimated 19,440,000 tons of coal.

There are three very small, widely scattered localities in southwestern Boyd and northern Lawrence Counties which contain estimated reserves in the Princess No. 10 bed. The thickness of the coal is reported to be less than 24 inches and the estimated original reserves are only 4,380,000 tons.

PRODUCTION

In the 131-year period between 1824 and 1955 the counties comprising the Princess reserve district produced a recorded total of about 30 million tons of coal. Of this, Boyd County has produced slightly less than 13 million tons and Carter County 12 million tons. Lawrence and Greenup Counties are of lesser importance having produced 3 million and 2 million tons, respectively (table 8).

The earliest production in the Princess reserve district was recorded in Greenup County in 1824. Production began in Boyd and Lawrence Counties in 1838 and in Carter County in 1866. Before 1850, Greenup County was the most important producing county, with a recorded production to that time of about 200,000 tons. In the same period Boyd and Lawrence Counties produced only about 10,000 tons each. Between 1850 and 1890, Boyd County became the leading producer, with the recorded total of about 2 million tons. In the same period, Carter County produced about 1 million tons, whereas the combined total of Greenup and Lawrence Counties was only about 300,000 tons. More recent trends in production and the status of each county are shown on figure 2. For all counties, the three most important periods of recorded production are (1) around 1900; (2) 1914 to 1918, the period of the first World War; and (3) 1940 to 1950, the years of the second World War and postwar prosperity. This latter period of peak production, the most important of the three, can probably be attributed in part to the widespread and relatively recent development of strip-mining methods in this area.

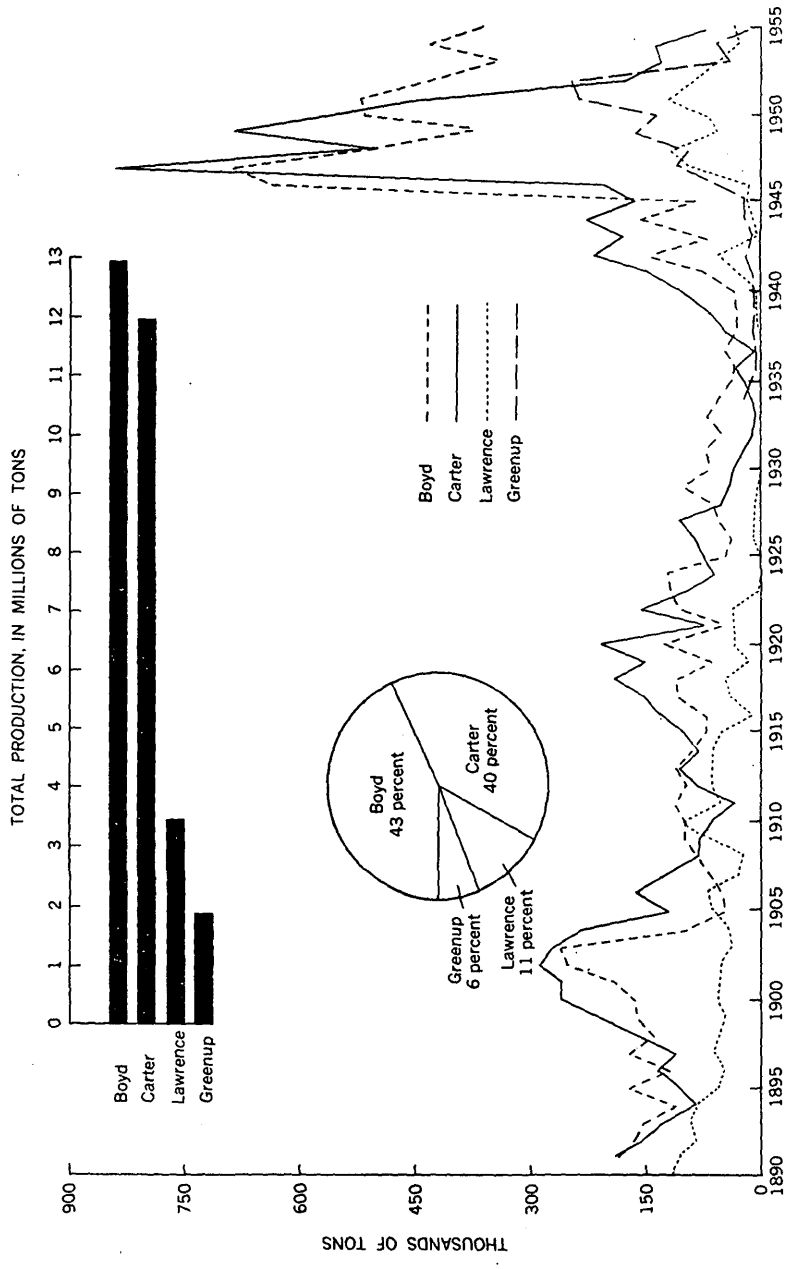

FIGURE 2.—Coal production in the Princess reserve district by county, 1890–1955.

Between 1890 and 1955, Boyd and Carter Counties led in total recorded production, with about 10 million tons each; Lawrence and Greenup Counties were of only minor importance, with a combined total of only 4 million tons.

RESERVE SUMMARY

The Princess reserve district contains an estimated total of 1,915,820,000 tons of original reserves as calculated in tables 5, 6, and 7, or roughly 2 billion tons. About 10 percent of this total is in beds more than 42 inches thick, 30 percent is in beds 28 to 42 inches, and the remaining 60 percent is in beds 14 to 28 inches. The reserves are distributed quite equally according to reliability categories. About 40 percent of the total is classified as measured or indicated, whereas the remaining 60 percent is classified as inferred. About 75 percent of the tonnage in beds more than 42 inches thick is classed as measured and indicated, whereas only 50 percent of the tonnage in the 28- to 42-inch category is classed as measured and indicated. Of the slightly more than one billion tons in the 14- to 28-inch category, only about 30 percent is classed as measured and indicated, and the remaining 70 percent is classed as inferred. The correlation of decrease in reliability with decrease in thickness is due to the fact that more data were available for the thick coal beds, and the estimators assumed rapid thinning of coal beds in inferred areas.

Original reserves are not equally distributed in counties making up the district. Of the total tonnage Carter and Lawrence Counties contain about 30 percent each, Boyd County has slightly less than 25 percent, and Greenup County has only 15 percent. Of the 200 million tons in beds thicker than 42 inches, Carter and Lawrence Counties have about 35 percent each, Boyd County has about 25 percent, and Greenup County only about 5 percent. In terms of tonnage in beds more than 28 inches thick, which is the approximate lower limit for commercial mining at the present time, Carter County contains about 35 percent, Boyd and Lawrence Counties have slightly less than 30 percent each, and Greenup County has about 5 percent.

COAL BEDS OF THE LICKING RIVER RESERVE DISTRICT

By JOHN W. HUDDLE

LOCATION

The Licking River reserve district, an area of about 1,400 square miles, includes all of Elliott, Morgan, Magoffin, and Wolfe Counties, and the coal-bearing parts of Rowan, Menifee, and Powell Counties. A few hills in Montgomery and southeastern Bath Counties are

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capped by coal-bearing rocks but these counties are omitted from consideration because the areas involved are very small and the reserves unknown. The counties included in the Licking River reserve district, except Magoffin County, lie along the western margin of the coal field and their relatively easy access led to the early development of the coal reserves. The West Liberty, Cannel City, and Evanston mining areas lie wholly or partly in the district (pl. 15).

DRAINAGE AND TOPOGRAPHY

The northwestward-flowing major streams that drain the Licking River reserve district cut steep-walled canyons into the Pottsville escarpment along the western margin of the district, broad flat valleys directly upstream from the escarpment, and winding narrow valleys into the plateau uplands near their headwaters. The Licking River, a tributary of the Ohio River, flows northwestward toward Cincinnati and drains most of the district, including Morgan, Magoffin, and Rowan Counties. The Red River, a tributary of the Kentucky River, drains Wolfe and Powell Counties; and the Little Sandy River, flows northward into the Ohio River and drains most of Elliott County. Elevations range from about 700 feet, where the major streams leave the district, to about 1,500 feet in southern Magoffin County. Local relief ranges from 300 to 500 feet.

TRANSPORTATION

Trucks are the principal means of transporting coal to local and distant markets. Main truck routes (pl. 3) are the north-south Kentucky State Route 7, the east-west U.S. 60 and Kentucky State Route 32 in the northern part of the district, U.S. 460 in the central part, and Kentucky State Route 15 in the southern part. Formerly coal was rafted to market on the Licking River but this has been discontinued for many years. Currently the only railroad in the district is a spur-line of the Chesapeake and Ohio Railway, which hauls coal from mines in southern Magoffin County. From 1905 to the early 1930's, three railroads in Morgan, Wolfe, Menifee, and Rowan Counties hauled lumber and coal, but these roads were abandoned when the timber supply was exhausted.

SOURCES OF DATA

Coal reserves of the Licking River district were estimated from information in published reports, company files, and geologic mapping (pl. 2). Reports by Crandall (1910), Browning and Russell (1919), Englund (1955), and Adkison (1957) are the principal published sources of information about the coal reserves. Additional work for use in this report was carried out in selected areas by the

authors and associates. Parts of Powell, Wolfe, Menifee, Morgan, Elliott, and all of Rowan, Bath, and Montgomery Counties had to be omitted from consideration because of lack of information.

STRATIGRAPHY

LEE FORMATION

The Lee formation, of Early Pennsylvanian age, is the older of the two coal-bearing formations in the Licking River reserve district. It ranges in thickness from about 200 feet along the western margin of the district to about 900 feet in southern Magoffin County. The lower part of the Lee differs markedly in lithologic character from the upper part, and on this basis it is divided into two members. The lower member, approximately equivalent to the Beattyville shale of Miller (1917, p. 2), is composed mainly of thin-bedded shale, siltstone, and sandstone. It contains at least three coal beds and, locally in northern Kentucky, it contains a bed of refractory flint clay which is known as the Olive Hill fire clay. The upper member is a massive cliff-forming quartzose sandstone. Both members are absent in places and each has a maximum thickness of about 200 feet in the area of outcrop. The lower member averages about 40 feet in thickness and the upper about 160 feet. The boundary between the Lee and the overlying Breathitt formation is drawn at the top of the cliff-forming sandstone or, where present, at the base of the Zachariah coal, which lies a few feet above the sandstone.

BREATHITT FORMATION

The Breathitt formation, of Middle Pennsylvanian age, directly overlies the Lee formation. Siltstone, shale, and sandstone make up most of the Breathitt formation, and coal, limestone, and underclay a minor part. The top of the formation is eroded and the maximum remaining thickness is about 1,400 feet in southern Magoffin County. Nearly all the coal reserves of the Licking River district are in the Breathitt formation.

COAL BED NAMES AND CORRELATION

The names and sequence of coal beds in the Licking River reserve district are shown in tables 4 and 5 and in figure 3. As is common elsewhere in eastern Kentucky, the same name has been applied to different coal beds, and different names have been applied to the same coal bed. For example, Crandall (1910) and Robinson (1927) confused the Grassy, Tom Cooper, and Gun Creek coal beds at various localities, and they assigned to isolated exposures of these three beds the single name "Van Lear" coal. This was based on the assumption that isolated exposures of the first good coal, 130 to 180

TABLE 5.—*Coal-bed names used in the Licking River reserve district*

Magoffin County Browning and Russell (1919)	Morgan County Kentucky Geological survey Map Robinson and others (1925)	Elliot County Kentucky Geological Survey Map Robinson and others (1928)	Cannel City quadrangle Englund (1955)	White Oak quadrangle Adkison (1957)	Tiptop quadrangle Welch (195-)	Campton quadrangle Briggs (1957)	This report
Hindman	Richardson	Richardson					Richardson—Skyline
Fugate					Hindman (?)		Hindman
Flag rider			} Sebastian	Sebastian	Fugate		Fugate
Flag							
Hazard			Nickell	Nickell	Oakley		Nickell—Oakley
Whitaker	Peach Orchard	Mud Seam	Adele	Index	Prater		Index—Prater—Adele
	Young			Colvin	Upper Haddix		Colvin
Young	Limestone			Haddix	Lower Haddix		Haddix
Trace Fork							Trace Fork

POSITION OF THE MAGOFFIN BEDS OF MORSE (1931)

Haddix				Copland	Upper Hamlin		Copland
Hamlin				Hamlin	Lower Hamlin		Upper Hamlin
Fire Clay rider		Fire Clay rider		Fire Clay rider	Fire Clay rider		Lower Hamlin
Fire Clay	Fire Clay Whitesburg	Fire Clay	Fire Clay	Fire Clay	Fire Clay		Fire Clay rider Fire Clay
Whitesburg							Upper Whitesburg
Gun Creek	Van Lear	Van Lear	Cannel City	Cannel City	Gun Creek		Gun Creek
Ivyton							Ivyton
Tom Cooper			Little Caney	Tom Cooper	Tom Cooper	Little Caney	Tom Cooper
Lacey Creek			Grassy			Grassy	Grassy
Howard	Lower Elkhorn						"Howard"
Wheelersburg	Lily					Zachariah	Zachariah—Wheelersburg
Mine Fork							Mine Fork Beattyville

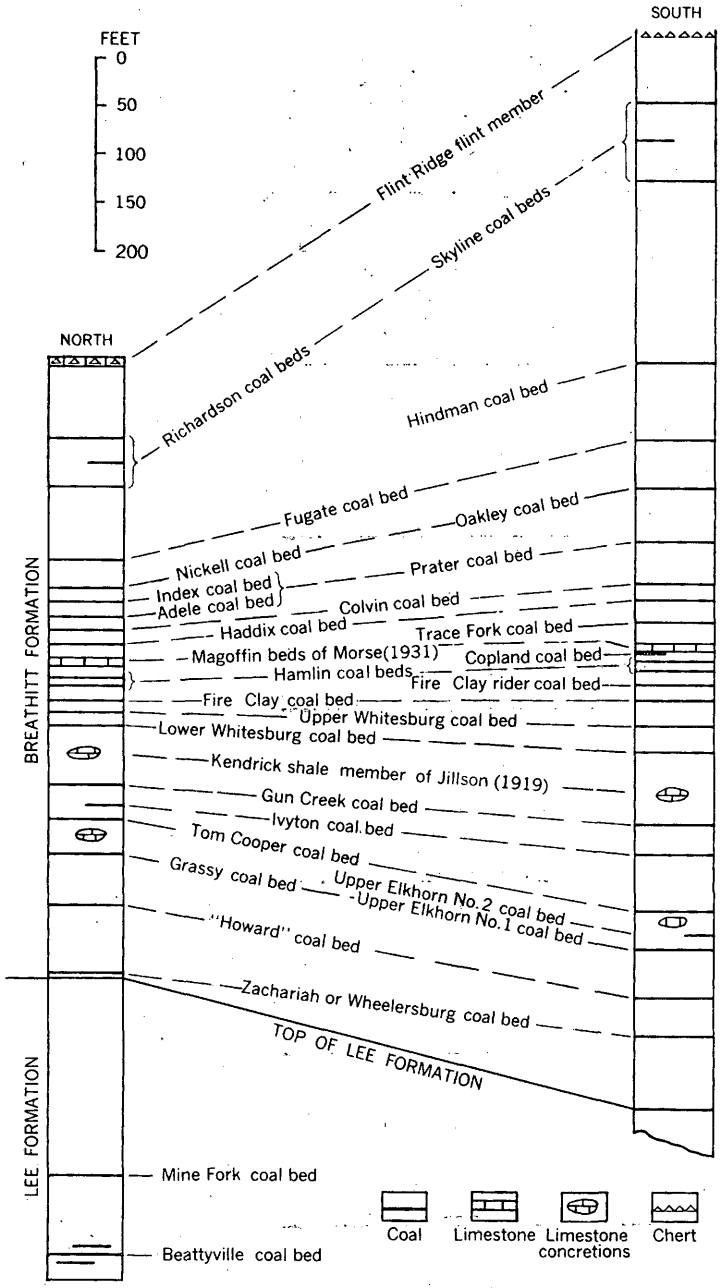


FIGURE 3.—Generalized geologic columns for the Licking River reserve district.

feet above the Lee formation, were all part of a single bed. This error is easily understandable, as the stratigraphic interval to beds above and below is only about 30 feet, which could not be detected in the type of reconnaissance mapping carried out by Crandall and Robinson. Actually all three coal beds—the Grassy, Tom Cooper, and Gun Creek—thicken and thin abruptly and are not consistent. As currently interpreted, the middle of the three coal beds is probably equivalent to the Upper Elkhorn No. 3 (also known as No. 2 and as Van Lear). Nevertheless, to use the information in the older reports it is necessary to distinguish which of the three coals was measured and called "Van Lear." The fact that both the Grassy and the Gun Creek contain cannel coal at many places still leads to misidentification at these localities.

Browning and Russell (1919) were inconsistent in the use of the coal-bed names they proposed in Magoffin County, and only by reference to their generalized section can the intended use of the names be determined. The many stratigraphic sections reported by Browning and Russell are very useful, but the thickening of the rocks southward in the county was not recognized, and some of the errors in correlation were caused by attempting to use intervals of relatively fixed thickness as a basis of correlation.

In the Licking River reserve district the coal beds are thin or absent in many places and thick only in isolated areas. Little prospecting has been done in areas of thin coal, and it is difficult to determine the correlation between isolated areas of thick coal by mapping through unprospected areas. The coal beds are nearly evenly spaced, averaging about 30 feet apart, and the interval between the beds is unusable as a criteron of correlation. Cannel coal is found in five or more beds and the common banded coal lacks distinguishing features.

KEY BEDS

The principal key beds for use in stratigraphic correlation in the Licking River reserve district are the Kendrick shale member of Jillson (1919), Fire Clay coal, and Magoffin beds of Morse (1931).

The Kendrick is characterized by ellipsoidal, silty, calcareous concretions in a shale and siltstone sequence 15 to 40 feet thick. Marine fossils occur locally near the base. The shale is thin or is replaced by other rock types north of the central part of Morgan County.

The Fire Clay coal, with its distinctive flint-clay parting, is a good key bed in the southern part of the district, but it is generally absent north of the center of the Dingus and Cannel City quadrangles. Flint-clay partings are also in the Gun Creek and Prater (or Index) coal beds which have locally been confused with the Fire Clay coal.

Generally the flint clay in the Fire Clay coal can be distinguished from similar partings in the Gun Creek and the Prater (or Index) coal beds on the basis of color and hardness. Flint clay in the Gun Creek coal is darker than that of the Fire Clay coal, and the parting in the Prater (or Index) coal bed is plastic when wet and is softer than that of the Fire Clay. When dry it has many characteristics of the Fire Clay parting, as pointed out by Browning and Russell (1919, p. 37). Flint clay associated with the coal in the Richardson zone and higher coal beds is distinguishable from the Fire Clay parting by its lower stratigraphic position.

The Magoffin beds are the most widely recognized marine bed in eastern Kentucky. They are absent in many localities, owing to nondeposition, subsequent erosion, or lateral gradation. They have a maximum thickness of about 15 feet in northern Morgan County. In the Licking River reserve district, the Magoffin is generally an argillaceous or arenaceous limestone with abundant marine fossils. Spheroidal concretions or lentils of concretionary limestone are common in a zone at the top of the Magoffin. In areas where both the Magoffin beds and the flint clay parting in the Fire Clay coal are absent, the identification of all coal beds is less certain than elsewhere.

GEOLOGIC STRUCTURE

Coal beds and adjacent rocks dip gently southeastward in the Licking River reserve district, except where this gentle dip is broken by faults and associated anticlines in the Irvine-Paint Creek uplift (pl. 4). In the Cannel City and Dingus 15-minute quadrangles, where the continuity of coal beds is broken by faulting or by erosion along the crests of anticlines, the correlation of some coal beds north and south of the structures is uncertain.

Structural uplift and subsequent erosion along the Irvine-Paint Creek axis is responsible for exposures of the Mine Fork coal bed in the Lee formation in eastern Morgan County and in the adjacent part of Johnson County. The stresses causing these structures were not intense enough to increase the rank of the coal or fracture it extensively and only locally is it necessary to take structure into account in planning mining operations.

COAL BEDS OF THE LEE FORMATION

Coal beds of the Lee formation occur in the lower shale member and within the massive cliff-forming sandstone member. There are one to four coal beds in the shale unit, called the Beattyville shale by Miller (1917, p. 2), and at least one in a shale bed in the upper sandstone member. Generally the coal beds are thinner than 14

inches and no reserves were calculated in much of the district, as shown in pl. 5. Correlation of the coals of the Lee formation is uncertain.

COAL BEDS IN THE BEATTYVILLE SHALE MEMBER

The coal beds in the Beattyville shale member below the massive cliff-forming sandstone member in the Licking River reserve district are discontinuous, and satisfactory correlations between them have not been established. For this reason the tonnage in these beds is reported as a single figure, even though it is probable that in isolated patches each of the four coal beds is thicker than 14 inches and was estimated separately.

The thickest coal bed known in the Beattyville shale member is in the northern half of the Frenchburg quadrangle in Menifee County, where Crandall (1910, pl. IV, sec. 1) reports the coal to be 40 inches thick at one locality and about 30 inches at other localities. Probably most of the 73,000 tons of coal reported mined in Menifee County came from these localities. Four analyses given by Crandall (1910, p. 45) show ash ranging from 3 to 7 percent and sulfur less than 2 percent. These analyses are not comparable to post-1913 U.S. Bureau of Mines analyses, because different standards and equipment were used, but they have some qualitative value.

Miller (1910, p. 50–51) reports that a coal in Powell County (his No. 1 or Hudson), below the massive sandstone member, is 17 to 24 inches thick in several places. The original coal reserves in this bed in part of Powell County are estimated as 1,490,000 tons.

Briggs (1957) reports about 2,500 tons of coal reserves in the Campton 7½ minute quadrangle (NE¼ Beattyville 15 minute quadrangle) at this horizon in pockets 14 to 15 inches thick. It was being mined for local use in 1954.

Original coal reserves in the Beattyville shale member coal beds are estimated as 41,140,000 tons in the parts of Elliott, Menifee, Powell, and Wolfe Counties included in this appraisal. Menifee County contains 75 percent of these reserves. Probably there are other areas of coal more than 14 inches thick in the Beattyville shale member; in some of these areas the coal is covered by younger rocks and must be located by drilling and in others the coal can be found by additional geologic mapping.

MINE FORK COAL BED

A coal bed, named the Mine Fork bed by Browning and Russell (1919, p. 27), occurs in a thin shale sequence in the cliff-forming sandstone member in eastern Morgan and Magoffin Counties and in the adjacent part of Johnson County along Mine Fork of Paint Creek.

It has a maximum thickness of 18 inches and, according to Hauser (1953, p. 13), is 93 feet below the top of the Lee formation and is underlain by an additional 300 to 400 feet of sandstone and shale. Estimated coal reserves are small, 12,520,000 tons, but additional reserves might be found by drilling.

A coal at approximately the stratigraphic level of the Mine Fork has been observed in northern Morgan County but wherever observed it has been less than 14 inches thick; thus thickness is not considered in estimating reserves in the Licking River reserve district. The position of the Mine Fork coal in the sandstone member of the Lee formation suggests a correlation with the Barren Fork coal of the Southwestern reserve district.

COAL BEDS OF THE BREATHITT FORMATION

Reserves have been estimated for 18 of the coal beds (or zones) of the Breathitt formation known in the Licking River reserve district; all other coal beds were omitted because they are too thin and irregular to be classed as reserves (fig. 3). All the coal beds have restricted areal distribution, either because they were deposited in limited basins or were removed by erosion after deposition. The coal beds are discussed individually in the following paragraphs beginning with the oldest bed and, in this district, the topographically lowest.

ZACHARIAH AND ZACHARIAH RIDER COAL BEDS

The Zachariah coal bed, at the base of the Breathitt formation, was named by Eyl in 1927. It is probably equivalent to the Lily coal of the Southwestern reserve district, but it is possibly equivalent to an older bed, the Barren Fork. Sporadic distribution (pl. 6) of the Lily, Barren Fork, and Zachariah coal beds makes it difficult to trace them into one another, and the chief basis for correlation is their position at or near the top of the cliff-forming sandstone member of the Lee formation. Locally there is a thin coal bed immediately above the Zachariah which is called the Zachariah rider coal.

Estimated reserves in the Zachariah coal and the Zachariah rider (Briggs, 1957) are confined to the southern part of Wolfe County in the Campton 7½ minute quadrangle (NE¼ Beattyville 15-minute quadrangle). The combined beds range in thickness from less than 14 inches to more than 42 inches. The estimated original reserves in the Zachariah bed and Zachariah rider total 52,880,000 and 1,720,000 tons, respectively. Both beds are mined as a single unit along the western edge of the Campton 7½-minute quadrangle (NE¼ Beattyville 15-minute quadrangle); eastward they split and

the rider lies from 3½ to 50 inches above the main bench; and still farther eastward the rider grades into carbonaceous shale.

Two "as-received analyses," by the U.S. Bureau of Mines, of the Zachariah coal and one analysis of the rider shows the coal to be high-volatile B bituminous, ranging in calorific value from 13,290 to 13,890 Btu and in ash from 3.1 to 3.7 percent in the main bench and as much as 19.1 percent in the rider (Briggs, 1957). One sample of the Zachariah contained 1.8 percent sulfur and another contained 3.1 percent, but a single sample of the rider had 6.4 percent.

Approximately 918,271 tons of coal were mined in Wolfe County between 1880 and 1954. Of this, two-thirds to three-fourths was probably mined by strip methods from the Zachariah bed in 1949 and 1950.

WHEELERSBURG COAL BED

A coal bed named the Wheelersburg by Browning and Russell (1919, p. 27), lies 60 to 90 feet above the top of the conglomeratic sandstone of the Lee formation near Wheelersburg on Mine Fork of Paint Creek in eastern Morgan County. Browning and Russell correlated this bed with the No. 1 coal of the "Old Kentucky Survey," which is presumed to be the Zachariah or Lily coal. At most localities the Wheelersburg coal bed is less than 14 inches thick, but at a few localities near Wheelersburg it is 22 to 28 inches thick. Some reserves probably exist in the bed but the amount is small and was not estimated for this report. The correlation of the Wheelersburg is uncertain, but it may be equivalent to the Zachariah or Lily coal.

"HOWARD" COAL BED

A thin coal bed, about 40 feet above the Wheelersburg coal bed on Mine Fork of Paint Creek in eastern Magoffin County and Morgan County, has been called the "Howard" bed by Browning and Russell (1919, p. 28). This coal is 14 to 24 inches thick at a few places within a small area in Magoffin County, according to Browning and Russell, but information as to thickness and extent of the bed is insufficient for estimating reserves. At other localities in the district a coal bed less than 14 inches thick is present at approximately this horizon but it is not persistent. Probably the "Howard" bed of Browning and Russell is not the same as the coal bed called "Howard" in Clay County nor another coal bed called "Howard" in Bell and Knox Counties. It is at the approximate stratigraphic position of the Lower Elkhorn or Upper Elkhorn No. 1 coal bed and may be equivalent to one of them.

GRASSY AND UPPER ELKHORN NO. 1 COAL BEDS

A thin but widely distributed coal bed 35 to 70 feet above the "Howard" (fig. 3) is named the Grassy bed by Englund (1955, p. 7) and the Lacey Creek bed by Browning and Russell (1919, p. 29). Lacey Creek is the older name but in its type area the Lacey Creek bed is actually the Tom Cooper bed, not the bed Browning and Russell intended to name. The name Grassy seems preferable because of confusion in meaning of the name Lacey Creek. The Grassy bed is less than 14 inches thick in much of the district, but areas of coal ranging in thickness from 14 to 46 inches are present in several quadrangles. These areas of thick coal beds seem to be elongated in a northward direction and they are quite limited in extent. The suggested correlation with the Upper Elkhorn No. 1 bed is uncertain and it may be equivalent either to the Upper Elkhorn No. 2 or to both beds. The distribution of the Grassy coal is shown on the map of the Upper Elkhorn No. 1 (pl. 7) because correlation with this bed seems the most probable. The estimated original coal reserves in the Grassy and Upper Elkhorn No. 1 beds total 233,570,000 tons in the Licking River reserve district. These beds rank fourth in total reserves for the district.

The principal areas of Grassy coal reserves are in the Cannel City, Dingus, and Isonville quadrangles, but the coal is generally less than 14 inches thick outside the area shaded in plate 7. In the Prestonsburg, Bays, and Dingus quadrangles the coal is below drainage and the thickness is unknown. Because of the regional dip, the coal rises westward and is eroded off the tops of the hills in most of the Frenchburg and Morehead quadrangles and in the western half of the Isonville quadrangle, but it remains on a hilltop in the Beattyville quadrangle. Although some coal was mined from the Grassy bed and shipped by railroad between 1905 and 1940, most of the coal remains. Mining was principally by parallel entries extending 100 to 130 feet back from the outcrop.

In most places the Grassy coal is bright-banded high-volatile B bituminous coal, but locally it is a dull splint or cannel coal. An as-received analysis by the U.S. Bureau of Mines of a sample taken by Englund (1955, p. 16) shows 2 percent ash, 0.7 percent sulfur, and a calorific value of 13,300 Btu. At many localities the coal bed is split into two or more benches by shale or underclay partings, and it may grade laterally into cannel coal 12 to 24 inches thick. In some areas the Grassy coal bed has a sandstone roof.

The area of estimated coal reserves in the Grassy bed in southern Magoffin County (pl. 7) is continuous with the Upper Elkhorn No. 1 coal bed in the Big Sandy and Hazard reserve districts. The coal resources estimated for the Grassy bed in southern Magoffin County

are tabulated with the Upper Elkhorn No. 1 coal bed instead of the Grassy coal bed, because here the correlation with the Upper Elkhorn No. 1 is more certain than with the Grassy bed in the northern part of the district. The coal ranges in thickness from less than 14 to as much as 36 inches, and coal thicker than 14 inches surrounds an area of coal thinner than 14 inches.

UPPER ELKHORN NO. 2 COAL BED

In the Licking River reserve district, reserve estimates of the Upper Elkhorn No. 2 coal are limited to the southern tip of Magoffin County. Information for estimating reserves in this bed came from the Hazard and Big Sandy reserve districts, and the coal is described in the reports for these districts. The estimated original reserves in the Upper Elkhorn No. 2 bed in the Licking River resource district total 1,080,000 tons.

TOM COOPER COAL BED

A coal bed 20 to 45 feet above the Grassy coal has been named the Tom Cooper by Browning and Russell (1919, p. 29) and the Little Caney by Englund (1955, p. 7). It is probably equivalent to the Millers Creek or Upper Elkhorn No. 3 of the Big Sandy and Hazard mining districts, the Darby of the Upper Cumberland reserve district, and the Jellico of the Southwestern reserve district. If these several names apply to a single bed, it is the nost persistent and important producing bed in the Eastern Kentucky coal field. In the Licking River reserve district the Tom Cooper coal is thin but persistent. It contains more estimated original reserves than any other bed in the district, a total of 501,090,000 tons, one-third of which is in beds more than 28 inches thick.

As shown on plate 8, the Tom Cooper coal bed crops out in an eastern and a western belt within the Licking River mining district. In the central part of the district—in Bays quadrangle and the western half of the Dingus quadrangle—the coal bed is generally below drainage and its thickness and extent are unknown. Drilling has proved the coal to be thin in some of this area, but reserves of coal more than 14 inches thick undoubtedly exist. In the Prestonsburg quadrangle the maximum thickness is 48 inches. In the eastern half of the Dingus quadrangle the coal is above drainage and the available information indicates a considerable area of coal ranging in thickness from 20 to 33 inches, which tends to be elongated in a northeastern direction. In the northwestern part of the Dingus quadrangle the Tom Cooper coal is less than 14 inches thick in much of the area, and in the rest of the area it is below drainage or unprospected. There is a small area of coal ranging from 14 to 30 inches in thickness in the southwestern part of the Dingus quadrangle. Along the western belt of outcrop

in the Cannel City quadrangle the coal is generally less than 14 inches thick, but coal ranging from 20 to 30 inches in thickness is present in local elongated areas which trend northward or eastward. In the Lee City and Beattyville quadrangles the regional dip raises the coal bed to the hilltops, where an area of about 1 by ½ mile contains coal with a maximum thickness of 59 inches. In the Isonville quadrangle a lens-like body of coal ranging from 14 to 38 inches in thickness has been mined for a number of years and is one of the principal sources of coal in Elliot County.

At most localities the Tom Cooper coal is brightbanded, high-volatile bituminous coal without parting and the bed has a distinctive black shale roof, which contains specimens of Lingulas at many places. The shale ranges from a fissile to a massive, silty shale and from black to medium gray. No analyses of the coal are available.

Production from the beds along the western outcrop belt has been small, confined to some drift mining in the Cannel City quadrangle and to drift and open-pit mining in the Beattyville and Isonville quadrangles. The large commercial operations are confined to southern Magoffin County. There the coal, known as the Upper Elkhorn No. 3, was developed as a result of expansion of mining from the Big Sandy mining district.

IVYTON COAL BED

A thin nonpersistent coal bed about midway stratigraphically between the Tom Cooper and the Gun Creek coal beds was named the Ivyton coal by Browning and Russell (1919, p. 32). In the type area in the Prestonsburg quadrangle the coal has a maximum thickness of 18 inches, and even though it recurs in many sections it is not known to contain lentils of coal extensive enough to constitute reserves as defined in this report.

GUN CREEK COAL BED

The Gun Creek coal bed was named in Magoffin County by Browning and Russell (1919, p. 32). It is called the Cannel City coal in Morgan County by Englund (1955, p. 8), and is known as the Amburgy coal in the Hazard area and the Williamson coal in the Big Sandy reserve district. It lies 25 to 90 feet above the Tom Cooper coal, and the interval increases to the south and east; 40 to 140 feet below the Fire Clay coal, this interval also increases toward the southeast. In spite of the fact that the Gun Creek is one of the persistent coal beds in eastern Kentucky, areas where the coal is thicker than 28 inches are few and relatively small; consequently it is not an important producing bed. Isolated patches of coal thicker than 14 inches occur in Magoffin, Morgan, Wolfe, and Elliott Counties (pl. 9). The maximum observed thickness in these patches is 37

inches. In several of the larger patches the coal ranges in thickness from 28 to 33 inches, and the long dimension of the thicker coal bodies trends toward the north and east. The estimated original reserves in the Gun Creek bed total 212,140,000 tons, of which about 80 percent is in the 14- to 28-inch category, and about 20 percent in the 28- to 42-inch category.

The Gun Creek coal is a bright banded coal at most localities, but locally it contains lentils of cannel coal. The principal production from this bed has been cannel coal in the Cannel City quadrangle and in the Isonville quadrangle near Bruin. Some common banded coal has been produced from this bed in Wolfe and Magoffin Counties. Several benches and splits separated by as much as 5 feet of parting are characteristic of the bed. In the Bays quadrangle the coal bed is 7 to 50 inches thick and contains two to six partings of bone, clay, shale, and siltstone as much as 24 inches thick. A thin flint-clay parting, which occurs near the base of the coal bed at many localities (Browning and Russell, 1919, p. 33), is generally black and hard, with conchoidal fracture. It is easily confused with the flint clay in the Fire Clay coal. A similar flint-clay parting also occurs in the Williamson coal in Pike County, which is here correlated with the Gun Creek.

The roof of the Gun Creek coal bed is shale and siltstone with calcareous concretions, 1 to 5 feet in diameter, and marine fossils. The shale is probably the Kendrick shale member. Englund (1955, p. 16) gives the following as-received analyses, made by the U.S. Bureau of Mines, of the Gun Creek cannel and banded coal in the Cannel City SE quadrangle:

Bureau of Mines laboratory No.	Type of coal	Analysis (percent)					Calorific value (Btu)
		Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	
D77810	Cannel	3.4	42.7	47.7	6.2	0.7	13,690
D77815	Banded	7.5	38.3	48.9	5.3	2.0	12,740

Production in the Cannel City area has essentially ceased, because the cannel coal is largely mined out. Some stripping of outcrop coal and robbing of pillars was done in the period 1950–56.

WHITESBURG COAL ZONE

The Whitesburg coal zone is as much as 40 feet thick at some localities. It contains about five splits and thin stringers of coal at various intervals in the zone. An upper and a lower bed are the principal splits of the Whitesburg coal zone. The lower bed lies 60

to 100 feet above the Gun Creek coal, and 5 to 60 feet below the Fire Clay coal. The interval below the Fire Clay coal thickens from the Cannel City quadrangle (Englund, 1955) to the Prestonsburg quadrangle (Browning and Russell, 1919, p. 33–36). The Upper Whitesburg coal lies 5 to 40 feet below the Fire Clay coal.

The lower bed has been generally recognized and widely correlated as the Whitesburg in the Licking River and Hazard reserve districts, but the upper one is the Whitesburg coal bed at Whitesburg (see Hazard reserve district report). The lower bed is probably the same as the Mills coal of the Southwestern reserve district, and the upper bed has also been named the Little Fire Clay and the Elisha Creek. In this report the most persistent beds of the five splits of coal occurring in this zone are designated the Upper and Lower Whitesburg.

The lower Whitesburg coal bed is more than 14 inches thick in areas in the Isonville, Dingus, Bays, and Paintsville quadrangles along the western side of the reserve district. Most of the reserves are in the 14- to 28-inch category but in a small area a maximum thickness of 65 inches is reported. It has been mined commercially in the Paintsville quadrangle (Hauser, 1953, p. 17). The coal is common, bright to dull banded, and in a few localities cannel coal is present. The Lower Whitesburg coal is easily recognizable in part of the area by hard, black, fissile shale which is the roof of the coal bed. In many places the roof shale contains Lingulas. A massive sandstone is above the black shale in the Dingus and Bays quadrangles, but where this sandstone is absent, shale with several thin coal beds occupies the interval.

Original reserves in the Lower Whitesburg coal bed are estimated as 91,780,000 tons for the Licking River reserve district. Approximately 80 percent of these reserves is in beds 14 to 28 inches in thickness.

The middle and upper splits of the Whitesburg coal are either less than 14 inches thick, or the area where the coal is thicker than 14 inches is too limited to be included in this estimate. The Upper Whitesburg of this report is a persistent split, but it is less than 14 inches thick at most localities and no resources were calculated.

FIRE CLAY COAL BED

The Fire Clay is important as a key bed and as a source of coal production in the Eastern Kentucky coal field. It ranks third in estimated original reserves in the Licking River reserve district. Total original reserves for the district are estimated to be 265,590,000 tons. Throughout most of the district the coal is above drainage, and data are available to estimate the reserves with reasonable assurance. The coal bed is absent in many places but locally irregular

bodies of coal ranging in thickness from 30 to 50 inches are known. The main areas of thicker coal (pl. 10) are in the Prestonsburg, Bays Dingus, Isonville, and Paintsville quadrangles, and these areas are elongated in an eastward or northeastward direction. Thick sandstone in channel-fill deposit is common above the Fire Clay coal, and the coal thickness decreases abruptly in the localities where erosion cut into the coal before the overlying sandstone was deposited.

The Fire Clay is a common banded bituminous coal and includes cannel coal at many localities. The distinctive feature of the bed is the characteristic flint-clay parting, which ranges in thickness from ¼ to 6 inches and averages 3 inches in Magoffin County. The flint-clay parting generally occurs near the base but may be at the top or bottom of the bed. Locally the coal is absent and the flint clay lies in an underclay shale. A dark-brown or chocolate color is characteristic of the flint-clay parting. On weathering the flint clay turns grayish white and the conchoidal fracture causes it to break into sharp chips which persist in the soil and are an aid to prospecting.

A sample of the Fire Clay cannel coal (Adkison, 1957, p. 18) from a locality on Pricey Creek in the Dingus quadrangle in Magoffin County was analyzed by the U.S. Bureau of Mines (laboratory No. D87739) with the following results (as-received):

Moisture	percent	1.4	
Volatile matter	do	42.9	
Fixed carbon	do	34.5	
Ash	percent	21.2	
Calorific value	Btu	11,980	

Another sample of cannel coal, collected by J. E. Johnston and C. Kilburn 1 mile north of Lenox in the Dingus quadrangle in Morgan County, was analyzed by the U.S. Bureau of Mines (laboratory No. D88289) with the following results (as-received):

Moisture	percent	2.5	
Volatile matter	do	46.1	
Fixed carbon	do	35.8	
Ash	percent	15.6	
Calorific value	Btu	12,530	

The Fire Clay coal, where it is common banded, is classified as high-volatile bituminous coal. The following analysis by the U.S. Bureau of Mines (laboratory No. D87740) is given by Adkison (1957, p. 18) for the common banded Fire Clay coal sampled near Harper in the Dingus quadrangle:

Moisture	percent	5.4	
Volatile matter	do	40.0	
Fixed carbon	do	49.0	
Ash	percent	5.6	
Calorific value	Btu	13,090	

Except for the cannel coal produced in the Dingus quadrangle, there was little commercial production from the Fire Clay bed in 1955. The coal in this area has been mined for many years and formerly was shipped by the Morehead and North Fork Railroad (now largely

abandoned). From 1950 to 1955 it was mined in open pits and hauled by truck for household use, mainly within the county. A small lentil of cannel coal in the Fire Clay coal, in the Cannel City quadrangle, has a high ash content.

FIRE CLAY RIDER COAL BED

The Fire Clay rider coal bed occurs sporadically a few inches to about 20 feet above the Fire Clay coal bed, but is absent, or not recognized, in much of the Licking River reserve district. At most exposures it is less than 14 inches thick, but locally in Magoffin County it is 14 to 32 inches thick. Indicated and inferred reserves totaling 3,040,000 tons have been estimated for these areas. Where the flint-clay parting is absent in the Fire Clay coal in the northern part of the district, the recognition of the Fire Clay coal bed and consequently of the Fire Clay rider bed is uncertain.

HAMLIN COAL ZONE

The Hamlin coal zone includes one to five thin coal beds in a zone as much as 20 feet thick. Generally the beds are less than 14 inches thick, but locally two or more of the beds join to form a bed—with thin shale partings—more than 14 inches in thickness. The Hamlin zone is the middle group of several thin coal beds lying in the zone between the Fire Clay coal and the Magoffin beds, where the sequence consists mainly of shale rather than massive sandstone in channel fills. Coals in this zone are named as follows: the bed closest to the Fire Clay is called the Fire Clay rider, several thin beds above are called Hamlin splits, and the coal closest to or immediately underlying the Magoffin beds is called the Copland coal. Naming individual beds depends on the recognition of the two key beds, the Fire Clay coal and the Magoffin beds.

The principal Hamlin coal reserves are in the Prestonsburg quadrangle, where the coal has a maximum thickness of 34 inches in a small area. A similar area in the Bays quadrangle contains coal ranging in thickness from 14 to 33 inches, and one in the Dingus quadrangle contains coal ranging in thickness from 14 to 21 inches. Only 7,640,000 tons of the estimated original reserves of 83,640,000 tons of Hamlin coal is in beds thicker than 28 inches; the remainder is in beds 14 to 28 inches in thickness.

COPLAND COAL BED

The coal bed that is 0 to about 5 feet below the Magoffin beds has been called the Haddix, Limestone, Taylor and Copland coal by various authors. The names "Haddix" and "Limestone" have been used for coal beds both above and below the Magoffin beds. The

type Haddix in the Buckhorn quadrangle, for example, is above the Magoffin. The name Copland, proposed by Morse (1931, p. 296 and 302), is the only name applied exclusively to the coal below the Magoffin beds and it is, therefore, chosen for use in this report. The Copland coal bed is less than 14 inches thick in the Licking River reserve district, and no reserves were estimated. At many localities no coal is present, but there is a non-bedded claystone with abundant fossil rootlets a few inches to a few feet below the Magoffin beds.

TRACE FORK COAL BED

Above the Magoffin beds and below the Index coal there are at at least three thin discontinuous coal beds, which locally are thicker than 14 inches. Common practice has been to call the thickest of these coal beds the Haddix regardless of its position. Browning and Russell (1919, p. 44–47) named these beds the Trace Fork, Upper and Lower splits of the Young, and in places the Whitaker. Adkison (1957, p. 11) named a thick coal in this zone the Colvin.

The lowest, or Trace Fork coal, 10 to 20 feet above the Magoffin beds, occurs sporadically and its position is occupied by channel-fill sandstone at many localities. Available information indicates that the coal is generally less than 14 inches thick and no reserves were estimated.

HADDIX COAL BED

The Haddix coal bed lies between 25 and 50 feet above the Magoffin beds. In the Licking River reserve district it is generally less than 14 inches thick, but in parts of Morgan and Magoffin Counties the bed ranges between 14 and 30 inches in thickness, and indicated and inferred original reserves are estimated to be 7,300,000 tons.

COLVIN COAL BED

The Colvin bed, which lies 35 to 60 feet above the Magoffin beds, is locally thick enough to contain estimable reserves. The principal area, described by Adkison (1957, p. 17–19), is in the Dingus quadrangle, where an eastward-trending elongate body of coal, ranging in thickness from 14 to 55 inches, is mined for household use. In the northwest corner of the Bays quadrangle there is an area of 4 square miles of coal as much as 45 inches thick in places. Elsewhere the Colvin is represented by stringers, less than 1 inch thick, in sandstone. Generally the coal is common banded but locally it is a cannel coal. Possibly other areas of coal exist, but there is insufficient information to estimate reserves. Total estimated original reserves are 12,880,000 tons in beds 14 to 42 inches in thickness.

HAZARD COAL ZONE: ADELE, INDEX, AND PRATER COAL BEDS

The coal beds in the Hazard zone, 55 to 100 feet above the Magoffin beds, are widespread; and several names, including Prater, Index, Adele, Whitaker, and Young, have been used in the Licking River reserve district by various authors for coal beds in this zone. The exact correlation of these named beds is uncertain; consequently, the number of beds and thickness of the zone is unknown. The names Adele, Index, and Prater are all used in this report. Total estimated original reserves in the Prater, Index, and Adele beds is 330,260,000 tons, and the zone ranks second in original reserves in the district. Individual beds range in thickness from a few inches to 68 inches. Beds are absent, owing to erosion shortly after deposition in some localities and to nondeposition in others. Coal splits in this zone are separated by 20 to 30 feet in some places. As shown in plate 11, the Hazard is one of the persistent zones in eastern Kentucky. It is recognizable at many localities by the presence of a soft "flint" clay parting in the Hazard coal. In the Cannel City quadrangle, the parting is a true flint clay which looks very much like the parting in the Fire Clay coal, and the coal has been miscorrelated by several authors.

The coal is common banded, bright to dull, and cannel coal is not reported at this horizon. In some areas, notably in the Cannel City and Dingus quadrangles, the coal is overlain by a black silty shale with Lingulas or in places by a shale which has a cannellike fracture and appearance. Pyritic lenses and nodules are common in the Prater coal bed in the Bays quadrangle.

Englund (1955, p. 11) named a split in the Hazard zone "Adele coal" for convenience in discussing the reserves of the Cannel City quadrangle. The Adele is generally less than 14 inches thick but a lenslike body of this coal, with a maximum thickness of 40 inches, contains reserves of 1,600,000 tons.

In the northeastern part of Cannel City quadrangle the Index coal is present only in small areas on hilltops. The coal has a maximum thickness of 44 inches and has been mined intermittently for many years. The percentage of depletion is not determinable from available records, but may be considerable. In the Isonville quadrangle the Index coal is near the top of the hills, and information as to the thickness and continuity of the bed is meager. Most of the 5,470,000 tons of estimated reserves is inferred coal in the 28- to 42-inch category.

The main areas of reserves in the Prater coal are in the Bays and Prestonsburg quadrangles, where the coal occurs low enough in the hills to underlie extensive areas. The thicker parts of the bed have an eastward trend and the thickness ranges from 14 to 69 inches in the area estimated. In parts of the Bays and Dingus quadrangles the

coal either is high on the hill, and the thickness unknown, or has been removed by erosion from the hilltops. In the northern half of the Dingus quadrangle the coal is widespread. A maximum thickness of 34 inches is reported but most of the reserves are in the 14- to 28-inch category; in part of the quadrangle the coal is less than 14 inches thick.

A sample of the Prater coal, collected by M. J. Bergin and E. J. Lyons from the Davis mine in the Bays quadrangle and analyzed by the U.S. Bureau of Mines (laboratory No. E–40284), is classified as high-volatile A bituminous and shows the following composition (as-received):

Moisture	4.5	Ash	9.1
Volatile matter	35.6	Sulfur	0.8
Fixed carbon	50.8	Calorific value	12,760

A sample of the Index coal, collected by K. J. Englund and J. E. Johnston near Index in the Cannel City quadrangle and analyzed by the U.S. Bureau of Mines (laboratory No. D–87743), is classified as high-volatile B bituminous and shows the following composition (as-received):

Moisture	7.6	Ash	5.7
Volatile matter	37.4	Sulfur	0.7
Fixed carbon	49.3	Calorific	12,640

OAKLEY AND NICKELL COAL BEDS

Two coal beds at approximately the same stratigraphic horizon, about 100 to 150 feet above the Magoffin beds, are called the Oakley bed in the Prestonsburg and Bays quadrangles and the Nickell bed in the Dingus, Cannel City and Isonville quadrangles. The Nickell and the Oakley coals may be the same bed but the correlation is uncertain. They are also correlated with the Flag bed as described in the U.S. Bureau of Mines report on Knott County and with the Hazard No. 7 bed of the Hazard reserve district.

Browning and Russell (1919) examined the Oakley coal, but they called it the Hazard bed in some areas and the Flag bed in others. As shown in plate 12, this coal zone is a persistent one. It is less than 14 inches thick in much of the district, but locally may thicken rapidly. The estimated original reserves in the Oakley bed are 157,270,000 tons. The principal reserves are in the Prestonsburg and in the Bays quadrangles, where the coal is present in the ridge along the Breathitt-Magoffin and Magoffin-Morgan County lines. Generally the areas of thick coal are elongated in a northerly or northeasterly direction, but in the Bays and Prestonsburg quadrangles the thick areas of Oakley coal trend northwestward. Maximum thickness in the district is 56 inches in the northeastern part of the quadrangle.

Estimated original reserves in the Nickell bed are 9,650,000 tons. The coal has a maximum thickness of 33 inches in the southern part of the Dingus quadrangle. In the northern part of the Dingus, in the Isonville, and in most of the Cannel City quadrangles, this coal bed is present only in the highest hills. It has not been prospected and, even though local exposures of coal bloom show that the bed is present, reserves cannot be estimated. The area is small and, consequently, the reserves are small.

In most of the area the Oakley and Nickell beds are composed of common banded bright coal, but locally, especially in the northwestern part of the Bays quadrangle, the upper bench is a dull attrital coal approaching a cannel coal. In the southwestern part of the Dingus quadrangle there is a lentil of cannel coal, locally known as the "Gas Cannel," which has an average thickness of 22 inches and a maximum of 28 inches. Cannel coal has not been reported in this zone elsewhere in the Licking River reserve district. Partings ranging from a fraction of an inch to a maximum of 12 inches are common.

The following analyses of the Oakley and Nickell coals have been made, on an as-received basis, by the U.S. Bureau of Mines:

	1	2	3		1	2	3
Moisture.....percent..	4.8	2.3	4.8	Ash.....percent..	6.5	13.8	13,130
Volatile matter....do....	37.6	45.8	44.5	Sulfur.....do....	.9	1.6	3.6
Fixed carbon.....do....	51.1	38.1	44.8	Calorific value.....Btu..	13,100	13,070	13,130

1. High-volatile A bituminous coal sampled by Bergin and Lyons near Guage in the Bays quadrangle, Breathitt County. U.S. Bureau of Mines laboratory No. E-40283.
2. Cannel coal sampled at the Reed Mine in the Dingus quadrangle, Morgan County (Adkison, 1957, p. 18). U.S. Bureau of Mines laboratory No. D-87748.
3. High-volatile A bituminous coal sampled near Adele in the Cannel City quandrangle, Morgan County (Englund, 1955, p. 16). U.S. Bureau of Mines laboratory No. D-77814.

FUGATE COAL BED

A coal bed above the Oakley and Nickell coals and below the Hindman coal is called the Fugate bed in southern Magoffin County and the Sebastian bed in Morgan County (Englund, 1955, p. 11; Welch, 1958, p. 596–597; Adkison, 1957, p. 13). The Fugate and Sebastian beds are certainly in the same zone and are probably the same bed. The name Fugate has priority and is used in this report. The coal bed lies 150 to 200 feet above the Magoffin beds, or 180 to 290 feet above the Fire Clay coal. It is probably the same as the coal in Magoffin County called the Flag bed at many localities and the Fugate bed at others by Browning and Russell (1919) and the same as the Hazard No. 8 or Francis bed in the Hazard reserve district. Throughout the Licking River reserve district the bed crops out high in the hills, and the area underlain by coal is relatively small. The

principal areas of reserves (pl. 13) are in the Prestonsburg quadrangle, where an eastward-trending body of coal, ranging in thickness from 28 to 51 inches, extends across the southern part of the quadrangle and thins to less than 14 inches in the northern half of the quadrangle. Another area of estimated reserves, mainly in the 14- to 28-inch category, lies in the Cannel City and Dingus quadrangles. Coal is present on one hilltop in the Isonville and at three localities in the Bays quadrangles.

The Fugate coal bed is characterized by a parting ranging in thickness from a fraction of an inch to a foot or more, which is near the middle of the bed and is composed of shale with abundant rootlets. The upper bench of coal is parted or laminated at many localities, and is a dull, relatively high ash coal. The lower bench is generally a dull to moderately bright banded bituminous coal. The roof at many localities is a cliff-forming sandstone, which Browning and Russell (1919, p. 15) called the "High Rock sandstone."

Total estimated original reserves in the Fugate coal are 70,850,000 tons, about one-half in beds 14 to 28 inches thick and about one-sixth in beds more than 42 inches thick.

Analyses by the U.S. Bureau of Mines of samples, reported by Englund (1955, p. 16) and Adkison (1957, p. 18), show the coal to be of high-volatile B bituminous rank. On an as-received basis the analyses are as follows:

	1	2	3		1	2	3
Moisture.....percent..	8.2	5.4	7.4	Ash.....percent..	12.9	9.4	8.3
Volatile matter....do....	35.8	38.1	35.5	Sulfur.....do....	2.5	2.7	.6
Fixed carbon.....do....	43.1	47.1	48.8	Calorific value.....Btu..	11,360	12,470	12,350

1. Sampled near Adele in the Cannel City SE quadrangle, Morgan County. U.S. Bureau of Mines laboratory No. D-77811.
2. Sampled at head of State Road Fork in the Cannel City SE quadrangle, Morgan County. U.S. Bureau of Mines laboratory No. D-77813.
3. Sampled in a strip mine near Stacy Fork in the Dingus SW quadrangle, Morgan County. U.S. Bureau of Mines laboratory No. D-87746.

Only small mines have operated in this bed and the original reserves are intact.

HINDMAN(?) COAL BED

A coal bed approximately 50 feet above the Fugate coal bed in the northwestern part of the Licking River reserve district and 90 feet above the Fugate in the southeastern part of the district is tentatively correlated with the Hindman coal of the Hazard reserve district. The principal area in which reserves were estimated lies in the western half of the Prestonsburg quadrangle, where the coal bed caps the highest ridges. Thicknesses ranging from 41 to 65 inches are reported in 10 localities. In the Bays quadrangle, a high coal along the ridge between Magoffin and Breathitt Counties is reported to be 36 and 16

inches thick at two isolated localities. At these localities the coal is weathered and contains partings of shale with abundant pyrite. In southern Magoffin County, Browning and Russell (1919, p. 55) report that the Hindman(?) coal (as the Fugate coal) ranges in thickness from 42 to 55 inches, excluding a shale parting ranging from 1 to 19½ inches in thickness. The roof is generally a sandstone, but in places it is a sandy shale. No analyses are available. The estimated original reserves are small, about 12,840,000 tons, but the bed is for the most part unexploited.

SKYLINE AND RICHARDSON COAL BEDS

A coal bed cropping out near the hilltops is called the Skyline bed in the southern part of Magoffin County (Welch, 1958, p. 598) and the Richardson bed in Morgan and Elliott Counties (fig. 16). At the type section of the Skyline coal, three or more splits of coal join to form a bed as much as 19 feet thick in places. Away from the type area the uppermost and lowermost splits of the Skyline are separated by as much as 70 feet of shale and sandstone. Estimated original reserves of the Skyline coal totaling 11,640,000 tons are present in the Bays quadrangle along the ridge between Magoffin and Breathitt Counties, where the bed has been exhausted locally by extensive stripping, augering, and underground mining. The coal ranges from 30 to 165 inches in thickness and includes a number of partings of shale and bone.

The Richardson coal bed, like the Skyline, consists of at least three splits, any one of which may be thick locally. The correlation of these splits is uncertain even in the same quadrangle and as the Richardson coal is doubtfully correlated with the Skyline coal, both names are used in this report.

Reserves in the Richardson coal bed, are estimated in the Dingus and Isonville quadrangles, where the bed caps the highest hills and ranges in thickness from 42 to 94 inches. It has been mined underground and by contour stripping but considerable reserves remain. Original reserves are estimated as 18,600,000 tons.

The coal bed reported by Fieldner and others (1944) as the Hindman bed at the Tiptop mine is from the Skyline bed. Analyses by the U.S. Bureau of Mines show the coal in the Skyline bed to be of high-volatile B bituminous rank. Other analyses, also by the U.S. Bureau of Mines, are given by Welch (1958, p. 602) and in the Hazard reserve district report.

PRINCESS NO. 6 AND NO. 7 COAL BEDS

Original reserves of the Princess No. 6 and No. 7 coal beds, reported for the Licking River reserve district, lie along the Elliott-Carter County line. All of the estimated coal, 1,660,000 and 1,250,000 tons

for the No. 6 and No. 7 beds, respectively, is inferred and in thin beds. Information for estimating these reserves came from the Princess district, and the two coal beds are discussed in the report on that district.

PRODUCTION

Recorded coal production from the Licking River reserve district between 1838 and 1900 was 173,795 tons, all of which was mined in Morgan and Menifee Counties (table 4). This is a small amount compared to the post-1900 production from the same counties and to the amount, nearly 9 million tons, which has been mined in the district since 1900. Morgan was the principal producing county between 1901 and 1933 (fig. 4). Most of the coal mined during this period was cannel, and about 40 percent of the 1934–56 production also was cannel coal. A total of about 1.5 million tons of cannel coal was mined, and the remaining production, in Morgan County and the rest of the district, was common banded bituminous coal amounting to about 7.5 million tons.

Relatively few mines produced most of the coal in the district, and they were responsible for many of the production peaks shown in figure 4. The 1926–27 peak production in Magoffin County came from two mines and most of the post-1933 production came from a single mine, except during 1947 when 785,859 tons of coal was produced by many small mines. Production peaks in Morgan, Wolfe, and Elliott Counties between 1946 and 1955 were mainly the result of the short-term operation of a few open-pit mines.

RESERVE SUMMARY

Original coal reserves of the Licking River reserve district are estimated as 2,173,340,000 tons, but only 702,670,000 tons are in beds more than 28 inches thick. Tables 9, 10, and 11 show the reserves by county, bed, thickness, and reliability categories. About 4 percent of the coal reserves of the district are in beds more than 42 inches thick, 28 percent in beds 28 to 42 inches thick, and 68 percent in beds 14 to 28 inches thick. Of the total reserves of the district, about 13 percent are classified as measured, 47 percent as indicated, and 40 percent as inferred. Estimated coal reserves in beds thicker than 42 inches are classified as 30 percent measured, 60 percent indicated, and 10 percent inferred. In the thickness category of 28 to 42 inches, 13 percent of the total is measured, 52 percent is indicated, and 35 percent is inferred. Coal in beds 14 to 28 inches thick is classified as 12 percent measured, 44 percent indicated, and 44 percent inferred.

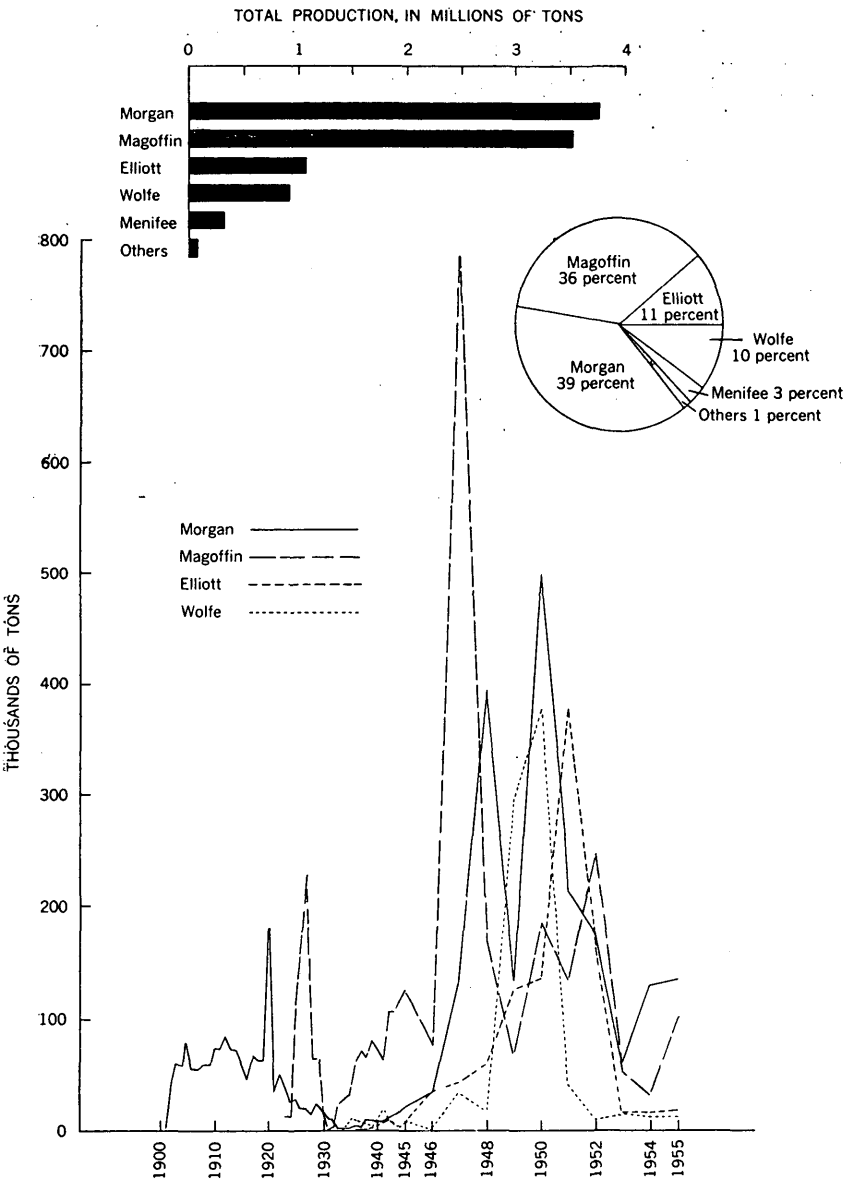


FIGURE 4.—Coal production in the Licking River reserve district by county, 1900-1955.

Magoffin County has more than half (52 percent) of the estimated original reserves in the Licking River reserve district and 75 percent of the coal more than 42 inches thick. Ranked by percentage of total estimated original reserves, the other counties in the district are as follows: Morgan, 22 percent; Elliott, 14 percent; Wolfe, 10 percent; Menifee, 1.4 percent; Powell, 0.2 percent; and Rowan,

0 percent. The counties have the same relative position and roughly the same percentages if they are ranked on the percentage of total original coal reserves in the district in beds more than 28 inches thick.

The development of coal reserves of the district is limited by the general lack of large reserves within a small area, railroad transportation, and local market for large quantities of coal. Commercial production in 1955 came from truck mines producing coal primarily for local consumption and to one railroad mine in southern Magoffin County.

COAL BEDS OF THE BIG SANDY RESERVE DISTRICT

By Leonard D. Harris

LOCATION

The Big Sandy reserve district is situated along the east-central border of eastern Kentucky and includes Martin, Johnson, Floyd, and Pike Counties (pl. 1). This district encompasses an area of 1,613 square miles; of which 227 square miles are in Martin County, 268 square miles in Johnson County, 339 square miles in Floyd County, and 779 square miles in Pike County.

DRAINAGE AND TOPOGRAPHY

The Big Sandy reserve district, which lies in the Appalachian Plateau, is highly dissected and the topography in general is characterized by V-shaped valleys separated by narrow sinuous ridges with moderately steep slopes. The northern part of the district, with an average relief of about 400 feet in Martin and Johnson Counties, is more subdued than the central and southern parts of the district in Floyd and Pike Counties, where the topography is more rugged and the average relief is approximately 800 feet.

The district lies completely within the Big Sandy River drainage area. Two main tributaries of the Big Sandy River drain the area; Tug Fork, located along the northeast border of the district, and Levisa Fork, which flows northward from southern Pike County across northeastern Floyd County and through the central part of Johnson County.

TRANSPORTATION

The Chesapeake and Ohio Railway, the Norfolk and Western Railroad, and the Carolina, Clinchfield, and Ohio Railway (pl. 3) are the principal means of coal transportation out of the Big Sandy reserve district. Branch lines of the Norfolk and Western serve south-central and eastern Pike County. The Carolina, Clinchfield, and Ohio Railway has a branch line a short distance up Russell Fork in southern

Pike County; and the Chesapeake and Ohio has a branch line that serves western Pike, Floyd, and Johnson Counties.

Three principal highways that link the secondary roads throughout the Big Sandy reserve district are U.S. 460 and U.S. 23, which serve Johnson, Floyd, and western and southern Pike Counties; and U.S. 119, which serves northeastern Pike County.

SOURCES OF DATA

This report presents a summary of data previously published on separate areas within the Big Sandy reserve district (pl. 2), supplemented by U.S. Geological Survey field work in Martin and eastern Johnson Counties. Measured and indicated reserves for Pike and Floyd Counties are based on reports by Hunt and others (1937) and by Dowd and others (1951a and 1951b). Inferred reserves for Pike and Floyd Counties were calculated by members of the U.S. Geological Survey using information obtained from published reports, coal companies, and mining engineers. Reserves in the western two-thirds of Johnson County have been calculated from information contained in a report on the Paintsville quadrangle by Hauser (1953). E. J. Lyons completed the fieldwork and prepared coal-bed maps for most of Martin County, and H. L. Smith did the fieldwork and coal-bed maps for that part of Martin County included in northeastern part of the Inez quadrangle. Fieldwork and compilation of coal-bed maps for the part of eastern Johnson County included in the western half Inez quadrangle was done by L. D. Harris.

STRATIGRAPHY

Rocks cropping out in the Big Sandy reserve district are, for the most part, confined to the Pennsylvania system. Mississippian and possibly Devonian rocks crop out in a small area along the western slope of Pine Mountain on the extreme southern border of Pike County.

The Pennsylvanian system in the district is divided into the Lee and Breathitt formations. Massive sandstone constitutes the main rock type of the Lee, but in contrast, the Breathitt is composed primarily of shale and siltstone with a smaller amount of massive sandstone and a few calcareous beds or zones. Lee outcrops are confined to the northwest part of Johnson County and the extreme southwest part of Pike County; the rest of the district is underlain by the Breathitt formation. The Lee and Breathitt formations thicken to the south. The interval from the base of the Lee to the Peach Orchard coal bed of the Breathitt formation is about 900 feet in Johnson and Martin Counties, but in southern Floyd and Pike Counties this interval increases to approximately 3,000 feet.

The marked southward thickening of the formations introduced many problems involving coal-bed correlation as the work progressed. A tentative solution to those problems was arrived at by analysis of the available core-hole logs and measured sections within the Big Sandy reserve district, and by control gained from correlation of coals around the perimeter of the district with those of other districts. In general, the correlations in Martin, Johnson, Floyd, and southern Pike Counties are good, but in northern Pike County, where control is limited, the correlations are tentative. More detailed field work is needed in the Big Sandy reserve district before correlation problems can be solved.

LEE FORMATION

In the Big Sandy reserve district the Lee formation is mainly in the subsurface, and little information is available concerning the contained coal beds. Only the upper part of the formation is exposed in the western part of Johnson County; however, subsurface information published by Hauser (1953, p. 12) indicates that the Lee in Johnson County is from 400 to 500 feet thick. In southern Pike County along Pine Mountain it increases in thickness to about 800 feet (Hinds, 1918, p. 13). Reserves have been calculated for only one coal bed, the Mine Fork, in the Lee formation in the Big Sandy reserve district.

BREATHITT FORMATION

The Breathitt formation crops out extensively in the Big Sandy reserve district, and is absent only in the outcrop areas of the Lee formation in western Johnson and southern Pike Counties. It contains 21 named coal beds for which reserves have been calculated. In the Big Sandy reserve district there are two stratigraphic marker zones that are of local significance and one that is of regional significance. These markers are the Kendrick shale member, the Fire Clay coal, and the Magoffin beds of Morse (1931) (fig. 5). The Kendrick shale member of Jillson (1919), containing large calcareous concretions, is found in the lower part of the Breathitt and is most important as a marker in Johnson and central Floyd Counties. The Fire Clay coal, which occurs near the middle of the Breathitt, is important in Floyd County where it generally contains a flint-clay parting about 3 inches thick (Dowd and others, 1951b, p. 9). The Magoffin beds, which lie 60 to 190 feet above the Fire Clay coal, is the only one of the three markers that has regional significance. The Magoffin has been reported in Johnson County by Hauser (1953, p. 18) and in Floyd and Pike Counties under the description of the Winifrede coal by Dowd and others (1951a, p. 18; 1951b, p. 9).

The total thickness of the Breathitt is not present anywhere in the district. Even so, a comparison of the interval from the base of the

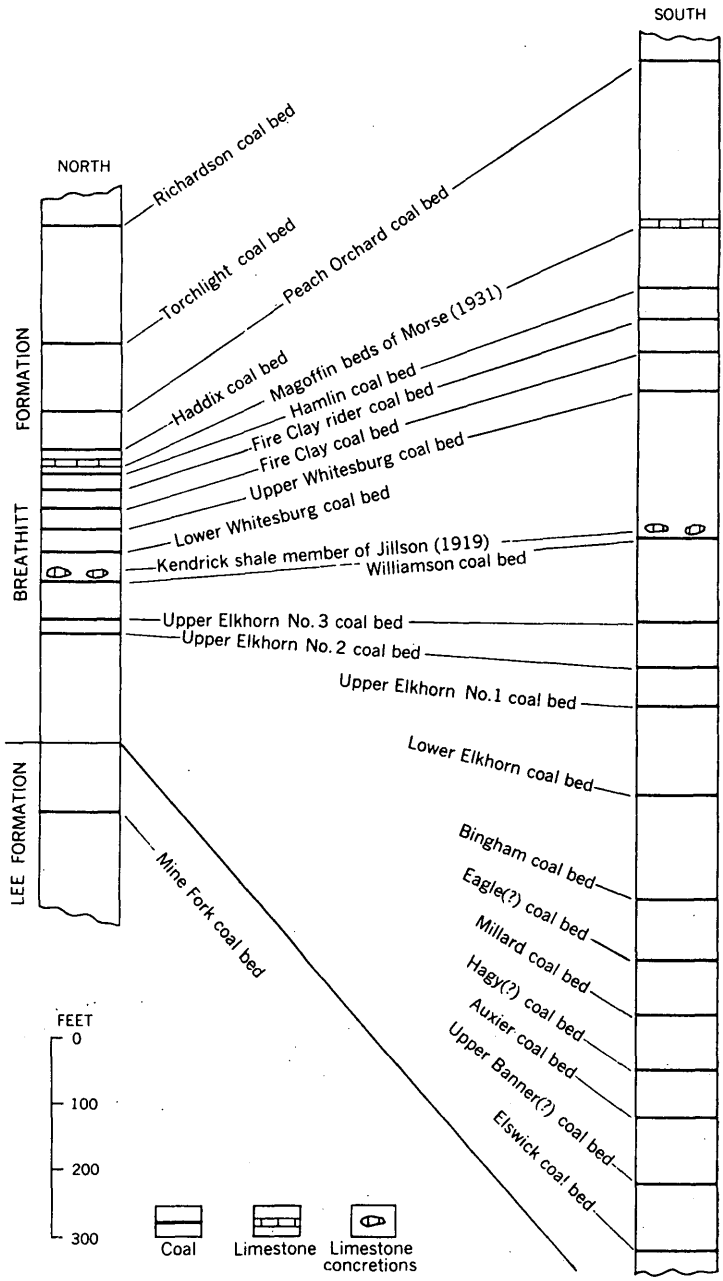


FIGURE 5.—Generalized geologic columns for the Big Sandy reserve district.

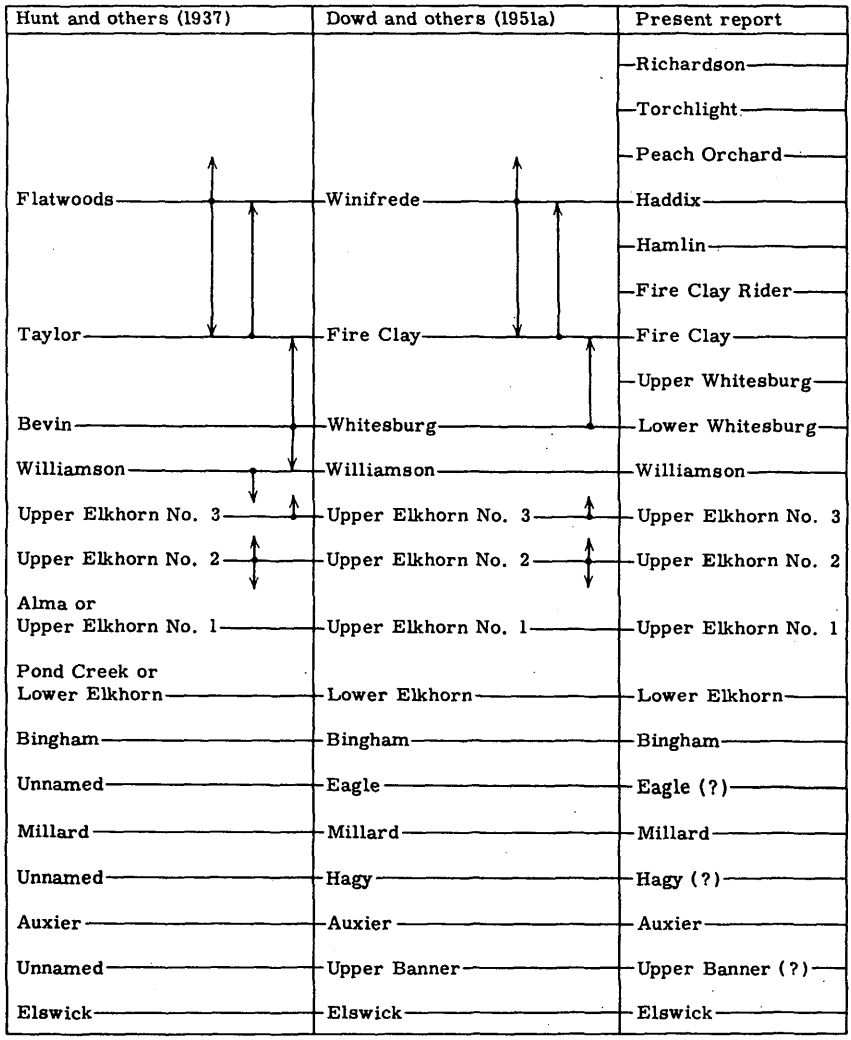
formation to the Fire Clay coal in the northern part of the district with that in the south shows the enormous southward thickening of the formation. Subsurface and surface information from Hauser (1953, p. 10–11) indicates that in Johnson County the interval from the base of the Breathitt to the Fire Clay coal bed is about 350 feet, but in southern Pike and Floyd Counties the same interval is about 1,900 feet (fig. 5). This thickening southward has complicated the correlation of the several named coal beds of the Breathitt formation. Hunt and others (1937) apparently assumed that the interval between their named coal beds remained relatively constant throughout Pike County, because they miscorrelated younger beds in northern Pike County with older beds in southern Pike County. Dowd and others (1951a) evidently followed Hunt's correlations with some modifications. The present writer has used the information in the reports mentioned above, but he has modified the correlations to conform with the regional interpretation of the stratigraphy of the Big Sandy reserve district. At best, the present interpretation is a compromise, especially in the northern part of Pike County. Table 6 has been prepared to show the nomenclature as used in this report and the nomenclature and range of usage for each particular name as used by Hunt and others (1937) and Dowd and others (1952a). Names used above the Williamson coal bed have a wide range in usage, but names used below the Williamson show a small variation due mainly to a shift upward or downward from named coal beds to locally prominent unnamed coals.

GEOLOGIC STRUCTURE

The structure of the Big Sandy reserve district is dominated by a large gently flexed synclinorium whose axial trace passes through northern Floyd and central Martin Counties (pl. 4). The southern limb of this synclinorium, where the rocks dip about one degree northwest, occupies most of Floyd, Pike, and southern Martin Counties. In northwest Floyd and western Johnson Counties the northern limb of the synclinorium has been modified by the monoclinal Paint Creek uplift area (Hauser, 1953, p. 40). This uplift, which consists of several local anticlines and synclines, is broken by the Irvine-Paint Creek fault. The rocks on the northern limb of the synclinorium in Martin County dip less than 1° to the southeast. Apparently the Warfield fault, which is extensive in West Virginia, extends a short distance into eastern Martin County where it dies out (Hudnall, 1924). Along the southern border of Pike County the Pine Mountain fault comes to the surface breaking the continuity of the coal-bearing rocks of Pennsylvanian age and exposing rocks that are possibly Devonian and Mississippian in age.

TABLE 6.—*Comparison of coal-bed names as used in the present report on the Big Sandy reserve district with coal-bed names used by Hunt and others (1937) and Dowd and others (1951a) in Pike County*

[The position of the names in the two left-hand columns are as Hunt and others and Dowd and others intended their usage; the vertical arrows show the range for which the names were actually used]



The flexures in the Big Sandy reserve district do not hinder the mining of coal. In some instances folding is beneficial because it facilitates mine dranage as well as downgrade movement of mine cars (Hunt and others, 1937, p. 11–12). Structure has its greatest effect on the position of the coal beds with respect to drainage; for instance, coal beds in the lower part of the Breathitt formation crop out extensively along the flanks of the synclinorium above drainage, but

near the center of the flexure in eastern Floyd and Martin Counties these same coal beds lie under drainage. Higher coal beds in the Breathitt formation crop out in the central part of the synclinorium in eastern Johnson, northeastern Floyd, northern Pike, and Martin Counties.

COAL BEDS OF THE LEE FORMATION

Few coal beds with recoverable reserves are known to crop out in the Lee formation in the Big Sandy reserve district. Only the Mine Fork coal in western Johnson County is described in this report. There is little or no subsurface information available and the position, thickness, and persistence of coal beds within the Lee cannot be evaluated.

MINE FORK COAL BED

The Mine Fork coal, occurring about 100 feet below the top of the Lee formation, crops out in a small area in western Johnson County (pl. 5). Inasmuch as the coal is thin, from 14 to 20 inches, it is locally mined only for domestic use (Hauser, 1953, p. 13). Estimated original reserves of the Mine Fork coal are 6,320,000 tons.

COAL BEDS OF THE BREATHITT FORMATION

Twenty-one coal beds of the Breathitt formation, most of which are high-volatile A or B bituminous, are described in ths section of the Big Sandy reserve district report. The coal is predominantly common banded, with alternating layers of bright and dull coal. Cannel coal rarely makes up an entire bed but does occur in zones within beds. Many coal beds contain partings which consist of laminated coal, bone rash, fire clay, or sandstone.

Partial chemical analyses of the coals, as cited from Hunt and others (1937), Dowd and others (1951a, 1951b), and Hauser (1953) are on an as-received basis. These analyses show that most of the coal in Floyd and Pike Counties has a fixed carbon content in excess of 55 percent, although to the north, in Johnson and parts of Martin Counties, the fixed carbon content is less than 55 percent. The moisture content usually ranges from 2 to 4 percent, but may be as high as 9 percent. Ash content averages about 6 percent; the sulfur content is low, averaging 1.3 percent; and the calorific value averages about 13,700 Btu.

Coal-bed thicknesses have a large range, but in the area of commercial development the beds usually are more than 30 inches thick. Nearly all the beds are accessible by drift entry; consequently there is little slope or shaft mining in the Big Sandy reserve district.

Reserves have been calculated for 21 named coal beds of the Breathitt formation in the Big Sandy reserve district. Many coal

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have extensive outcrops, but actually contain limited reserves because of their restricted position near the tops of hills. Only the Lower Elkhorn and Upper Elkhorn Nos. 1, 2, and 3 occur consistently near the base of the hills over large areas; consequently the reserves contained in these beds constitute 56 percent of the estimated reserves in the district. All 21 coal beds are exposed in Pike County and most of the beds above the Lower Elkhorn crop out in Floyd, Martin, and Johnson Counties. The most important commercial coal beds in Pike County are the Lower Elkhorn, Upper Elkhorn Nos. 1, 2, and 3, and the Bingham; beds of secondary importance are the Elswick, Williamson, and Haddix. In Floyd County the Upper Elkhorn Nos. 1, 2, and 3, and the Fire Clay are the most important commercial coal beds. The Upper Elkhorn No. 3 has been a consistent producer in Johnson County, and the Fire Clay and Haddix coal beds are of secondary importance. The most important commercial coal bed in Martin County is the Upper Elkhorn No. 3, with the Peach Orchard and Torchlight having secondary importance.

The outcrop area of the Elswick, Upper Banner(?), Auxier, Hagy(?), Millard, Eagle(?), and Bingham coal beds is in southern Pike County along Russell and Levisa Forks of the Big Sandy River, and the extreme eastern part of Pike County near the common borders of Kentucky, Virginia, and West Virginia. The Elswick has the smallest area of outcrop, with each succeeding coal having a slightly larger area. Over the remainder of the district these coals are below drainage, and information concerning their character and extent is not available. Dowd and others (1951a, figs. 10–13) have published outcrop maps for the Elswick, Auxier, Bingham, and Millard coal beds.

ELSWICK COAL BED

The Elswick coal bed occurs about 500 feet above the base of the Breathitt formation. In eastern Pike County the coal averages nearly 32 inches in thickness, with a shale parting from 1 to 5 inches thick. In southern Pike County, where it has been mined commercially, the coal averages 38 inches in thickness, excluding a shale or bone parting ranging in thickness from 1 to 9 inches. This coal has an average ash content of 9.7 percent, contains about 2.4 percent sulfur, and has a calorific value of about 13,600 Btu (Hunt and others, 1937, p. 57; Dowd and others, 1951a, p. 32, table 19).

There are 108,560,000 tons of estimated reserves in the Elswick coal: 3,420,000 tons in beds more than 42 inches thick, 39,420,000 tons in beds 28 to 42 inches thick, and 65,720,000 tons in beds 14 to 28 inches thick.

UPPER BANNER(?) COAL BED

The coal bed called the Upper Banner by Dowd and others (1951a, p. 6), which occurs about 100 feet above the Elswick, crops out in a limited area in southern Pike County. A comparison of sections in southern Pike County and eastern Buchanan County, Va. (Hinds, 1918, pl. 5, p. 16), however, suggests that the coal is younger than the Upper Banner. Because the correlation is doubtful, the coal is referred to as the Upper Banner(?) in this report. This coal, where it averages 36 inches in thickness, has been mined commercially on a small scale. An average of the analyses from Hunt and others (1937, p. 58) indicates that this coal has an ash content of about 8 percent, is low in sulfur (about 0.7 percent), and has a calorific value of about 13,070 Btu. Reserves of 55,620,000 tons, in all categories, are estimated for this bed.

AUXIER COAL BED

The Auxier coal bed, which crops out in eastern and southern Pike County, lies about 100 feet above the Upper Banner(?) coal bed. This coal, which is mined commercially on a small scale, averages 30 inches in thickness with a 1- to 4-inch shale parting. It contains, on the average, 6.8 percent ash, 1.8 percent sulfur, and has a heating value of about 14,000 Btu (Hunt and others, 1937, p. 59–60). Total estimated reserves in the Auxier are 203,960,000 tons: 9,420,000 tons in beds more than 42 inches thick, 41,040,000 tons in beds 28 to 42 inches thick, and 153,500,000 tons in beds 14 to 28 inches thick.

HAGY(?) COAL BED

The coal bed called the Hagy by Dowd and others (1951a, p. 6), lies about 70 feet above the Auxier coal bed. It is termed the Hagy(?) coal in this report because there is a doubt as to its equivalency with the Hagy coal bed of Virginia. Comparative sections from Pike County and Buchanan County, Va., suggest that this coal is younger than the Hagy as used by Hinds (1918, p. 16, pl. 5).

The Hagy(?) ranges in thickness from 15 to 42 inches and averages 24 inches, excluding a local shale parting that averages 2 inches but which may be as much as 5 inches. Chemical analyses are not available for this coal. Estimated reserves of the Hagy(?) total 93,580,000 tons: 24,570,000 tons in beds 28 to 42 inches thick and 69,010,000 tons in beds 14 to 28 inches thick.

MILLARD COAL BED

The Millard coal bed is thin over most of eastern and southern Pike County, but contains relatively large reserves because of its broad areal extent. The bed contains 22,000 tons of coal in beds

more than 42 inches thick, 66,380,000 tons in beds 28 to 42 inches thick, and 375,930,000 tons in beds 14 to 28 inches thick, for a total of 449,340,000 tons. This coal, occurring 85 feet above the Hagy(?) coal bed, is usually 20 to 24 inches in thickness, but locally may thicken to as much as 38 inches. There has been little or no commercial mining of the Millard; however, it has been mined on a small scale for domestic use. Hunt and others (1937, p. 60–61) and Dowd and others (1951a, p. 32) indicate that the Millard has, on the average, an ash content of 8.7 percent, 1.3 percent sulfur, and a calorific value of about 13,600 Btu.

EAGLE(?) COAL BED

The Eagle(?) coal is apparently a local bed present only in the eastern part of Pike County. It lies about 80 feet above the Millard coal bed and has been correlated with the Eagle coal bed of Virginia (Dowd and others, 1951a, p. 6). This coal, which has a total estimated reserve of 92,540,000 tons, is usually at least 24 inches thick, excluding a 1- to 2-inch parting.

BINGHAM COAL BED

The Bingham coal bed, which is the oldest important coal in the Breathitt formation, is mined commercially in southern Pike County, where it is known locally as the Feds Creek or Clintwood. This coal bed occurs from 80 to 100 feet above the Eagle(?) coal and is thickest along the Kentucky-Virginia border, where it averages nearly 45 inches; westward it thins to about 18 inches. It commonly contains partings ranging from ½ inch to 37 inches in thickness but averaging about 2 inches. Coal samples from the Bingham have an average ash content of 8.8 percent with 1.5 percent sulfur and a calorific value of about 13,400 Btu (Hunt and others, 1937, p. 62–63; Dowd and others, 1951a, p. 32).

Estimated reserves in the Bingham coal total 211,930,000 tons: 70,640,000 tons in beds more than 42 inches thick, 117,420,000 tons in beds 28 to 42 inches thick, and 211,930,000 tons in beds 14 to 28 inches thick.

LOWER ELKHORN COAL BED

The Lower Elkhorn coal bed, occurring about 160 feet above the Bingham coal, crops out only in the eastern two-thirds of Pike County. Well and prospect boring records indicate it is present in central Floyd County (Dowd and others, 1951b, p. 8) and in southeastern Martin County along the Pike-Martin County border, but over the rest of the district information is not available as to the extent or character of the coal. Dowd and others (1951a, fig. 9) have published a map showing the outcrop areas of the Lower Elkhorn in Pike County. In their publication (p. 6), they list the names Pond Creek, Freeburn,

Warfield, No. 2 Gas, Campbell Creek, and Shelby Gap as synonymous to the Lower Elkhorn coal bed.

In the northeastern part and near the southern boundary of Pike County the coal ranges in thickness from 40 to 60 inches with a shale parting or rash that ranges from 2 to 10 inches in thickness. Locally, in the southwestern part of the county, 4 to 5 inches of cannel coal may be present (Hunt and others, 1937, pl. 37). The lower Elkhorn thins westward and ranges from 28 to 40 inches in thickness with local pockets as much as 60 inches thick. A zone of laminated coal, which may be as much as 18 inches thick, is commonly present at or near the top of the coal (Dowd and others, 1951a, p. 26). The Lower Elkhorn coal has been mined commercially over its entire outcrop area; however, its most extensive development has been in the northeastern part of Pike County along Pond Creek. Production figures from the Kentucky Department of Mines and Minerals (Sisk, 1954) show that about 53 percent of the coal produced in Pike County came from the Lower Elkhorn. Analyses from Hunt and others (1937, p. 63–74) and Dowd and others (1951a, p. 32) show that the Lower Elkhorn has an average content of ash 4.3 percent, and sulfur 0.58 percent; and a calorific value of 14,000 Btu.

Total estimated reserves of the Lower Elkhorn in the Big Sandy reserve district are 1,254,470,000 tons, of which 871,860,000 tons is in beds more than 42 inches thick, 306,290,000 tons in beds 28 to 42 inches thick, and 76,320,000 tons in beds 14 to 28 inches thick.

UPPER ELKHORN NO. 1 COAL BED

The Upper Elkhorn No. 1 coal bed, 100 to 140 feet above the Lower Elkhorn coal, does not have a thickness uniform over its entire outcrop area but tends to occur in thick pockets locally (pl. 7). In parts of Pike County this coal is known as the Alma bed and in southwest Floyd County as the Wayland bed. It is usually more than 36 inches thick in northeastern Pike County, whereas in southern and western Pike County it ranges in thickness from 12 to 49 inches with most sections less than 28 inches. In west-central Pike County and east and west-central Floyd County, the Upper Elkhorn No. 1 thickens to more than 30 inches and in places to as much as 54 inches thick. Over most of the area the Upper Elkhorn No. 1 contains one or more partings of shale or bone that usually do not exceed 5 inches in thickness. This coal has been mined commercially on a limited basis in Pike County and extensively in west-central Floyd County. An average of the analyses from Hunt and others (1937, p. 74–77) and Dowd and others (1951a, p. 32; 1951b, p. 15) shows that the coal contains 4.6 percent ash, 0.7 percent sulfur, and has a calorific value of about 14,200 Btu.

Total estimated reserves of the Upper Elkhorn No. 1 coal bed are 1,050,760,000 tons, of which 606,970,000 tons occur in Pike County and 443, 790,000 tons in Floyd County. Of the total, 235,190,000 tons occur in beds more than 42 inches thick, 563,760,000 tons in beds 28 to 42 inches, and 342,790,000 tons in beds 14 to 28 inches.

UPPER ELKHORN NO. 2 COAL BED

The Upper Elkhorn No. 2 coal bed has almost the same distribution as the Upper Elkhorn No. 1 coal (pl. 7), with the exception that it has been reported in core holes in northeastern Floyd County and extreme south-central Johnson County. The interval from the Upper Elkhorn No. 1 coal to the Upper Elkhorn No. 2 usually ranges from about 20 to 60 feet; however, Dowd and others (1951a, p. 24; 1951b, p. 12) state that the interval between the Upper Elkhorn No. 1 and No. 2 decreases to a minor parting in several places in Floyd and Pike Counties. These two coal beds have been treated as a single bed where they have come together, and the reserves were included with the Upper Elkhorn No. 2 coal (Dowd and others, 1951a, p. 24). The Upper Elkhorn No. 2 is generally more than 36 inches thick in the southern half of Floyd and Pike Counties, but to the north the coal is not as uniform and thins to about 24 inches. Where the bed is thickest it generally has partings of bone or shale that range in thickness from 1 to 18 inches. Laminated coal, a few inches thick, commonly occurs near the top of the bed in southern Pike County. Dowd and others (1951a, p. 24) report that a thin layer of flint clay, which makes roof control difficult, occurs just over the coal in extreme eastern and extreme western Pike County. At one locality in southern Pike County the Upper Elkhorn No. 2 contains as much as 34 inches of cannel coal, which has been mined commercially (Hunt and others, 1937, p. 48). In southern Floyd and Pike Counties, where the Upper Elkhorn No. 2 is mined commercially, analyses from Hunt and others (1937, p. 77–83) and Dowd and others (1951a, p. 32; 1951b, p. 15) indicate that the average ash content of the coal is 4.3 percent that of sulfur is 0.7 percent; and the calorific value, approximately 14,000 Btu.

Total estimated reserves of the Upper Elkhorn No. 2 coal bed are 1,446,570,000 tons, of which 483,710,000 tons is in beds more than 42 inches thick, 639,240,000 tons is in beds 28 to 42 inches, and 360,280,000 tons is in beds 14 to 28 inches. Pike County contains 69 percent of the total estimated resources, Floyd County, 29 percent, and Johnson County, 2 percent.

UPPER ELKHORN NO. 3 COAL BED

The Upper Elkhorn No. 3 bed, which lies from 20 feet in the north to 70 feet in the south above the Upper Elkhorn No. 2, has one of

the most extensive outcrop areas of the coal beds occurring in the Big Sandy reserve district (pl. 8). Locally in Pike and Martin Counties the coal has been called the Cedar Grove and possibly the Thacker. It usually has a thickness in excess of 32 inches with local pockets that range from 42 to 70 inches in thickness. Dowd and others (1951a, p. 22; 1951b, p. 10) state that in places in Floyd and Pike Counties a thin parting may increase in thickness to several feet causing the Upper Elkhorn No. 3 to be multibedded. It is a solid coal bed with no partings to the north in Johnson County, where the Upper Elkhorn No. 3 is known as the Van Lear or Millers Creek. This coal has been mined commercially over the entire Big Sandy reserve district because it is of good quality. Available analyses show, on an as-received basis, an average content of ash, about 3.9 percent and sulfur, 0.9 percent; and a calorific value of 14,200 Btu (Hauser, 1953, p. 46–47; Dowd and others, 1951a, p. 32, and 1951b, p. 15; Hunt and others, 1937, p. 83–86).

Reserves of the Upper Elkhorn No. 3 coal bed are estimated at 1,761,490,000 tons; 41 percent of the total occurs in Floyd County, 33 percent in Pike County, 22 percent in Johnson County, and 4 percent in Martin County.

WILLIAMSON COAL BED

The limited distribution of the Williamson coal bed shown on figure 11 probably outlines only areas of thick coal. The bed is probably present over larger areas in Floyd and Pike Counties, but there is not enough detailed information available to determine the extent or character of the Williamson in these counties. The coal is too thin in most of Johnson and Martin Counties to be included in the reserve estimate. Locally in Johnson and Floyd Counties the Williamson has been called the Amburgy. Hauser (1953, p. 17) indicated that the Williamson ranges in thickness from 6 to 12 inches in the part of Johnson County included in the Paintsville quadrangle, but in the extreme southwestern part of the county in the Prestonsburg quadrangle the Williamson ranges in thickness from 24 to 27 inches.

The interval from the Upper Elkhorn No. 3 to the Williamson coal increases from 70 feet in southern Martin County and northeastern Pike County to about 125 feet in Floyd and western Pike Counties. In northeastern Pike County, where the coal is mined commercially, and in the extreme southeastern part of Martin County, the Williamson generally ranges in thickness from 36 to 78 inches and contains several partings of shale. These partings become so numerous in southeastern Pike County that the coal has little commercial value. The Williamson seldom exceeds 24 inches in thickness

to the north and west, away from the areas of thick coal in Pike and Martin Counties. Analyses from Hunt and others (1937, p. 86–87) and Dowd and others (1951a, p. 32) show that on an as-received basis the Williamson has an average content of ash, 5.9 percent, and sulfur, 2.7 percent; and a calorific value of 13,750 Btu.

The estimated reserves in the Williamson bed in the Big Sandy reserve district total 480,830,000 tons, of which 176,930,000 tons is in beds more than 42 inches thick, 129,700,000 tons in beds 28 to 42 inches, and 174,200,000 tons in beds 14 to 28 inches.

LOWER WHITESBURG COAL BED

The character and extent of the Lower Whitesburg coal bed in the Big Sandy reserve district cannot be accurately evaluated because of limited information. However, available information in four small areas suggests that the coal is thin over most of the district. One area lies in the southwestern part of Johnson County along the Magoffin County border, another area is in east-central Johnson County near the Martin County border, the third area lies along the south-central border of Martin County and the north-central border of Pike County where the Lower Whitesburg bed has been called the Hernshaw bed, and the fourth area lies in north-central Pike County. The Lower Whitesburg in Johnson County, which occurs about 100 feet above the Upper Elkhorn No. 3 coal bed, is usually 18 to 24 inches thick with local areas as much as 42 inches. In Martin and Pike Counties the Lower Whitesburg averages about 24 inches in thickness. It has had little commercial development in eastern Pike County and southwest Johnson County where Hauser (1953, p. 17) called it the Whitesburg coal. An estimated 127,080,000 tons of reserves are reported for the Lower Whitesburg coal bed.

UPPER WHITESBURG COAL BED

The Upper Whitesburg coal bed has a limited distribution in east-central Johnson County, west-central Martin County, along the border of southeast Johnson and northern Floyd Counties, and in a small area in southwest Pike County. It ranges in thickness from 11 to 43 inches in these areas, with an average thickness of about 20 inches. This coal occurs from 120 to 140 feet above the Upper Elkhorn No. 3 in Johnson County, where it is called the Little Fire Clay coal bed (Hauser, 1953, p. 17), and about 350 feet above the Upper Elkhorn No. 3 in southwest Pike County.

The estimated reserves in the Upper Whitesburg coal total 78,370,000 tons, of which 4,450,000 tons is in beds more than 42 inches thick, 860,000 tons in beds 28 to 42 inches, and 73,060,000 tons in beds 14 to 28 inches.

FIRE CLAY COAL BED

The Fire Clay coal bed in Martin and Johnson Counties is 140 to 160 feet above the Upper Elkhorn No. 3 coal, but in southern Floyd and Pike Counties it is approximately 425 feet above the Upper Elkhorn No. 3 coal. Locally this coal has been called the Hazard No. 4, Bevins, Taylor, Chilton, and Springfield. Distribution of the Fire Clay coal is shown on plate 10.

Usually the Fire Clay is a multibedded coal containing one or more partings that may be shale, bone, or flint clay. The coal can be used as a stratigraphic marker in Floyd County because it contains a distinctive parting of flint clay 3 to 6 inches thick. The flint clay is uncommon over the rest of the district, where the coal is parted by bone or shale. The Fire Clay coal in Johnson County is about 30 inches thick, excluding a 1- to 6-inch parting, and locally it may be as much as 48 inches thick. In eastern Johnson County the Fire Clay bed may contain 5 inches of cannel coal locally, but in western Johnson County Hauser (1953, p. 17–18) reports that the uppermost part of the Fire Clay may contain as much as 12 inches of cannel coal. The average thickness in Floyd, Pike, and Martin Counties probably exceeds 30 inches but there is a wide range in bed thickness and an increase in the number of partings. Hunt and others (1937, p. 54–56) called this coal Flatwoods and indicate that locally it contains from 15 to 28 inches of cannel coal. There has been little commercial development of the Fire Clay coal in Floyd and Johnson Counties. An average of the analyses cited by Hauser (1953, p. 46–47) shows that on an as-received basis the coal contains about 11 percent ash and 2.4 percent sulfur and has a calorific value of about 12,300 Btu.

Estimated reserves of the Fire Clay coal in Floyd County are 188,180,000 tons, in Johnson County 127,320,000 tons, in Martin County 195,860,000 tons, and in Pike County 303,000,000 tons. The estimated reserves total 814,360,000 tons: 127,280,000 tons in beds more than 42 inches thick, 429,060,000 tons in beds 28 to 42 inches, and 258,020,000 tons in beds 14 to 28 inches.

FIRE CLAY RIDER COAL BED

The interval from the Fire Clay bed to the Fire Clay rider bed increases southward from 20 to 30 feet in Johnson County to about 50 feet in southwest Pike County. Limited control suggests that the Fire Clay rider is thin in the big Sandy reserve district. Reserves were calculated in two small areas; one in extreme southwest Pike County where the Fire Clay rider ranges in thickness from 26 to 30 inches, and the other in a narrow band through central Martin County where it averages 24 inches. Total reserves are estimated at 132,120,000 tons.

HAMLIN COAL BED

Reserves in the Hamlin coal bed have been computed for a few small isolated areas in central Martin County, in northeast, northwest, and southwest Pike County, and in southeast Floyd County. This coal lies 20 to 30 feet above the Fire Clay rider coal bed in Martin and northern Pike Counties and about 50 feet above the Fire Clay rider in southern Floyd County. In Martin County the Hamlin coal is generally thin, averaging less than 18 inches in thickness, but to the south in Pike County it is usually more than 40 inches thick, excluding shale partings from 1- to 8-inches thick; and in Floyd County it is about 30 inches thick excluding a 1- to 4-inch shale parting. Estimated reserves in the Hamlin coal bed total 222,770,000 tons.

HADDIX COAL BED

The Haddix coal bed, commonly called the Flatwoods or Winifrede coal, is 60 to 100 feet above the Fire Clay bed in the northern part of the district. It occurs in a band across the southern half of Johnson and Martin Counties, in small areas in northeast Floyd County, and along the western and northern borders of Pike County. In Johnson County and in parts of Floyd County the Haddix, which crops out high on the hills, averages 35 inches in thickness with the range in thickness from 15 to 62 inches. The Haddix contains from 4 to 15 inches of cannel coal locally in western Johnson County, and in south-central Johnson County near the Floyd County border Hauser (1953, p. 42) reports the presence of a commercial pocket of cannel coal 4 to 10 feet thick which he has tentatively correlated with the Haddix. The coal tends to have shale partings 1 to 18 inches thick to the east in Pike County, but the coal alone averages 32 inches. The Haddix coal bed is mined on a small scale for commercial use and locally for domestic use. A single analysis on an as-received basis from Hauser (1953, p. 46) shows that the Haddix coal has a content of ash, 5.1 percent and sulfur, 1.1 percent; and has a calorific value of 13,010 Btu.

The Haddix coal bed has an estimated reserve of 311,310,000 tons, of which 69,840,000 tons occurs in beds more than 42 inches thick, 185,500,000 tons in beds 28 to 42 inches, and 60,970,000 tons in beds 14 to 28 inches. Most of the reserves are in Martin County, which has a total of 188,920,000 tons.

PEACH ORCHARD COAL BED

The Peach Orchard bed, which crops out high on the hills, lies 150 feet above the Fire Clay bed in Johnson and Martin Counties, but in southwest Pike County this interval increases to 440 feet. It is generally more than 40 inches thick, excluding partings that

range in thickness from 1 to 20 inches, and may locally exceed 80 inches. The distribution of the coal in Johnson, Floyd, Martin, and Pike Counties is shown on plate 11. The Peach Orchard has been mined commercially on a small scale in Martin and Pike Counties.

The estimated reserves of this bed total 504,060,000 tons, with 303,520,000 tons in beds more than 42 inches thick, 168,440,000 tons in beds 28 to 42 inches, and 32,100,000 tons in beds 14 to 28 inches. Of the total reserves, 73 percent occurs in Martin County, 18 percent in Pike County, 7 percent in Johnson County, and 2 percent in Floyd County.

TORCHLIGHT COAL BED

The Torchlight bed, locally called the Coalburg bed, is about 100 feet above the Peach Orchard bed and crops out only in the northern part of the Big Sandy reserve district. It occurs in a band from southeast Johnson County through Martin County, with a few small areas along the northeast border of Floyd and the northwest border of Pike Counties (pl. 13). The Torchlight coal is usually more than 40 inches thick and has several shale or bone partings that range in thickness from 1 to 6 inches. It has been developed commercially on a small scale in Martin County. The reserves of the Torchlight bed total 310,070,000 tons, of which 78 percent is in beds more than 42 inches thick, 20 percent in beds 28 to 42 inches, and 2 percent in beds 14 to 28 inches.

RICHARDSON COAL BED

The Richardson coal bed, which occurs from 170 to 200 feet above the Torchlight coal, crops out in long narrow strips in eastern Johnson, northern Floyd, Pike, and Martin Counties (pl. 14). These narrow strips are found only in the highest ridges; consequently, the coal has a small outcrop area and is relatively inaccessible. The coal bed ranges in thickness from 35 to 120 inches and averages 72 inches, with partings of shale or rash that range from 2 to 6 inches in thickness.

The estimated reserves in the Richardson coal bed total 81,010,000 tons.

PRODUCTION

Commercial development of the coals in the Big Sandy reserve district was first reported in Johnson and Martin Counties in 1879, in Floyd County in 1889, and in Pike County in 1904 (table 8). From the 1880's to the late 1920's there was a general increase in production with the maximum of 14,846,700 tons being reported in 1926. In the 1930's, production declined to an average of about 9.5 million tons per year, but with the advent of the Second World War production again increased and reached a maximum of 24,846,400 tons in 1947.

Since 1947 there has been a general decline, and in 1955 production was about 14.1 million tons. Total production, including 1955, was 509,649,300 tons; Martin County has produced 2 percent of the total, Johnson County, 8 percent, Floyd County, 35 percent, and Pike County, 55 percent.

Figure 6 shows the total production, yearly production from 1900 to 1955, and the percent of total production by county. The Lower Elkhorn, Upper Elkhorn Nos. 1, 2, and 3, and Williamson coal beds have had the largest commercial development. Approximately 93 percent of the total production in 1955 in the Big Sandy reserve district was from the Elkhorn coal beds. Smaller production has come from the Elswick, Bingham, Fire Clay, Haddix, Peach Orchard, and Torchlight beds.

Floyd County has produced about 177,825,500 tons of coal, including 1955 production. The Upper Elkhorn No. 3 coal bed has consistently been the largest producer in the county, followed by the Upper Elkhorn No. 1 and No. 2. The Kentucky Department of Mines and Minerals (Phalan, 1955) lists 357 mines operating in Floyd County. The average yearly production for the past 10 years is approximately 5 million tons per year. The all-time record for yearly production was set in 1947 with a total of 8,341,700 tons produced.

Most of the 40,218,900 tons of coal produced in Johnson County has come from the Upper Elkhorn No. 3 coal bed. Yearly production for the past 10 years has averaged about 700,000 tons, with a maximum production of 2,208,800 tons in 1947. There were 128 operating mines producing coal in Johnson County in 1955 (Phalan, 1955).

Pike County, with a total recorded production of 280,956,600 tons, exceeds the total combined production of the other three counties in the Big Sandy reserve district. Most of the production has come from the Lower Elkhorn coal bed followed, in order, by the Upper Elkhorn Nos. 1, 2, and 3, and the Williamson coal beds. Peak production of 13,851,000 tons was attained in 1947. This is considerably more than the approximate average of 9 million tons produced per year for the past 10 years. The Kentucky Department of Mines and Minerals Annual Report lists 487 operating mines in Pike County in 1955.

Coal production in Martin County reached a peak of 637,200 tons in 1926. Since then production in general has leveled off with an approximate yearly average of 200,000 tons. The total production was 10,648,300 tons, most of which was probably produced from the Upper Elkhorn No. 3 bed. According to the Annual Report of the Kentucky Department of Mines and Minerals, there were 13 operating mines in Martin County in 1955.

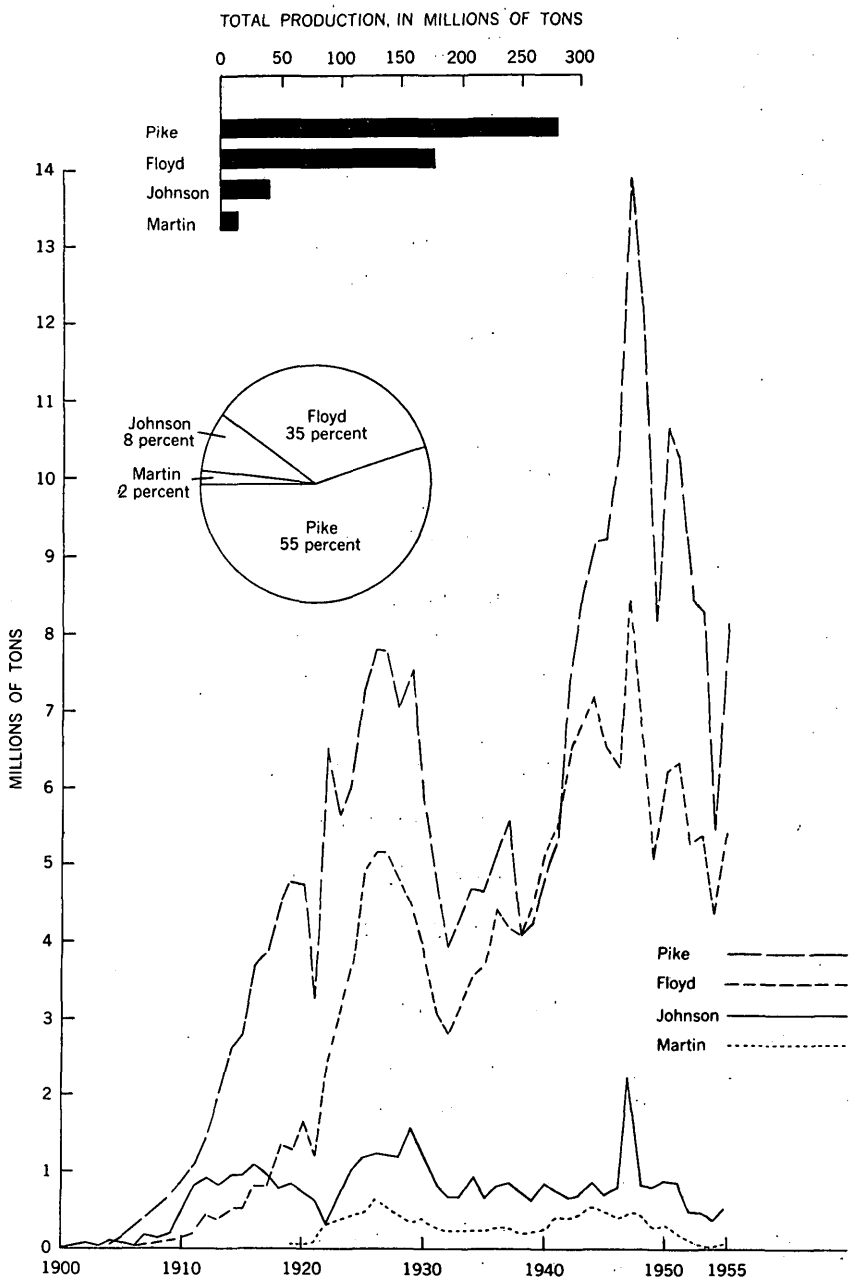

FIGURE 6.—Coal production in the Big Sandy reserve district by county, 1900–1955.

SUMMARY OF RESERVE ESTIMATES

Reserve estimates in the Big Sandy reserve district are reported as original resources for Martin and Johnson Counties and as remaining reserves for Floyd and Pike Counties. In Floyd and Pike Counties remaining reserves are based on published reports by Dowd and others (1951a and 1951b). In these reports mined-out areas were excluded from calculation, and only remaining and recoverable reserves are cited. The term estimated reserves is used in this report when referring to the total original and remaining reserves of the several counties.

Estimated reserves in the Big Sandy reserve district total 9,990,180,000 tons; of this, 3,033,620,000 tons is in beds more than 42 inches thick, 3,981,430,000 tons in beds 28 to 42 inches, and 2,975,130,000 tons in beds 14 to 28 inches. About 31 percent of the estimated reserves are measured, 35 percent indicated, and 34 percent inferred. Pike County has 59 percent of the estimated reserves, Floyd County 19 percent, Martin County 14 percent, and Johnson County 8 percent.

The Lower Elkhorn and the Upper Elkhorn Nos. 1, 2, and 3 coal beds contain 56 percent of the estimated reserves in the Big Sandy reserve district. Pike County contains 62 percent of the estimated reserves in these beds, Floyd County 29 percent, Johnson County 7 percent, and Martin County 2 percent. A complete resume of reserves by bed and county is given in table 10.

COAL BEDS OF THE HAZARD RESERVE DISTRICT

By KENNETH J. ENGLUND

LOCATION

The Hazard reserve district covers an area of 1,886 square miles in the south-central part of the Eastern Kentucky coal field (pl. 1). It includes all of Breathitt, Knott, Leslie, and Perry Counties and the parts of Letcher and Harlan Counties lying north of the Pine Mountain fault. Hazard, a mining center and county seat of Perry County, is the source of the district name.

DRAINAGE AND TOPOGRAPHY

The Hazard reserve district lies in a sharply dissected area of the Appalachian Plateau. It is characterized by narrow sinuous ridges and deep V-shaped valleys, with cliffs or benches of irregular continuity lining the steep slopes at many places. Local relief in excess of 1,000 feet is not uncommon, and flatland is for the most part limited to narrow flood plains, which are sparsely distributed along

the main streams. Drainage in the Hazard district flows northwestward along the Middle and North Forks of the Kentucky River except in extreme eastern Knott and Letcher Counties, where tributaries of the Big Sandy River flow northeastward.

TRANSPORTATION

The principal cities of the district are the coal mining centers of Hazard, Hindman, Hyden, Jackson, Jenkins, and Whitesburg. These cities are on a network of paved highways which serve as important links in the transportation of coal from many scattered mines to the railroad. Major highways are Kentucky State Route 15, which crosses the district in a southeasterly direction; Kentucky State Routes 30 and 80, extending across the district in a southwesterly direction; U.S. 421, which serves Leslie County; and U.S. 119, which extends southwestward through Letcher County. Rail transportation in the Hazard resource district is handled mostly by the Louisville and Nashville Railroad. The main trackage, along the North Fork of the Kentucky River, and several branch lines serve much of Breathitt, Perry, and Letcher Counties (pl. 3). Coal from eastern Breathitt and Knott Counties is transported by the Chesapeake and Ohio Railway. Coal mined in Leslie County is trucked to rail terminals in nearby Clay and Perry Counties.

SOURCES OF DATA

Coal reserves of the Hazard reserve district are based on data assembled from several sources (pl. 2). Publications of the U.S. Geological Survey provided most of the original reserve figures for Perry County, southern and eastern Breathitt County, the northern four-fifths of Leslie County, and western Knott and Letcher Counties (Johnston and Heck, 1950; Stafford and Englund, 1953; Williamson and Adkison, 1953; Johnston and others, 1955; Welch, 1958). Reserve figures for the remainder of Knott and Letcher Counties are based essentially on the U.S. Bureau of Mines (Dowd and others, 1952; Wallace and others, 1953) for remaining measured and indicated reserves figures, supplemented by the addition of inferred reserves. Data used in the preparation of estimates of inferred reserves were assembled by M. J. Bergin in Knott County, K. J. Englund in Letcher County, and H. L. Smith and K. J. Englund in Harlan County. Reconnaissance studies by M. J. Bergin in northern Breathitt County and H. L. Smith in southern Leslie County provided additional coal reserve information.

Original reserves are reported for Breathitt, Leslie, and Perry Counties and the part of Harlan County in the Hazard reserve district. Estimated reserve figures for Knott and Letcher Counties include

original reserves for tonnages calculated by the U.S. Geological Survey and remaining reserves for tonnages calculated by the U.S. Bureau of Mines.

STRATIGRAPHY

The outcropping bedrock of the Hazard reserve district is assigned to the Lee and Breathitt formations of Pennsylvanian age. These coal-bearing rocks consist mainly of alternating beds of sandstone, siltstone, shale, coal, and underclay, with some conglomeratic and calcareous beds.

LEE FORMATION

The Lee formation, the lowest of the two coal-bearing formations in the Eastern Kentucky coal field, is almost entirely in the subsurface in the Hazard reserve district. Only the uppermost beds are exposed where the formation crops out along the North Fork of the Kentucky River in western Breathitt County. In the outcrop area the Lee formation includes strata up to the Zachariah coal bed and consists mostly of massive crossbedded sandstone with conglomeratic lenses. In the subsurface it is predominantly sandstone and is widely known as the "Salt sands." Available drill records show that the thickness of the Lee formation increases southward from approximately 500 feet in Breathitt County to 950 feet in Leslie County.

BREATHITT FORMATION

The Breathitt formation includes all Pennsylvanian strata lying above the Lee formation in the Hazard reserve district. It consists of beds of sandstone, siltstone, and shale interbedded with lesser amounts of coal, underclay, limestone, and chert. The thickness of the Breathitt formation ranges from about 1,300 feet in eastern Breathitt County to about 2,500 feet in southern Leslie County.

Several thin distinctive units in the Breathitt formation serve as key beds in the identification and correlation of coal beds (fig. 7). These units, consisting of thin flint-clay beds and marine fossil zones, are discussed in the order of their importance as key beds. The most useful key bed is the flint-clay parting of the Fire Clay coal, which occurs near the middle of the Breathitt formation. This flint clay, a dark-brownish rock with a distinct conchoidal fracture, is found throughout most of the Hazard reserve district. A somewhat similar flint clay occurs 10 to 20 feet above the Hazard coal bed in the eastern part of Breathitt County. It appears to be more impure and less extensive than the flint clay of the Fire Clay coal bed. Also, its stratigraphic position, approximately 200 feet above the Fire Clay coal bed in eastern Breathitt County, aids in distinguishing it from the similar parting in the Fire Clay coal.

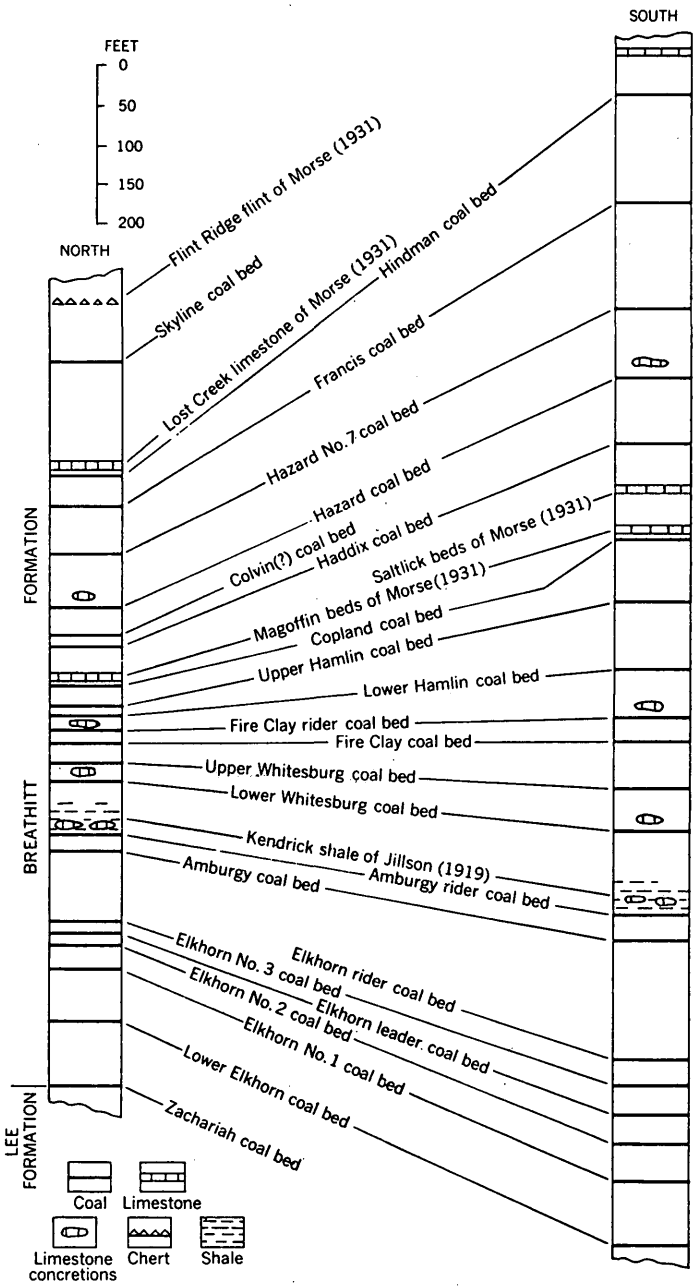

FIGURE 7.—Generalized geologic columns for the Hazard reserve district.

Calcareous and concretionary beds containing marine fossils also serve as important key beds in the Breathitt formation. The most useful and widespread of these is the Magoffin beds of Morse (1931), or "fossil limestone" as it is termed in early reports on the coal-bearing rocks of eastern Kentucky. Its position above the Fire Clay coal bed ranges from 60 feet in Breathitt County to 280 feet in southern Leslie County. Where typically developed, the Magoffin consists of a basal bed of crinoidal limestone, which ranges in thickness from about 2 to 30 inches, and an overlying bed of shale, which is as much as 70 feet thick. The shale is partly calcareous, sparsely fossiliferous, and contains ellipsoidal limestone concretions that locally are extensive enough to form a continuous ledge. At a few localities the basal limestone bed is absent and the fossils at the base of the Magoffin beds are found in a calcareous shale or siltstone. In parts of the Hazard reserve district, mostly in Perry and Leslie Counties, marine fossils also are present in a bed of calcareous shale or siltstone lying 30 to 70 feet above the Magoffin beds, and this unit may be equivalent to the Saltlick beds of Morse (1931, p. 303–304).

A persistent zone of marine fossils also occurs at the base of the Kendrick shale member of Jillson (1919). The fossils are usually in a dark-gray calcareous shale or silty limestone which overlies the Amburgy or Amburgy rider coal beds. The Kendrick shale member averages about 25 feet in thickness and the interval from the fossil zone at its base up to the Fire Clay coal bed increases southward from 110 feet in Breathitt County to 290 feet in Leslie County. Ironstone bands or nodules and large ellipsoidal concretions of silty limestone also are in the Kendrick shale member.

Less extensive horizons of marine fossils occur in calcareous beds or concretions throughout the Breathitt formation. Of these, the fossil beds above the Lower Whitesburg, Fire Clay rider, Hazard, and Hindman coal beds serve locally as useful key beds (fig. 7).

GEOLOGIC STRUCTURE

The Pennsylvanian rocks of the Hazard reserve district lie in a broad synclinal flexure, whose axis extends northeastward across Leslie, Perry, and Breathitt Counties. Dips in the area are generally less than one-half degree but increase to as much as one degree near the Pine Mountain fault on the southeast border of the district. This regional structure is locally modified by minor anticlines, synclines, domes, and noses. These structural features are very gentle and do not impede mining operations, but they do influence effective drainage of mine workings.

COAL BEDS OF THE LEE FORMATION

The coal beds of the Lee formation are in the subsurface in the Hazard reserve district. They are not mined and have been tested by core drilling at only a few scattered localities. Available information indicates that the coal is relatively thin and is of unpredictable lateral extent; therefore, reserve estimates are not included in this report. Future drilling in the Lee formation may reveal areas of minable coal worthy of reserve calculations.

COAL BEDS OF THE BREATHITT FORMATION

The Breathitt formation in the Hazard reserve district contains 23 principal coal beds, of which 21 contain estimated reserves. Areal distribution of reserves in 9 of the 21 coal beds is shown in plates 6 to 14. The oldest beds crop out in western Breathitt and Perry Counties, and dip southeastward into the subsurface. After crossing the synclinal axis in the central part of the district the beds again rise toward the surface and are exposed near the eastern and southeastern margins of the Hazard reserve district. Coal beds in the middle of the formation crop out in most of the district, whereas the highest beds are limited mostly to eastern Breathitt County and to small parts of Perry and Knott Counties. The names applied to coal beds in this report (table 3) have originated in the Hazard reserve district except for the Zachariah (Eyl, 1927) and Colvin (Adkison, 1957) bed names, which are from nearby Lee and Magoffin Counties, respectively.

All coal is of high-volatile A or B bituminous rank and is mostly banded except for local pockets of cannel coal. Thicknesses of coal beds range from less than 1 inch to a maximum of about 14 feet. In areas of commercial development the beds usually range in thickness from 35 to 45 inches. Intervals between the principal coal beds range from 0 to nearly 200 feet, with an average of 50 feet in many areas. Most of the coal beds have wide lateral persistence but are variable in thickness, and locally may be cut out beneath channel-fill sandstone.

ZACHARIAH COAL BED

The Zachariah coal bed, at the base of the Breathitt formation, is exposed only in western Breathitt County where it lies 375 feet below the Fire Clay coal bed. From this area of outcrop the bed dips beneath drainage, and the interval to the Fire Clay coal increases southeastward with the general thickening of the formation. The coal ranges in thickness from 20 to 30 inches, excluding a few thin partings, which are usually less than 1 inch thick. Coal analyses, available only from nearby Wolfe County (Briggs, 1957), classify the

TABLE 7.—*Comparison of coal-bed names used in the Hazard reserve district*

Doud and others (1952)	Stafford and Englund (1953)	Williamson and Adkison (1953)	Wallace and others (1953)	Wallace and others (1954)	Johnston, Stafford, and Welch (1955)	Welch (1958)	Present report
		Knob coal			Helton(?)	Upper Skyline / Lower Skyline — Skyline	Skyline
Hindman	Hindman	Hindman	Hindman	Hindman	Hindman	Hindman	Hindman
	Francis	Francis			Francis	Fugate	Francis
Flag	Hazard No. 7	Hazard No. 7	Flag	Flag	Hazard No. 7	Oakley	Hazard No. 7
	Hazard	Hazard		Hazard No. 6	Hazard	Prater	Hazard
						Upper Haddix	Colvin(?)
	Haddix	Haddix		Haddix	Haddix	Lower Haddix	Haddix
	Copland				Copland		Copland
	Hamlin	Hamlin	Haddix		Hamlin coal zone	Upper Hamlin / Lower Hamlin	Upper Hamlin / Lower Hamlin
	Fire Clay rider	Fire Clay rider			Fire Clay rider	Fire Clay rider	Fire Clay rider
Fire Clay	Fire Clay	Fire Clay	Fire Clay	Fire Clay	Fire Clay	Fire Clay	Fire Clay
Whitesburg	Little Fire Clay	Whitesburg	Whitesburg		Little Fire Clay		Upper Whitesburg
	Upper Split / Lower Split — Whitesburg				Whitesburg splits	Whitesburg	Lower Whitesburg
	Amburgy rider				Amburgy rider		Amburgy rider
Amburgy	Amburgy		Amburgy	Amburgy	Amburgy	Gun Creek	Amburgy
							Elkhorn rider
Upper Elkhorn No. 3	Elkhorn No. 3(?)		Upper Elkhorn No. 3	Upper Elkhorn No. 3		Tom Cooper	Upper Elkhorn No. 3
			Elkhorn Leader				Elkhorn Leader
Upper Elkhorn No. 2			Upper Elkhorn No. 2				Upper Elkhorn No. 2
Upper Elkhorn No. 1			Upper Elkhorn No. 1				Upper Elkhorn No. 1
			Lower Elkhorn				Lower Elkhorn
							Zachariah

Zachariah coal as high-volatile B bituminous. The range in composition and heating values of two samples (Bureau of Mines laboratory Nos. E–47318 and E–47319), on an as-received basis, is as follows:

	Low	High		Low	High
Moisture.....percent..	5.2	6.2	Sulfur.....do....	3.1	3.7
Volatile matter.....do....	40.7	45.1		1.8	3.1
Fixed carbon.....do....	46.0	50.0	Colorific value.....Btu..	13,750	13,890
			Ash.....percent..		

The Zachariah coal bed is not actively mined in the Hazard reserve district and its only development consists of a few small mines 5 miles north of Jackson. The total estimated original reserves of the Zachariah coal bed—53,200,000 tons—are in the indicated and inferred categories and are in a small area of western Breathitt County (pl. 6). In the remainder of the district core data are insufficient for reserve calculations or an evaluation of mining possibilities.

LOWER ELKHORN COAL BED

The Lower Elkhorn coal bed, slso known as the Shelby Gap coal bed, is mainly in the subsurface in the Hazard reserve district. Its principal area of outcrop is in eastern Letcher County where it is the lowest coal bed of economic importance, occurring 560 to 680 feet below the Fire Clay coal bed and about 200 feet above the probable position of the Zachariah coal bed. In this area the thickness ranges from 14 to 32 inches, excluding a parting of laminated coal and shale as much as 13 inches thick. An analysis of the coal, on an as-received basis, from Shelby Gap follows (Crider, 1916, p. 195, laboratory No. G–3720):

Moisture.....percent..	2.1	Ash.....percent..	4.2
Volatile matter.....do....	36.1	Sulfur.....do....	.7
Fixed carbon.....do....	57.6	Calorific value.....Btu..	13,790

Little is known of the Lower Elkhorn coal in the central part of the Hazard reserve district, where the bed lies at depths of 400 feet or more below the main streams. The regional rise of strata in the northwest part of the district brings the bed to the surface in a small area of western Breathitt County. In this outcrop area the Lower Elkhorn bed occurs about 320 feet below the Fire Clay coal bed and is less than 14 inches thick.

The total estimated original reserves, 30,340,000 tons, of the Lower Elkhorn coal bed are in Letcher County. Northeast of Jenkins, near the county line, small-scale workings in the bed have provided coal for local use. As only a few acres are mined, the remaining reserves are for the most part the same as original reserves. Because the bed

is largely untested in the subsurface, additional core drilling will undoubtedly increase the original reserve figure.

UPPER ELKHORN COAL BEDS

The Upper Elkhorn coal beds include, in ascending order, Upper Elkhorn No. 1, Upper Elkhorn No. 2, Elkhorn Leader, Upper Elkhorn No. 3, and Elkhorn rider. These beds lie 50 to 100 feet above the Lower Elkhorn coal bed and 60 to 220 feet below the Amburgy coal bed. Rocks containing the Upper Elkhorn coal beds thin northwestward from 150 feet in Letcher County, where all five beds are recognized, to 50 feet in western Breathitt County, where only two persistent beds (probably Upper Elkhorn No. 1 and No. 3) are present. The principal outcrop area is in eastern Knott and Letcher Counties, where the Upper Elkhorn No. 3 is widely mined. In the central part of the Hazard reserve district the Upper Elkhorn coal beds are in the subsurface and have been tested locally by core drilling in western Knott County, eastern Breathitt County, and southern Perry County.

UPPER ELKHORN NO. 1 COAL BED

The Upper Elkhorn No. 1 coal bed, at the base of the Upper Elkhorn coal zone, occurs 260 to 600 feet below the Fire Clay coal bed. This interval is greatest in the southeastern part of the district. The Upper Elkhorn No. 1 coal bed crops out principally in eastern Knott and Letcher Counties (pl. 7); the bed dips westward into the subsurface and underlies the central and southwestern parts of the Hazard reserve district. The bed also crops out in parts of western Breathitt County.

In Letcher County the Upper Elkhorn No. 1 coal bed ranges in thickness from 14 to 17 inches and is of little economic importance. It thickens northward to as much as 55 inches, excluding partings, on the eastern edge of Knott County. Mining is limited to this area of thick coal but is hampered by a clay or shale parting as much as 16 inches thick in some workings. Prospect hole records show that the coal thins westward and in western Breathitt County a probable correlative, the Grassy coal bed, is generally thin but averages about 24 inches thick in a small area near the center of the county. Analyses, available only from nearby Floyd County, show that the Upper Elkhorn No. 1 coal bed is of good quality (Dowd and others, 1951, p. 15). The total estimated reserves—246,730,000 tons—are mostly in the 14- to 28-inch category.

UPPER ELKHORN NO. 2 COAL BED

The Upper Elkhorn No. 2 coal bed contains reserves only in eastern Knott and Letcher Counties, where it lies about 400 to 540 feet below the Fire Clay coal bed. Its areas of outcrop and distribution are

similar to those of the Upper Elkhorn No. 1, which lies 10 to 50 feet lower.

In Letcher County the thickness of the Upper Elkhorn No. 2 is irregular, rarely exceeding 28 inches; locally the bed contains one or more partings. Although the bed is thicker in Knott County, ranging to as much as 36 inches, there also it is variable in thickness and contains one or more partings. From these outcrop areas in Letcher and Knott Counties, the bed dips northwestward beneath drainage. Information from a few core holes indicates that the Upper Elkhorn No. 2 thins westward and possibly converges with the Upper Elkhorn No. 1 to form a bed or zone which, in outcrops in the western part of the district, may be represented by the Grassy coal bed. Because mined areas are insignificant, the remaining reserves are the same as the total estimated original reserves, 336,670,000 tons. This tonnage includes a small amount of reserves in the southern part of Letcher County, which is in the Upper Cumberland River reserve district.

ELKHORN LEADER COAL BED

A thin persistent coal bed, occurring about 40 feet above the Upper Elkhorn No. 2 and 30 feet below the Upper Elkhorn No. 3 in Letcher County, is known as the Elkhorn Leader or Elkhorn Marker coal bed. In areas of calculated reserves, limited to the central and eastern parts of the county, the bed averages about 20 inches in thickness. In the remainder of the Hazard reserve district the bed is very thin or absent. Because of its thinness the Elkhorn Leader coal bed has not been worked commercially. The total estimated original reserves in the bed, 104,820,000 tons, are the same as the remaining reserves. Some reserves from the southern part of Letcher County, in the Upper Cumberland River reserve district, are included in the U.S. Bureau of Mines measured and indicated reserve tonnages for this bed (Wallace and others, 1953).

UPPER ELKHORN NO. 3 COAL BED

The Upper Elkhorn No. 3 coal bed, occurring in the upper part of the Upper Elkhorn coal zone, is one of the most widespread high-quality beds of minable thickness in the Hazard reserve district. The demand for high-quality metallurgical coke has depleted extensive areas of the bed in Letcher and Knott Counties.

Stratigraphically, the Upper Elkhorn No. 3 coal bed ranges from 220 feet below the Fire Clay coal bed in Breathitt County to 450 feet below the Fire Clay coal bed in Letcher County. It crops out principally in Knott and Letcher Counties on the east side of the district, and to a lesser extent in a western belt in parts of Breathitt, Perry, and Leslie Counties (pl. 8). The largest area of the Upper Elkhorn

No. 3 coal bed is in the subsurface across the central part of the district, where the bed generally lies at depths of about 300 feet below the principal streams.

The area of thickest coal, located in eastern Letcher County, averages about 75 inches but is almost totally mined out. A shale parting, commonly ranging from 1 to 5 inches in thickness, occurs near the center of the bed. From this area of thick coal in eastern Letcher County the bed thins westward to an average of 44 inches in thickness in central Letcher County and northward to an average of 38 inches in thickness in central and eastern Knott County. Prospect hole records from parts of Breathitt, Perry, and western Knott Counties indicates that in the central part of the district the thickness is as high as 48 inches but an average of 32 inches probably is typical. In the western belt of outcrop the thickness ranges from 12 to 39 inches and averages about 24 inches.

In addition to the extensive mining, mostly by railroad mines, in the outcrop area in Knott and Letcher Counties, the Upper Elkhorn No. 3 is truck-mined on a small scale in western Breathitt County, and is worked by slope entry at one locality in extreme eastern Breathitt County.

The Upper Elkhorn No. 3 coal is of high volatile A bituminous rank. The range in composition and calorific value, on an as-received basis, of 21 samples from Letcher County (Fieldner and others, 1944, p. 112–114, Bureau of Mines laboratory Nos. A–58087–58090, 21294–21297, 21299–21301, 21303–21306, 21308–21312, 21317) and one sample from the Elkhorn No. 3 mine in Breathitt County (Welch, 1958, p. 602, Bureau of Mines laboratory No. D–93335) is as follows:

	Letcher County		Breathitt County		Letcher County		Breathitt County
	Low	High			Low	High	
Moisture----percent--	2.1	3.9	4.2	Ash----------percent--	2.6	3.8	2.4
Volatile matter--do----	33.8	37.6	36.9	Sulfur----------do----	.5	1.1	.9
Fixed carbon---do----	55.0	59.9	56.5	Calorific value---Btu--	14,500	14,860	13,790

The estimated reserves in the Upper Elkhorn No. 3 coal bed total 1,366,250,000 tons, including a very small tonnage from southern Letcher County in the Upper Cumberland River reserve district. As most of the total tonnage is in or near the outcrop areas, future core drilling in the central part of the district is likely to reveal additional reserves.

ELKHORN RIDER COAL BED

The Elkhorn rider bed, the uppermost of the Upper Elkhorn coal beds, is recognized only in parts of Knott, Letcher, and Perry Counties

It is about 30 feet above the Upper Elkhorn No. 3 coal and may be a split of that bed. The thickness is generally less than 14 inches but locally ranges from 20 to 26 inches. Although the bed has not been worked commercially, it may be developed in the future where local conditions are favorable for it to be strip-mined with the underlying Upper Elkhorn No. 3. Reserves are not calculated for the Elkhorn rider coal bed for this report as areas of coal more than 14 inches thick seem, on the basis of available information, to be of limited lateral extent.

AMBURGY COAL BED

The Amburgy coal is a persistent bed occurring 60 to 95 feet above the Upper Elkhorn No. 3 coal bed in Breathitt County and 200 to 225 feet above the same bed in Letcher County. The interval up to the Fire Clay coal bed also increases southeastward, from a minimum of about 120 feet in Breathitt County to maximums of 265 feet in Letcher County and 300 feet in southern Perry County.

In the principal outcrop area, located in Letcher County and adjacent parts of Knott and Perry Counties (pl. 9), the bed ranges in thickness from 17 to 45 inches, excluding partings, and averages about 30 inches thick. Commonly the bed contains one or two partings consisting of 1 to 4 inches of shale, and locally it may contain as much as 12 inches of laminated coal and shale. Westward from this belt of outcrop the Amburgy coal bed dips into the subsurface where it has been encountered in core holes at a few localities, mostly in eastern Breathitt County. Core-hole records show that the coal, known as the Gun Creek bed in this area (Welch, 1958, p. 589), lies 120 to 200 feet below the main streams and averages about 32 inches thick, excluding a thin shale parting that is present in the bed at several localities. In a western belt of outcrop the Amburgy coal bed contains reserves in small areas of Breathitt, Leslie, and Perry Counties, where the average thickness is about 30 inches.

Analyses, on an as-received basis, of eight channel samples collected by the U.S. Geological Survey near Hyden in Leslie County show the following range in composition for the Amburgy coal bed (Bureau of Mines laboratory Nos. D–6983, D–6984, D–8849, D–9794, D–22946, D–28592, D–28594, D–28608):

	Low	High		Low	High
Moisture.....percent..	3.2	6.8	Ash.....percent..	2.0	8.2
Volatile matter.....do....	33.5	40.7	Sulfur.....do....	0.2	02.9
Fixed carbon.....do....	49.9	55.0	Calorific value.....Btu..	12,640	13,770

The Amburgy coal bed is mainly a source of coal for local use in the Hazard reserve district but it has been worked on a small scale by a few truck mines in Letcher and Leslie Counties. The total estimated reserves for the Amburgy coal bed—1,172,290,000 tons—are mostly in the 14- to 28-inch category. This total includes a very small tonnage in southern Letcher County in the Upper Cumberland River reserve district.

AMBURGY RIDER COAL BED

The Amburgy rider, a relatively thin and commercially unimportant coal bed, is useful as a marker bed. In most parts of the Hazard reserve district it is recognized by the presence of marine fossils in the overlying shale. The Amburgy rider coal bed is 10 to 30 feet above the Amburgy coal bed, but at some localities only one bed occurs at this stratigraphic position, indicating that the Amburgy rider may feather out or possibly merge with the underlying Amburgy coal bed. Over most of the area the thickness is less than 14 inches; however, subsurface data indicates as much as 28 inches of coal locally. The Amburgy rider coal bed is not worked commercially, and future development may be limited to areas where it is thick enough to be stripped with the underlying Amburgy coal bed. Reserves are not included in this report, as areas of reserve thickness are of undetermined lateral extent.

WHITESBURG COAL BEDS

The Whitesburg coal beds generally consist of two beds of little economic importance lying between the Kendrick shale member and the Fire Clay coal. Locally the lower bed is split into two benches or beds which have been called Whitesburg splits (table 7). Strata including the Whitesburg coal beds and intervening rocks thin northward from a maximum of 85 feet in thickness in Leslie County to less than 40 feet in Breathitt County. This thinning continues northward to Morgan County, beyond the Hazard reserve district, where the Whitesburg coal beds converge with the overlying Fire Clay coal and only thin partings separate the beds. Because of the thinness of the Whitesburg beds and their proximity to the Fire Clay coal bed in that area, they are not mapped separately but are considered to be part of the Fire Clay coal zone (Englund, 1955, p. 9).

The uppermost of the Whitesburg coal beds, which is 25 to 60 feet below the Fire Clay coal bed, was originally named Whitesburg for the county seat of Letcher County (Hodge, 1908, p. 40). Later the name "Whitesburg" was applied to a coal bed, believed to be the Whitesburg correlative, which commonly occurs 75 to 100 feet below the Fire Clay coal bed in Leslie and Perry Counties (table 7). Therefore, a new name, Little Fire Clay, was given to the bed occurring

about 40 feet below the Fire Clay coal. Subsequently, reports on areas in the western and northern parts of the Hazard reserve district followed this revised usage, whereas reports on areas at or near the type locality of the Whitesburg coal continued to use the original terminology (table 7). Because of the diverse usage of the name "Whitesburg," the names "Lower Whitesburg" and "Upper Whitesburg" are here used in describing these beds. The name "Lower Whitesburg" refers to the bed which was previously unnamed in the eastern part of the district but was erroneously called Whitesburg in other parts. The name "Upper Whitesburg" refers to the bed originally named Whitesburg but also termed the Little Fire Clay in the western and northern parts of the district.

LOWER WHITESBURG COAL BED

The Lower Whitesburg coal bed occurs 80 to 150 feet above the Amburgy coal bed and about 45 to 125 feet below the Fire Clay coal bed. These intervals are largest in the southern and southeastern parts of the district.

The Lower Whitesburg coal bed is present, lying above the level of the principal streams, in most parts of the Hazard reserve district. It is generally less than 14 inches thick and may occur in two benches 5 to 30 feet apart. Areas of estimated reserves are limited to south-central Leslie County, where the bed ranges from 14 to 46 inches in thickness, and to southern Breathitt County, where the coal ranges from 14 to 34 inches in thickness. At many localities the bed is characterized by thin shale partings and pyrite nodules. Analyses from Leslie County classify the Lower Whitesburg as high-volatile A bituminous coal (Johnston and Heck, 1950). The range in composition and calorific value of three samples—Bureau of Mines laboratory Nos. D–6981, D–9790, D–28599—on an as-received basis, is as follows:

	Low	High		Low	High
Moisture.....percent	2.6	3.7	Ash.....percent	6.0	7.2
Volatile matter.....do	37.4	40.5	Sulfur.....do	1.3	1.9
Fixed carbon.....do	49.4	52.9	Calorific value.....Btu	13,330	13,820

The Lower Whitesburg coal bed has been mined commercially by a few small truck mines, but is more commonly worked for local fuel. The total estimated original reserves—149,470,000 tons—are in Breathitt and Leslie Counties.

UPPER WHITESBURG COAL BED

The Upper Whitesburg coal bed, originally named Whitesburg, is commercially important in a belt on the east edge of the Hazard

reserve district. In this area it lies about 40 feet above the Lower Whitesburg coal bed and 25 to 65 feet below the Fire Clay coal bed. The thickness ranges from 14 to 63 inches and averages about 32 inches. The bed thins westward and is generally less than 14 inches thick in other parts of the district.

In Breathitt, Leslie, and Perry Counties the Upper Whitesburg coal has been called the Little Fire Clay (table 7) and lies about 40 feet or less below the Fire Clay bed.

Extensive commercial development of the bed is limited to the vicinity of Whitesburg, although in other localities the bed is a source of coal for local use. The total estimated reserves—264,010,000 tons—are in Knott and Letcher Counties except for a small tonnage in southern Leslie County.

FIRE CLAY COAL BED

The Fire Clay coal bed, commercially known as the Hazard No. 4, is the most widely mined bed in the Hazard reserve district. Its outcrop, on the lower hill slopes in the western and central parts of the district, provides favorable access for drift operations. In eastern Knott and Letcher Counties the bed rises nearly to the hilltops. Only Breathitt County lacks extensive distribution of the Fire Clay coal bed (pl. 10).

Throughout most of the area of estimated reserves the thickness ranges from 30 to 50 inches and averages about 36 inches. Areas of thick coal contain as much as 48 inches in western Perry County, 66 inches in north-central Leslie County, 55 inches in central Perry County, and 52 inches in central Letcher County.

The Fire Clay coal bed is composed of brightly banded coal, and partings, other than the flint-clay marker, are fairly uncommon. The flint clay occurs in the lower part of the coal bed and generally ranges from 3 to 4 inches in thickness. At many mines only coal lying above the flint-clay parting is worked. Analyses, on an as-received basis, of channel samples collected by the U.S. Geological Survey in Leslie (10 samples), Letcher (2 samples), and Perry (6 samples) Counties show the following range in composition and calorific values:

	Leslie		Letcher		Perry	
	Low	High	Low	High	Low	High
Moisture, percent	2.8	5.6	3.2	4.5	3.0	4.4
Volatile matter, do	34.7	39.7	33.5	35.6	34.9	37.7
Fixed carbon, do	51.7	55.3	52.5	54.8	54.0	56.6
Ash, do	3.2	6.4	6.4	9.5	3.4	6.9
Sulfur, do	.7	1.2	.7	.9	.6	.8
Calorific value, Btu	13,260	14,000	12,880	13,590	13,320	13,840

Development of the Fire Clay coal bed is most extensive in a belt extending eastward across the south-central part of the district. In Perry and Letcher Counties the bed is worked on a large scale by railroad and truck mines. In Leslie County it is worked only by truck mines. Although mining has depleted large tonnages of the Fire Clay coal bed, it represents only a small percentage of the total estimated original reserves of 2,363,410,000 tons, so that large areas remain for future development.

FIRE CLAY RIDER COAL BED

The Fire Clay rider coal bed is commercially important on the west side of the Hazard reserve district in parts of Breathitt, Leslie, and Harlan Counties and in western Perry County. In this area its stratigraphic position above the Fire Clay coal bed ranges from 1 to 50 feet but averages about 25 feet. The thickness of the bed in the western part of the district ranges from a few inches to 48 inches, excluding thin partings of shale and impure coal. In areas of thick coal the average thickness is 34 inches.

In the remainder of the district the Fire Clay rider coal bed lies 10 to 75 feet above the Fire Clay coal bed and is generally less than 14 inches thick.

Analyses, on an as-received basis, of six channel samples (Bureau of Mines laboratory Nos. D–10417, D–21257, D–22953, D–28589, D–28602, D–28604) collected by the U.S. Geological Survey in Leslie County show the following range in composition and calorific values:

	Low	High		Low	High
Moisture.....percent..	2.8	7.3	Ash.....percent..	3.8	11.1
Volatile matter.....do....	35.3	41.2	Sulfur.....do....	.9	2.5
Fixed carbon.....do....	47.7	53.7	Calorific value.....Btu..	12,660	13,990

The Fire Clay rider coal bed is worked at many localities for local fuel, and recent commercial developments are limited to intermittently operated truck mines. Only a very small fraction of the total estimated original reserves of 783,580,000 tons has been mined.

HAMLIN COAL BEDS

A zone of thin coal beds, occurring between the Fire Clay rider and Copland coal beds is commonly known as the Hamlin coal beds or Hamlin splits. The number of beds increases from two to six in a southerly direction and two of these, designated Lower Hamlin and Upper Hamlin, contain calculated reserves. Although the correlations of these beds are doubtful over large areas, the names do indicate the relative position of reserves assigned to beds in the Hamlin coal zone.

LOWER HAMLIN COAL BED

The Lower Hamlin coal bed is unimportant commercially but marks a widespread coal horizon in the Hazard reserve district. It occurs approximately 20 to 60 feet above the Fire Clay rider coal bed and 30 to 110 feet above the Fire Clay coal bed. These intervals are greatest in the southern part of the district.

The Lower Hamlin coal bed is slightly more than 14 inches thick in scattered localities but contains calculated resources only in a small area extending across the Leslie-Harlan County line. Here it averages about 20 inches in thickness and is worked for local use only. The total estimated original reserves—35,670,000 tons—are in the 14- to 28-inch category.

UPPER HAMLIN COAL BED

The Upper Hamlin coal is generally the uppermost bed in the Hamlin coal zone. Reserves occur only in small areas of Letcher County and in southern Leslie County where the bed is 70 to 90 feet above the Lower Hamlin coal bed and 140 to 220 feet above the Fire Clay coal bed. The Upper Hamlin coal bed is commonly less than 14 inches thick but in areas of estimated reserves it increases to as much as 70 inches and averages about 32 inches. Thin partings of shale and impure coal are present at many localities. The total estimated original reserves, 65,410,000 tons, are the same as remaining reserves, as mined areas are insignificant. The total reserves include a small tonnage located in southern Letcher County in the Upper Cumberland River reserve district.

COPLAND COAL BED

The Copland coal bed is at the base of the Magoffin beds and 20 to 70 feet above the Upper Hamlin coal bed. It lies approximately 60 feet above the Fire Clay coal bed in the area of estimated reserves in west-central Breathitt County. The thickness is as much as 55 inches in this area but is generally less than 6 inches in the remainder of the Hazard reserve district. Mining of the bed has been on a small scale for local use only. As mined areas are of negligible size, the total, estimated original reserves of 17,850,000 tons are the same as the remaining reserves.

HADDIX COAL BED

The Haddix coal bed is commercially important locally in the Hazard reserve district. It marks the first coal horizon above the Magoffin beds and lies 100 to 375 feet above the Fire Clay coal bed. The principal occurrence of the bed is in Breathitt County, but local areas of estimated reserves occur in other parts of the district. In areas of estimated reserves the thickness of the bed ranges from 14 to

52 inches and averages about 30 inches. Much of the variation in thickness is associated with "rolls" or undulations in the base of the sandstone which commonly overlies the coal.

At a few localities in Breathitt County the Haddix coal bed has been truck-mined but more commonly it has been worked for local household fuel. Only a very small percentage of the total estimated original reserves of 471,810,000 tons has been depleted by mining. Part of this total reserve is in southern Letcher County in the Upper Cumberland River reserve district.

COLVIN(?) COAL BED

The name "Colvin(?)" is used in this report for a coal bed which may be an upper split of the Haddix coal. On the basis of its stratigraphic position, 10 to 15 feet above the Haddix coal bed, it is tentatively correlated with the Colvin bed of nearby Magoffin County. Reserves are in a small area on the Breathitt-Knott County line, where the bed lies about 125 feet above the Fire Clay coal bed. The Colvin(?) coal bed is relatively thin, averaging about 20 inches thick, and commonly includes thin partings of shale or impure coal. The total estimated coriginal reserves, 16,150,000 tons, are mostly in the 14- to 28-inch category.

HAZARD COAL BED

The Hazard coal bed is of major commercial importance in the Hazard reserve district. It is also known as the Hazard No. 6 and more commonly as the Hazard No. 5A where it is mined in Perry County. In eastern Breathitt County the Hazard coal is referred to as the Prater bed, which is identified by a thin flint-clay marker bed, and in the south-central part of the district it is called the Leatherwood coal. This correlation is tentative, as available information indicates probable correlation of the Leatherwood with the Haddix coal bed.

The Hazard coal bed lies 30 to 80 feet above the Haddix coal and 150 to 380 feet above the Fire Clay coal bed. It contains reserves in a broad belt extending southwestward across the central and southwestern parts of the district where it crops out on the upper hill slopes (pl. 11). The thickness of the coal bed is variable but commonly ranges from 40 to 60 inches in many thick pockets throughout the area of estimated reserves. Thin partings, generally ranging in thickness from 1 to 3 inches, are present at a few localities. In some areas, mostly in Perry and Leslie Counties, one or two thin benches of coal lie several feet above or below the Hazard coal bed. The most recent analyses available are of the Leatherwood coal bed in southern Perry County (Davis and others, 1952, p. 6). The range

in composition and calorific values of these three analyses, on an as-carbonized basis, is as follows:

	Low	High		Low	High
Moisture.....percent..	3.4	3.6	Ash.....percent..	3.5	4.6
Volatile matter.....do....	36.8	38.7	Sulfur.....do....	.6	.9
Fixed carbon.....do....	53.9	56.1	Calorific value.....Btu..	13,710	13,900

Extensive developments in the Hazard coal bed are located principally in Perry County where the bed is worked by railroad mines and to a lesser extent by truck mines. In other parts of the district it is commercially developed by a few scattered truck mines but is more commonly a source of fuel for local residents. Although the Hazard coal is extensively mined, large areas of thick coal are available for future development as transportation facilities improve. Of the total estimated original reserves, 1,310,430,000 tons, less than one percent has been mined and lost in mining in the Hazard reserve district.

HAZARD NO. 7 COAL BED

The Hazard No. 7 coal bed is very important commercially in the Hazard reserve district as it contains large reserves and is extensively developed (pl. 12). It is often referred to as the Flag coal bed but the Flag, as named by Hodge (1908, p. 43) in south-central Breathitt County, is probably stratigraphically higher. Previous reports (Dowd and others, 1952; Stafford and Englund, 1953; Williamson and Adkison, 1953) combined reserves for the Hazard No. 7 and Flag coal beds, although the latter two reports recognized the correlation of these beds as only tentative. Reserve figures for this report are based on the above-mentioned publications, and therefore the resert figures for the Flag bed in southern Breathitt and northern Knott Counties are combined with the Hazard No. 7. However, the distribution of the Flag coal bed in these areas is shown with its likely correlative, the Francis coal bed (pl. 13).

The Hazard No. 7 coal bed is called the Oakley coal bed in eastern Breathitt County (Welch, 1958, p. 596), where it lies about 200 feet above the Fire Clay coal bed. This interval thickens southward to a maximum of about 550 feet in southern Leslie County. The interval down to the Hazard coal bed ranges from 40 to 90 feet in thickness.

The Hazard No. 7 occurs in two principal areas of the Hazard reserve district, one in the northern part and the other in the central and southern part. The northernmost area is in eastern Breathitt County where the bed crops out on the upper hill slopes. The thickness ranges from 14 to 66 inches and averages about 30 inches. Part-

ings are thin and consist of shale or impure coal. Mining in this area has provided coal for local use.

In the central and southern part of the district the Hazard No. 7 crops out on the upper hill slopes in Perry County, most of western and central Knott County, and adjacent parts of southern Breathitt and western Letcher Counties. It also occurs in scattered hilltop areas in Leslie County. The thickness of the coal ranges mostly from 45 to 75 inches in the principal area of commercial development, in north-central Perry County and the adjacent part of western Knott County. In the remainder of the area of estimated reserves the coal is thinner and averages about 32 inches thick. Partings of shale or impure coal are thin and of limited lateral extent.

The Hazard No. 7 coal is of high-volatile A bituminous rank. The range in composition and calorific values, on an as-received basis, of columnar samples collected by the U.S. Geological Survey from three mines near Hazard in Perry County (Johnston and others, 1955; Bureau of Mines laboratory Nos. D–49807, D–49810, and D–54492) and from the Mar Coal Co. mine 5.5 miles northeast of Guage in Breathitt County (Bureau of Mines laboratory No. E–40283) are as follows:

	Low	High		Low	High
Moisture.....percent..	4.2	4.8	Ash.....percent..	5.4	6.5
Volatile matter.....do....	35.0	37.6	Sulfur.....do....	.6	.9
Fixed carbon.....do....	51.1	54.7	Calorific value.....Btu..	13,100	13,290

Extensive areas of the Hazard No. 7 coal bed have been exhausted by large railroad mines, and to a lesser extent by truck mines, in the central part of the Hazard reserve district. Coal that has been mined and lost in mining represents about 19 percent of the total estimated original reserves of 1,491,910,000 tons.

FRANCIS COAL BED

The Francis coal bed is also known as the Hazard No. 8, Fugate, and Flag. These names originated in different parts of the Hazard reserve district but represent the same bed or beds at approximately the same stratigraphic position. However, some correlations are tentative as reserves occur in isolated areas.

The Francis coal bed lies above the Fire Clay coal bed from a minimum of 225 feet in Breathitt County to a maximum of 725 feet in Leslie County. An interval of 15 to 140 feet down to the Hazard No. 7 also is greatest in the southern part of the district.

The principal distribution of the Francis coal bed is in eastern Breathitt County and northern Knott County where it crops out on

the upper hill slopes. Scattered hilltop occurrences of estimated reserves extend southward through Perry and Leslie Counties to northern Harlan County.

In areas of estimated reserves the thickness of the coal ranges from 14 to 96 inches and commonly averages 40 inches or more, excluding partings. The bed is thick enough to be mined but partings, which are generally 6 to 12 inches thick, split the bed into three benches in many areas. Because of these partings and the presence of more desirable coal 50 to 100 feet above or below the Francis in many areas, the Francis coal bed has not been commercially mined. However, the bed is a source of fuel for local residents who work it at many localities. Mining in the Francis coal bed is for the most part uneconomical at present but the bed contains large reserves which may, after sufficient cleaning, become an important source of fuel in the future.

Analyses, on an as-received basis, of a sample collected in Knott County (Welch, 1958, p. 602; Bureau of Mines laboratory No. D–93340) and two samples collected in north-central Perry County (Bureau of Mines laboratory Nos. E–16519 and E–17288) by the U.S. Geological Survey show the following range in composition and calorific values:

	Low	High		Low	High
Moisture.....percent..	2.8	5.4	Ash.....percent..	5.3	12.7
Volatile matter.....do....	36.5	40.1	Sulfur.....do....	.8	1.8
Fixed carbon.....do....	48.0	51.4	Calorific value.....Btu..	12,150	13,470

The total estimated original reserves in the Francis coal bed, 416,610,000 tons, are essentially the same as remaining reserves, as mined-out areas are of negligible size.

HINDMAN COAL BED

The Hindman coal bed, also known as the Hazard No. 9 bed in Perry County and the Helton bed in southern Leslie County, is the highest bed mined in the central part of the Hazard reserve district. Previously the Helton coal bed has been considered to be stratigraphically higher than the Hindman coal but, on the basis of southward thickening of the stratigraphic section, it seems very likely that these coal beds are correlatives. Reserves in the Hindman coal bed are limited to small hilltop areas in the central and southern parts of the district.

The Hindman coal bed lies about 320 to 880 feet above the Fire Clay coal and 40 to 150 feet above the Francis coal. It is identified

at many localities by the presence of marine fossils in the overlying shale. In the central and southern parts of the district the thickness of the coal is generally more than 42 inches and ranges from 50 to 70 inches in most areas. The Hindman coal thins northward and in central Breathitt County cannot be identified with certainty. In this area the coal bed that occurs about 40 feet above the Francis coal bed and underlies the Lost Creek limestone of Morse (1931, p. 304) may be the Hindman.

Impurities in the Hindman coal bed consist of thin shale partings and irregular layers of pyrite nodules. The range in composition and calorific values of two columnar samples collected by the U.S. Geological Survey from the Eblen Coal Co. mine in Perry County and the Bluebird Coal Co. mine 6 in Knott County, on an as-received basis, is as follows (Johnston, Stafford, and Welch, 1955; Bureau of Mines laboratory Nos. D–49808 and D–54488):

	Low	High		Low	High
Moisture.....percent..	3.1	3.9	Ash.....percent..	5.5	8.4
Volatile matter.....do....	36.8	37.2	Sulfur.....do....	1.8	2.5
Fixed carbon.....do....	51.7	53.4	Calorific value.....Btu..	13,130	13,350

Mining of the Hindman coal is most extensive near Hazard, where it has been worked by underground and strip methods. Of the total estimated original reserves of 340,660,000 tons, approximately 5 percent has been mined and lost in mining.

SKYLINE COAL BED

The Skyline coal bed, a probable correlative of the Richardson coal, is the highest bed mined in the northeastern part of the Hazard resource district. It crops out in the ridge tops of eastern Breathitt and northern Knott Counties (pl. 14) and lies 220 to 280 feet above the Francis coal, which is the next underlying coal bed of notable thickness.

The Skyline coal, which is as much as 167 inches thick excluding partings, is the thickest coal bed in the district. It contains several partings of shale and impure coal. In a northeasterly direction the Skyline coal splits into two benches which are separated by 10 to 80 feet of shale, siltstone, and sandstone. The lower bench ranges from 20 to 99 inches in thickness and the upper bench, although it is generally less than 28 inches thick, attains a maximum thickness of 77 inches.

Analyses, on an as-received basis, of three channel samples from the Skyline strip mine in Breathitt County show the following range in

composition and calorific values (Welch, 1958, p. 602; Bureau of Mines laborary Nos. D–93338, D–93336, and D–93337):

	Main Skyline coal bed	Upper bench of Skyline coal bed	Lower bench of Skyline coal bed
Moisture.....percent	5.2	4.1	5.3
Volatile matter.....do	36.4	35.8	37.1
Fixed carbon.....do	52.2	50.5	54.3
Ash.....do	6.2	9.6	3.3
Sulfur.....do	.8	.8	.8
Calorific value.....Btu	12,860	12,430	13,320

The Skyline coal bed was worked by large strip mines which have depleted approximately 28 percent of the total estimated original reserves of 25,100,000 tons.

PRODUCTION

Coal is reported to have been mined from the Hazard reserve district for about 100 years, but large scale commercial production has been limited to the past 50 years (table 4). Production reached a peak of about 19.5 million tons in 1948 and has levelled off at an annual average of about 13.3 million tons in recent years (1952–55). Most of this coal was mined from the Upper Elkhorn No. 3, Fire Clay, and Hazard No. 7 coal beds. Locally, all the coal beds are accessible by drift entry, which is the principal mining method in the district. Large stripping operations are limited to a few areas where coal beds near the hilltops are mined. Mining by slope entry, at a depth of approximately 300 feet, is in operation at one locality in eastern Breathitt County.

Production in the Hazard reserve district is mostly from Letcher County, which has supplied 46 percent, and Perry County, which has supplied 42 percent of the total coal mined (fig. 8). Knott, Leslie, and Breathitt Counties are of lesser importance, with 5, 4, and 3 percent of the total mined coal, respectively. The total recorded production, through 1955, from the Hazard reserve district—454,266,900 tons—represents about 4 percent of the total estimated reserves.

SUMMARY OF RESERVE ESTIMATES

Coal beds in the Hazard reserve district contain a total estimated reserve of 11,062,370,000 tons. Approximately 26 percent of this total tonnage is in beds more than 42 inches thick, 37 percent is in beds 28 to 42 inches, and 37 percent in beds 14 to 28 inches. In the categories of reliability, 35 percent of the total estimated reserves is classified as measured, 40 percent as indicated, and 25 percent as in-

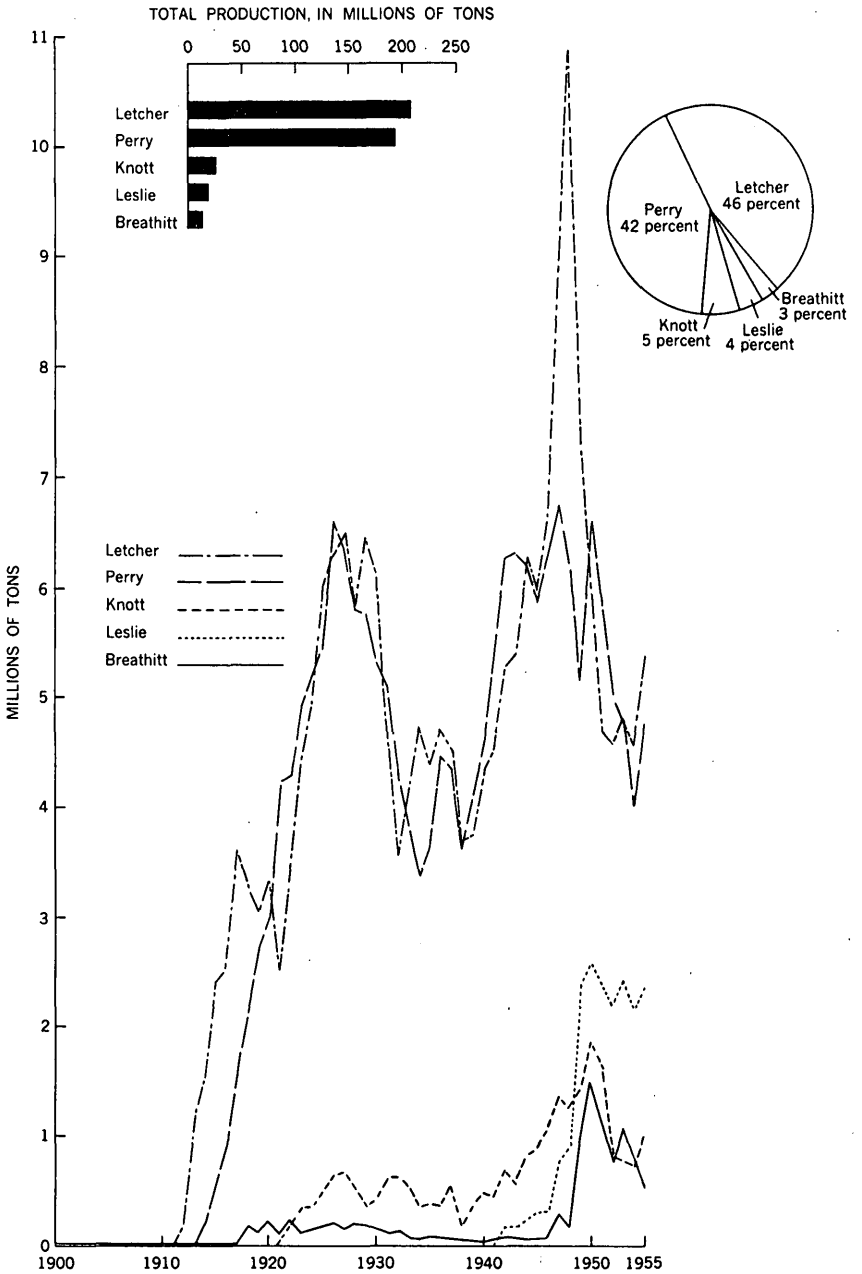

FIGURE 8.—Coal production in the Hazard reserve district by county, 1900–1955.

ferred. These three categories show the following distribution according to thickness classifications:

	Percent of total tonnage in beds of indicated thickness		
	42 inches or more	28 to 42 inches	14 to 28 inches
Measured	46	36	18
Indicated	20	40	40
Inferred	8	32	60

The actual coal reserves in the Hazard reserve district are possibly much greater than those calculated, as some of the beds, mostly those beneath the Whitesburg coals, underlie large areas where there has been little or no core drilling. As these beds are of commercial importance in the outcrop areas, it is likely that they also contain reserves where subsurface prospecting is lacking. Therefore, undisclosed reserves probably will increase considerably the total calculated reserves based on present information.

COAL BEDS OF THE SOUTHWESTERN RESERVE DISTRICT

By Erwin J. Lyons

LOCATION

The Southwestern reserve district of the Eastern Kentucky coal field contains about 3,400 square miles and is triangular in shape (pl. 15). The district includes all of Clay, Knox, Laurel, Lee, McCreary, and Owsley Counties, and parts of Bell, Clinton, Estill, Jackson, Madison, Pulaski, Rockcastle, Wayne, and Whitley Counties, a total of 15. Within the Southwestern reserve district are the producing areas of Barbourville, Corbin, Jellico, Manchester, McKee, Somerset, and Whitley City.

The boundaries of the Southwestern reserve district are the north lines of Estill and Lee Counties; the east lines of Lee, Owsley, Clay, and Bell Counties; the Pine Mountain fault; the Kentucky-Tennessee State line; and the Pottsville escarpment (pl. 1).

DRAINAGE AND TOPOGRAPHY

The largest rivers in the Southwestern reserve district are the Kentucky and the Cumberland (pl. 1). The Kentucky River flows northwestward through the northern part of the district. Its largest tributaries are the South Fork of the Kentucky River which flows northward through the eastern part of the district, and Station Camp Creek, which flows northward through the northwestern part of the

district. The main tributaries of the South Fork of the Kentucky River are Goose Creek and Red Bird River.

The Cumberland River flows westward through the southern part of the district; its largest tributaries are the Rockcastle River, which flows into the Cumberland River from the north, and the South Fork of the Cumberland River, which enters the Cumberland from the south. The Kentucky River and its tributaries drain the northern and eastern parts of the district and the Cumberland River and its tributaries the southern and western parts.

The Southwestern reserve district contains three physiographic units: the westward-facing Pottsville escarpment with its characteristic sandstone cliffs, natural bridges, gorges, and waterfalls; a bench-like area immediately southeast of the escarpment, which was formed on resistant sandstone beds; and an upland region farther east whose pattern is one of crooked valleys, winding ridges, steep slopes, and a scarcity of flatlands.

TRANSPORTATION

U.S. Highways 25—including 25 East and 25 West—27, and 421 are north and south roads through the district and are linked by Kentucky State Routes 30, 80, and 92 (pl. 3).

Railway transportation is furnished by the Southern Railway System in the southwestern part of the district and by the Louisville and Nashville Railroad in the northern, central, and eastern parts.

The Kentucky River is navigable from a short distance above Beattyville, in the northeastern part of the district, to the Ohio River.

SOURCES OF DATA

Most of the information about this district was obtained by reconnaissance fieldwork by members of the U.S. Geological Survey (pl. 2). This information was supplemented by data from reports and records of the Kentucky Geological Survey, the Department of Economic Development of Kentucky, and several coal companies. The principal sources of published information relating to the western part of the district and the coals of the Lee formation are reports by Crandall (1891), Sullivan (1891), Fohs (1912), and Miller (1910). Information about the eastern part of the district and coals of the Breathitt formation is given in some of the above reports and also in reports by Hodge (1910, 1918a, 1918b), Crandall and Sullivan (1912), Russell (1918), and Jillson and Hodge (1919).

STRATIGRAPHY

The Pennsylvanian system in the Southwestern reserve district is represented by the Lee and Breathitt formations, the Lee formation being the older. The boundary between the two is at the base of the

Lily coal or its equivalents (fig. 9) or, where this coal is absent, at the top of the Corbin sandstone of the Lee formation.

The Lee formation is best exposed in the Pottsville escarpment along the western margin of the district. Eastward from the escarpment the Lee formation is overlain by the Breathitt formation, and in the eastern part of the district the Lee is exposed only in the larger and more deeply eroded valleys and in some of the areas underlain by structural highs.

The contact of the Lee formation with the underlying Mississippian rocks is disconformable. The pre-Pennsylvanian erosion surface locally has a relief as great as 100 feet in the district. Where the Mississippian rocks are limestone or red or green shale, or where the basal bed of the Lee formation is sandstone or conglomerate, the contact is easily recognized. In places, however, the Mississippian rocks and the rocks of the Lee formation have similar lithologic characteristics, and the position of the contact is not easily determined.

The thickness of the Lee formation increases from about 350 feet in Lee County to 800 feet or more in McCreary County (Miller, 1910, p. 6–7). The Lee consists of conglomerate, sandstone, siltstone, shale, underclay, and coal. The rocks most characteristic of the Lee formation are the quartz-pebble conglomerates which are massive, cliff forming, and coarse grained in many places. The pebbles are scattered through the rock or are concentrated in bands or lentils. The Rockcastle and Corbin units of Campbell (1898) and the Livingston member of Miller (1910, p. 9–10) are conglomerates of this type, although the Corbin is much less conglomeratic than the others and is a sandstone in many exposures. In the Breathitt formation quartz-pebble conglomerate beds are known only in a very few localities (Wanless, 1946, p. 12), and pinkish, friable sandstone, closely resembling the Cobin, was found about 70 feet above the Lily coal in the Stearns quadrangle and in the interval between the Bacon Creek and Blue Gem coal beds in the Manchester quadrangle.

The thickest exposures of the Breathitt formation are in the extreme southeastern and eastern parts of the district, particularly in the north half of the Pineville quadrangle and the south half of the Big Creek quadrangle where about 1,000 feet of the formation is exposed. In the Hazard reserve district to the east the Breathitt formation thickens markedly from north to south, but in the Southwestern reserve district it thickens from the northeast to the southwest, that is, from the Big Creek to the Stearns quadrangle. The amount of thickening in the Southwestern reserve district is only about 150 feet and is entirely in the interval between the Moss and Fire Clay coal beds (fig. 9).

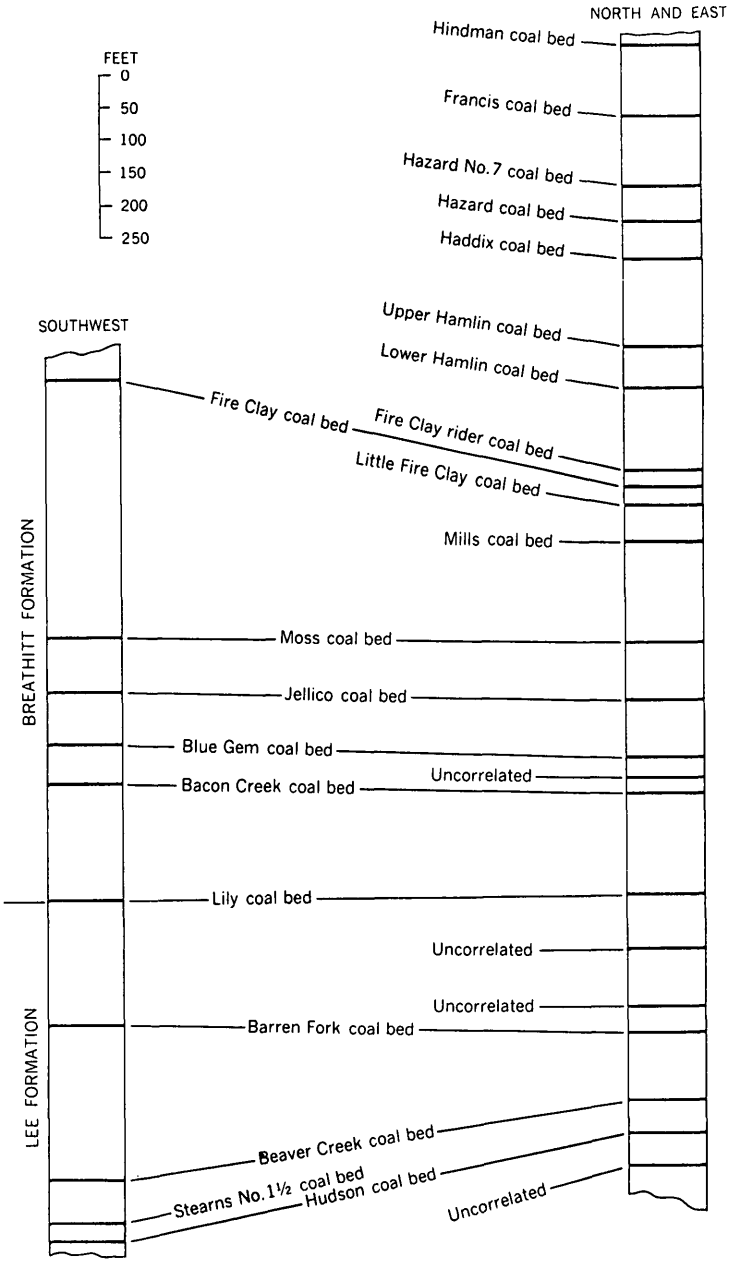

FIGURE 9.—Generalized geologic columns for the Southwestern reserve district.

In addition to the coal and underclay and very little limestone, the rocks of the Breathitt formation consist of shale, sandstone, and siltstone. These rocks are much like those of the Lee formation, the most noticeable difference being the higher content of mica and the lower content of quartz of the sandstone in the Breathitt.

The Kendrick shale member and the Magoffin beds of the Breathitt formation are not well exposed in the Southwestern reserve district. The Kendrick shale member was not recognized except possibly in one drill hole. Hodge (1918b, p. 85) noted a thin, fossiliferous limestone, which probably represents the Magoffin beds, above the Hamlin coal in the Goose Creek area but found it in only two localities. The Fire Clay coal bed which, because of its distinctive flint clay partings, is one of the best marker beds of the Breathitt formation throughout most of the Eastern Kentucky coal field. However, it has too limited a distribution in the Southwestern reserve district to be useful for correlation (pl. 10).

GEOLOGIC STRUCTURE

The rocks of the Southwestern reserve district have a regional dip to the southeast, about 20 feet per mile. Superimposed on this gentle regional dip are anticlines, synclines, domes, and basins. The only large faults are the Mount Vernon fault in Rockcastle County and the White Mountain fault and an unnamed fault in Bell County (pl. 4).

The trends of the larger folds, such as the Rockcastle River uplift, the Eastern Kentucky syncline, and the Artemus anticline, are northeast, in general parallel to the Pine Mountain fault. The trends of many of the smaller folds, however, vary from this direction.

The Rockcastle River uplift is in Laurel, Clay, and Owsley Counties. As described by McFarlan (1943, p. 145), it is about 30 miles long and 10 miles wide, and has a maximum closure of 80 feet. Jillson (1926, p. 229) states that well records indicate the interval between the top of the Mississippian rocks and the Lily coal increases southeast from the uplift.

The Artemus anticline is in Knox and Whitley Counties. Two pronounced domes about 5 miles apart are on the anticline in the Barbourville quadrangle (Jillson and Hodge, 1919, p. 4–7; Theis, 1949). Because of this structure, the Lee formation is exposed at the surface in this area.

The southwestern extension of the Eastern Kentucky syncline lies north of the Artemus anticline in Knox County. To the northeast this syncline, according to McFarlan (1943, p. 137), is a distinct basin with a closure on the 900-foot contour line of the Fire Clay coal, but in the Southwestern reserve district the basin is not well defined.

COAL BEDS OF THE LEE FORMATION

As many as fifteen coal beds are in the Lee formation in some parts of the Southwestern reserve district, but only three, the Hudson, Beaver Creek, and Barren Fork, have been correlated throughout the area. Although most of the coal beds, other than these three, are thin and do not extend any great distance, some are thick enough and of wide enough extent to be mined. These are included in the discussion below according to their stratigraphic position and, except for the Stearns No. 1½ coal bed, have been designated as "Uncorrelated" coal beds (fig. 9).

Plate 5 shows the distribution of all the coal beds of the Lee throughout the Southwestern reserve district.

UNCORRELATED COAL BEDS

In the northern and eastern parts of the Tyner quadrangle a coal, known locally as the "Bottom seam," is present about 75 feet above the Mississippian rocks and about 50 feet below the position of the Hudson coal. The maximum measured thickness of the bed is 39 inches. It has been mined from strip pits in a few localities in the quadrangle. Total estimated original reserves in all reliability categories are 36,810,000 tons.

In the west-central part of the Livingston quadrangle a coal bed 25 to 45 feet below the Hudson coal may be a correlative of the "Bottom seam." In this area the maximum thickness of the bed is 22 inches. Total estimated original reserves, all classified as inferred, amount to 3,990,000 tons.

HUDSON COAL BED

The Hudson coal bed, also called the Lee No. 1, the Stearns No. 1, the Livingston, and the Parting bed, has been identified throughout the Southwestern reserve district. In most places it is too thin to be mined and in others it is absent, having never been deposited because of the topographic relief of the pre-Pennsylvanian surface.

The interval between the Hudson coal and the Mississippian rocks ranges from 20 to 100 feet. Reserves of workable thickness were found only in the Barthell and Stearns quadrangles in the southern part of the district, where the maximum thickness of the bed is 76 inches, and in the Livingston quadrangle in the northern part, where the maximum thickness is 52 inches.

The Hudson bed is common banded coal in most places, but in some exposures in the Livingston quadrangle the upper part of the bed is cannel coal. Miller (1910, p. 16) stated that the coal has a parting which may thicken from a few inches to several feet in a short distance, but this parting was seen only in the Livingston quadrangle

in a few places. Analyses, on an as-received basis, of mine samples from the Co-Operative, the Fidelity, and Stearns No. A mines in McCreary County show the following range of composition and calorific values (Fieldner and others, 1944, p. 117):

	Low	High		Low	High
Moisture.....percent..	3.1	3.8	Ash.....percent..	5.7	9.9
Volatile matter.....do....	35.5	39.4	Sulfur.....do....	1.9	3.4
Fixed carbon.....do....	50.0	54.0	Calorific value.....Btu..	12,870	13,490

When the Hudson coal was first opened, most of the production was from the area adjacent to the Cumberland River in the northern half of the Cumberland Falls quadrangle. In recent years production has been largely from the Barthell quadrangle in McCreary County, the Livingston quadrangle in Rockcastle, Jackson, and Laurel Counties. It is probable that much of the coal that is readily accessible from outcrop has been mined out, especially in the northern part of the district.

Total estimated original reserves of the Hudson coal in all three reliability categories amount to 188,010,000 tons, of which 93,650,000 tons is in the southern part of the district and 94,360,000 tons in the northern.

STEARNS NO. 1½ COAL BED

The Stearns No. 1½ coal bed has been mined rather extensively in the Barthell and Stearns quadrangles in McCreary County. It lies 10 to 25 feet above the Hudson coal. The maximum thickness of the bed is 68 inches. Analyses, on an as-received basis, of six mine samples from the Worley mine in the Barthell quadrangle show the following range of composition and calorific values (Fieldner and others, 1944, p. 118):

	Low	High		Low	High
Moisture.....percent..	3.7	4.4	Ash.....percent..	3.5	5.4
Volatile matter.....do....	35.0	38.2	Sulfur.....do....	0.5	0.7
Fixed carbon.....do....	54.6	55.9	Calorific value.....Btu..	13,390	13,910

The last reported production from the Stearns No. 1½ bed was in 1953 from the Barthell quadrangle. It is probable that most of the coal easily accessible from the outcrop has been mined out. Total estimated original reserves in all three reliability categories amount to 26,090,000 tons.

BEAVER CREEK COAL BED

Probably the most widely distributed of the coal beds in the Lee formation is the Beaver Creek bed, also called the Stearns No. 2,

the New Livingston, and the Beattyville bed. It extends almost continuously from the Pall Mall quadrangle in the extreme southwestern corner of the district to the Beattyville quadrangle in the northeastern part of the district. The largest gap in its known distribution is in the northern part of the Dykes quadrangle. In the westermost quadrangles, the Pall Mall, Monticello, and part of the Burnside, relatively small hilltop areas are underlain by the Beaver Creek coal. To the east the coal goes below drainage approximately along a line extending from the eastern part of the Barthell quadrangle to the Cumberland Falls quadrangle to the eastern part of the Livingston quadrangle to the Beattyville quadrangle.

The interval between the Beaver Creek and Hudson beds ranges from 30 to 140 feet. In some places, especially in the northern part of the district, the Hudson bed is absent and the Beaver Creek coal in some localities is only 20 feet above the Mississippian rocks. The maximum thickness of the Beaver Creek bed ranges from 34 to 72 inches. The thinner beds are in the Mount Vernon and Livingston quadrangles and the thicker in the Barthell and Stearns quadrangles. In a few exposures the coal contains a parting of clay or shale and lenses or stringers of iron sulfide. A 6-inch layer of cannel coal was found at one locality in the Burnside quadrangle, and Miller (1910, p. 26) reports the occurrence of a 10-inch layer of cannel coal along the Rockcastle River in Pulaski County. Analyses of two mine samples, on an as-received basis, from the Stearns No. 1 mine in McCreary County show the following range in composition and calorific values (Fieldner and others, 1944, p. 117):

	Low	High		Low	High
Moisture.....percent..	2.4	2.7	Ash.....percent..	10.1	12.5
Volatile matter.....do....	37.5	40.8	Sulfur.....do....	3.2	3.4
Fixed carbon.....do....	46.7	47.3	Calorific value.....Btu..	10,380	13,330

The roof is shale, silty shale, or siltstone, overlain in places by sandstone which rests directly on the coal where the shale or siltstone is absent.

In recent years the larger part of the production of the Beaver Creek coal has come from McCreary, Pulaski, and Lee Counties. Total estimated original reserves in all three reliability categories amount to 666,380,000 tons.

BARREN FORK COAL BED

The Barren Fork coal is known also as the Stearnes No. 3, the Corley, Hollow, and the Bond bed. It is exposed in three fairly large areas: the Livingston and the Tyner quadrangles; the Dykes and the London quadrangles; and the Burnside and north half of the Cum-

berland Falls quadrangles. Smaller areas in which the coal is found are in the Beattyville and the Irvine quadrangles, the Mount Vernon and the Livingston quadrangles, and the Stearns and the north half of the Barthell quadrangles.

The interval between the Barren Fork and Beaver Creek coals in the northern part of the district ranges from 90 to 160 feet. It increases southward, however, and in the southern part the range is from 150 to 260 feet. The maximum thickness of the bed is 51 inches, but in the extreme northeastern and southwestern parts of the district the bed is much thinner and in some areas is not thicker than 16 inches. Fohs (1912, p. 62–63) reported a thickness of 85 inches in Rockcastle County, but this was not confirmed. Most of the coal is common banded, but a few exposures contain layers of cannel coal. The coal contains only a few partings of clay or shale; however, a single parting may be as thick as 3 feet. Iron sulfide lenses, as much as one-half inch thick, are not uncommon.

The roof rock of the coal is shale or siltstone containing ironstone concretions. A sandstone bed overlies these rocks in many of the exposures and, where they are absent, forms the roof rock of the coal. The sandstone is very fine to medium grained, thin bedded to massive, and conglomeratic in places, and it reaches its maximum thickness of 80 feet in the southern part of the district.

Present production from the Barren Fork coal is largely from Jackson County, with a smaller tonnage coming from Laurel and McCreary Counties. Most of the coal is mined underground, but some of it is mined by surface stripping. The Barren Fork mines in McCreary County at one time were large producers but are now shut down. Total estimated original reserves in all three reliability categories amount to 438,630,000 tons.

UNCORRELATED COAL BEDS

In the Tyner quadrangle a coal bed 25 to 55 feet above the Barren Fork coal probably is the same as a bed that lies 145 to 200 feet below the Lily coal in the Stearns quadrangle. In the Tyner quadrangle the bed is no more than 15 inches thick and is exposed only in small areas in the northern and central parts of the northwest quarter of the quadrangle. In the Stearns quadrangle the bed has a maximum thickness of 21 inches and is found only in the southwestern part of the northeast quarter of the quadrangle. The coal is mined only for domestic use. In the Tyner quadrangle where all the estimated original reserves are classified as inferred, they total 9 million tons. In the Stearns quadrangle, where they are classified as indicated and inferred, they total 17,450,000 tons.

In the southwestern quarter of the Beattyville 15-minute quad-

rangle, at a vertical interval of 110 to 150 feet above the Barren Fork coal, is an unnamed and uncorrelated coal bed that has a maximum thickness of 46 inches. The roof rock is a black shale, silty shale, or siltstone overlain by a thin- to medium-bedded sandstone which, where the shale or siltstone is absent, forms the roof rock. There are two commercial mines in the coal. Estimated original reserves in all three reliability categories total 33,060,000 tons.

In the northeastern quarter of the Beattyville 15-minute quadrangle are isolated occurrences of a coal bed, averaging 15 inches in thickness, at about the same stratigraphic position as the coal described above. Where this coal is absent, a sandstone containing coal fragments or a very carbonaceous claystone is present. In a few places the coal is mined for domestic use. Estimated original reserves, all in the indicated and inferred categories, total 3,400,000 tons.

What is probably the same coal occurs about 110 feet below the Lily coal in the Corbin and the Stearns quadrangles. The maximum thickness of the bed is 36 inches in the Stearns quadrangle and 20 inches in the Corbin quadrangle. At one small mine in the Stearns quadrangle the coal has a bony streak near the top of the bed. In both quadrangles the coal has been mined by open-pit methods, and in the Stearns quadrangle an underground mine also was operated. Estimated original reserves in all three reliability categories total 10,780,000 tons for both quadrangles.

COAL BEDS OF THE BREATHITT FORMATION

The Breathitt formation of the Southwestern reserve district contains 15 named coals of which 13 are thick and extensive enough to warrant computing reserve tonnages (fig. 9). In addition, there are a number of uncorrelated coals, but reserves were calculated for only one of them.

LILY COAL BED

The Lily coal originally was called the No. 1 coal because of its position as the first extensive coal above the "Conglomerate" or Lee formation. Miller (1910, p. 55) called it the No. 4 because it is the fourth extensive coal above the base of the Pennsylvanian system. At the present time it is known in the southern part of the district as the Swamp Angel, River Gem, and Williamsburg bed; in the central part as the Lily, Manchester, Horse Creek, and Pittsburgh bed; and in the north, in Lee and adjoining counties, as the Zachariah bed.

In the Southwestern reserve district the Lily coal is present in four separate areas (pl. 6). The southernmost area is in McCreary and Whitley Counties in the Stearns and Jellico quadrangles and in the southern part of the Corbin quadrangle. Northeast of this area, mostly in Knox County, is a relatively small area in the Barbourville

quadrangle. The largest of the four areas is mostly in Laurel and Clay Counties, occupying the northern part of the Corbin quadrangle, parts of the London, Manchester, and Big Creek quadrangles, and the southern part of the Booneville quadrangle, and a very small outlier in the Livingston quadrangles. The fourth and smallest of the areas is in Lee and Owsley Counties in the Beattyville quadrangle. This last is a part of the area of the Zachariah coal of Wolfe and Breathitt Counties in the Licking River and Hazard reserve districts, respectively. Each of these four areas is discussed separately.

In the southernmost area the Lily coal goes below drainage in the Jellico quadrangle about half a mile north of the Kentucky-Tennessee State line and about 2 miles east of the western border of the quadrangle (pl. 6). The bed is close to drainage level, however, at about the center of the quadrangle where it is mined from the valley bottoms by open-pit methods.

In this area the Lily coal thickens to the east and northeast, the maximum thickness increasing from approximately 25 inches in the Stearns quadrangle to approximately 35 inches in the Jellico to more than 40 inches in the Corbin quadrangle. In the western part of the area lenses of iron sulfide, and less commonly of bony material, were found in some exposures of the Lily. None were found in the eastern part. A parting of siltstone, shale, or rashy material, usually in the upper part of the bed, was seen in a few outcrops, most of them in the Stearns quadrangle. The thickest parting noted was 18 inches. The following analysis of the Lily coal is of a delivered sample from the Campbell River Gem mine (open pit) in McCreary County (Aresco and others, 1956, p. 21):

Moisture (as-received)	percent	4.0	
Volatile matter (dry)	do	40.0	
Fixed carbon (dry)	do	49.1	
Ash (dry)	percent	10.9	
Sulfur (dry)	do	3.3	
Calorific value (as-received)	Btu	12,620	

In most exposures of the coal the roof rock is siltstone or shale, not uncommonly containing ironstones. A roof rock of sandstone was seen at only one locality in the Jellico quadrangle.

Production of the Lily coal in this area has been predominantly by strip-mining methods. Estimated original reserves in all three reliability categories total 247,990,000 tons.

In Knox County in the Barbourville quadrangle the Lily coal occurs in an eastward-trending band through the north half of the quadrangle. The bed crops out in this area because of the Artemus anticline, the highest parts of which are in the northwest and northeast quarters of the quadrangle (Jillson and Hodge, 1919, p. 4–7; Theis, 1949). At present (1955) very little, if any, coal is mined from the

Lily bed in this area, and most of the old mines are caved so that the coal could be examined in only two exposures. The greatest thickness measured was 20 inches, but a maximum thickness of 30 inches was reported. Jillson and Hodge (1919, p. 34) state that there is no parting in the Lily coal in this area, but that at one locality there is a rider coal 20 feet above the seam. Estimated original reserves in this area in all three reliability categories total 44,340,000 tons.

The Lily coal in the east-central part of the Southwestern reserve district is exposed best in Laurel and Clay Counties (pl. 6). Except for a small outlier in the Livingston quadrangle, the seam has been eroded or thins to less than 14 inches north and west of the London and Manchester quadrangles, and west, north, and northeast of the Booneville quadrangle. The coal is below drainage to the south and east.

The Lily is common banded coal except in the London and Booneville quadrangles, where cannel coal either makes up the entire bed or forms a layer on top of the banded coal. In the western part of the area, mostly in the London quadrangle, the coal has a bony streak in the middle or near the top of the bed and in many of its outcrops also has lenses of iron sulfide. Shale partings, which are as much as 7 inches thick in some exposures, are more rare. Analyses, on an as-received basis, of 21 tipple samples of Lily coal from 6 mines in Clay County show the following range in composition and calorific values (Fieldner and others, 1944, p. 61–62):

	Low	High		Low	High
Moisture.....percent..	3.0	7.2	Ash.....percent..	4.2	8.8
Volatile matter.....do....	33.2	39.1	Sulfur.....do....	.9	2.7
Fixed carbon.....do....	50.6	54.8	Calorific value.....Btu..	12,940	13,970

In the eastern part of the London quadrangle and in the west-central part of the Manchester quadrangle, a rider coal overlies the Lily at an interval ranging from 6 to 18 feet. The rider has a maximum thickness of 15 inches. A shale that overlies the rider contains Lingulas in some places.

Throughout most of its extent the roof rock of the Lily coal is shale or claystone, which in some outcrops contains ironstones or Lingulas, the last occurring mostly in the eastern part of the London quadrangle. In the Manchester quadrangle and in the Booneville quadrangle, the shale and claystone roof is absent and sandstone forms the immediate roof.

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Production in this area has been by both underground and strip-mining methods, most of the strip mining being done in Laurel County. Estimated original reserves in all three reliability categories total 510,000,000 tons.

The most northern and smallest area of Lily coal in the Southwestern reserve district is in the Beattyville quadrangle in Lee and Owsley Counties. The coal in the northeastern part of Beattyville quadrangle is a part of the area of Zachariah coal in the Licking River reserve district and is described under that name in the section on that district. In the Beattyville qudrangle the maximum thickness of the bed is 46 inches, but it thins to less than 14 inches in a short distance to the north and west. In most places the coal is in two benches separated by shaly partings and overlain by siltstone and silty shale. Erosion has removed not only the roof rock but also the upper bench of the coal in some places, and a very fine grained thin-to medium-bedded sandstone has been deposited. A 3-inch rider coal 6 feet above the main bed was seen in one exposure.

In recent years production from the Lily coal in this area has been small. Estimated original reserves in both the Beattyville quadrangle in all three reliability categories total 17,860,000 tons.

BACON CREEK COAL BED

The Bacon Creek coal is a thin but relatively persistent bed in the southern, southeastern, and eastern parts of the Southwestern resource district, largely in McCreary, Whitley, Knox, and Clay Counties. It is also known as the Lower Blue Gem and, in Whitley and McCreary Counties, as the Black Wax, and is correlated with the Lower Elkhorn coal. The Bacon Creek coal lies from 120 to 180 feet above the Lily coal throughout most of the area in which it is found, but in the Stearns and the Jellico quadrangles the interval is 220 to 250 feet thick.

The coal is thin, its thickness averaging only about 17 inches in those areas where the bed is 14 inches or more thick. The maximum thickness measured was 23 inches. A parting was found at only one locality, which was in the Jellico quadrangle. The roof rock is shale except in four exposures in the northern part of the Jellico quadrangle, where it is sandstone.

Commercial production from the Bacon Creek seam is not very large, probably because in most of the areas where this bed is 14 inches or more thick the overlying coalbeds are thicker. The areas for which reserves were computed are rather small and are in the Stearns quadrangle, the northern half of the Jellico quadrangle, the southern half of the Corbin quadrangle, and the western half of

the Big Creek quadrangle. Estimated original reserves, all in the indicated and inferred categories, total 20,860,000 tons.

UNCORRELATED COAL BED

In the Barbourville quadrangle are several areas of coal, which locally is called the Mudslip. This coal is 25 to 30 feet below the Blue Gem bed. In the few sections seen the coal bed was approximately 24 inches thick, and in one exposure it contained much iron sulfide. The roof rock is sandstone or siltstone. Most of the coal is mined for local domestic use. Estimated original reserves, classified as indicated and inferred, total 10,980,000 tons.

BLUE GEM COAL BED

The Blue Gem coal is one of the more preferable coal beds in the Southwestern reserve district. It is correlated with the Upper Elkhorn No. 1 coal, the Lower Howard bed as defined by Russell (1918, p. 197), and the No. 6 coal of Miller (1910, p. 61–62). The interval between the Blue Gem and the underlying Bacon Creek coal ranges from 30 to 150 feet, the maximum and minimum intervals both being in the western part of the district. Within a 7½-minute quadrangle, however, the range of interval is not more than 40 feet.

The largest area of Blue Gem coal is in Whitley and Knox Counties, with small extensions into McCreary and Bell Counties (pl. 7). North of this large area are four smaller ones—one each in Clay County and in northern Knox County, and two in Laurel County. The largest area has been limited on the west and northwest by erosion, and to the south, east, and northeast the coal, except in a few places, lies below drainage. The Pine Mountain fault terminates the coal bed in the southeastern part of the Jellico quadrangle, and the coal thins to less than 14 inches in the Fonde quadrangle a little north of the Pine Mountain fault, and along an east-west line in the south-central part of the Barbourville quadrangle.

In the largest area of Blue Gem coal the maximum thickness is 36 inches, but the thickness of most of the bed is 20 to 25 inches. The areas of thicker coal are relatively small. In Laurel County where there are two small areas of Blue Gem coal, the bed is only 15 inches thick, but in Clay County it is 33 inches thick and in northern Knox County 23 inches. The Blue Gem coal throughout most of its extent is a single bed of bright attrital coal, but in a few exposures the coal is split by a shale parting as much as 3 inches thick, or it has a rashy layer either on top of the coal or as a parting. Analyses of 3 tipple samples of the Blue Gem coal from 1 mine in Knox County and of 13 tipple samples of the Blue Gem coal from 5 mines in Whitley County,

on an as-received basis, show the following range of composition and calorific values (Fieldner and others, 1944, p. 109, 162, 163):

	Low	High		Low	High
Moisture.....percent..	2.4	6.3	Ash.....percent..	1.4	8.7
Volatile matter.....do....	33.7	44.4	Sulfur.....do....	0.7	3.7
Fixed carbon.....do....	48.2	56.2	Calorific value.....Btu..	12,820	14,170

The roof rock of the Blue Gem coal bed in the southwestern part of the district is a grayish shale, separated from the coal in places by a thin bed of black fissible shale. A fine-grained thin-bedded to massive sandstone overlies the grayish shale in some exposures and, where the shale is absent, lies immediately on the coal. The exposures in which the sandstone forms the immediate roof, or is separated from the coal by a thin bed of claystone, become more numerous to the north and east in the Corbin and Barbourville quadrangles, and the sandstone is the predominant roof rock in some areas. The sandstone also is a prominent cliff former in many places (Crandall and Sullivan, 1912, p. 103).

Most of the Blue Gem coal is mined underground; only a small amount is obtained by stripping. The major part of the production is from Knox and Whitley Counties. Production from the Blue Gem bed has decreased in this district in recent years. Many of the active mines are truck mines and are relatively small producers. Decrease in production possibly is due in part to the opening of thicker beds in the area and in part to the increased cost of mining thin beds by hand methods. In the largest area of Blue Gem coal in Whitley and Knox Counties, estimated original reserves in all three reliability categories total 452,670,000 tons. In the four smaller areas in Clay, Laurel, and northern Knox Counties, estimated original reserves total 17,910,000 tons, all in the indicated and inferred categories.

JELLICO COAL BED

The Jellico coal is one of the more important coal beds of the Breathitt formation in the Southwestern reserve district. It is known as the Straight Creek coal in Bell County, the Beech Creek coal in Clay County, and probably is the equivalent of the upper split of the Howard coal of Hodge (1918a, p. 6, 58; 1918b, p. 87) and the Upper Howard coal as defined by Russell (1918, p. 196–197). It is correlated with the Upper Elkhorn No. 3 coal in this report. The Jellico coal lies 60 to 125 feet above the Blue Gem coal in the Southwestern reserve district, but the range of interval in a particular area is not more than 30 feet, except in the Barbourville quadrangle where it is 60 feet.

The larger areas in which the Jellico coal occurs are in Whitley, Knox, Bell, and Clay Counties, and from these, smaller areas extend into eastern McCreary and Laurel Counties (pl. 8). To the west the Jellico coal is eroded, and on the southeast it is terminated by the Pine Mountain fault. The coal is below drainage to the east because of the regional dip, and in the northern part of Knox County because of the Eastern Kentucky syncline. No Jellico coal was found in eastern Whitley County in the area around the junction of the Corbin, Barbourville, Fonde, and Jellico quadrangles, probably because exposures are poor, and it has not been prospected or mined because it splits into thin seams.

The Jellico coal has a maximum thickness of 64 inches in the Pineville quadrangle, and in a number of localities throughout the district the bed is more than 42 inches thick, but most of these areas of thicker coal are relatively small. The thickness of most of the Jellico coal ranges from 28 to 42 inches. The Jellico is a single bed throughout the most of its extent, but in a few places it is split by a clay or shale parting, which, except in a very few exposures, is less than 9 inches thick. Analyses, on a as-received basis, of 34 mine samples of the Jellico coal from 9 mines in Bell County show the following range of composition and calorific values (Fieldner and others, 1944, p. 45–56):

	Low	High		Low	High
Moisture.....percent..	2.0	5.1	Ash.....percent..	1.2	7.4
Volatile matter.....do....	34.8	40.5	Sulfur.....do....	.7	1.7
Fixed carbon.....do....	54.1	58.1	Calorific value.....Btu..	13,120	14,600

The roof rock of the Jellico coal is shale, sandstone, and, in a few exposures, siltstone. The shale is light to dark gray, thin and evenly bedded, and contains a few ironstones. The sandstone overlies the shale or, where the shale is absent, lies directly on the coal with an erosional contact in many places. The sandstone is very fine to fine grained, medium bedded to massive, crossbedded in some exposures, and, in a few areas, forms a cliff. The lower part of the bed, in many outcrops, contains coal fragments and lenses.

Most of the production of Jellico coal in the Southwestern reserve district comes from Bell, Knox, and Whitley Counties with some intermittent production from Laurel and McCreary Counties. Clay County has no recent recorded production. For the past few years the largest single producer has been Whitley County. Most of the Jellico coal once was mined principally by underground methods, but in recent years the tonnage produced by strip mining is approaching

that from underground mines. Estimated original reserves in all three reliability categories total 712,380,000 tons.

In the northern part of the district in the Beattyville quadrangle a coal bed, which is correlated with the Jellico, is present in small areas on the ridge along the Lee-Owsley County line. In the few exposures seen, the coal was 34 to 39 inches thick and at one outcrop had a half-inch shale parting. The roof is of sandstone. Estimated original reserves, all in the inferred category, total 3 million tons.

MOSS COAL BED

The Moss coal, also known locally as the Rim or Dirty coal, is one of the less important coals of the Southwestern reserve district. It is correlated with the Amburgy bed. The interval between the Moss and the underlying Jellico bed ranges from 60 to 140 feet in thickness, in most localities from 75 to 115 feet. The largest area of Moss coal is in Knox and Bell Counties, and smaller areas are Whitley, Clay, Owsley, and Lee Counties (pl. 9). The largest area is terminated by the Pine Mountain fault on the southeast; to the east the coal goes below drainage in the Pineville quadrangle.

The Moss coal is not more than 42 inches thick in most of the outcrop area, and the average thickness is less than 30 inches. In one locality in the Pineville quadrangle, the bed has a maximum thickness of 51 inches. In the largest area in Knox and Bell Counties the coal contains partings of clay or shale, which in most localities are less than 20 inches thick but in some are as much as 30 inches. To the west and north the partings become scarcer. The coal contains small amounts of iron sulfide. In a few places a rider coal, less than 12 inches thick, lies approximately 10 feet above the main bed.

The roof rock of the Moss coal is shale or siltsone, overlain in places by a sandstone bed, which lies directly on the coal where the shale or siltstone is absent.

Although there is some production from the Moss, it is relatively small. Recorded production for the years 1952, 1953, 1954 (Sisk), and 1955 (Phalan) for the Southwestern reserve district is less than 100,000 tons. Estimated original reserves in all three reliability categories total 277,410,000 tons.

MILLS COAL BED

The Mills coal bed is not an important producer in the Southwestern reserve district. It is correlated with the Whitesburg coal. The interval between the Mills and the underlying Moss coal ranges from 115 to 165 feet, in most of the area being approximately 150 feet. The largest area of Mills coal is in Knox County in the Pineville

quadrangle. Smaller areas are in the Barbourville and Big Creek quadrangles.

The maximum thickness of the Mills coal in the Pineville quadrangle is 33 inches, and the average thickness of coal that is more than 14 inches thick is 21 inches. In this same area the coal in about half of the exposures contains partings of clay or shale which range from 3 to 26 inches in thickness. The roof is sandstone or shale.

There had been no recorded production of the Mills coal from this area in recent years. Estimated original reserves in all three reliability categories total 45,220,000 tons.

FIRE CLAY COAL BED

The Fire Clay, one of the most important coal beds in the Eastern Kentucky coal field, is a good producer and an important stratigraphic marker. It is also called the Dean, Hazard No. 4, and No. 4 bed. The interval between it and the underlying Moss coal ranges from 220 to 260 feet in the northern part of the district, and increases to a range of 360 to 400 feet in the southern and southwestern parts. In two small areas in the southwestern quarter of the Pineville quadrangle, the thickness of the interval is extreme, being about 520 feet.

The two largest areas of Fire Clay coal in the Southwestern reserve district are in eastern Clay County, and in southern Clay, northeastern Knox, and northern Bell Counties (pl. 10). A smaller, but fairly extensive, area of hilltop coal is present in southern Knox County and the adjacent parts of Whitley and Bell Counties. To the west of these larger areas are small outliers in Whitley, Knox, Laurel, and Clay Counties.

The greatest thickness of Fire Clay coal in this district is 80 inches, and much of the coal is 30 to 45 inches thick. The coal is noted for a parting of flint clay which, in the Southwestern reserve district, has a maximum thickness of 7 inches and may be near the top, middle, or bottom of the bed. This parting is not everywhere present, but was found in this district in the Corbin quadrangle, the Fonde quadrangle, the Barbourville quadrangle, the Pineville quadrangle, and the Big Creek quadrangle. In some areas the coal also contains partings of clay, shale, and siltstone, which in a few exposures are as thick as 42 inches, but commonly are less than 12 inches. As many as four partings of this kind may be present in the bed at one locality. A layer of cannel coal, less than 1 foot thick and of local extent, is found in the Manchester and the Pineville quadrangles. Analyses, on an as-received basis, of 7 mine samples from 2 mines in Bell County and of 12 mine samples from 3 mines in Knox County, show the following

range in composition and calorific values (Fieldner and others, 1944, p. 50, 109):

	Low	High		Low	High
Moisture.....percent..	3.6	7.3	Ash.....percent..	5.0	8.1
Volatile matter.....do....	33.8	37.2	Sulfur.....do....	.6	1.3
Fixed carbon.....do....	51.2	57.5	Calorific value.....Btu..	12,580	13,480

The roof rock of the Fire Clay coal bed is very fine grained to medium-grained sandstone or shale overlain by sandstone. The distribution of the sandstone and shale is irregular.

Production of the Fire Clay coal in the Southwestern reserve district is largely from underground mines. Most, if not all, of the tonnage is from Bell, Clay, and Knox Counties. From 1952 to 1954, inclusive, the largest producer was Bell County, followed by Knox and Clay Counties, in that order. In 1955, however, the largest tonnage came from Clay County, with Bell County second and Knox County third. Estimated original reserves for the entire district in all three reliability categories total 475,490,000 tons.

FIRE CLAY RIDER COAL BED

The Fire Clay rider coal, also called the McGuire, Upper Fire Clay, and Hazard No. 4A bed, is not an important bed in the Southwestern reserve district. It overlies the Fire Clay coal at intervals ranging from 5 to 70 feet. The smaller interval is in the Barbourville quadrangle and the larger in the Pineville quadrangle. The largest areas of the coal are in the northern part of the Pineville quadrangle, but in the Barbourville qudarangle it is well exposed along a ridge on the Knox-Bell County line.

The maximum thickness of the Fire Clay rider coal, excluding partings, is 60 inches, but most of it is 28 to 42 inches thick. In many of the exposures in the northern part of the Pineville quadrangle the coal bed contains from two to six partings of clay or shale, and in many places the total thickness of the partings exceeds that of the coal layers. In the hilltop area in the Barbourville quadrangle the coal in about half of the outcrops contains a single parting of clay or shale, generally less than 9 inches thick. In the Pineville quadrangle, layers of cannel coal are beneath or on top of the banded coal or, in some places, the entire bed is cannel coal. Maximum thickness of the cannel coal is 41 inches. Two analyses of mine or car samples from Jacks Creek in Clay County show the following range of composition, in percent, of the Fire Clay rider coal (Fieldner and others, 1922, p. 33):

	Low	High		Low	High
Moisture	1.0	1.2	Ash	5.9	6.0
Volatile matter	27.9	33.4	Sulfur	.4	.7
Fixed carbon	59.7	64.9			

The roof rock of the Fire Clay rider coal bed is shale overlain by sandstone which, where the shale is absent, rests directly on the coal.

The Fire Clay rider is mined mostly for local domestic use and is not an important producer. This is because of its limited area, the presence of numerous partings in some areas, and the availability nearby of other coals which are thicker or more easily mined. Estimated original reserves in all three reliability categories total 103,960,000 tons.

LOWER HAMLIN COAL BED

The Lower Hamlin coal in the Southwestern reserve district occurs mostly in Clay County, but small areas extend into Knox and Leslie Counties. The Lower Hamlin coal lies 95 to 175 feet above the Fire Clay coal. Its maximum thickness is 48 inches, but throughout most of the area it is 20 to 30 inches thick. In most exposures, except those in the eastern Big Creek quadrangle, the coal contains a parting a few inches thick. Production is small and for local domestic use. Estimated original reserves in all three reliability categories total 118,610,000 tons.

UPPER HAMLIN COAL BED

In the northern part of the Pineville quadrangle a coal bed lies about 70 feet above the Lower Hamlin bed. This bed is here called the Upper Hamlin coal and is the Haddix coal of Jillson and Hodge (1919, p. 2, 29). In the Pineville quadrangle the coal generally is less than 35 inches thick, but to the west the bed has a maximum thickness of 58 inches. Partings of clay or shale are not uncommon, in some places being present in such numbers and thicknesses that the coal is not minable. Approximately half of the coal sections of Jillson and Hodge (1919, p. 75, 77, 80–82) for the Pineville quadrangle show cannel coal as much as 25 inches thick. So far as is known, no coal is mined from this bed. Estimated original reserves total 21,370,000 tons, all in the indicated and inferred categories.

HADDIX COAL BED

The Haddix coal bed in the Southwestern reserve district is confined exclusively to Clay and Leslie Counties, Clay County having the larger area of coal. This coal is 100 to 165 feet above the Upper Hamlin coal. The thickest coal is in the Big Creek quadrangle where the thickness reaches a maximum of 70 inches, but throughout most of the area the bed is 30 to 37 inches thick. The coal commonly has

as many as five partings, most of them of clay or siltstone but a few of sandstone. The thickness of the partings ranges from 0 to 3½ feet. Drilling has revealed a coal zone extending over an interval of about 20 feet in one or two places, but most of the individual coal layers in the zone are less than 14 inches thick. No production has been reported from this bed in recent years. Estimated original reserves in all three reliability categories total 54,440,000 tons.

HAZARD COAL BED

The Hazard or Hazard No. 6 coal bed was seen at only one locality in the south-central part of the Big Creek quadrangle in Clay County, where 22 inches of bloom and weathered coal occur under a shaly sandstone or siltstone roof (pl. 11). The Hazard coal lies about 55 feet above the Haddix coal in this area. So far as is known, there is no production from the Hazard coal in this district. All estimated reserves have been assigned to the inferred category and total 3,010,000 tons.

HAZARD NO. 7 COAL BED

The Hazard No. 7 coal bed approximately 55 feet above the Hazard bed, probably is the same, in most localities, as the coal called the Flag by Hodge (1918a, p. 5) in his report on the coal beds of Goose Creek and its tributaries in Clay County. The bed is not well exposed or open in many places in the Southwestern reserve district. Only four localities were found where the coal could be examined, and at only one of these was the coal thicker than 14 inches; at this exposure it was approximately 18 inches thick. No reserves were computed for the Hazard No. 7 coal.

FRANCIS COAL BED

Information on the Francis or Hazard No. 8 coal bed was obtained for only a few relatively small areas in the northeastern part of the Pineville quadrangle (fig. 15). Hodge (1918b, p. 83) states that the Francis bed is not of much importance and, where found, is thin in this region. The Francis coal is approximately 105 feet above the Hazard No. 7 bed. In most sections studied the coal is split by sandstone, shale, or clay partings into benches which individually are less than 2 feet thick. No production of this coal is known in this district. Estimated original reserves, all in the indicated and inferred categories, total 9,710,000 tons.

HINDMAN COAL BED

The Hindman or Hazard No. 9 coal bed is the highest recognized coal in the Southwestern reserve district, lying approximately 115 feet

above the Francis coal. It is known to be thicker than 14 inches in only two small areas in the east-central part of the Pineville quadrangle. Hodge (1918b, p. 83) states that the Hindman usually lies under a thick, soft shale and at some places contains a heavy clay parting. Several of the exposures seen had one or more partings of clay or shale, the thickest of which was 19 inches. The thickest coal bed found was 53 inches and was in a single bench. No production is known from this district. The only estimated reserves for the Hindman coal are in the indicated and inferred categories and total 1,330,000 tons.

PRODUCTION

The earliest recorded production of coal in Kentucky was from the Southwestern reserve district in 1790 (Eavenson, 1942, p. 300, 538). Not until 1824, when the mines in Greenup County started producing, was there any record of production from another district in the Eastern Kentucky coal field. The Southwestern reserve district is credited with more than half of the total production of eastern Kentucky coal before the 1840's, but thereafter this district lost its dominating position and only during one decade—the 1890's—did it furnish more than half of the total production of eastern Kentucky for a 10-year period. Since the 1920's, it has produced less than 10 percent of the coal from the Eastern Kentucky coal field.

Three of the fifteen counties in the Southwestern reserve district—Knox, McCreary, and Whitley—have accounted for about 70 percent of the total production of the district (fig. 10). Bell County also has had a large production but, because it lies largely within the Upper Cumberland reserve district, it is included in the report on that district. Of the remaining 30 percent of production, approximately 17 percent can be credited to Clay and Laurel Counties and 11 percent to Jackson, Lee, Pulaski, and Rockcastle Counties. Clinton, Owsley, Wayne, and Madison Counties produced the remaining one percent. Estill County has no recorded production. Figure 10 shows the yearly production from 1900 through 1955 of the five counties that have been the largest producers in the Southwestern reserve district. These five counties account for approximately 88 percent of the total production of the district. The curves show in general three periods of high production since 1900—one between 1910 and 1920, the second in the 1920's, and the third in the middle and late 1940's. Total recorded production for the Southwestern reserve district through 1955 amounts to 144,423,300 tons (table 8).

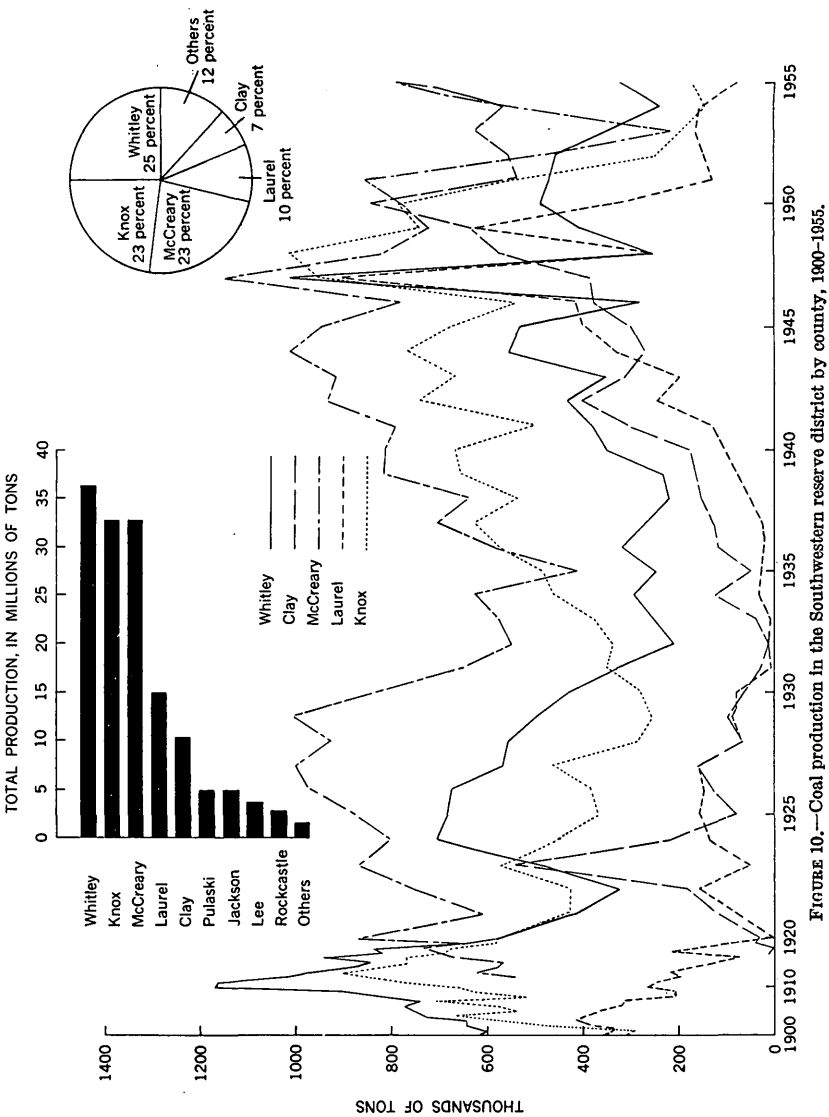

FIGURE 10.—Coal production in the Southwestern reserve district by county, 1900–1955.

SUMMARY OF RESERVE ESTIMATES

The original coal reserves in the Southwestern reserve district total 4,582,140,000 tons, of which 1,433,600,000 tons or 31 percent are in the Lee formation and the remainder, 3,148,540,000 tons, in the Breathitt formation (tables 9–11). About 48 percent of the total tonnage is in beds 28 inches or more thick and 9 percent in beds 42 inches or more thick. Only about 7.5 percent of the total tonnage is in the measured category, 39 percent in the indicated, and 53.5 percent in the inferred. The table below shows the distribution according to thickness within these three reliability categories:

Category	42 inches or more (percent)	28 to 42 inches (percent)	14 to 28 inches (percent)
Measured	23	47	30
Indicated	12	44	44
Inferred	5	35	60

Four counties contain about 67 percent of the total coal reserves of the Southwestern reserve district. Clay County contains 21 percent of the total; Knox, 20 percent; Whitley, 14 percent; and McCreary, 12 percent. All the reserves in Clay and Knox Counties and most of those in Whitley County are in the Breathitt formation, but 85 percent of the reserves in McCreary County are in the Lee formation. None of the remaining 11 counties of the district contain more than 8 percent of the total coal reserves, and for two counties, Estill and Madison, no reserve tonnages were calculated, because apparently the amounts would be relatively insignificant.

COAL BEDS OF THE UPPER CUMBERLAND RIVER RESERVE DISTRICT

By Henry L. Smith

LOCATION

The Upper Cumberland River reserve district is in the southeastern part of the Eastern Kentucky coal field between Pine Mountain on the northwest and Cumberland Mountain on the southeast (pl. 1), and includes parts of Letcher, Harlan, Bell, and Whitley Counties. The total area of the district is approximately 800 square miles, with a length of about 100 miles and an average width of about 8 miles. Of this total area, about 67 square miles are in Letcher County, 423 in Harlan County, 288 in Bell County, and 22 in Whitley County.

This reserve district is divided by Rocky Face, a ridge between Cumberland Gap and Pineville Gap, into two subdistricts (pl. 1); the

Middlesboro subdistrict west of Rocky Face includes parts of Bell and Whitley Counties and the Harlan subdistrict to the east includes parts of Bell, Harlan, and Letcher Counties.

DRAINAGE AND TOPOGRAPHY

The Upper Cumberland River reserve district is drained entirely by the Cumberland River and its tributaries. The Cumberland River flows out of the district at Pineville Gap at an elevation of approximately 1,000 feet. The principal headwaters of the Cumberland River in the Harlan subdistrict are Poor, Clover, and Martins Forks. In the central part of the subdistrict, between the city of Harlan and Rocky Face Mountain, the chief tributaries are Wallins, Puckett, and Brownies Creeks. Yellow and Clear Creeks drain the Middlesboro subdistrict west of Rocky Face and join the Cumberland River near Pineville Gap.

The Upper Cumberland River reserve district is a part of the Cumberland Mountain section of the Appalachian Plateau. It is separated from the main part of the plateau to the north by Pine Mountain. This region, between Pine and Cumberland Mountains, contains the highest and most rugged topography in Kentucky. It is characterized by high narrow ridges and winding V-shaped valleys with steep slopes. The highest elevation in Kentucky, 4,145 feet, is near The Doubles on Black Mountain in the eastern part of the district. The crest of Pine Mountain ranges from about 2,140 feet in the western part of the district to about 3,265 feet in the northeastern part near the Kentucky-Virginia State line. Cumberland Mountain is similar in relief to Pine Mountain. Its crest, ranging from 2,500 to 3,600 feet, forms the Kentucky-Virginia State line on the south.

TRANSPORTATION

Many paved highways and railroad spurs traverse the district, making most of the mining areas accessible (pl. 3). Although some coal shipments are handled by trucks, the chief means of coal transportation to the various markets is by railroad. The Louisville and Nashville Railroad, entering the district from the north through Pineville Gap, serves the principal mining areas. Some of the mining area around Middlesboro is served by the Southern Railway System.

A network of State and Federal highways makes it possible to reach any part of the coal-producing areas. U.S. 119, one of the main highways, traverses the northern part of the district from Pineville Gap east along the Cumberland River valley to Cumberland and across Pine Mountain to Whitesburg. Kentucky State Route 160 joins U.S. 119 at Cumberland and runs south through Benham and Lynch, across Black Mountain, to Appalachia, Va. U.S. 421 joins

U.S. 119 at Harland and extends southward across Harlan County to Pennington Gap, Va. U.S. 25 East crosses the district from Cumberland Gap north to Pineville.

SOURCES OF DATA

The coal reserve estimates for this district were prepared from data acquired from many sources (pl. 2). Measured and indicated coal reserve estimates for Harlan and Letcher Counties were obtained from field studies and from published reports of the U.S. Bureau of Mines (Wallace and others, 1953, 1954) and the Kentucky Geological Survey (Hodge, 1912). Inferred reserves in these counties were prepared by K. J. Englund.

Reserve estimates of coal in Bell and Whitley Counties were made from data obtained by field reconnaissance, supplemented by data from coal operators and by published reports of the U.S. Geological Survey and the Kentucky Geological Survey. Ashley and Glenn (1906) mapped the geology and coal reserves in the region south of Pine Mountain. Their work covered an area extending from Log Mountain in western Bell County to about 10 miles east of Harlan in Harlan County. Crandall and Sullivan (1912) reported on the coals in Log Mountain and in the area west of Rocky Face to Toms Creek of the Cumberland River in eastern Bell County.

STRATIGRAPHY

Coal-bearing strata exposed in the Upper Cumberland River reserve district are of Early and Middle Pennsylvanian age. The basal group of the Pennsylvanian consists of sandstone, siltstone, shale, clay, and coal. This group has been divided into the Lee formation and the Breathitt formation equivalents.

LEE FORMATION

The Lee formation, the oldest strata of Pennsylvanian age exposed in this district, has been estimated by Ashley and Glenn (1906, p. 35) as about 1,000 to 1,500 feet thick. This formation, disconformably overlying the Pennington shale of Late Mississippian age, contains three massive conglomeratic sandstone beds, which occur in the basal, middle, and upper parts of the formation. These beds are separated by shale, siltstone, and a few thin coal beds of no commercial importance at the present time.

Resistant sandstone in the Lee formation forms the crests of Pine and Cumberland Mountains. The Naese sandstone member, a prominent cliff former along the Cumberland River near Pineville, has been designated by Ashley and Glenn (1906) as the top of the formation. Reserve estimates were not calculated for the coals in this formation in the Upper Cumberland River reserve district.

ROCKS EQUIVALENT TO THE BREATHITT FORMATION

In this report all strata younger than the Lee formation that are equivalent to the Breathitt formation northeast of Pine Mountain, are grouped together for convenience in discussion. Ashley and Glenn (1906, p. 31–44) divided these strata into five formations by selecting arbitrarily certain coal beds as formational boundaries. These formations are, in ascending order, the Hance, the Mingo with the Lower Hance coal at the base, the Catron with the Poplar Lick coal at the base, the Hignite with the Lower Hignite coal at the base, and the Bryson which lies above the Red Spring coal. These formations have a maximum thickness of about 2,500 feet and are composed of sandstone, siltstone, shale, underclay, and coal. They contain the commercially important coal beds for which original reserve estimates have been made.

Because of the Rocky Face fault, which is a transverse fault that crosses the Middlesboro syncline between Pineville Gap and Cumberland Gap, it is difficult to correlate the coal beds; hence they are designated by different names. Tentative correlation across the fault of the coal beds is shown in figure 11.

The most useful stratigraphic marker in the Harlan subdistrict is the Fire Clay coal bed. This coal bed usually can be identified by a dark-brown to olive-gray flint-clay parting, 1 to 8 inches thick, in the lower part of the coal bed. The Darby coal bed, because of its extensive distribution and importance as a major coal producer in the Harlan subdistrict, is a useful stratigraphic marker. In places where the correlation is doubtful, coal beds above and below this horizon can usually be correlated on the basis of the interval to the Darby bed.

In the Middlesboro subdistrict two coal beds can be used as stratigraphic markers, the Sterling and the Sandstone Parting beds. The Sterling (Fire Clay rider) bed can be distinguished from the Poplar Lick, which occurs 30 to 50 feet stratigraphically below, by the presence of pyritized marine fossils in its roof shales; the roof shales of the Poplar Lick bed contain only fossil plant remains. The Sandstone Parting coal, which occurs 200 to 250 feet below the Poplar Lick bed, has a thin sandstone parting ranging in thickness from a fraction of an inch to 3 inches that varies in its position from the top to the bottom of the bed.

GEOLOGIC STRUCTURE

The Upper Cumberland River reserve district is found only in a broad, gentle downwarp named the Middlesboro syncline (pl. 4). This syncline, a part of the Cumberland overthrust block, is bounded on the northwest by the Pine Mountain fault and on the southeast by the Powell Valley anticline. It enters the district in eastern Harlan

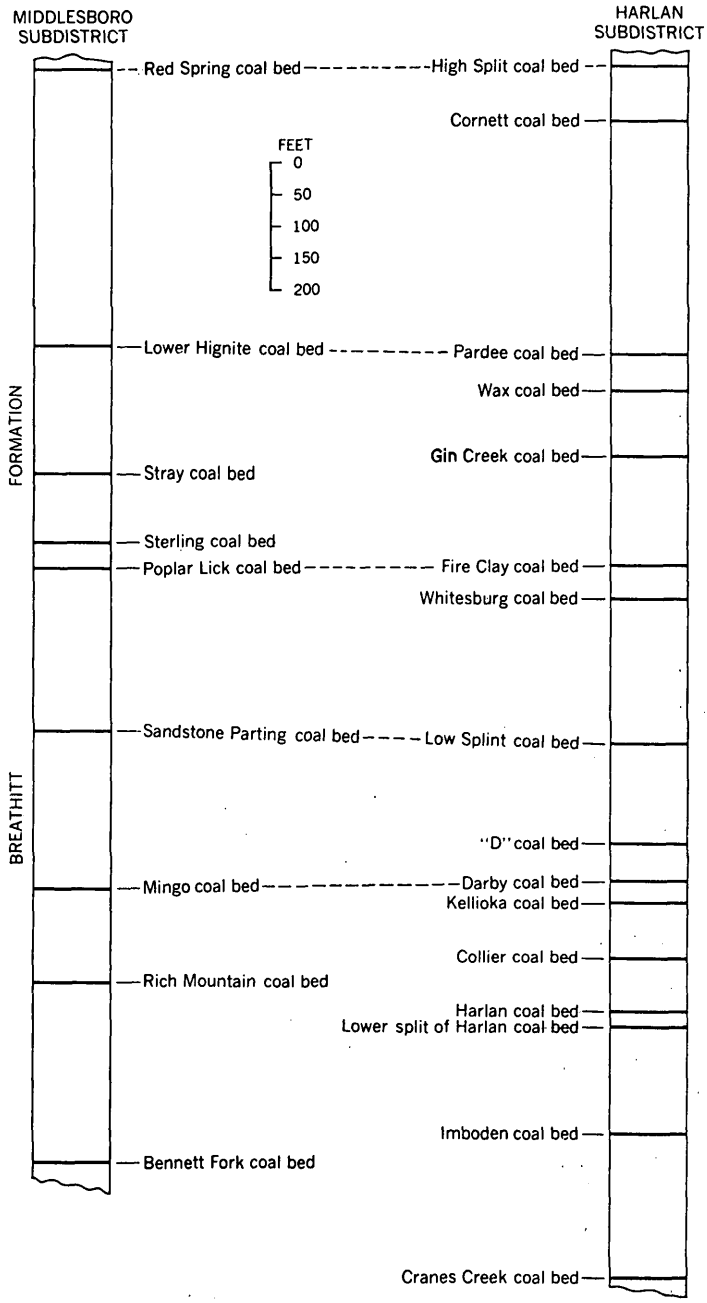

FIGURE 11.—Generalized geologic columns for the Upper Cumberland River reserve district.

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County and continues nearly parallel to the southern slopes of Pine Mountain. The axis of the syncline lies to the north of the center of the district and south of the Cumberland River and its tributary, Poor Fork. It is broken by a transverse fault zone, the Rocky Face fault, which extends across the Middlesboro syncline between Cumberland Gap and Pineville Gap. The axis of the syncline passes through Log Mountain, west of Rocky Face, between Clear Creek and Stony Fork, and continues southwestward, crossing the Kentucky-Tennessee State line west of Clear Fork.

The Rocky Face fault (pl. 4) is described by Ashley and Glenn (1906, p. 47) as a faulted arch with the downthrown side to the west. The prominent westward-facing scarp on the upthrown side is made up of conglomeratic sandstone of Lee age. The fault changes to an anticlinal fold at both ends (Rich, 1933, p. 1222).

At the base of Pine Mountain, northwest of the syncline, the dip of the strata ranges from 10° to 65°, but south of the axis the dip is gentler, about 100 feet to the mile, to the foot of Cumberland Mountain (Ashley and Glenn, 1906, p. 45).

The principal coal-producing areas of the district are in the central part of the Middlesboro syncline, where the coal is nearly flat lying. The coal beds dip steeply along Pine and Cumberland Mountains and are too disturbed and crushed to mine.

COAL BEDS OF THE LEE FORMATION

The coal beds of the Lee formation are not being mined commercially in this district at the present time. The few coal beds present in the formation are thin, impure, and steeply dipping, which makes mining difficult. Reserve estimates have not been made for the coal beds of this formation.

COAL BEDS IN ROCKS EQUIVALENT TO THE BREATHITT FORMATION

Rocks equivalent to the Breathitt formation are about 2,500 feet thick and contain 25 coal beds for which original reserve estimates have been made in this district. Plates 7 to 14 show the areal distribution of six of these coal beds.

Measured, indicated, and inferred reserves have been determined for 25 coal beds in the Upper Cumberland River reserve district. Intervals between the principal coal beds range from a few feet to nearly 400 feet. Individual coal beds usually have a wide lateral extent, but may range considerably in thickness within a given area or may be entirely cut out by channel-fill sandstone. All are common banded or splint variety of coal and may contain local lenses of cannel coal.

HARLAN SUBDISTRICT

The Harlan subdistrict is located east of Rocky Face, and includes parts of Bell, Harlan, and Letcher Counties. Reserve estimates have been made of 16 coal beds which are discussed briefly in ascending stratigraphic order.

CRANES CREEK COAL BED

The Cranes Creek coal bed, the lowest in the Breathitt formation equivalents of the subdistrict, is exposed along Cranes Creek in southeastern Bell County (Ashley and Glenn, 1906, p. 115, 122). Locally this bed has been called the Blue Gem coal. Its stratigraphic position is about 200 to 250 feet below the Imboden coal bed (fig. 11) and about 150 feet below the Cawood sandstone (Ashley and Glenn, 1906, p. 120).

This bed, which is not a commercially important coal in the subdistrict, ranges from 17 to 28 inches in thickness and averages about 21 inches. The estimated original reserves of the Cranes Creek coal bed in the Harlan subdistrict total 17,610,000 tons.

IMBODEN COAL BED

The Imboden coal is considered a good coking coal and has been mined chiefly for that purpose. It is mined principally in Harlan and Letcher Counties in the northeastern part of the subdistrict, and in southeastern Bell County in the western part. The bed is known as the Mason coal in Bell County, and as the Lower Elkhorn coal in some areas in the northeastern part of the subdistrict. The interval between the Imboden coal bed and the overlying Harlan bed, about 180 to 200 feet, is shown in figure 11.

The thickest coal in the subdistrict averages about 62 inches and is found in the Whitesburg quadrangle in Letcher County. Outcrop, mine, and test-drill hole sections of the coal show that the bed ranges in thickness from 33 to 93 inches. Numerous partings of bone, laminated coal, shale, and clay, ½ inch to 10 inches thick, are distributed throughout the bed. The coal thins to the southwest of this area and in the Big Stone Gap quadrangle it averages about 48 inches thick. In small isolated areas in central Harlan County the coal averages about 37 inches in thickness, and is about 35 inches thick in the northern half of the Middlesboro quadrangle in Bell County.

A chemical analysis, on an as-received basis, of one sample from a mine on Franks Creek of the Cumberland River (Crider, 1916, p. 55) shows the following composition.

Moisture	1.51	Ash	8.38
Volatile matter	34.00	Sulfur	1.33
Fixed carbon	56.11	Calorific value	14,215

The estimated reserves of the Imboden coal bed in the Harlan subdistrict total 474,230,000 tons.

LOWER SPLIT OF THE HARLAN COAL BED

The Lower Split of the Harlan coal bed, which is found only in the northeastern part of Harlan County, lies from 2 to 40 feet below the Harlan coal. This coal splits from the Harlan bed (Wallace and others 1954, p. 19) in the northwestern part of the Big Stone Gap quadrangle and continues eastward to the Kentucky-Virginia State line as an individual bed separated from the Harlan bed proper by shale and sandstone.

Drill-hole data and outcrop sections of the bed indicate that the coal ranges in thickness from 8 to 62 inches, and averages about 38 inches. Partings within the bed average about 8 inches in thickness.

The calculated reserves of this bed in the Harlan subdistrict total 117,840,000 tons, mostly in the measured and indicated categories.

HARLAN COAL BED

The Harlan coal bed has been extensively mined throughout Harlan County and southeastern Bell and Letcher Counties. The Harlan is one of the most important coalbeds mined in the subdistrict because it has more reserve tonnage than any other bed and is regarded as an excellent coking coal. Plate 7 shows the distribution of the bed throughout the Harlan subdistrict.

The Harlan bed is known as the Hance coal in southeastern Bell County, and is also called the Upper Elkhorn No. 1 coal in Harlan and southeastern Letcher Counties. This coal bed may be equivalent to the Upper Elkhorn No. 1 bed in the Big Sandy reserve district. It is about 180 to 200 feet above the Imboden bed and 690 to 760 feet below the Fire Clay bed (fig. 11).

In the Middlesboro quadrangle in Bell County the Harlan coal is exposed in the hilltops where it is mined by stripping methods. It consists of three benches; the upper bench averages about 33 inches thick, the middle bench about 54 inches, and the lower bench about 39 inches. The middle bench is separated from the upper and lower benches by sandstone and shale partings 8 to 10 feet thick.

Most of the coal has been mined in the southern half of the Harlan quadrangle and the Nolansburg quadrangle in Harlan County. In this area, where the Harlan bed is without partings, the coal ranges in thickness from 30 to 50 inches and averages about 35 inches. Where shale partings occur in the bed, they range in thickness from 1 to 14 inches. Total thickness of the coal, excluding partings, ranges from 21 to 112 inches and averages about 48 inches throughout the district. The coal in southeastern Letcher County averages about 39 inches thick.

This coal is of high-volatile A bituminous rank. A chemical analysis, on an as-received basis, of a composite of six mine samples (Bureau of Mines Laboratory Nos. 81893-81898) from a mine near Chevrolet (Fieldner and others, 1944, p. 72) shows the following composition:

Moisture	2.6	Ash	3.5
Volatile matter	36.7	Sulfur	.8
Fixed carbon	57.2	Calorific value	14,130

A total of 676,760,000 tons of reserves has been calculated for this bed in the Harlan subdistrict.

COLLIER COAL BED

The Collier bed occurs 85 to 100 feet above the Harlan bed. Data from test-drill holes and outcrops indicate that the coal ranges in thickness from 17 to 70 inches in areas where it is mined. It is of no great commercial importance in southeastern Letcher County, where it ranges in thickness from 5 to 25 inches. In eastern Harlan County the coal is without partings and ranges in thickness from 31 to 51 inches. In the central and southwestern part of the county the Collier coal occurs with partings of clay and shale rangining in thickness from 3 to 24 inches.

Calculated reserves of the Collier coal bed in the subdistrict total 469,640,000 tons. This tonnage does not include a small amount of reserves in southeastern Letcher County, which is reported in the estimate for the Hazard reserve district.

KELLIOKA COAL BED

The stratigraphic position of the Kellioka coal bed is about 20 to 40 feet below the Darby coal. Areal distribution and production from this bed is limited to northeastern Harlan County and southeastern Letcher County. It is also known as the Elkhorn Leader coal and, in Virginia, as the Taggart Marker bed.

Drill-hole data in the Nolansburg quadrangle and the Big Stone Gap quadrangle in Harlan County show the coal to be erratic in thickness, ranging from 15 to 45 inches and averaging about 29 inches throughout this area. The bed contains one or two clay or shale partings ½ inch to 5 inches thick in a few places. In Letcher County the Kellioka bed has been mined along Poor Fork, where the coal ranges from 20 to 59 inches in thickness and averages about 35 inches.

In the Harlan subdistrict the Kellioka bed has total calculated reserves of 137,610,000 tons. Some reserve tonnage in southern Letcher County of this subdistrict is included in the estimate for the Hazard reserve district.

DARBY COAL BED

The Darby bed is the second most important commercially mined coal bed in the Harlan subdistrict, being exceeded in production only by the Harlan bed. The bed, which occurs 190 to 225 feet above the Harlan coal, is also known as the Taggart, "C," Keokee, and the Upper Elkhorn No. 3 coal. It crops out and is mined in the central and eastern part of Harlan County and southeastern Letcher County (pl. 8). Partings of shale and clay occur in the bed in some areas.

The bed ranges in thickness from 18 to 99 inches in the Whitesburg quadrangle in Letcher County, as shown by drill-hole, outcrop, and mine sections of the coal. Where the shale and clay partings are present in the bed, thickness of the partings ranges from 1 to 15 inches. Much of the coal in this area has been mined out.

In Harlan County the thickest coal in the Darby bed is found in the northwestern part of the Big Stone Gap quadrangle where it has been almost totally mined. It ranges in thickness from 27 to 76 inches and averages about 51 inches as shown by mine and drill-hole measurements of the bed. Partings of shale, 1 to 10 inches thick, occur in some places. In part of the Big Stone Gap quadrangle near the Kentucky-Virginia State line the coal ranges in thickness from 26 to 63 inches and averages about 38 inches. Most of the coal has been mined in the southern half of the Nolansburg quadrangle, where it averages about 38 inches thick. The coal thins in the northeastern part of the quadrangle and along Poor Fork, ranging in thickness from 10 to 33 inches and averaging about 25 inches. In the northwestern part of the quadrangle, along Poor and Clover Forks, the coal ranges in thickness from 20 to 45 inches and averages about 34 inches according to drill-hole and mine sections. In the Harlan quadrangle the bed ranges in thickness from 20 to 46 inches and averages about 32 inches.

This coal is of high-volatile A bituminous rank. Analyses, on an as-received basis, of composites of 17 mine samples (Bureau of Mines laboratory Nos. 24834–24837, A42640–A42642, A87921–A87925, and B56494–B56498) from mines near Benham Kenvir, Liggett, and Lynch in Harlan County (Fieldner and others, 1944, p. 71, 79, 83, 84) show the following range in chemical composition:

	Low	High		Low	High
Moisture.....percent..	2.5	3.6	Ash.....percent..	2.4	6.0
Volatile matter.....do....	34.6	37.5	Sulfur.....do....	.5	1.1
Fixed carbon.....do....	54.3	58.8	Calorific value.....Btu..	13,640	14,590

Calculated reserves of the Darby coal bed in the Harlan subdistrict total 415,160,000 tons. This tonnage does not include a small amount present in southern Letcher County, which is reported in the Hazard reserve district.

"D" COAL BED

In Harlan County the "D" coal bed occurs about 60 feet above the Darby bed. It crops out and is mined in the Nolansburg and the Big Stone Gap quadrangles. Outcrop and test-drill-hole data in this area show that the coal bed has partings of shale and bone about three inches thick. The coal ranges in thickness from 14 to 76 inches and averages about 38 inches.

The "D" bed of the Harlan subdistrict contains calculated reserves of 122,910,000 tons.

LOW SPLINT COAL BED

The Low Splint coal bed occurs about 200 to 230 feet above the Darby bed (fig. 11). This coal is known as the Amburgy bed north of Pine Mountain, and as the Creech bed in the western part of the Harlan subdistrict. Plate 9 shows the areal distribution of this bed in the subdistrict.

In the Middlesboro quadrangle in Bell County the Low Splint coal bed averages about 53 inches thick. Mine, test-drill hole, and outcrop coal sections in Harlan and Letcher Counties show that the coal has partings of shale, clay, and bone ranging in thickness from ½ to 14 inches. The coal averages about 50 inches thick throughout this area.

The Low Splint coal is of high-volatile A bituminous rank. A chemical analysis, on an as-received basis, of a composite of five mine samples (Bureau of Mines laboratory Nos. A88556–A88560) from a mine near Low Splint (Fieldner and others, 1944, p. 79) shows the following composition:

Moisture----------percent--	3.7	Ash----------percent--	4.2
Volatile matter--------do----	37.8	Sulfur----------do----	.7
Fixed carbon----------do----	54.3	Calorific value----------Btu--	13,830

Calculated reserves of the Low Splint coal bed in the Harlan subdistrict total 130,420,000 tons. Some reserve tonnage in southern Letcher County of this subdistrict is included in the estimates of the Hazard reserve district.

UPPER WHITESBURG COAL BED

The Upper Whitesburg coal bed, a thin and commercially unimportant coal in the Harlan subdistrict, is confined to the southern part of Letcher County. It occurs 40 to 60 feet below the Fire Clay bed. Test-drill-hole data indicate that the coal ranges in thickness from 13 to 17 inches. Because of the small amount of reserves occurring in this subdistrict, estimates are reported in the Hazard reserve district.

FIRE CLAY COAL BED

The Fire Clay coal bed is a key stratigraphic marker in the Harlan subdistrict. It can usually be recognized by a brown to olive-gray flint clay parting, 2 to 8 inches thick, which is found in the lower half of the bed. In many areas only the coal above this parting is mined.

This bed, 270 to 280 feet above the Low Splint bed (fig. 11), is generally known in the subdistrict as the Wallins Creek bed. North of Pine Mountain it is locally called the Dean and the Hazard No. 4 bed, and in the Log Mountain region of the Middlesboro subdistrict it is known as the Poplar Lick coal. The coal crops out and is mined in the central and eastern parts of the subdistrict. Plate 10 shows the areal extent of the Fire Clay bed.

The coal averages about 17 inches thick in the Whitesburg quadrangle in Letcher County. It thickens to the southwest from Letcher County, and in the Big Stone Gap quadrangle the coal is about 20 inches thick. In the southern half of the Nolansburg quadrangle the coal thicknesses range from 36 to 39 inches and contain partings of shale, bone, and flint clay 6 to 8 inches thick.

The coal reaches its maximum thickness in the southern quarter of the Harlan quadrangle where the bed averages about 103 inches thick and contains partings of clay and shale about 11 inches thick. Most of the coal in this area has been mined out. In the southwestern quarter of the Harlan quadrangle the coal averages about 44 inches thick and has partings of shale or flint clay about 4 inches thick.

The Fire Clay coal is of high-volatile A bituminous rank. Analyses, on an as-received basis, of composites of 10 mine samples (Bureau of Mines laboratory Nos. 81900–81905 and 82056–82059) from mines near Twila, in Harlan County (Fieldner and others, 1944, p. 86), show the following range in chemical composition:

	Low	High		Low	High
Moisture.....percent..	3.1	3.3	Ash.....percent..	3.3	4.8
Volatile matter.....do....	37.7	39.1	Sulfur.....do....	.7	1.0
Fixed carbon.....do....	54.3	54.4	Calorific value.....Btu..	13,650	13,820

Calculated reserves of the Fire Clay bed in the Harlan subdistrict total 132,270,000 tons.

GIN CREEK COAL BED

The Gin Creek coal, approximately 100 feet below the Wax bed, is mined principally in the Nolansburg quadrangle in Harlan County. In Virginia it is known as the No. 8 bed. Locally the Gin Creek bed is split into two benches by a shale parting ½ inch to 12 inches thick.

The coal ranges in thickness from 18 to 52 inches and averages about 29 inches throughout this area.

Calculated reserves of the Gin Creek coal bed in the Harlan subdistrict total 39,790,000 tons.

WAX COAL BED

The stratigraphic position of the Wax coal bed is about 10 to 60 feet below the Pardee coal and about 270 feet above the Fire Clay coal (Wallace and others, 1954a, p. 14). It is known as the High Cliff bed and in Virginia as the No. 9 coal.

The coal crops out in the Nolansburg quadrangle in Harlan County, and increases in thickness from the northern to the southern part of the quadrangle. In the northeastern part of the quadrangle the coal is about 30 inches thick and has a 1-inch shale parting, whereas in the southern half of the quadrangle the coal ranges in thickness from 17 to 65 inches with thin partings of shale about 1 to 3 inches thick.

The calculated reserves of the Wax bed in the Harlan subdistrict total 53,610,000 tons.

PARDEE COAL BED

The Pardee coal bed occurs about 300 to 360 feet above the Fire Clay coal bed (fig. 11) in the central and northeastern parts of the Harlan subdistrict. It is correlated with the Hamlin coal north of Pine Mountain in the Hazard resource district, and with the Limestone and Smith coal beds of the Harlan subdistrict.

The thickness of the Pardee coal bed ranges from 80 to 122 inches and averages about 104 inches in the Whitesburg quadrangle in Letcher County. It usually contains one or two partings of shale, 1 to 24 inches thick. About half of the area for which reserve estimates have been determined has been mined out.

The coal in the central part of Harlan County occurs with and without partings. Where partings are present, the bed is divided by shale 1 to 18 inches thick. The coal ranges in thickness from 20 to 74 inches and averages about 50 inches.

Calculated reserves of the Pardee coal bed in the Harlan subdistrict total 76,210,000 tons. This tonnage excludes a small amount of reserves in southern Letcher County, which is reported in the Hazard reserve district.

CORNETT COAL BED

The Cornett coal bed of the Harlan subdistrict, about 80 to 100 feet below the High Splint bed (fig. 11), is correlated with the Hazard bed of Kentucky and with the Morris and No. 11 beds of Virginia. Areal distribution of this coal, which crops out high in the hilltops of Black Mountain in the eastern part of the subdistrict, is shown on plate 11.

The Cornett bed is usually without partings in the northeastern part of the subdistrict, but locally has partings of shale and clay 1 to 13 inches thick. In this area the average thickness of the coal is about 62 inches. In the eastern part of the subdistrict the thickness of the coal averages about 40 inches, with a local parting of shale or clay ½ inch to 14 inches thick.

The calculated remaining reserves of the Cornett coal bed in the subdistrict total 141,190,000 tons.

HIGH SPLINT COAL BED

The High Splint bed is the highest coal currently mined in the Harlan subdistrict for which reserve estimates have been made. This bed is called the No. 12 in Lee County, Va., and is here correlated with the Hazard No. 7 of the Hazard reserve district. Its stratigraphic position is about 80 to 100 feet above the Cornett bed and 770 to 850 feet above the Fire Clay coal (fig. 11). Areal distribution of the High Splint bed in the eastern part of the subdistrict is shown on plate 12.

The coal ranges in thickness from 49 to 58 inches and is usually without partings. Shale or clay partings, where present, range in thickness from ½ inch to 3 inches.

This coal bed is of high-volatile A bituminous rank. A chemical analysis, on an as-received basis, of a composite of four mine samples (Bureau of Mines Laboratory Nos. 81698–81701), from a mine near High Splint (Fieldner and others, 1944, p. 79) shows the following composition:

Moisture----------percent--	4. 8	Ash----------percent--	6. 0
Volatile matter---------do----	35. 8	Sulfur----------do----	. 7
Fixed carbon----------do----	53. 4	Calorific value----------Btu--	13, 170

A total of 165,480,000 tons of remaining reserves has been calculated for the High Splint coal bed in the Harlan subdistrict. These reserves occur mostly as measured coal in the more than 42-inch category.

MIDDLESBORO SUBDISTRICT

The Middlesboro subdistrict, west of Rocky Face, includes parts of Bell and Whitley Counties. Original reserve estimates have been made for nine coal beds which are discussed briefly, in ascending stratigraphic order.

BENNETT FORK COAL BED

The Bennett Fork coal bed is the lowest and oldest coal that has been extensively mined in the Middlesboro subdistrict. This bed, 275 to 300 feet below the Rich Mountain coal (fig. 11), is composed of two benches separated by 8 to 16 feet of shale and sandstone.

The upper bench is mined generally and reserve estimates have been made only for it.

The upper bench, which crops out along Bennett and Stony Forks, ranges in thickness from 28 to 47 inches, averaging about 34 inches. It is usually clean, but when shale and clay partings are present they range in thickness from ½ inch to 6 inches. In eastern Whitley and western Bell Counties the Bennett Fork coal ranges in thickness from 24 to 35 inches and averages about 30 inches.

Estimated original reserves of the upper bench of the Bennett Fork coal bed in the Middlesboro subdistrict total 32,770,000 tons.

RICH MOUNTAIN COAL BED

The Rich Mountain bed is known as the Blue Gem bed in the area around Pruden, Tenn., and as the Yellow Creek bed on Bennett Fork (Glenn, 1925, p. 237). It lies about 120 to 180 feet below the Mingo bed and about 300 feet above the Bennett Fork bed (fig. 11). In the Fonde quadrangle the coal crops out along Bennett Fork. It is a single bed at many mine and outcrop sections; at others it is separated into two benches by a shale parting 2 to 6 inches thick. The thickness of the coal in this area ranges from 24 to 33 inches and averages about 29 inches.

In the Middlesboro subdistrict the original reserve estimates of the Rich Mountain coal bed total 16,460,000 tons.

MINGO COAL BED

The Mingo coal bed, locally known as the Mason bed, is one of the more important coals mined in the Middlesboro subdistrict. As shown on figure 11, the stratigraphic position of the coal bed is about 250 feet below the Sandstone Parting bed.

In the Fonde quadrangle the Mingo coal crops out and is mined along Bennett and Stony Forks, and near Fonde at the head of Clear Fork. The coal is thin near the mouth of Bennett Fork, ranging from 21 to 28 inches in thickness and averaging about 24 inches. A section from the Yellow Creek mine, reported by Ashley and Glenn (1906, p. 69), shows two benches of coal; the lower bench, which is 30 inches thick, is separated from the upper bench, which is 38 inches thick, by about 54 inches of clay and thin coal lenses. Along Cabin Hollow of Bennett Fork the coal occurs as two benches separated by clay and shale 2 to 30 inches thick; the upper bench averages about 26 inches thick and the lower bench about 25 inches. In the Clear Fork area two benches of coal are separated by shale partings 8 inches thick; the lower bench averages about 21 inches thick and the upper bench about 22 inches. Along Stony Fork the coal lacks partings and averages about 27 inches thick.

In the Clear Creek and Little Clear Creek area of the Fonde quadrangle the coal is locally without partings, and in these areas it averages about 39 inches thick. Elsewhere, the bed consists typically of a lower bench of coal about 29 inches thick, a shale parting about 7 inches thick, and an upper bench of coal about 17 inches thick.

Stripping methods are used to mine the Mingo bed in the western part of the Fonde quadrangle. The coal, without partings, ranges in thickness from 27 to 52 inches and averages about 42 inches throughout the area. Where partings occur, the coal ranges in thickness from 46 to 79 inches and averages about 60 inches; the parting separating the coal is about 4 inches thick.

This coal is of high-volatile A bituminous rank. A chemical analysis, on an as-received basis, of a composite of four mine samples (Bureau of Mines laboratory Nos. 21781–21784) from a mine near Chenoa (Fieldner and others, 1944, p. 48) shows the following composition:

Moisture----------percent--	4. 4	Ash----------percent--	2. 4
Volatile matter--------do----	36. 1	Sulfur----------do----	. 8
Fixed carbon----------do----	57. 1	Calorific value----------Btu--	13, 940

Estimated original reserves of the Mingo coal in the Middlesboro subdistrict total 140,990,000 tons.

SANDSTONE PARTING COAL BED

The Sandstone Parting coal bed has been mined extensively in the Log Mountain area of the Middlesboro subdistrict, especially along Bennett and Stony Forks, Clear Creek, and Little Clear Creek, in the Fonde quadrangle. It is about 200 to 250 feet below the Poplar Lick bed and about 250 feet above the Mingo coal (fig. 11). The sandstone parting, for which this bed is named, ranges from a fraction of an inch to 3 inches in thickness and varies in position from the top to the bottom of the coal bed. It is pyritic, dark in color, and tends to adhere to the coal so that some coal is lost in cleaning. This parting and also the coal bed are known locally as the "Jack Rock."

Coal mined in the Mingo Mountains quadrangle (SE¼ Fonde 15-minute quadrangle) averages about 39 inches thick. Partings of sandstone and shale within the bed range in thickness from ½ inch to 12 inches. In the Davisburg quadrangle (NE¼ Fonde 15-minute quadrangle) the coal ranges in thickness from 17 to 44 inches and averages about 33 inches. Partings of sandstone, shale, and bone, 1½ to 12 inches thick, are present in the upper, middle, or lower portions of the coal bed. The average total thickness of partings within the bed is about 4 inches.

The Sandstone Parting coal is of high-volatile A bituminous rank. A chemical analysis, on an as-received basis, of a composite of four mine samples (Bureau of Mines laboratory Nos. 82413–82416) from a mine near Shamrock (Fieldner and others, 1944, p. 55) shows the following composition:

Moisture	3.1	Ash	6.9
Volatile matter	35.1	Sulfur	1.0
Fixed carbon	54.9	Calorific value	13,460

The estimated original reserves of the Sandstone Parting coal bed in the Middlesboro subdistrict total 72,490,000 tons.

POPLAR LICK COAL BED

The Poplar Lick coal bed occurs about 200 to 250 feet above the Sandstone Parting bed (fig. 11). Because of its stratigraphic position, this bed has been correlated with the Windrock bed of Tennessee (Glenn, 1925, p. 226) and with the Dean, Wallins Creek, and Fire Clay beds to the north and east of the Middlesboro subdistrict, although it does not possess the characteristic flint-clay parting. Outcrops of this coal bed are found along the drainage of Bennett and Stony Forks in the Fonde quadrangle and along Clear Creek and Little Clear Creek in the northeast quarter of the quadrangle. Plate 10 shows the areal distribution of the Poplar Lick bed in this subdistrict.

In the Bennett Fork area of the Fonde quadrangle the Poplar Lick coal is divided into two benches of about equal thickness, the upper bench averaging about 24 inches and the lower bench about 22 inches. The clay or shale parting between the benches is about 10 inches thick. In this area the combined thickness of the two coal benches mined is about 44 inches. In the area of Stony Fork and its tributaries the coal benches are separated by partings of clay and shale averaging about 13 inches thick. The coal mined along this drainage ranges from 23 to 60 inches in sickness and averages about 44 inches.

In the area of Clear and Little Clear Creeks in the Fonde quadrangle, the coal bed is separated by partings of bone, shale, and clay, dividing the coal into two or more benches. The thickness of the partings within the bed averages about 4 inches throughout the area, and the coal mined is about 49 inches thick.

The Poplar Lick coal is of high-volatile A bituminous rank. Analyses, on an as-received basis, of composites of 12 mine samples (Bureau of Mines laboratory Nos. 21617–21620, 82067–82070, and 82072–82075) from mines near Harrison, Logmont, and Ralston in Bell County

(Fieldner and others, 1944, p. 51, 55) show the following range in chemical composition:

	Low	High		Low	High
Moisture----------percent--	2.8	3.4	Ash----------percent--	5.0	10.6
Volatile matter--------do----	36.7	37.9	Sulfur----------do----	1.0	2.8
Fixed carbon----------do----	49.9	53.9	Calorific value----------Btu--	12,860	13,710

Estimated original reserves for the Poplar Lick coal bed in the Middlesboro subdistrict total 102,820,000 tons.

STERLING COAL BED

The Sterling coal bed is 30 to 50 feet above the Poplar Lick coal and is distinguished from it by the presence of pyritized marine fossils in the roof shale, which in the Poplar Lick coal contains only fossil plant remains (Glenn, 1925, p. 226). The Sterling bed is considered to be equivalent to the Big Mary bed in Tennessee and to the Fire Clay Rider coal in the Southwestern and Hazard resource districts.

Along Bennett and Stony Forks in the Fonde quadrangle, at localities where the coal is without partings, it ranges in thickness from 32 to 60 inches and averages about 45 inches. Elsewhere in the area the coal has partings of bone, shale, and clay ½ to 26 inches thick, which average about 6 inches thick. Excluding partings, the total thickness of coal ranges from 22 to 60 inches and averages about 41 inches.

This coal bed is of high-volatile A bituminous rank. Chemical analysis, on an as-received basis, of a composite of four mine samples (Bureau of Mines laboratory Nos. 82408–82411) from the mine near Shamrock (Fieldner and others, 1944, p. 55) shows the following composition:

Moisture----------percent--	2.3	Ash----------percent--	9.4
Volatile matter--------do----	36.7	Sulfur----------do----	3.1
Fixed carbon----------do----	51.6	Calorific value----------Btu--	13,150

Estimated original reserves of the Sterling coal bed in the Middlesboro subdistrict total 24,640,000 tons.

STRAY COAL BED

This coal bed, which is about 150 feet above the Poplar Lick bed, has been called the Stray bed in the Log Mountain area. Most mining of the coal is along Stony Fork and its tributaries and along Little Clear Creek in the Fonde quadrangle.

The Stray coal usually has one to three partings of shale and clay, ranging in thickness from 1 to 24 inches and averaging about 5 inches. The coal, excluding partings, ranges in thickness from 18 to 44 inches and averages about 34 inches.

This coal is of high-volatile A bituminous rank. Chemical analysis, on an as-received basis, of a channel sample (Bureau of Mines laboratory No. E77739), collected in 1955 by T. R. Jolley, of the U.S. Bureau of Mines, from a mine about 10 miles northwest of Middlesboro shows the following composition:

Moisture----------percent--	2. 4	Ash----------percent--	11. 2
Volatile matter--------do----	36. 4	Sulfur----------do----	1. 5
Fixed carbon----------do----	50. 0	Calorific value----------Btu--	12, 750

Estimated original reserves of the Stray coal bed in the Middlesboro subdistrict total 59,290,000 tons.

LOWER HIGNITE COAL BED

In the Middlesboro subdistrict the Lower Hignite coal bed has been correlated with the Pewee or Merwin coal bed of Tennessee, and tentatively with the Pardee coal of the Harlan subdistrict and the Pardee bed of Virginia (Wanless, 1946, p. 147). The average interval between the Lower Hignite and the Poplar Lick coal bed is about 350 feet (fig. 11). In the Fonde quadrangle the coal crops out and is mined along Bennett, Stony, and Clear Forks.

Throughout the Fonde quadrangle the coal ranges in thickness from 14 to 65 inches and averages about 42 inches. Partings within the bed are from 2 to 8 inches thick. North of Stony Fork in the Fonde quadrangle the coal is about 42 inches thick. Where the bed is separated by partings in this area, the coal mined averages about 44 inches thick and the partings of clay, shale, and bone are from ½ to 8 inches thick. In the western half of the Fonde quadrangle the Lower Hignite bed is about 43 inches thick and contains a 2-inch parting of shale near the middle of the bed.

The Lower Hignite coal is of high-volatile A bituminous rank. Chemical analysis, on an as-received basis, of a composite of four mine samples (Bureau of Mines laboratory Nos. B44722–B44725) from a mine 10 miles northwest of Middlesboro (Fieldner and others, 1944, p. 52) shows the following composition:

Moisture----------percent--	3. 5	Ash----------percent--	4. 4
Volatile matter--------do----	37. 0	Sulfur----------do----	. 8
Fixed carbon----------do----	55. 1	Calorific value----------Btu--	13, 870

Estimated original reserves of the Lower Hignite coal bed in the Middlesboro subdistrict total 61,640,000 tons.

RED SPRING COAL BED

The Red Spring coal bed, which crops out high on Log Mountain, is the highest bed that has been mined commercially in the Middles-

boro subdistrict (pl. 12). Its stratigraphic position is about 440 feet above the Lower Hignite bed (fig. 11), and it is tentatively correlated with the High Splint bed of the Harlan subdistrict.

This coal is about 60 inches thick in the hilltops of the Fonde quadrangle and contains several partings of clay and shale 1 inch to 11 inches thick. North of Stony Fork in the Fonde quadrangle the coal has one or two partings of clay or shale ½ inch to 10 inches thick, and averages about 42 inches in thickness.

The Red Spring coal is of high-volatile A bituminous rank. Chemical analysis, on an as-received basis, of a tipple sample (Bureau of Mines laboratory No. E–77739), collected in 1955 by T. R. Jolley, of the U.S. Bureau of Mines, from a mine about 10 miles northwest of Middlesboro shows the following composition:

Moisture	percent	4. 9	Ash	percent	7. 6
Volatile matter	do	35. 9	Sulfur	do	. 6
Fixed carbon	do	51. 6	Calorific value	Btu	12, 930

Estimated original reserves of the Red Spring coal bed in the Middlesboro subdistrict total 11,810,000 tons.

PRODUCTION

Commercial production of coal in the Upper Cumberland River reserve district was first reported in Bell County in 1879 and in Harlan County in 1911 (table 8). Coal mining increased from 1879 to 1928, the maximum annual production being about 17,948,000 tons in 1928. During the depression years of the early 1930's coal production in the district declined and the minimum annual production was about 8,572,600 tons in 1932. The district's peak production was in the late 1930's and early 1940's, the maximum annual tonnage being about 18,827,100 tons in 1942. Since that time there has been a general decline, and in 1955 the district produced about 10,698,500 tons.

Total production for the Upper Cumberland River reserve district from 1879 to 1955 was 532,274,200 tons. Of this total, Harlan County accounted for 423,816,100 tons, or 80 percent of the total, and Bell County 108,458,100 tons, or 20 percent of the total production of the district. Figure 12 shows yearly and total production for the years 1900 to 1955. The chief producing beds in Harlan County are the Harlan, Darby, Fire Clay, and High Splint. In Bell County production has come mostly from the Straight Creek, Mingo, Lower Hignite, and Fire Clay beds.

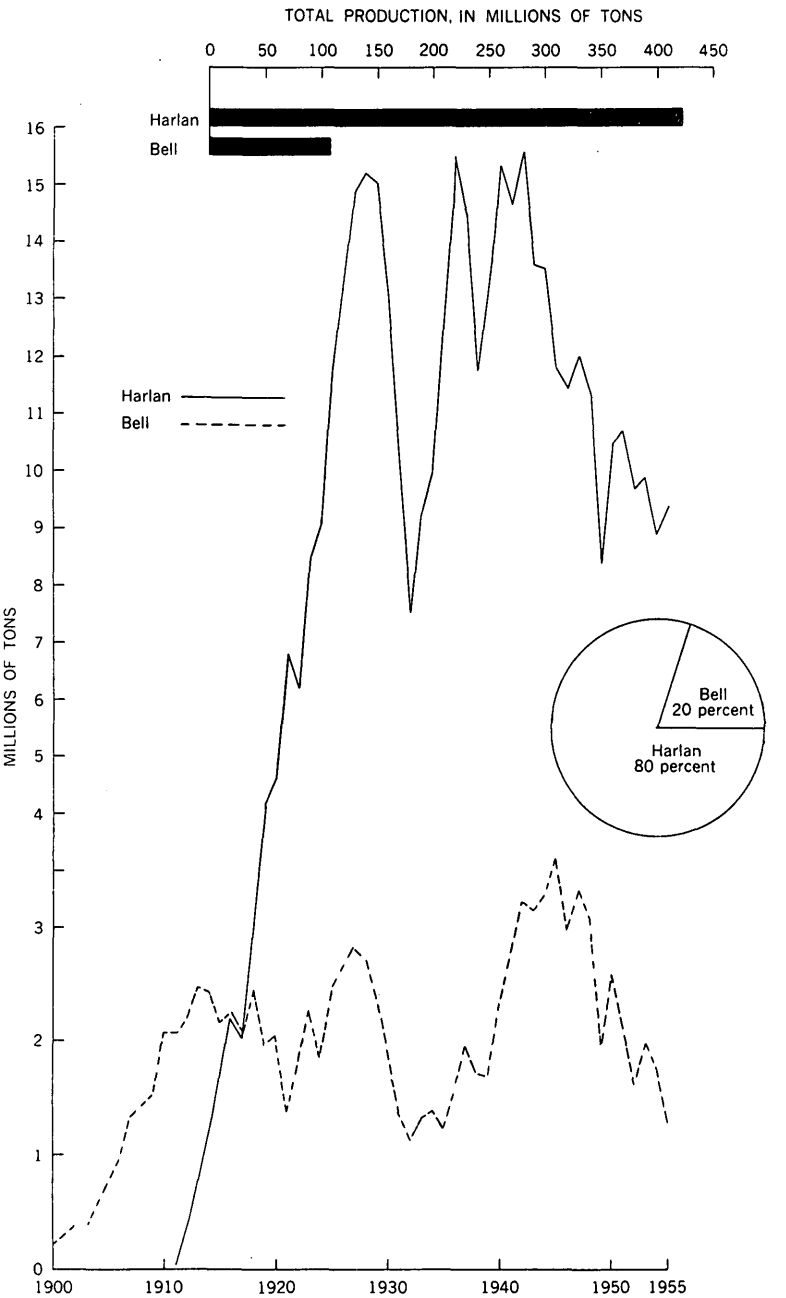


FIGURE 12.—Coal production in the Upper Cumberland River reserve district, 1900-1955.

620706—62——12

SUMMARY OF RESERVE ESTIMATES

Original reserves are reported only for those parts of Bell and Whitley Counties in the Upper Cumberland River resource district. Figures for Harlan and Letcher Counties are estimated original reserves calculated by the U.S. Geological Survey and remaining reserves calculated by the U.S. Bureau of Mines.

Total coal reserves of the Upper Cumberland River reserve district are estimated as 3,693,640,000 tons. Tables 9, 10, and 11 show reserve estimates by county, bed thickness, and reliability categories. About 17 percent of the calculated reserves are in beds 14 to 28 inches thick, 45 percent in beds 28 to 42 inches, and 38 percent in beds more than 42 inches. Of the total estimated reserves of the district about 43 percent are classified as measured coal, 28 percent as indicated, and 29 percent as inferred. These reliability categories show the following percentage according to thickness:

	42 inches or more	28 to 42 inches	14 to 28 inches
Measured	55	37	8
Indicated	39	52	9
Inferred	13	50	37

Harlan County has about 70 percent of the total calculated reserves in all categories, and 71 percent of the coal in the category more than 42 inches thick. Bell County contains 25 percent of the total calculated reserves and 21 percent of the coal more than 42 inches thick. The part of Letcher County included in the district has about 5 percent of the calculated reserves and about 8 percent of the coal more than 42 inches thick. The part of Whitley County within the Upper Cumberland River reserve district has only a small amount (less than 1 percent) of the calculated reserves for the district.

Part 4. PRODUCTION, MINING METHODS, AND SUMMARY OF RESERVE ESTIMATES OF COAL IN EASTERN KENTUCKY

By J. W. Huddle, E. J. Lyons, H. L. Smith, and J. C. Ferm

PRODUCTION OF COAL IN EASTERN KENTUCKY

Utilization of the coal reserves of eastern Kentucky has been dependent upon accessibility; transportation by water, railroads, and highways; the parallel development of industries within the area; and the industrialization of the Middle West. The history of coal mining in eastern Kentucky is divided into two periods: an early one when all

production was dependent upon water transportation, and a later period, from 1880 on, when railroads expanded and opened new fields.

EARLY PERIOD: 1790–1880

The earliest mining was along the rivers on which coal could be rafted or taken by boat to the populated areas on the north and west. The first reported commercial mining was in 1790 on Sturgeon Creek near Beattyville in Lee County, the coal being shipped via the Kentucky River to the vicinity of Lexington. Operations along or near the Kentucky River expanded until by 1835 about 3,000 tons of coal per year was being shipped down the river from mines as far upstream as Hazard (Eavenson, 1942, p. 303). About 5,000 tons of coal was mined in Greenup County in 1824. Operations began along the Cumberland River in McCreary and adjacent counties in 1827, along the Licking River below West Liberty in the 1830's, and along Tug Fork of the Big Sandy River near Boldman about 1855 (Eavenson, 1942, p. 311), the coal being shipped via these rivers to markets outside of the coal field.

The iron industry, using locally mined iron ore, was active in the Ashland and Red River areas from about 1805 to 1885. Although coal mines were opened in both areas to supply the needs of the industry, the amount of coal used was small. Most of the iron furnaces used charcoal in the charge, but coal was used in two of the blast furnaces in the Ashland area and provided steam power at several furnaces and foundries.

Salt was produced from brines in the Goose Creek area near Manchester in the early 1800's, and for every pound of salt produced about 1 pound of coal was required to evaporate the brine. Salt production in 1834 and 1837 amounted to about 10,000 and 6,000 tons, respectively (Eavenson, 1942, p. 303, 309), and the coal required for this was mined south of Manchester along Goose Creek.

Although the records of early production in the Eastern Kentucky coal field are incomplete, it is apparent that the amount of coal mined annually before 1880 was small.

LATER PERIOD: 1880–1955

The 10th Census Report of 1880 (see also Eavenson, 1942, map 14, p. 417) reported 24 mines operating in eastern Kentucky, all in the western and northern counties of the coal field. Most of the coal was shipped out of the mining area by river transportation, except in the Princess reserve district where it was shipped by railroad. A small part of the production in the early part of this period was used locally by the iron and salt industries.

By 1900, railroads were serving most of the western margin of the coal field and had extended to Prestonsburg in the Big Sandy district and to the Middlesboro field. However, they had reached only the margins of the areas that contained large amounts of thick coal. Large-scale production did not begin until the decade between 1910 and 1920 when the railroads reached the center of the Elkhorn mining area in southern Pike County, the Harlan-Benham mining area, and the Hazard mining area. After this, production declined in the western part of the coal field, except in McCreary County where there was unmined coal of sufficient thickness and extent to permit fairly large operations and later mechanized mining.

The expansion of railroads reached its peak in 1920; after that some of the railroads were abandoned as the coal and timber were exhausted, especially along the western tier of counties in the coal field. In recent years spur tracks have been laid only into areas containing large reserves and to mines with life expectancy of 20 to 30 years. Truck highways have been important in the recent development of large production in areas without railroads.

Production in the Eastern Kentucky coal field increased during the 1920's, declined during the 1930's, and revived during World War II, reaching a peak production of more than 66 million tons in 1947 immediately after the war. This peak was a result of the large demands by industry and of the 1946 strikes, which reduced stocks of coal. A decrease in the demand for coal during 1949–54 was due to conversion to oil, natural gas, or electricity by many railroads and industrial and domestic coal consumers. Increasing demands for coal in 1954–55 seem to be due to industrial expansion, large demand for oven coke, and for coal to generate electricity.

Only six counties, Bell, Floyd, Harlan, Letcher, Perry, and Pike, have produced large tonnages of coal (table 9). Bell County has had the longest period of production, but the amount of coal mined annually has declined as the thick coal beds have been exhausted. Pike County has had the next longest period of production. Harlan County production began about 1911 and has increased steadily until the total is greater than that of any other county. Letcher, Perry, and Floyd Counties began producing large quantities of coal between 1910 and 1914 and have produced consistently since then. Production in all six counties has been mainly from the Fire Clay and older beds, particularly those of the Elkhorn zone, except in Harlan County in recent years, and in Perry County where production has been from the Fire Clay and younger beds.

Leslie County recently has become an important producer. Its annual production has been more than 2 million tons since 1949, and the 1955 production amounted to more than 5.5 percent of the eastern

Kentucky production for that year. Total production, however, is not as large as the other major producing counties because large-scale mining was not possible until truck highways were built in the 1940's.

MINING METHODS IN EASTERN KENTUCKY

The earliest methods of mining were very simple and consisted of "raising" coal from creek beds and mining back into the outcrop in creek banks and other natural exposures. These "coal banks" were operated intermittently, and during the periods of inactivity rock falls made new openings necessary when operations were renewed. Mining extended back from the outcrop only a short distance—an arm's length or as far as the character of the overlying rocks permitted; drifts into flat-lying coals for distances of 100 to 300 feet were made only where roof conditions were favorable. Many mines were abandoned as soon as ventilation became a problem, and a new entry was driven a short distance away. Later, with improved methods of ventilation, cross entries were driven and rooms turned.

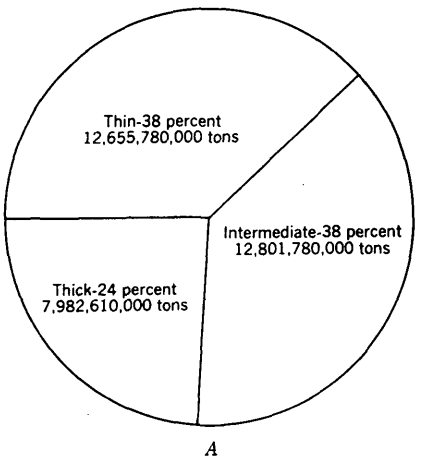
In eastern Kentucky nearly all the mining has been by room-and-pillar method, and most of the mines have been drift mines. A shaft mine operating near Middlesboro in the early 1900's was finally abandoned because of water problems, and a few shaft and slope mines have been operated in Harlan, Johnson, Martin, Magoffin, and Whitley Counties. Commerical stripping in alluvial bottoms and along the contours on the hillsides has been practiced intermittently from the beginning of mining in the State. Some stripping has been done in all districts, but production from strip mines has been especially important in the Princess reserve district and in the Southwestern reserve district near Corbin, and from combination stripping and augering in Magoffin, Perry, and Harlan Counties. In some areas, contour stripping has been used as preparation for underground mining, the stripped area being used for roadways and sites for surface facilities. The intricate dissection of the Plateau forms many miles of outcrop of coal beds which can be mined by stripping along the outcrop and augering in from the high wall of the pit.

The mechanization of mines since the period of 1910–25, beginning with cutting machines and followed by loaders and continuous-mining machinery, has resulted in greatly increased production per man. According to the annual report of the Kentucky Department of Mines and Minerals for 1955, approximately 20 percent of the coal mined was hand loaded and 80 percent machine loaded; underground mining produced approximately 93 percent of the total, or 39,760,374 tons, and strip mining approximately 7 percent, or 2,894,294 tons.

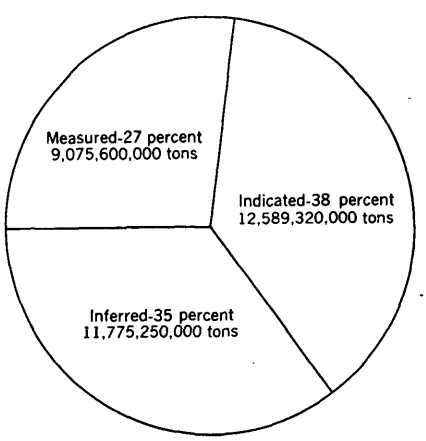
SUMMARY OF RESERVE ESTIMATES

ESTIMATED ORIGINAL RESERVES

Total coal reserves of eastern Kentucky are estimated at almost 33.5 billion tons of high-volatile bituminous coal, which is classified as original, except in a few counties for which only remaining reserves were calculated (table 5). Of this, 65 percent is classified as measured and indicated and 35 percent as inferred (fig. 13*B*). About 24 percent



A



B

FIGURE 13.—Distribution of original coal reserves of eastern Kentucky: (*A*), according to thickness of beds and (*B*), according to reliability of data used in preparing estimates.

of the coal is in thick beds (42 inches or more), 38 percent in beds of intermediate thickness (28 to 42 inches), and 38 percent in thin beds (14 to 28 inches) (fig. 13*A*). The reliability categories contain the following percentage distribution according to thickness:

	14 to 28 inches	28 to 42 inches	42 inches or more
Measured	15	36	49
Indicated	37	43	20
Inferred	56	35	9

The distribution of coal reserves by county is shown in figure 14. Ten counties, which form a group in the eastern and southeastern part of the Eastern Kentucky coal field, have more than one billion tons of original coal reserves each. Approximately 73 percent of the total reserves is in these 10 counties, and nearly 48 percent is in Pike, Harlan, Knott, Perry, and Leslie Counties. Six counties—Pike, Harlan, Knott, Perry, Letcher, and Martin—each have more than half a billion tons of coal in beds thicker than 42 inches and more than one billion tons in beds thicker than 28 inches. Although Bath, Lewis, Madison, Montgomery, and Rowan Counties have records of coal production, no reserves were estimated for these counties because of insufficient information.

The reserves are unevenly distributed in the three coal-bearing formations, the Breathitt formation containing about 32 billion tons, the Lee about 1.5 billion tons, and the Conemaugh about 22 million tons. Important beds in the Breathitt formation, on the basis of their content of coal resources, are:

	Billion tons		*Billion tons*
Upper Elkhorn No. 3 and correlative beds	4. 93	Upper Elkhorn No. 2 and correlative beds	2. 27
Fire Clay and correlative beds	4. 18	Hazard No. 7 and correlative beds	1. 82
Upper Elkhorn No. 1 and correlative beds	2. 70	Lower Elkhorn and correlative beds	1. 77
Hazard and correlative beds	2. 69		
Amburgy and correlative beds	2. 30		

These eight beds contain 71 percent of the coal reserves of the Breathitt formation. All but two of them—the Hazard and Hazard No. 7—are below the Magoffin member in the lower part of the Breathitt, and they contain 57 percent of the coal in the formation. The Lower Elkhorn and three Upper Elkhorn beds together contain an estimated 11.68 billion tons of coal, the largest coal reserve in any particular zone. Table 10 shows the distribution of the total original coal reserves by bed.

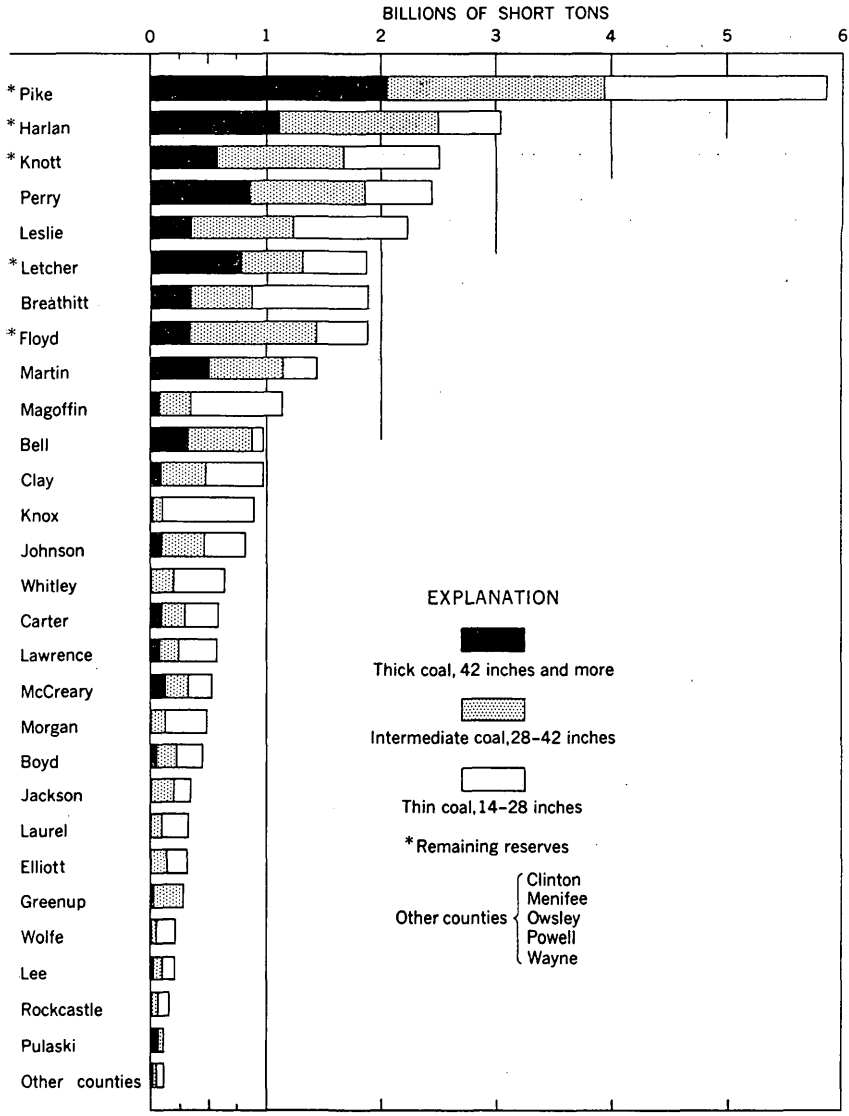


FIGURE 14.—Thickness categories of original coal reserves, by county.

ESTIMATED REMAINING RESERVES

The estimated remaining reserves for the Eastern Kentucky coal field totaled 32,270,780,000 tons as of January 1, 1956 (fig. 15). The remaining reserves for Pike, Floyd, Letcher, Knott, and Harlan Counties were estimated by excluding mined-out areas of these counties. The extent of the mined-out areas in the rest of the Eastern

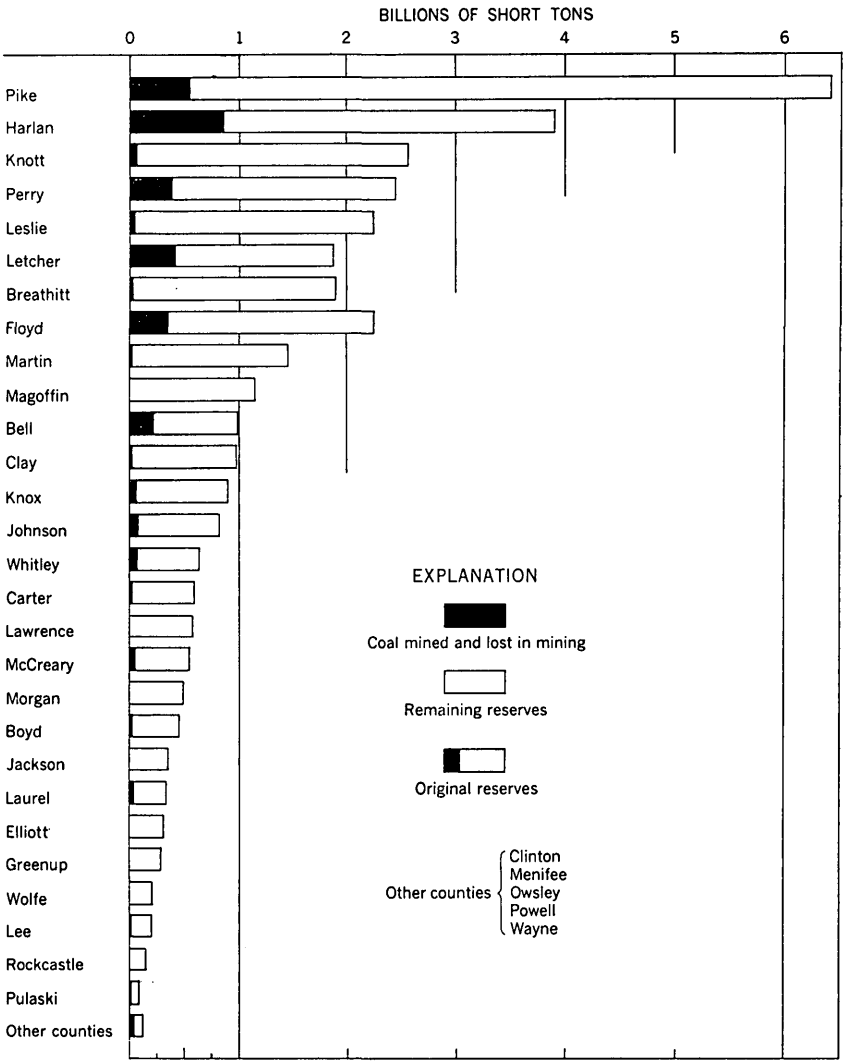


FIGURE 15.—Coal mined and lost in mining and coal in remaining and original reserves, by county.

Kentucky coal field was not known accurately enough to use this method, and the estimate of the remaining reserves, therefore, was made by doubling the recorded production, which is equivalent to assuming a 50 percent recovery, and subtracting this amount from the estimated original reserves. In Harlan and Bell Counties, the remaining reserves amount to about 78 percent of the original reserves, and in Perry, Letcher, and Floyd to about 90 percent.

Assuming that all past production came from beds 28 inches or more thick, the total remaining coal reserves in this category are estimated at 19,614,990,000 tons. Ten counties contain 78 percent of the remaining reserves and 5—Pike, Harlan, Knott, Perry, and Floyd—contain 56 percent (table 8).

ESTIMATED RECOVERABLE RESERVES

Assuming a 50 percent recovery, the recoverable reserves are one-half of the remaining reserves. For eastern Kentucky this amounts to 16,135,390,000 tons of recoverable coal in all thickness categories and 9,807,500,000 tons in beds 28 or more inches thick. Table 8 shows the recoverable reserves in beds more than 28 inches thick for the 10 counties with the largest tonnages.

TABLE 8.—*Remaining and recoverable coal reserves in beds more than 28 inches thick in the 10 leading counties of Eastern Kentucky*

[In millions of tons. 50 percent recoverability is assumed]

County	Remaining reserves	Recoverable reserves	County	Remaining reserves	Recoverable reserves
Pike	3,947.23	1,973.62	Leslie	1,212.73	606.37
Harlan	2,478.93	1,239.46	Martin	1,136.98	568.49
Knott	[1] 1,667.34	833.67	Breathitt	854.20	427.10
Perry	1,479.95	739.98	Bell	662.34	331.17
Floyd	1,435.93	717.96			
Letcher	[2] 1,289.33	644.66	Total	16,164.96	8,082.48

[1] Includes original reserves in the Cornettsville and Blue Diamond quadrangles.
[2] Includes original reserves in the Cornettsville quadrangle.

WESTERN KENTUCKY AND TOTAL KENTUCKY RESERVES

To permit a comparison of the original coal reserves in Kentucky with those of other States it is necessary to take into account the large reserves of the Western Kentucky coal field, which was not included in the present study. The Western Kentucky coal field is part of the larger Eastern Interior Basin, which covers most of Illinois and parts of Indiana and western Kentucky. The coal reserves of Illinois and Indiana have recently been re-estimated by Cady (1952) and by Spencer (1953) respectively, and the results of their work when compared with earlier work of M. R. Campbell can be used to suggest the probable reserves of the Western Kentucky coal field.

Comparison of original reserves in the Eastern Interior Coal Basin as estimated by M. R. Campbell and by recent workers

State	Original reserves as estimated by M. R. Campbell, 1913–29 (millions of short tons)	Original reserves as estimated or assumed by recent workers (millions of short tons)	Recent figures as percentage of Campbell figures
Illinois	201,400	[1] 137,321	[1] 68
Indiana	53,051	37,293	70
Western Kentucky	55,540	[2] 38,878	[2] 70

[1] Includes remaining reserves as of Jan. 1, 950, in beds 28 inches or more thick.
[2] Assumed.

The accompanying table shows the results obtained by Campbell and the more recent workers. As noted in the table the recent estimates for Illinois and Indiana were 68 and 70 percent, respectively, of the older Campbell estimate. The recent estimate for Illinois is not strictly comparable with the other estimates because it includes only remaining reserves as of January 1, 1950, in beds 28 or more inches thick, but it aids in establishing the maximum possible difference between the older and the newer work.

The recent estimate for Indiana is strictly comparable with the older Campbell estimate as it is for original reserves in beds 14 or more inches thick, Therefore, the 70 percent factor obtained as a result of the restudy of coal reserves in Indiana seems to be a reasonable one to apply to the older Campbell figure for western Kentucky. On this basis, the older figure of 55,540 million tons for western Kentucky would be reduced to 38,878 million tons as noted in the table.

The estimate of 38,878 million tons for the Western Kentucky coal field added to the figure of 33,440 million tons for the Eastern Kentucky coal field yields the new figure of 72,318 million tons for Kentucky as a whole. Although there is no particular accuracy in a figure thus determined, it is useful in indicating the probable order of magnitude of Kentucky reserves. At this reduced order of magnitude, Kentucky ranks high among the States in estimated original reserves of bituminous coal.

TABLE 10.—*Summary of original coal reserves in eastern Kentucky by county according to abundance, reliability of data, and thickness*

Explanation of asterisks:

*Remaining reserves as estimated previously by Bureau of Mines: Floyd County, as of January 1, 1949; Harlan County, as of January 1, 1952; Knott County, as of January 1, 1950; Letcher County, as of January 1, 1952; and Pike County, as of January 1, 1948

**Total of remaining reserves plus additional original reserves determined as part of present study. Figure for additional original reserves is identified by position on line between asterisked figures for remaining and total reserves. All other figures are total original reserves

[In millions of short tons]

County	Measured reserves, in beds of indicated thickness in inches				Indicated reserves, in beds of indicated thickness in inches			
	14 to 28	28 to 42	>42	Total	14 to 28	28 to 42	>42	Total
Bell	7.80	66.10	71.90	145.80	31.61	198.47	126.74	356.82
Boyd					73.22	95.79	46.26	215.27
Breathitt	122.19	162.72	124.88	409.79	407.04	266.81	195.29	3,869.14
Carter					100.07	113.38	55.48	268.93
Clay	17.35	45.47	6.52	69.34	137.15	161.94	18.38	317.47
Clinton						1.04	5.81	6.85
Elliott	2.50	3.05		5.55	40.55	52.71	4.17	97.43
Floyd	*31.80	*315.86	*205.64	*553.30	*333.51	*686.51	*97.13	*1,117.15
		.97		.97	3.57	8.82	10.58	22.97
	*31.80	**316.83	*205.64	**554.27	**337.08	**695.33	**107.71	**1,140.12
Greenup					91.50	39.67	7.56	138.73
Harlan	*118.64	*534.75	*732.89	*1,386.28	*64.94	*381.35	*254.10	*700.39
	.44	2.73	7.52	10.69	16.69	95.89	31.06	143.64
	**119.08	**537.48	**740.41	**1,396.97	**81.63	**477.24	**285.16	**844.03
Jackson	3.15	16.25	.54	19.94	47.17	86.19	.28	133.64
Johnson	17.22	59.46	5.49	82.17	121.07	158.82	48.85	328.74
Knott	*182.28	*400.30	*192.86	*775.44	*332.06	*318.62	*85.41	*736.09
	36.24	73.84	183.75	293.83	119.10	181.95	105.33	406.38
	**218.52	**474.14	**376.61	**1,069.27	**451.16	**500.57	**190.74	**1,142.47
Knox	36.76	23.14	31.15	91.05	171.40	86.76	31.15	289.31
Laurel	3.94	8.51	1.31	13.76	81.27	54.23	1.94	137.44
Lawrence	2.83			2.83	66.19	50.14	48.72	165.05
Lee	4.72	8.01	1.93	14.66	34.28	25.47	6.12	65.87
Leslie	126.96	205.60	148.15	480.71	370.04	428.77	103.38	902.19
Letcher	*51.59	*146.22	*491.18	*688.99	*237.48	*165.54	*153.66	*556.68
	2.01	29.05	48.64	79.70	23.98	36.39	26.84	87.21
	**53.60	**175.27	**539.82	**768.69	**261.46	**201.93	**180.50	**643.89
McCreary	17.12	16.52	19.96	53.60	104.59	132.62	91.84	329.05
Magoffin	77.99	49.66	19.49	147.14	406.26	212.65	40.89	659.80
Martin	7.58	22.18	26.77	56.53	76.29	181.85	229.97	488.11
Menifee					18.46	4.80		23.26
Morgan	81.26	20.94	4.24	106.44	117.25	28.21	2.25	147.71
Owsley		.56	.66	1.22	3.32	1.56		4.88
Perry	187.18	369.75	595.13	1,152.06	260.48	352.63	218.11	831.22
Pike	*225.68	*621.18	*1,518.04	*2,364.90	*500.75	*630.18	*420.06	*1,550.99
		.24	.44	.68		4.20	5.25	9.45
	*225.68	**621.42	**1,518.48	**2,365.58	*500.75	**634.38	**425.31	**1,560.44
Powell					2.06	.98		3.04
Pulaski	.74	1.71	9.67	12.12		15.55	25.80	41.35
Rockcastle	.37	.80		1.17	22.38	20.94	1.85	45.17
Wayne					7.71	15.02	9.67	32.40
Whitley	15.81	17.25	1.07	34.13	165.13	108.96	2.59	276.68
Wolfe	10.06	10.00	.75	20.81	58.88	23.70	.24	82.82
Total	**1,392.21	**3,232.82	**4,450.57	**9,075.60	**4,647.45	**5,429.11	**2,512.76	**12,589.32

TABLE 10.—*Summary of original coal reserves in eastern Kentucky by county according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

County	Inferred reserves, in beds of indicated thickness in inches				All categories			County total, all beds
	14 to 28	28 to 42	>42	Total	14 to 28	28 to 42	>42	
Bell	60.64	304.19	111.92	476.75	100.05	568.76	310.56	979.37
Boyd	153.06	77.61	10.56	241.23	226.28	173.40	56.82	456.50
Breathitt	480.90	115.36	11.88	608.14	1,010.13	544.89	332.05	1,887.07
Carter	207.69	96.85	15.70	320.24	307.76	210.23	71.18	589.17
Clay	356.29	186.75	45.49	588.53	510.79	394.16	70.39	975.34
Clinton						1.04	5.81	6.85
Elliott	120.15	80.10	3.67	203.92	163.20	135.86	7.84	306.90
Floyd					*365.31	*1,002.37	*302.77	*1,670.45
	81.86	91.78	18.64	192.28	85.43	101.57	29.22	216.22
	81.86	91.78	18.64	192.28	**450.74	**1,103.94	**331.99	**1,886.67
Greenup	134.77	13.26	2.02	150.05	226.27	52.93	9.58	288.78
Harlan					*183.58	*916.10	*986.99	*2,086.67
	368.75	381.62	57.02	807.39	385.88	480.24	95.60	961.72
	368.75	381.62	57.02	807.39	**569.46	**1,396.34	**1,082.59	**3,048.39
Jackson	101.33	92.04		193.37	151.65	194.48	.82	346.95
Johnson	207.77	156.38	44.61	408.76	346.06	374.66	98.95	819.67
Knott					*514.34	*718.92	*278.27	*1,511.53
	183.13	111.12	14.16	308.41	338.47	366.91	303.24	1,008.62
	183.13	111.12	14.16	308.41	**852.81	**1,085.83	**581.51	**2,520.15
Knox	327.39	179.07	11.33	517.79	535.55	288.97	73.63	898.15
Laurel	145.68	35.49		181.17	230.89	98.23	3.25	332.37
Lawrence	288.99	102.33	22.27	413.59	358.01	152.47	70.99	581.47
Lee	68.95	40.58	10.41	119.94	107.95	74.06	18.46	200.47
Leslie	495.01	270.59	94.98	860.58	992.01	904.96	346.51	2,243.48
Letcher					*289.07	*311.76	*644.84	*1,245.67
	346.54	148.20	43.61	538.35	372.53	213.64	119.09	705.26
	346.54	148.20	43.61	538.35	**661.60	**525.40	**763.93	**1,950.93
McCreary	105.22	63.78	14.60	183.60	226.93	212.92	126.40	566.25
Magoffin	288.72	39.08	.69	328.49	772.97	301.39	61.07	1,135.43
Martin	186.32	410.22	287.29	883.83	270.19	614.25	544.03	1,428.47
Menifee	7.66			7.66	26.12	4.80		30.92
Morgan	144.20	83.85	3.99	232.04	342.71	133.00	10.48	486.19
Owsley	9.71	8.95		18.66	13.03	11.07	.66	24.76
Perry	142.33	267.14	62.65	472.12	589.99	989.52	875.89	2,455.40
Pike					*726.43	*1,251.36	*1,938.10	*3,915.89
	1,181.71	632.78	114.86	1,929.35	1,181.71	637.22	120.55	1,939.48
	1,181.71	632.78	114.86	1,929.35	**1,908.14	**1,888.58	**2,058.65	**5,855.37
Powell	.90			.90	2.96	.98		3.94
Pulaski	8.06	10.38	8.14	26.58	8.80	27.64	43.61	80.05
Rockcastle	60.63	38.38		99.01	83.38	60.12	1.85	145.35
Wayne	4.45	1.95		6.40	12.16	16.97	9.67	38.80
Whitley	253.54	87.46	8.79	349.79	434.48	213.67	12.45	660.60
Wolfe	93.77	12.56		106.33	162.71	46.26	.99	209.96
Total	6,616.12	4,139.85	1,019.28	11,775.25	**12,655.78	**12,801.78	**7,982.61	**33,440.17

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TABLE 11.—*Original coal reserves in eastern Kentucky by county and bed according to abundance, reliability of data and thickness*

Explanation of asterisks:
*Remaining reserves as estimated previously by Bureau of Mines: Floyd County as of January 1, 1949; Harlan County as of January 1, 1952; Knott County as of January 1, 1950; Letcher County as of January 1, 1952; and Pike County as of January 1, 1948
**Total of remaining reserves plus additional original reserves determined as part of present study. Figure for additional original reserves is identified by position on line between asterisked figures for remaining and total resources. All other figures are total original resources

[In millions of short tons]

Bed	Measured reserves, in beds of indicated thickness in inches				Indicated reserves, in beds of indicated thickness in inches				Inferred reserves, in beds of indicated thickness in inches				Total, each category			Total, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Bell County																
Bennett Fork	0.22	1.70	0.07	1.99	1.29	10.08		11.37	1.30	13.35		14.65	2.81	25.13	0.07	28.01
Blue Gem					.13	.16		.29	2.49	1.96		4.45	2.62	2.12		4.74
Cranes Creek	1.04	.28		1.32	4.35			4.35	11.94			11.94	17.33	.28		17.61
Fire Clay	1.82	5.31	4.89	12.02	4.27	20.44	5.37	30.08	7.67	36.67	21.92	66.26	13.76	62.42	32.18	108.36
Fire Clay rider	.23	.74	.88	1.85	.15	.36	.28	.79	.31		.78	1.09	.69	1.10	1.94	3.73
Francis			.24	.24	.25	.56	.87	1.68			.42	.42	.25	.56	1.53	2.34
Harlan	.12	2.22	18.49	20.83	.52	1.61	2.30	4.43		1.46	12.27	13.73	.64	5.29	33.06	38.99
Hindman						.05	.88	.93			.40	.40		.05	1.28	1.33
Imboden	.15	11.32		11.47	1.56	21.94	6.79	30.29	8.71	39.36	3.83	51.90	10.42	72.62	10.62	93.66
Jellico		14.27	.85	15.12	1.30	48.32	1.81	51.43	1.56	58.72		60.28	2.86	121.31	2.66	126.83
Lily									.30			.30	.30			.30
Lower Hamlin									.34			.34	.34			.34
Lower Hignite	.06	9.59	8.36	18.01		17.01	20.58	37.59		.28	5.76	6.04	.06	26.88	34.70	61.64
Mingo	1.59	8.26	13.76	23.61	6.18	27.38	19.89	53.45	2.67	41.91	19.35	63.93	10.44	77.55	53.00	140.99
Moss	1.51	2.89	.10	4.50	7.51	7.75	2.89	18.15	18.55	18.58	3.21	40.34	27.57	29.22	6.20	62.99
Poplar Lick		2.45	18.05	20.50	.16	7.36	47.78	55.30		.21	26.81	27.02	.16	10.02	92.64	102.82
Red Spring		1.47	3.24	4.71		.79	.99	1.78		.56	4.76	5.32		2.82	8.99	11.81
Rich Mountain	.34	1.03		1.37	.03	4.43		4.46		10.63		10.63	.37	16.09		16.46
Sandstone Parting	.35	3.03		3.38	2.94	19.07	.08	22.09	.44	45.18	1.40	47.02	3.73	67.28	1.48	72.49
Sterling	.37	1.54	2.97	4.88	.34	2.14	12.34	14.82			4.94	4.94	.71	3.68	20.25	24.64
Stray					.63	9.02	3.89	13.54	4.36	35.32	6.07	45.75	4.99	44.34	9.96	59.29
Total	7.80	66.10	71.90	145.80	31.61	198.47	126.74	356.82	60.64	304.19	111.92	476.75	100.05	568.76	310.56	979.37
Boyd County																
Princess No. 3					1.90			1.90	15.71	3.56		19.27	17.61	3.56		21.17
Princess No. 4					.45			.45	8.06			8.06	8.51			8.51
Princess No. 5					12.90	15.34	2.27	30.51	19.00	12.24		31.24	31.90	27.58	2.27	61.75

Princess No. 5A					11.59	6.04		17.63	25.81	3.07		28.88	37.40	9.11		46.51
Princess No. 5B					7.75			7.75	7.04			7.04	14.79			14.79
Princess No. 6					7.51	17.51	7.28	32.30	20.00	13.10	3.34	36.44	27.51	30.61	10.62	68.74
Princess No. 7					19.13	53.45	33.28	105.86	12.67	40.34	7.22	60.23	31.80	93.79	40.50	166.09
Princess No. 8					9.76	3.45	3.43	16.64	28.54	1.13		29.67	38.30	4.58	3.43	46.31
Princess No. 9					2.23			2.23	13.04	4.17		17.21	15.27	4.17		19.44
Princess No. 10									3.19			3.19	3.19			3.19
Total					73.22	95.79	46.26	215.27	153.06	77.61	10.56	241.23	226.28	173.40	56.82	456.50
Breathitt County																
Amburgy					15.44	9.83		25.27	30.00	40.79		70.79	45.44	50.62		96.06
Colvin (?)	0.41	0.20		0.61	11.39			11.39					11.80	.20		12.00
Copland						6.19	0.82	7.01	10.84			10.84	10.84	6.19	0.82	17.85
Fire Clay	14.69	1.45		16.14	21.86			21.86	36.42	1.21		37.63	72.97	2.66		75.63
Fire Clay rider	72.57	89.86	3.79	166.22	39.84	12.66		52.50	17.26	4.36		21.62	129.67	106.88	3.79	240.34
Francis	1.66	6.50	1.06	9.22	13.78	53.29	94.86	161.93	22.53	9.08	5.73	37.34	37.97	68.87	101.65	208.49
Haddix	16.03	18.40	3.51	37.94	68.49	55.91	11.93	136.33	67.80	7.82	.03	75.65	152.32	82.13	15.47	249.92
Hazard	12.62	18.32	6.86	37.80	68.75	48.34	7.22	124.31	45.94	7.46		53.40	127.31	74.12	14.08	215.51
Hazard No. 7	3.17	21.60	92.51	117.28	50.93	45.46	72.90	169.29	50.17	17.54	6.12	73.83	104.27	84.60	171.53	360.40
Hindman					4.11		1.00	5.11	2.62			2.62	6.73		1.00	7.73
Lower Whitesburg					28.42	1.96		30.38	60.58	19.96		80.54	89.00	21.92		110.92
Skyline	.07	1.09	15.63	16.79	.11	1.98	3.28	5.37	.12	1.98		2.10	.30	5.05	18.91	24.26
Uncorrelated					4.11	3.06		7.17	15.41			15.41	19.52	3.06		22.58
Upper Elkhorn No. 1					5.70	1.70		7.40	12.55	.37		12.92	18.25	2.07		20.32
Upper Elkhorn No. 3	.97	5.30	1.52	7.79	59.41	26.43	3.28	89.12	70.16	4.79		74.95	130.54	36.52	4.80	171.86
Zachariah					14.70			14.70	38.50			38.50	53.20			53.20
Total	122.19	162.72	124.88	409.79	407.04	266.81	195.29	869.14	480.90	115.36	11.88	608.14	1,010.13	544.89	332.05	1,887.07
Carter County																
Firé Clay					4.53	6.55	2.83	13.91	7.37	8.49		15.86	11.90	15.04	2.83	29.77
Grassy					1.41			1.41	14.08			14.08	15.49			15.49
Gun Creek					2.57			2.57	10.28			10.28	12.85			12.85
Lee									5.28			5.28	5.28			5.28
Princess No. 3					17.43	8.70		26.13	36.51	.41		36.92	53.94	9.11		63.05
Princess No. 4					3.78	4.49		8.27	15.95	1.87		17.82	19.73	6.36		26.09
Princess No. 5					15.44	12.97	8.09	36.50	36.19	24.47	6.08	66.74	51.63	37.44	14.17	103.24
Princess No. 5A					2.95			2.95	10.11			10.11	13.06			13.06
Princess No. 6					5.46	4.49		9.95	23.14	17.44	2.54	43.12	28.60	21.93	2.54	53.07
Princess No. 7					8.63	38.78	36.53	83.94	7.28	22.48	7.08	36.84	15.91	61.26	43.61	120.78
Princess No. 8					2.18	2.74		4.92	5.58	7.94		13.52	7.76	10.68		18.44
Tom Cooper					35.69	34.66	8.03	78.38	35.92	13.75		49.67	71.61	48.41	8.03	128.05
Total					100.07	113.38	55.48	268.93	207.69	96.85	15.70	320.24	307.76	210.23	71.18	589.17

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TABLE 11.—*Original coal reserves in eastern Kentucky by county and bed according to abundance, reliability of data and thickness*—Con.

[In millions of short tons]

Bed	Measured reserves, in beds of indicated thickness in inches				Indicated reserves, in beds of indicated thickness in inches				Inferred reserves, in beds of indicated thickness in inches				Total, each category			Total, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Clay County																
Bacon Creek									1.88			1.88	1.88			1.88
Blue Gem										3.77		3.77		3.77		3.77
Fire Clay	3.41	8.12	3.48	15.01	40.93	41.49	7.41	89.83	80.46	30.05		110.51	124.80	79.66	10.89	215.35
Fire Clay rider	.16	2.90	1.77	4.83	7.16	6.43	1.62	15.21	25.13	6.46		31.59	32.45	15.79	3.39	51.63
Francis									.11	1.02	4.40	5.53	.11	1.02	4.40	5.53
Haddix		.82	.95	1.77	2.93	2.03	6.04	11.00	17.10	10.16	14.41	41.67	20.03	13.01	21.40	54.44
Hazard									3.01			3.01	3.01			3.01
Jellico		1.36		1.36	17.32	16.18		33.50	60.45	47.52		107.97	77.77	65.06		142.83
Lily	12.23	29.83	.32	42.38	55.47	79.34		134.81	100.81	38.65		139.46	168.51	147.82	.32	316.65
Lower Hamlin	1.24	2.44		3.68	5.78	13.81	3.31	22.90	27.70	37.22	26.68	91.60	34.72	53.47	29.99	118.18
Mills	.31			.31	.82			.82	2.98			2.98	4.11			4.11
Moss					4.93	1.20		6.13	26.62	8.00		34.62	31.55	9.20		40.75
Upper Hamlin					1.81	1.46		3.27	10.04	3.90		13.94	11.85	5.36		17.21
Total	17.35	45.47	6.52	69.34	137.15	161.94	18.38	317.47	356.29	186.75	45.49	588.53	510.79	394.16	70.39	975.34
Clinton County																
Beaver Creek						1.04	5.81	6.85						1.04	5.81	6.85
Elliott County																
Beattyville									4.79			4.79	4.79			4.79
Colvin									1.38			1.38	1.38			1.38
Fire Clay					4.11	8.33		12.44	18.89	14.48		33.37	23.00	22.81		45.81
Fugate										1.22		1.22		1.22		1.22
Grassy					5.68	8.21		13.89	22.12	18.44		40.56	27.80	26.65		54.45
Gun Creek					1.53	.20		1.73	5.81			5.81	7.34	.20		7.54
Index					8.78	14.03	3.60	26.41	21.77	16.98	1.06	39.81	30.55	31.01	4.66	66.22
Nickell									.12			.12	.12			.12
Princess No. 6									1.66			1.66	1.66			1.66
Princess No. 7									1.25			1.25	1.25			1.25
Richardson					.25		.57	.82	3.86	2.39	2.61	8.86	4.11	2.39	2.18	9.68

Tom Cooper	2.50	3.05		5.55	20.03	21.94		41.97	34.40	22.80		57.20	56.93	47.79		104.72
Uncorrelated									3.52			3.52	3.52			3.52
Whitesburg					.17			.17	.58	3.79		4.37	.75	3.79		4.54
Total	2.50	3.05		5.55	40.55	52.71	4.17	97.43	120.15	80.10	3.67	203.92	163.20	135.86	7.84	306.90

Floyd County

Fire Clay	*1.52	*23.59	*26.71	*51.82	*34.11	*51.84	*17.88	*103.83					*35.63	*75.43	*44.59	*155.65
									10.80	21.73		32.53	10.80	21.73		32.53
	*1.52	*23.59	*26.71	*51.82	*34.11	*51.84	*17.88	*103.83	10.80	21.73		32.53	**46.43	**97.16	*44.59	**188.18
Haddix							.33	.33		6.96	4.61	11.57		6.96	4.94	11.90
Hamlin	*.04	*6.61	*4.46	*11.11		*10.13	*.93	*11.06					*.04	*16.74	*5.39	*22.17
Peach Orchard									.42	10.47		10.89	.42	10.47		10.89
Richardson							5.41	5.41			5.07	5.07			10.48	10.48
Torchlight						4.36	.91	5.27		4.65	3.94	8.59		9.01	4.85	13.86
Upper Elkhorn No. 1	*8.48	*94.84	*38.07	*141.39	*89.41	*167.94	*31.10	*288.45					*97.89	*262.78	*69.17	*429.84
									9.14	4.81		13.95	9.14	4.81		13.95
	*8.48	*94.84	*38.07	*141.39	*89.41	*167.94	*31.10	*288.45	9.14	4.81		13.95	**107.03	**267.59	*69.17	**443.79
Upper Elkhorn No. 2	*12.60	*73.89	*37.99	*124.48	*86.45	*134.66	*29.39	*250.50					*99.05	*208.55	*67.38	*374.98
		.97		.97		4.46		4.46	32.34	10.73		43.07	32.34	16.16		48.50
	*12.60	**74.86	*37.99	**125.45	*86.45	**139.12	*29.38	**254.96	32.34	10.73		43.07	**131.39	**224.71	*67.38	**423.48
Upper Elkhorn No. 3	*9.16	*116.93	*98.41	*224.50	*123.54	*321.94	*17.83	*463.31					*132.70	*438.87	*116.24	*687.81
									9.55	29.38		38.93	9.55	29.38		38.93
	*9.16	*116.93	*98.41	*224.50	*123.54	*321.94	*17.83	*463.31	9.55	29.38		38.93	**142.25	**468.25	*116.24	**726.74
Upper Whitesburg					3.30			3.30	6.47			6.47	9.77			9.77
Williamson					.27		3.93	4.20	13.14	3.05	5.02	21.21	13.41	3.05	8.95	25.41
Total	*31.80	**316.83	*205.64	**554.27	**337.08	**695.33	**107.71	**1,140.12	81.86	91.78	18.64	192.28	**450.74	**1,103.94	**331.99	**1,886.67

Greenup County

Fire Clay					0.39			0.39	10.91			10.91	11.30			11.30
Grassy					2.49			2.49	4.74			4.74	7.23			7.23
Gun Creek					2.53	2.27		4.80	10.96			10.96	13.49	2.27		15.76
Lee										4.41		4.41		4.41		4.41
Princess No. 3					62.66	15.48	0.77	78.91	35.75	3.42	0.77	39.94	98.41	18.90	1.54	118.85
Princess No. 4					3.56	6.85	1.00	11.41	24.95			24.95	28.51	6.85	1.00	36.36
Princess No. 5					3.80	3.66	.67	8.13	13.94	4.20		18.14	17.74	7.86	.67	26.27
Princess No. 5A									2.42			2.42	2.42			2.42
Princess No. 5B					4.50			4.50	5.61			5.61	10.11			10.11
Princess No. 6						1.26	.18	1.44	5.88	1.23	.58	7.69	5.88	2.49	.76	9.13
Princess No. 7					.41	9.28	4.47	14.16	.78		.67	1.45	1.19	9.28	5.14	15.61
Princess No. 8							.47	.47	.26			.26	.26		.47	.73
Tom Cooper					11.16	.87		12.03	18.57			18.57	29.73	.87		30.60
Total					91.50	39.67	7.56	138.73	134.77	13.26	2.02	150.05	226.27	52.93	9.58	288.78

TABLE 11.—*Original coal reserves in eastern Kentucky by county and bed according to abundance, reliability of data and thickness*—Con

[In millions of short tons]

Bed	Measured reserves, in beds of indicated thickness in inches				Indicated reserves, in beds of indicated thickness in inches				Inferred reserves, in beds of indicated thickness in inches				Total, each category			Total, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Harlan County																
Amburgy									5.95	4.86		10.81	5.95	4.86		10.81
Collier	*16.99	*107.26	*58.60	*182.85	*6.50	*113.75	*12.01	*132.26					*23.49	*221.01	*70.61	*315.11
									97.21	50.56	0.51	148.28	97.21	50.56	.51	148.28
	*16.99	*107.26	*58.60	*182.85	*6.50	*113.75	*12.01	*132.26	97.21	50.56	.51	148.28	**120.70	**271.57	**71.12	**463.39
Cornett	*8.11	*18.49	*48.91	*75.51	*.78	*18.86	*21.27	*40.91					*8.89	*37.35	*70.18	*116.42
									1.88	14.14	5.04	21.06	1.88	14.14	5.04	21.06
	*8.11	*18.49	*48.91	*75.51	*.78	*18.86	*21.27	*40.91	1.88	14.14	5.04	21.06	**10.77	**51.49	**75.22	**137.48
"D"	*1.24	*35.53	*16.15	*52.92									*1.24	*35.53	*16.15	*52.92
									7.20	54.48	8.31	69.99	.720	54.48	8.31	69.99
	*1.24	*35.53	*16.15	*52.92					7.20	54.48	8.31	69.99	**8.44	**90.01	**24.46	**122.91
Darby	*23.54	*128.21	*86.62	*238.37	*.62	*117.19	*5.65	*123.46					*24.16	*245.40	*92.27	*361.83
									27.03	22.04	2.67	51.74	27.03	22.04	2.67	51.74
	*23.54	*128.21	*86.62	*238.37	*.62	*117.19	*5.65	*123.46	27.03	22.04	2.67	51.74	**51.19	**267.44	**94.94	**413.57
Fire Clay	*7.00	*15.22	*25.33	*47.55	*13.59	*18.38	*11.28	*43.25					*20.59	*33.60	*36.61	*90.80
	.22	.90		1.12	1.57	4.66		6.23	41.11	39.52	2.65	83.28	42.90	45.08	2.65	90.63
	**7.22	**16.12	*25.33	**48.67	**15.16	**23.04	*11.28	**49.48	41.11	39.52	2.65	83.28	**63.49	**78.68	**39.26	**181.43
Fire Clay rider					2.97	.42		3.39	6.84	1.93		8.77	9.81	2.35		12.16
Francis			1.31	1.31		.86	4.60	5.46	2.62	1.53	.93	5.08	2.62	2.39	6.84	11.85
Gin Creek					9.69	9.38	2.63	21.70	10.93	7.16		18.09	20.62	16.54	2.63	39.79
Haddix			.61	.61		2.45	.11	2.56	.36	16.79		17.15	.36	19.24	.72	20.32
Harlan	*27.81	*127.49	*197.63	*352.93	*1.97	*72.52	*95.82	*170.31					*29.78	*200.01	*293.45	*523.24
									66.06	24.29	8.92	99.27	66.06	24.29	8.92	99.27
	*27.81	*127.49	*197.63	*352.93	*1.97	*72.52	*95.82	*170.31	66.06	24.29	8.92	99.27	**95.84	**224.30	**302.37	**622.51
Hazard	.22	.18	3.90	4.30		65.63	17.04	82.67					.22	65.81	20.94	86.97
Hazard No. 7					.44			.44	5.88	2.90		8.78	6.32	2.90		9.22
Hindman		.48	1.37	1.85	.28	2.89	6.68	9.85		4.59	11.24	15.83	.28	7.96	19.29	27.53
High Splint	*1.58	*5.34	*148.52	*155.44		*4.23		*4.23					*1.58	*9.57	*148.52	*159.67
Imboden	*1.65	*20.74	*45.31	*67.70			*87.54	*87.54					*1.65	*20.74	*132.85	*155.24
		1.17	.33	1.50		9.60		9.60	21.46	68.63		90.09	21.46	79.40	.33	101.19
	*1.65	**21.91	**45.64	**69.20		9.60	*87.54	**97.14	21.46	68.63		90.09	**23.11	**100.14	**133.18	**256.43
Kellioka	*9.33	*10.73		*20.06									*9.33	*10.73		*20.06
									45.22	36.01	4.74	85.97	45.22	36.01	4.74	85.97
	*9.33	*10.73		*20.06					45.22	36.01	4.74	85.97	**54.55	**46.74	4.74	**106.03
Lower Hamlin					1.74			1.74	6.11			6.11	7.85			7.85
Lower Split of Harlan	*14.66	*25.29	*23.51	*63.46	*34.18			*34.18					*48.84	*25.29	*23.51	*97.64
									1.16	19.04		20.20	1.16	19.04		20.20
	*14.66	*25.29	*23.51	*63.46	*34.18			*34.18	1.16	19.04		20.20	**50.00	**44.33	*23.51	**117.84

Low Splint	*.45	*27.44	*26.18	*54.07	*3.39	*29.63	*9.36	*42.38					*3.84	*57.07	*35.54	*96.45
									8.11		4.97	13.08	8.11		4.97	13.08
	*.45	*27.44	*26.18	*54.07	*3.39	*29.63	*9.36	*42.38	8.11		4.97	13.08	**11.95	*57.07	**40.51	**109.53
Pardee	*.25	*5.22	*44.01	*49.48		*2.25	*7.59	*9.84					*.25	*7.47	*51.60	*59.32
									.61	9.24	7.04	16.89	.61	9.24	7.04	16.89
	*.25	*5.22	*44.01	*49.48		*2.25	*7.59	*9.84	.61	9.24	7.04	16.89	**.86	**16.71	**58.64	**76.21
Upper Elkhorn No. 3									1.28			1.28	1.28			1.28
Wax	*6.03	*7.79	*12.12	*25.94	*3.91	*4.54	*3.58	*12.03					*9.94	*12.33	*15.70	*37.97
									11.73	3.91		15.64	11.73	3.91		15.64
	*6.03	*7.79	*12.12	*25.94	*3.91	*4.54	*3.58	*12.03	11.73	3.91		15.64	**21.67	**16.24	*15.70	**53.61
Total	**119.08	**537.48	**740.41	**1,396.97	**81.63	**477.24	**285.16	**844.03	368.75	381.62	57.02	807.39	**569.46	**1,396.34	**1,082.59	**3,048.39

Jackson County

Barren Fork	1.39	11.57		12.96	16.87	42.19		59.06	28.30	31.01		59.31	46.56	84.77		131.33
Beaver Creek	.82	2.82		3.64	14.40	26.97		41.37	26.15	37.87		64.02	41.37	67.66		109.03
Hudson	.52	1.70	0.54	2.76	6.70	11.65	0.28	18.63	19.05	16.89		35.94	26.27	30.24	0.82	57.33
Uncorrelated	.42	.16		.58	9.20	5.38		14.58	27.83	6.27		34.10	37.45	11.81		49.26
Total	3.15	16.25	0.54	19.94	47.17	86.19	0.28	133.64	101.33	92.04		193.37	151.65	194.48	0.82	346.95

Johnson County

Fire Clay	1.43	2.51		3.94	19.46	18.82	1.49	39.77	53.07	30.54		83.61	73.96	51.87	1.49	127.32
Haddix			1.70	1.70		8.17	21.21	29.38	4.92	38.33	12.87	56.12	4.92	46.50	35.78	87.20
Lower Whitesburg	.94	.76		1.70	14.40	3.28		17.68	32.27	1.27		33.54	47.61	5.31		52.92
Mine Fork	.19			.19	.95			.95	5.18			5.18	6.32			6.32
Peach Orchard					.96		6.72	7.68	1.38	5.30	21.00	27.68	2.34	5.30	27.72	35.36
Richardson							2.46	2.46			7.62	7.62			10.08	10.08
Torchlight			.80	.80		.94	11.55	12.49		5.40	3.12	8.52		6.34	15.47	21.81
Upper Elkhorn No. 2						6.47		6.47	22.26			22.26	22.26	6.47		28.73
Upper Elkhorn No. 3	12.06	56.19	2.99	71.24	62.54	121.14	5.42	189.10	52.49	75.54		128.03	127.09	252.87	8.41	388.37
Upper Whitesburg	2.60			2.60	17.55			17.55	32.77			32.77	52.92			52.92
Williamson					5.21			5.21	3.43			3.43	8.64			8.64
Total	17.22	59.46	5.49	82.17	121.07	158.82	48.85	328.74	207.77	156.38	44.61	408.76	346.06	374.66	98.95	819.67

TABLE 11.—*Original coal reserves in eastern Kentucky by county and bed according to abundance, reliability of data and thickness*—Con.

[In millions of short tons]

Bed	Measured reserves, in beds of indicated thickness in inches				Indicated reserves, in beds of indicated thickness in inches				Inferred reserves, in beds of indicated thickness in inches				Total, each category			Total, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Knott County																
Amburgy	*1.20	*25.21		*26.41	*82.10	*32.32		*114.42					*83.30	*57.53		*140.83
					.31			.31	27.55	49.51		77.06	27.86	49.51		77.37
	*1.20	*25.21		*26.41	**82.41	*32.32		**114.73	27.55	49.51		77.06	**111.16	**107.04		**218.20
Colvin					4.15			4.15					4.15			4.15
Fire Clay	*105.28	*155.20	*91.59	*352.07	*21.06	*15.21	*2.28	*38.55					*126.34	*170.41	*93.87	*390.62
	28.58	19.32	2.00	49.90	56.20	32.45	2.18	90.83	40.46	.50		40.96	125.24	52.27	4.18	181.69
	**133.86	**174.52	**93.59	**401.97	**77.26	**47.66	**4.46	**129.38	40.46	.50		40.96	**251.58	**222.68	**98.05	**572.31
Fire Clay rider					1.75			1.75	1.56			1.56	3.31			3.31
Francis	1.00	.63	.86	2.49	1.45	6.09	4.58	12.12		4.34	2.08	6.42	2.45	11.06	7.52	21.03
Haddix	5.99	21.32	2.69	30.00	22.45	15.26	.73	38.44	1.17			1.17	29.61	36.58	3.42	69.61
Hazard	.67	2.13	12.22	15.02	14.59	27.60		42.19	8.69	8.99		17.68	23.95	38.72	12.22	74.89
Hazard No. 7		*7.27	*7.98	*15.25	*9.88	*42.03	*43.99	*95.90					*9.88	*49.30	*51.97	*111.15
		17.02	134.35	151.37	1.44	47.63	60.95	110.02	9.81	14.71	4.82	29.34	11.25	79.36	200.12	290.73
		**24.29	**142.33	**166.62	**11.32	**89.66	**104.94	**205.92	9.81	14.71	4.82	29.34	**21.13	**128.66	**252.09	**401.88
Hindman			*.32	*.32											*.32	*.32
			27.95	27.95	6.78	10.18	35.19	52.15		2.39	7.22	9.61	6.78	12.57	70.36	89.71
			**28.27	**28.27	6.78	10.18	35.19	52.15		2.39	7.22	9.61	6.78	12.57	**70.60	**90.03
Skyline			.04	.04		.21	.48	.69		.07	.04	.11		.28	.56	.84
Upper Elkhorn No. 1	*3.65	*10.53	*13.90	*28.08	*76.68	*32.38	*4.77	*113.83					*80.33	*42.91	*18.67	*141.91
									16.61			16.61	16.61			16.61
	*3.65	*10.53	*13.90	*28.08	*76.68	*32.38	*4.77	*113.83	16.61			16.61	**96.94	*42.91	*18.67	**158.52
Upper Elkhorn No. 2	*39.71	*42.26	*2.37	*84.34	*83.38	*48.78		*132.16					*123.09	*91.04	*2.37	*216.50
									14.60	3.29		17.89	14.60	3.29		17.89
	*39.71	*42.26	*2.37	*84.34	*83.38	*48.78		*132.16	14.60	3.29		17.89	**137.69	**94.33	*2.37	**234.39
Upper Elkhorn No. 3	*22.75	*158.62	*76.70	*258.07	*8.70	*120.31	*34.37	*163.38					*31.45	*278.93	*111.07	*421.45
		13.42	3.64	17.06	9.98	42.53	1.22	53.73	48.65	22.26		70.91	58.63	78.21	4.86	141.70
	*22.75	**172.04	**80.34	**275.13	**18.68	**162.84	**35.59	**217.11	48.65	22.26		70.91	**90.08	**357.14	**115.93	**563.15
Upper Whitesburg	*9.69	*1.21		*10.90	*50.26	*27.59		*77.85					*59.95	*28.80		*88.75
									14.03	5.06		19.09	14.03	5.06		19.09
	*9.69	*1.21		*10.90	*50.26	*27.59		*77.85	14.03	5.06		19.09	**73.98	**33.86		**107.84
Total	**218.52	**474.14	**376.61	**1,069.27	**451.16	**500.57	**190.74	**1,142.47	183.13	111.12	14.16	308.41	**852.81	**1,085.83	**581.51	**2,520.15

Knox County

Blue Gem	27.56			27.56	100.79	1.30		102.09	101.78	7.15		108.93	230.13	8.45		238.58
Fire Clay	.06	8.33	12.11	20.50	5.92	25.26	24.76	55.94	19.56	28.55	6.11	54.22	25.54	62.14	42.98	130.66
Fire Clay rider	.05	.59	1.02	1.66	6.06	7.11	.49	13.66	11.33	21.52	.43	33.28	17.44	29.22	1.94	48.60
Francis									.31	.61	.92	1.84	.31	.61	.92	1.84
Jellico	4.15	10.25	16.71	31.11	22.97	28.01	3.62	54.60	66.88	51.48	2.56	120.92	94.00	89.74	22.89	206.63
Lily	.20	.47		.67	5.09	2.80		7.89	32.28	5.03		37.31	37.57	8.30		45.87
Lower Hamlin										.09		.09		.09		.09
Mills					4.39	1.77		6.16	30.30	4.65		34.95	34.69	6.42		41.11
Moss	4.74	3.50	1.31	9.55	24.93	20.48	1.66	47.07	54.69	57.91	.41	113.01	84.36	81.89	3.38	169.63
Uncorrelated					1.25			1.25	9.73			9.73	10.98			10.98
Upper Hamlin						.03	.62	.65	.53	2.08	.90	3.51	.53	2.11	1.52	4.16
Total	36.76	23.14	31.15	91.05	171.40	86.76	31.15	289.31	327.39	179.07	11.33	517.79	535.55	288.97	73.63	898.15

Laurel County

Barren Fork					12.88	9.82		22.70	55.96	9.03		64.99	68.84	18.85		87.69
Beaver Creek	0.41	0.49		0.90	4.29	2.23		6.52	18.10			18.10	22.80	2.72		25.52
Blue Gem					.80			.80	6.96			6.96	7.76			7.76
Fire Clay										.36		.36		.36		.36
Hudson					.26	1.61		1.87	.48	3.22		3.70	.74	4.83		5.57
Jellico					1.15	2.49	1.94	5.58	2.00	8.42		10.42	3.15	10.91	1.94	16.00
Lily	3.53	8.02	1.31	12.86	61.89	38.08		99.97	62.18	14.46		76.64	127.60	60.56	1.31	189.47
Total	3.94	8.51	1.31	13.76	81.27	54.23	1.94	137.44	145.68	35.49		181.17	230.89	98.23	3.25	332.37

Lawrence County

Fire Clay	0.85			0.85	22.42	5.64		28.06	62.70	3.61		66.31	85.97	9.25		95.22
Fire Clay rider	1.35			1.35	5.44			5.44	11.22			11.22	18.01			18.01
Peach Orchard	.63			.63	15.20	5.36	6.55	27.11	70.28	32.71	15.39	118.38	86.11	38.07	21.94	146.12
Princess No. 6									12.23			12.23	12.23			12.23
Princess No. 7					2.34	3.80	4.61	10.75	9.32	4.72	6.44	20.48	11.66	8.52	11.05	31.23
Princess No. 8					7.77	17.69	1.38	26.84	48.91			48.91	56.68	17.69	1.38	75.75
Princess No. 10									1.19			1.19	1.19			1.19
Richardson					3.93	4.98	30.15	39.06	29.83	53.57	.44	83.84	33.76	58.55	30.59	122.90
Tom Cooper									10.68	2.02		12.70	10.68	2.02		12.70
Torchlight					4.49	12.67	6.03	23.19	23.62	5.70		29.32	28.11	18.37	6.03	52.51
Whitesburg					4.60			4.60	9.01			9.01	13.61			13.61
Total	2.83			2.83	66.19	50.14	48.72	165.05	288.99	102.33	22.27	413.59	358.01	152.47	70.99	581.47

TABLE 11.—*Original coal reserves in eastern Kentucky by county and bed according to abundance, reliability of data and thickness*—Con.

[In millions of short tons]

Bed	Measured reserves, in beds of indicated thickness in inches				Indicated reserves, in beds of indicated thickness in inches				Inferred reserves, in beds of indicated thickness in inches				Total, each category			Total, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Lee County																
Barren Fork					3.33			3.33	11.45			11.45	14.78			14.78
Beaver Creek	2.91	5.77	1.93	10.61	19.16	17.69	5.62	42.47	41.44	32.20	10.41	84.05	63.51	55.66	17.96	137.13
Jellico									.08	1.49		1.57	.08	1.49		1.57
Lily	.29	1.15		1.44	2.63	1.33		3.96	4.34	.88		5.22	7.26	3.36		10.62
Uncorrelated	1.52	1.09		2.61	9.16	6.45	.50	16.11	11.64	6.01		17.65	22.32	13.55	.50	36.37
Total	4.72	8.01	1.93	14.66	34.28	25.47	6.12	65.87	68.95	40.58	10.41	119.94	107.95	74.06	18.46	200.47
Leslie County																
Amburgy	3.11	14.94		18.05	24.86	24.68		49.54	59.48	65.55		125.03	87.45	105.17		192.62
Fire Clay	78.96	108.88	80.67	268.51	85.27	130.17	21.03	236.47	130.23	76.97	23.46	230.66	294.46	316.02	125.16	735.64
Fire Clay rider	18.39	21.19	8.98	48.56	134.54	94.55	19.38	248.47	119.64	11.50	4.33	135.47	272.57	127.24	32.69	432.50
Francis	.17		7.06	7.23	5.42	11.96	8.65	26.03	14.08	18.60	12.52	45.20	19.67	30.56	28.23	78.46
Haddix		.12	1.08	1.20	1.51	5.07		6.58	15.53	6.07		21.60	17.04	11.26	1.08	29.38
Hazard	9.82	51.02	43.91	104.75	55.23	114.67	25.25	195.15	32.72	26.62	6.12	65.46	97.77	192.31	75.28	365.36
Hazard No. 7	2.42	6.14	1.74	10.30	37.45	39.37	15.79	92.61	18.93	18.65	.35	27.93	58.80	64.16	17.88	140.84
Hindman			3.54	3.54	1.60	3.00	13.28	17.88	19.74	16.33	48.00	84.07	21.34	19.33	74.82	105.49
Lower Hamlin									27.82			27.82	27.82			27.82
Lower Whitesburg	14.09	3.31	1.17	18.57	17.46			17.46	2.52			2.52	34.07	3.31	1.17	38.55
Upper Elkhorn No. 3					2.14	4.80		6.94	22.41	25.00		47.41	24.55	29.80		54.35
Upper Hamlin					3.03	.50		3.53	22.54	5.30	.20	28.04	25.57	5.80	.20	31.50
Upper Whitesburg					1.53			1.53	9.37			9.37	10.90			10.97
Total	126.96	205.60	148.15	480.71	370.04	428.77	103.38	902.19	495.01	270.59	94.98	860.58	992.01	904.96	346.51	2,243.48
Letcher County																
Amburgy	*12.46	*11.79	*20.30	*44.55	*40.86	*48.59	*5.19	*94.64					*53.32	*60.38	*25.49	*139.19
	1.31	.80		2.11	3.59	4.62		8.21	107.90	34.29	1.77	143.96	112.80	39.71	1.77	154.28
	**13.77	**12.59	*20.30	**46.66	**44.45	**53.21	*5.19	**102.85	107.90	34.29	1.77	143.96	**166.12	**100.09	**27.26	**293.47
Collier									6.25			6.25	6.25			6.25

			*.64	*.64												*.64	*.64
Cornett										2.40	.67	3.07		2.40	.67		3.07
			*.64	*.64						2.40	.67	3.07		2.40	**1.31		**3.71
Darby									1.22	.37		1.59	1.22	.37			1.59
Elkhorn Leader	*22.62	*6.41	*1.30	*30.33	*32.55	*9.88		*42.43					*55.17	*16.29	*1.30		*72.76
									32.06			32.06	32.06				32.06
	*22.62	*6.41	*1.30	*30.33	*32.55	*9.88		*42.43	32.06			32.06	**87.23	*16.29	*1.30		**104.82
Fire Clay	*.08	*15.73	*98.31	*114.12	*3.25	*16.59	*69.60	*89.44					*3.33	*32.32	*167.91		*203.56
	.70	24.25	7.86	32.81	17.92	22.00	4.55	44.47	8.29	54.75	1.35	64.39	26.91	101.00	13.76		141.67
	**.78	**39.98	**106.17	**146.93	**21.17	**38.59	**74.15	**133.91	8.29	54.75	1.35	64.39	**30.24	**133.32	**181.67		**345.23
Francis										1.56		1.56		1.56			1.56
Haddix			*11.48	*11.48		*2.53	*6.70	*9.23						*2.53	*18.18		*20.71
										4.62		4.62		4.62			4.62
			*11.48	*11.48		*2.53	*6.70	*9.23		4.62		4.62		**7.15	*18.18		**25.33
Harlan	*.35			*.35	*2.67	*8.83		*11.50					*3.02	*8.83			*11.85
									3.41			3.41	3.41				3.41
	*.35			*.35	*2.67	*8.83		*11.50	3.41			3.41	**6.43	*8.83			**15.26
Hazard		3.20	35.80	39.00	1.76	7.86	15.47	25.09	.04	5.18	1.49	6.71	1.80	16.24	52.76		70.80
Hazard No. 7			*.66	*.66											*.66		*.66
		.80	4.98	5.78	.71	1.91	6.82	9.44	2.16	2.44	2.57	7.17	2.87	5.15	14.37		22.39
		.80	**5.64	**6.44	.71	1.91	6.82	9.44	2.16	2.44	2.57	7.17	2.87	5.15	**15.03		**23.05
High Splint		*.47	*3.03	*3.50		*1.13		*1.13						*1.60	*3.03		*4.63
									1.18			1.18	1.18				1.18
		*.47	*3.03	*3.50		*1.13		*1.13	1.18			1.18	1.18	*1.60	*3.03		**5.81
Imboden	*.54	*4.85	*69.53	*74.92	*.42	*6.54	*27.74	*34.70					*.96	*11.39	*97.27		*109.62
									14.52			14.52	14.52				14.52
	*.54	*4.85	*69.53	*74.92	*.42	*6.54	*27.74	*34.70	14.52			14.52	**15.48	*11.39	*97.27		**124.14
Kellioka		*4.96		*4.96		*3.15		*3.15						*8.11			*8.11
									17.60	5.87		23.47	17.60	5.87			23.47
		*4.96		*4.96		*3.15		*3.15	17.60	5.87		23.47	17.60	**13.98			**31.58
Low Splint									.73	8.99	11.17	20.89	.73	8.99	11.17		20.89
Lower Elkhorn	*3.06	*4.40		*7.46	*2.52	*3.97		*6.49					*5.58	*8.37			*13.95
									16.39			16.39	16.39				16.39
	*3.06	*4.40		*7.46	*2.52	*3.97		*6.49	16.39			16.39	**21.97	*8.37			**30.34
Upper Elkhorn No. 1			*.45	*.45	*51.62	*.65		*52.27					*51.62	*.65	*.45		*52.72
									15.17			15.17	15.17				15.17
			*.45	*.45	*51.62	*.65		*52.27	15.17			15.17	**66.79	*.65	*.45		**67.89
Upper Elkhorn No. 2	*6.61			*6.61	*48.42	*2.75		*51.17					*55.03	*2.75			*57.78
									35.41	9.09		44.50	35.41	9.09			44.50
	*6.61			*6.61	*48.42	*2.75		*51.17	35.41	9.09		44.50	**90.44	**11.84			**102.28
Upper Elkhorn No. 3	*3.62	*71.12	*264.32	*339.06	*31.67	*40.54	*24.79	*97.00					*35.29	*111.66	*289.11		*436.06
									25.36	8.09	24.59	58.04	25.36	8.09	24.59		58.04
	*3.62	*71.12	*264.32	*339.06	*31.67	*40.54	*24.79	*97.00	25.36	8.09	24.59	58.04	**60.65	**119.75	**313.70		**494.10
Upper Hamlin			*7.54	*7.54	*.59	*1.18	*18.41	*20.18					*.59	*1.18	*25.95		*27.72
									3.06	6.78		9.84	3.06	6.78			9.84
			*7.54	*7.54	*.59	*1.18	*18.41	*20.18	3.06	6.78		9.84	**3.65	**7.96	*25.95		**37.56
Upper Whitesburg	*2.25	*26.49	*13.62	*42.36	*22.91	*19.21	*1.23	*43.35					*25.16	*45.70	*14.85		*85.71
									55.79	3.77		59.56	55.79	3.77			59.56
	*2.25	*26.49	*13.62	*42.36	*22.91	*19.21	*1.23	*43.35	55.79	3.77		59.56	**80.95	**49.47	*14.85		**145.27
Total	**53.60	**175.27	**539.82	**768.69	**261.46	**201.93	**180.50	**643.89	346.54	148.20	43.61	538.35	**661.60	**525.40	**763.93	**1,950.93	

TABLE 11.—*Original coal reserves in eastern Kentucky by county and bed according to abundance, reliability of data and thickness*—Con.

[In millions of short tons]

Bed	Measured reserves, in beds of indicated thickness in inches				Indicated reserves, in beds of indicated thickness in inches				Inferred reserves, in beds of indicated thickness in inches				Total, each category			Total, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
McCreary County																
Bacon Creek					1.87			1.87					1.87			1.87
Barren Fork	3.96	4.54		8.50	26.81	21.67		48.48	37.50	59.74		97.24	68.27	85.95		154.22
Beaver Creek	2.24	4.52	13.78	20.54	25.90	68.98	54.76	149.64	6.61	.92	14.60	22.13	34.75	74.42	83.14	192.31
Blue Gem					2.72			2.72	5.30			5.30	8.02			8.02
Hudson	2.56	3.51	2.95	9.02	17.64	35.80	31.19	84.63					20.20	39.31	34.14	93.65
Jellico					1.46	.32		1.78	6.54	1.28		7.82	8.00	1.60		9.60
Lily	4.26	.11		4.37	21.33	2.17		23.50	33.33	1.84		35.17	58.92	4.12		63.04
Stearns No. 1	4.10	3.84	3.23	11.17	3.52	3.68	5.89	13.09	1.83			1.83	9.45	7.52	9.12	26.09
Uncorrelated					3.34			3.34	14.11			14.11	17.45			17.45
Total	17.12	16.52	19.96	53.60	104.59	132.62	91.84	329.05	105.22	63.78	14.60	183.60	226.93	212.92	126.40	566.25
Magoffin County																
Colvin	4.81	1.38		6.19	5.31			5.31					10.12	1.38		11.50
Fire Clay	35.88	8.81		44.69	74.82	26.84		101.66	23.83	2.25		26.08	134.53	37.90		172.43
Fire Clay rider					.93			.93	2.11			2.11	3.04			3.04
Fugate	.04	.31	0.94	1.29	15.43	9.30	9.57	34.30	15.31	10.85		26.16	30.78	20.46	10.51	61.75
Grassy	.77			.77	5.10			5.10	7.71			7.71	13.58			13.58
Gun Creek	2.35	1.58		3.93	52.81	6.03		58.84	56.89	1.52		58.41	112.05	9.13		121.18
Haddix						1.24		1.24	5.69			5.69	5.69	1.24		6.93
Hamlin	1.30	1.31		2.61	38.61	6.33		44.94	13.23			13.23	53.14	7.64		60.78
Hindman						2.33	1.35	3.68	8.82	.34		9.16	8.82	2.67	1.35	12.84
Index	2.31	4.97	10.05	17.33	33.96	42.31	20.36	96.63	11.38	5.94		17.32	47.65	53.22	30.41	131.28
Mine Fork	.31			.31	1.31			1.31	5.53			5.53	7.15			7.15
Nickell						.45		.45	.09			.09	.09	.45		.54
Oakley	6.14	10.27	1.49	17.90	23.57	53.20	7.13	83.90	33.44	6.39		39.83	63.15	69.86	8.62	141.63
Prater	.84	1.09		1.93	7.67	7.28	.37	15.32	1.57			1.57	10.08	8.37	.37	18.82
Skyline		.68	5.85	6.53	.12	1.13	2.11	3.36	.84	.22	0.69	1.75	.96	2.03	8.65	11.64
Tom Cooper	15.23	10.73	1.00	26.96	84.94	28.71		113.65	47.31	5.82		53.13	147.48	45.26	1.00	193.74
Uncorrelated					.06			.06	.66			.66	.72			.72
Upper Elkhorn No. 1		1.76		1.76	22.16	20.33		42.49	27.56	5.75		33.31	49.72	27.84		77.56

Upper Elkhorn No. 2					1.08			1.08					1.08			1.08
Whitesburg	8.01	6.77	.16	14.94	38.38	7.17		45.55	26.75			26.75	73.14	13.94	.16	87.24
Total	77.99	49.66	19.49	147.14	406.26	212.65	40.89	659.80	288.72	39.08	.69	328.49	772.97	301.39	61.07	1,135.43
Martin County																
Fire Clay	0.71	6.50		7.21	19.32	57.99		77.31	39.50	71.84		111.34	59.53	136.33		195.86
Fire Clay rider	1.92	.79		2.71	17.30	21.27		38.57	24.99	20.64		45.63	44.21	42.70		86.91
Haddix	.41	2.39		2.80	12.56	28.97	1.89	43.42	38.36	87.69	16.65	142.70	51.33	119.05	18.54	188.92
Hamlin	.71	1.52	.17	2.40	7.52	21.41	3.18	32.11	18.76	57.68		76.44	26.99	80.61	3.35	110.95
Lower Elkhorn										23.83		23.83		23.83		23.83
Lower Whitesburg	1.86			1.86	6.05	2.93		8.98	37.40			37.40	45.31	2.93		48.24
Peach Orchard	1.97	8.27	9.50	19.74	12.11	28.21	85.17	125.49	8.37	84.04	129.57	221.98	22.45	120.52	224.24	367.21
Richardson						.38	19.15	19.53		1.31	39.19	40.50		1.69	58.34	60.03
Torchlight		1.33	13.73	15.06	1.43	15.93	106.88	124.24	5.50	25.91	72.75	104.16	6.93	43.17	193.36	243.46
Upper Elkhorn No. 3		1.38	3.37	4.75		3.35	13.70	17.05		11.92	29.13	41.05		16.65	46.20	62.85
Upper Whitesburg									7.60			7.60	7.60			7.60
Williamson						1.41		1.41	5.84	25.36		31.20	5.84	26.77		32.61
Total	7.58	22.18	26.77	56.53	76.29	181.85	229.97	488.11	186.32	410.22	287.29	883.83	270.19	614.25	544.03	1,428.47
Menifee County																
Beattyville					18.46	4.80		23.26	7.66			7.66	26.12	4.80		30.92
Morgan County																
Adele	0.19			0.19	0.39			0.39					0.58			0.58
Fire Clay	14.16	3.14	1.56	18.86	5.46	2.82		8.28	6.58	1.55		8.13	26.20	7.51	1.56	35.27
Fugate	1.06	.56		1.62	5.28	.36		5.64					6.34	.92		7.26
Brassy	22.30			22.30	36.47			36.47	15.70			15.70	74.47			74.47
Gun Creek	8.27	14.30		22.57	9.71	6.45		16.16	13.43	.36		13.79	31.41	21.11		52.52
Haddix						.30		.30	.07			.07	.07	.30		.37
Hamlin					1.59			1.59	10.44			10.44	12.03			12.03
Index	5.43			5.43	14.09	3.91		18.00	51.30	37.58		88.88	70.82	41.49		112.31
Mine Fork	.34			.34	1.59			1.59	3.44			3.44	5.37			5.37
Nickell					1.18			1.18	.69			.69	1.87			1.87
Oakley	4.07			4.07	4.36			4.36	2.46	4.75		7.21	10.89	4.75		15.64
Richardson			2.68	2.68			2.25	2.25			3.99	3.99			8.92	8.92
Tom Cooper	25.44	2.94		28.38	37.13	14.37		51.50	39.67	39.61		79.28	102.24	56.92		159.16
Uncorrelated									.42			.42	.42			.42
Total	81.26	20.94	4.24	106.44	117.25	28.21	2.25	147.71	144.20	83.85	3.99	232.04	342.71	133.00	10.48	486.19

TABLE 11.—*Original coal reserves in eastern Kentucky by county and bed according to abundance, reliability of data and thickness*—Con.

[In millions of short tons]

Bed	Measured reserves, in beds of indicated thickness in inches				Indicated reserves, in beds of indicated thickness in inches				Inferred reserves, in beds of indicated thickness in inches				Total, each category			Total, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Owsley County																
Barren Fork					2.68			2.68	2.23			2.23	4.91			4.91
Beaver Creek									5.13	3.37		8.50	5.13	3.37		8.50
Jellico										1.43		1.43		1.43		1.43
Lily		0.56	0.66	1.22	.64	1.56		2.20	2.16	3.71		5.87	2.80	5.83	0.66	9.29
Uncorrelated									.19	.44		.63	.19	.44		.63
Total		0.56	0.66	1.22	3.32	1.56		4.88	9.71	8.95		18.66	13.03	11.07	0.66	24.76
Perry County																
Amburgy	10.38	7.53		17.91	35.86	57.28		93.14	50.85	199.23		250.08	97.09	264.04		361.13
Fire Clay	91.13	148.78	54.81	294.72	76.68	85.41	63.57	225.66	30.98	10.22	23.86	65.06	198.79	244.41	142.24	585.44
Fire Clay rider	37.77	24.94	.59	63.30	27.40	2.84		30.24	1.73			1.73	66.90	27.78	.59	95.27
Francis	5.36	9.00	13.88	28.24	10.19	21.95	15.08	47.22	3.16	8.31	8.29	19.76	18.71	39.26	37.25	95.22
Haddix	12.91	17.45	4.42	34.78	25.67	9.33		35.00	3.75			3.75	42.33	26.78	4.42	73.53
Hazard	23.67	123.02	127.01	273.70	56.19	106.24	44.39	206.82	9.19	5.30	1.89	16.38	89.05	234.56	173.29	496.90
Uazard No. 7	5.90	32.05	356.96	394.91	18.38	32.46	64.71	115.55	12.03	19.72	14.31	46.06	36.31	84.23	435.98	556.52
Hindman		5.81	37.46	43.27	1.55	16.88	30.36	48.79		3.52	14.30	17.82	1.55	26.21	82.12	109.88
Hpper Elkhorn No. 3	.06	1.17		1.23	8.56	20.24		28.80	30.64	20.84		51.48	39.26	42.25		81.51
Total	187.18	369.75	595.13	1,152.06	260.48	352.63	218.11	831.22	142.33	267.14	62.65	472.12	589.99	989.52	875.89	2,455.40
Pike County																
Auxier	*14.38	*24.29	*6.65	*45.32	*60.05	*13.19		*73.24					*74.43	*37.48	*6.65	*118.56
									79.07	3.56	2.77	85.40	79.07	3.56	2.72	85.04
	*14.38	*24.29	*6.65	*45.32	*60.05	*13.19		*73.24	79.07	3.56	2.77	85.40	**153.50	**41.04	**9.42	**203.96
Bingham	*16.65	*72.41	*68.85	*157.91	*57.79	*23.75	*1.79	*83.33					*74.44	*96.16	*70.64	*241.24
									137.49	21.26		158.75	137.49	21.26		158.75
	*16.65	*72.41	*68.85	*157.91	*57.79	*23.75	*1.79	*83.33	137.49	21.26		158.75	**211.93	**117.42	*70.64	**399.99

Eagle (?)	*7.22	*12.78	*3.15	*23.15	*34.72	*10.72		*45.44					*41.94	*23.50	*3.15	*68.59
									23.95			23.95	23.95			23.95
	*7.22	*12.78	*3.15	*23.15	*34.72	*10.72		*45.44	23.95			23.95	**65.89	*23.05	*3.15	**92.54
Elswick	*.83	*14.36	*1.83	*17.02	*7.32	*16.88	*1.59	*25.79					*8.15	*31.24	*3.42	*42.81
									57.57	8.18		65.75	57.57	8.18		65.75
	*.83	*14.36	*1.83	*17.02	*7.32	*16.88	*1.59	*25.79	57.57	8.18		65.75	**65.72	**39.42	*3.42	**108.56
Fire Clay	*5.40	*21.88	*31.73	*59.01	*15.64	*74.54	*45.40	*135.58					*21.04	*96.42	*77.13	*194.59
									57.06	47.28	4.07	108.41	57.06	47.28	4.07	108.41
	*5.40	*21.88	*31.73	*59.01	*15.64	*74.54	*45.40	*135.58	57.06	47.28	4.07	108.41	**78.10	**143.70	**81.20	**303.00
Fire Clay rider			*10.03	*10.03			*4.12	*4.12							*14.15	*14.15
									19.07	10.50	1.49	31.06	19.07	10.50	1.49	31.06
			*10.03	*10.03			*4.12	*4.12	19.07	10.50	1.49	31.06	19.07	10.50	**15.64	**45.21
Haddix			*2.87	*2.87			*2.07	*2.07							*4.94	*4.94
									4.72	12.99	5.64	23.35	4.72	12.99	5.64	23.35
			*2.87	*2.87			*2.07	*2.07	4.72	12.99	5.64	23.35	4.72	12.99	**10.58	**28.29
Hagy (?)	*17.67	*9.40		*27.07	*26.13	*.52		*26.65					*43.80	*9.92		*53.72
									25.21	14.65		39.86	25.21	14.65		39.86
	*17.67	*9.40		*27.07	*26.13	*.52		*26.65	25.21	14.65		39.86	**69.01	**24.57		**93.58
Hamlin		*4.42	*21.38	*25.80	*4.79	*10.09	*18.63	*33.51					*4.79	*14.51	*40.01	*59.31
									14.41	15.93		30.34	14.41	15.93		30.34
		*4.42	*21.38	*25.80	*4.79	*10.09	*18.63	*33.51	14.14	15.93		30.34	**19.20	**30.44	**40.01	**89.65
Lower Elkhorn	*16.57	*110.64	*764.23	*891.44	*2.95	*73.49	*77.24	*153.68					*19.52	*184.13	*841.47	*1,045.12
									56.80	98.33	30.39	185.52	56.80	98.33	30.39	185.52
	*16.57	*110.64	*764.23	*891.44	*2.95	*73.49	*77.24	*153.68	56.80	98.33	30.39	185.52	**76.32	**282.46	**871.86	**1,230.64
Lower Whitesburg			*2.00	*2.00											*2.00	*2.00
						1.81		1.81		22.11		22.11			23.92	23.92
			*2.00	*2.00		1.81		1.81		22.11		22.11			23.92	*2.00	**25.92
Millard	*81.34	*42.37	*6.81	*130.52	*138.52	*10.28	*.22	*149.02					*219.86	*52.65	*7.03	*279.54
									156.07	13.73		169.80	156.07	13.73		169.80
	*81.34	*42.37	*6.81	*130.52	*138.52	*10.28	*.22	*149.02	156.07	13.73		169.80	**375.93	**66.38	*7.03	**449.34
Peach Orchard	*1.45	*7.73	*38.66	*47.84	*.15	*7.02	*7.13	*14.30					*1.60	*14.75	*45.79	*62.14
									5.29	17.40	5.77	28.46	5.29	17.40	5.77	28.46
	*1.45	*7.73	*38.66	*47.84	*.15	*7.02	*7.13	*14.30	5.29	17.40	5.77	28.46	**6.89	**32.15	**51.56	**90.60
Richardson											.42	.42			.42	.42
Torchlight			*.68	*.68											*.68	*.68
		.24	.44	.68		2.39	2.59	4.98		.68	23.92	24.60		3.31	26.95	30.26
		.24	**1.12	**1.36		2.39	2.59	4.98		.68	23.92	24.60		3.31	**27.63	**30.94
Upper Banner (?)	*2.43	*4.75	*3.30	*10.48	*2.14	*6.45		*8.59					*4.57	*11.20	*3.30	*19.07
									21.15	15.40		36.55	21.15	15.40		36.55
	*2.43	*4.75	*3.30	*10.48	*2.14	*6.45		*8.59	21.15	15.40		36.55	**25.72	**26.60	*3.30	**55.62
Upper Elkhorn No. 1	*33.18	*112.73	*64.35	*210.26	*67.22	*101.01	*7.24	*175.47					*100.40	*213.74	*71.59	*385.73
									135.36	82.43	3.45	221.24	135.36	82.43	3.45	221.24
	*33.18	*112.73	*64.35	*210.26	*67.22	*101.01	*7.24	*175.47	135.36	82.43	3.45	221.24	**235.76	**296.17	**75.04	**606.97
Upper Elkhorn No. 2	*6.15	*104.18	*247.93	*358.26	*52.55	*160.18	*111.20	*323.93					*58.70	*264.36	*359.13	*682.19
									147.93	143.70	20.54	312.17	147.93	143.70	20.54	312.17
	*6.15	*104.18	*247.93	*358.26	*52.55	*160.18	*111.20	*323.93	147.93	143.70	20.54	312.17	**206.63	**408.06	**379.67	**994.36
Upper Elkhorn No. 3	*7.81	*45.82	*126.85	*180.48	*16.51	*74.82	*95.85	*187.18					*24.32	*120.64	*222.70	*367.66
									120.35	84.57	10.95	215.87	120.35	84.57	10.95	215.87
	*7.81	*45.82	*126.85	*180.48	*16.51	*74.82	*95.85	*187.18	120.35	84 57	10.95	215.87	**144.67	**205.21	**233.65	**583.53

TABLE 11.—*Original coal reserves in eastern Kentucky by county and bed according to abundance, reliability of data and thickness*—Con.

[In millions of short tons]

Bed	Measured reserves, in beds of indicated thickness in inches				Indicated reserves, in beds of indicated thickness in inches				Inferred reserves, in beds of indicated thickness in inches				Total, each category			Total, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Pike County—Continued																
Upper Whitesburg	*1.15	*0.86	*4.45	*6.46									*1.15	*0.86	*4.45	*6.46
									1.62			1.62	1.62			1.62
	*1.15	*.86	*4.45	*6.46					1.62			1.62	**2.77	*.86	*4.45	**8.08
Williamson	*13.45	*32.56	*112.29	*158.30	*14.27	*47.24	*47.58	*109.09					*27.72	*79.80	*159.87	*267.39
							2.66	2.66	118.59	20.08	5.45	144.12	118.59	20.08	8.11	146.78
	*13.45	*32.56	*112.29	*158.30	*14.27	*47.24	**50.24	**111.75	118.59	20.08	5.45	144.12	**146.31	**99.88	**167.98	**414.17
Total	*225.68	**621.42	**1,518.48	**2,365.58	*500.75	**634.38	**425.31	**1,560.44	1,181.71	632.78	114.86	1,929.35	**1,908.14	**1,888.58	**2,058.65	**5,855.37
Powell County																
Beattyville					2.06	0.98		3.04	0.90			0.90	2.96	0.98		3.94
Pulaski County																
Barren Fork	0.74	1.71	2.96	5.41		7.12		7.12	1.49	0.23		1.72	2.23	9.06	2.96	14.25
Beaver Creek			6.71	6.71		8.43	25.80	34.23	6.57	10.15	8.14	24.86	6.57	18.58	40.65	65.80
Total	0.74	1.71	9.67	12.12		15.55	25.80	41.35	8.06	10.38	8.14	26.58	8.80	27.64	43.61	80.05
Rockcastle County																
Barren Fork					3.19	5.95		9.14	15.56	6.75		22.31	18.75	12.70		31.45
Beaver Creek	0.37	0.80		1.17	18.93	5.08		24.01	44.51	12.75		57.26	63.81	18.63		82.44
Hudson					.26	9.91	1.85	12.02	.56	18.88		19.44	.82	28.79	1.85	31.46
Total	.37	.80		1.17	22.38	20.94	1.85	45.17	60.63	38.38		99.01	83.38	60.12	1.85	145.35

Wayne County

Beaver Creek					7.71	15.02	9.67	32.40	4.45	1.95		6.40	12.16	16.97	9.67	38.80

Whitley County

Bacon Creek					3.45			3.45	13.66			13.66	17.11			17.11
Bennett Fork		0.44		0.44		3.20		3.20		1.12		1.12		4.76		4.76
Blue Gem	13.00	1.30		14.30	80.62	7.25		87.87	105.54			105.54	199.16	8.55		207.71
Fire Clay							0.87	.87		12.17	7.72	19.89		12.17	8.59	20.76
Jellico	2.08	14.64	1.07	17.79	23.09	86.35	1.72	111.16	23.06	57.41	1.07	81.54	48.23	158.40	3.86	210.49
Lily	.73	.20		.93	55.47	12.01		67.48	100.67	15.87		116.54	156.87	28.08		184.95
Moss					.06	.15		.21	2.94	.89		3.83	3.00	1.04		4.04
Uncorrelated		.67		.67	2.44			2.44	7.67			7.67	10.11	.67		10.78
Total	15.81	17.25	1.07	34.13	165.13	108.96	2.59	276.68	253.54	87.46	8.79	349.79	434.48	213.67	12.45	660.60

Wolfe County

Adele					0.93	0.12		1.05					0.93	0.12		1.05
Beattyville					1.49			1.49					1.49			1.49
Fire Clay					4.98			4.98	7.10			7.10	12.08			12.08
Fugate	0.37			0.37	.20			.20					.57			.57
Grassy	4.19	0.58		4.77	5.39			5.39	3.25			3.25	12.83	.58		13.41
Gun Creek	.68	2.90		3.58	7.10	9.87		16.97	9.17	1.18		10.35	16.95	13.95		30.90
Hamlin					2.02			2.02	8.81			8.81	10.83			10.83
Nickell					2.02	.91		2.93	4.19			4.19	6.21	.91		7.12
Tom Cooper	3.55	1.83		5.38	11.66	3.90		15.56	14.56	7.97		22.53	29.77	13.70		43.47
Uncorrelated					14.23			14.23	20.21			20.21	34.44			34.44
Zachariah	.74	4.69	0.75	6.18	8.33	8.90	0.24	17.47	25.82	3.41		29.23	34.89	17.00	0.99	52.88
Zachariah rider	.53			.53	.53			.53	.66			.66	1.72			1.72
Total	10.06	10.00	0.75	20.81	58.88	23.70	0.24	82.82	93.77	12.56		106.33	162.71	46.26	.99	209.96

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*

Explanation of asterisks:
*Remaining reserves as estimated previously by Bureau of Mines: Floyd County as of January 1, 1949; Harlan County as of January 1, 1952; Knott County as of January 1, 1950; Letcher County as of January 1, 1952; and Pike County as of January 1, 1948
**Total of remaining reserves plus additional original reserves determined as part of present study. Figure for additional original reserves is identified by position on line between asterisked figures for remaining and total reserves. All other figures are total original reserves

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Bell County																
Barbourville:																
Blue Gem					0.13	0.16		0.29	2.49	1.96		4.45	2.62	2.12		4.74
Fire Clay			4.45	4.45			2.23	2.23			4.04	4.04			10.72	10.72
Fire Clay rider	0.23	0.74	.88	1.85	.15	.36	.28	.79			.78	.78	.38	1.10	1.94	3.42
Jellico									.03	4.46		4.49	.03	4.46		4.49
Lily									.30			.30	.30			.30
Moss										.68		.68		.68		.68
Total	0.23	0.74	5.33	6.30	0.28	0.52	2.51	3.31	2.82	7.10	4.82	14.74	3.33	8.36	12.66	24.35
Fonde:																
Bennett Fork	0.22	1.70	0.07	1.99	0.81	8.41		9.22	1.30	12.22		13.52	2.33	22.33	0.07	24.73
Fire Clay		.35	.44	.79		.99	3.14	4.13		.51	1.39	1.90		1.85	4.97	6.82
Lower Hignite	.06	9.59	8.36	18.01		17.01	20.58	37.59		.28	5.76	6.04	.06	26.88	34.70	61.64
Mingo	1.59	8.26	13.76	23.61	6.18	27.38	19.89	53.45	2.67	41.91	19.35	63.93	10.44	77.55	53.00	140.99
Poplar Lick		2.45	18.05	20.50	.16	7.36	47.78	55.30		.21	26.81	27.02	.16	10.02	92.64	102.82
Red Spring		1.47	3.24	4.71		.79	.99	1.78		.56	4.76	5.32		2.82	8.99	11.81
Rich Mountain	.34	1.03		1.37	.03	4.43		4.46		10.63		10.63	.37	16.09		16.46
Sandstone Parting	.35	3.03		3.38	2.94	19.07	.08	22.09	.44	45.18	1.40	47.02	3.73	67.28	1.48	72.49
Sterling	.37	1.54	2.97	4.88	.34	2.14	12.34	14.82			4.94	4.94	.71	3.68	20.25	24.64
Stray					.63	9.02	3.89	13.54	4.36	35.32	6.07	45.75	4.99	44.34	9.96	59.29
Total	2.93	29.42	46.89	79.24	11.09	96.60	108.69	216.38	8.77	146.82	70.48	226.08	22.79	272.84	226.06	521.69
Harlan:																
Fire Clay									0.54			0.54	0.54			0.54
Fire Clay rider									.31			.31	.31			.31
Francis			0.24	0.24	0.25	0.56	0.87	1.68			0.42	.42	.25	0.56	1.53	2.34
Hindman						.05	.88	.93			.40	.40		.05	1.28	1.33
Lower Hamlin									.34			.34	.34			.34
Total			0.24	0.24	0.25	0.61	1.75	2.61	1.19		0.82	2.01	1.44	0.61	2.81	4.86

Middleboro:															
Bennett Fork					.48	1.67		2.15		1.13		1.13	0.48	2.80		3.28
Cranes Creek	1.04	0.28		1.32	4.35			4.35	11.94			11.94	17.33	.28		17.61
Harlan	.12	2.22	13.45	15.79	.52	1.61	1.35	3.48					.64	3.83	14.80	19.27
Imboden	.15	8.80		8.95	1.56	14.82	6.79	23.17	8.71	22.70	3.83	35.24	10.42	46.32	10.62	67.36
Total	1.31	11.30	13.45	26.06	6.91	18.10	8.14	33.15	20.65	23.83	3.83	48.31	28.87	53.23	25.42	107.52
Pineville:																
Fire Clay	1.82	4.96		6.78	4.27	19.45		23.72	7.13	36.16	16.49	59.78	13.22	60.57	16.49	90.28
Harlan			5.04	5.04			0.95	.95		1.46	12.27	13.73		1.46	18.26	19.72
Imboden		2.52		2.52		7.12		7.12		16.66		16.66		26.30		26.30
Jellico		14.27	.85	15.12	1.30	48.32	1.81	51.43	1.53	54.26		55.79	2.83	116.85	2.66	122.34
Moss	1.51	2.89	.10	4.50	7.51	7.75	2.89	18.15	18.55	17.90	3.21	39.66	27.57	28.54	6.20	62.31
Total	3.33	24.64	5.99	33.96	13.08	82.64	5.65	101.37	27.21	126.44	31.97	185.62	43.62	233.72	43.61	320.95
County total	7.80	66.10	71.90	145.80	31.61	198.47	126.74	356.82	60.64	304.19	111.92	476.75	100.05	568.76	310.56	979.37

Boyd County

Ceredo:															
Princess No. 3					1.90			1.90	8.22			8.22	10.12			10.12
Princess No. 4					.45			.45	6.00			6.00	6.45			6.45
Princess No. 5					8.36	8.03	2.27	18.66	14.23	3.59		17.82	22.59	11.62	2.27	36.48
Princess No. 5A					8.03	6.04		14.07	14.01	3.07		17.08	22.04	9.11		31.15
Princess No. 5B					7.75			7.75	7.04			7.04	14.79			14.79
Princess No. 6					7.51	17.51	7.28	32.30	17.62	12.73	3.34	33.69	25.13	30.24	10.62	65.99
Princess No. 7					18.21	38.46	7.57	64.24	12.52	33.98		46.50	30.73	72.44	7.57	110.74
Princess No. 8					8.14	2.35	3.18	13.67	25.60			25.60	33.74	2.35	3.18	39.27
Princess No. 9					2.23			2.23	13.04	4.17		17.21	15.27	4.17		19.44
Princess No. 10									3.19			3.19	3.19			3.19
Total					62.58	72.39	20.30	155.27	121.47	57.54	3.34	182.35	184.05	129.93	23.64	337.62
Grayson:															
Princess No. 3									7.49	3.56		11.05	7.49	3.56		11.05
Princess No. 4									2.06			2.06	2.06			2.06
Princess No. 5					4.54	7.31		11.85	4.77	8.65		13.42	9.31	15.96		25.27
Princess No. 5A					3.56			3.56	11.80			11.80	15.36			15.36
Princess No. 6									2.38	.37		2.75	2.38	.37		2.75
Princess No. 7					.92	14.99	25.71	41.62	.15	6.36	7.22	13.73	1.07	21.35	32.93	55.35
Princess No. 8					1.62	1.10	.25	2.97	2.94	1.13		4.07	4.56	2.23	.25	7.04
Total					10.64	23.40	25.96	60.00	31.59	20.07	7.22	58.88	42.23	43.47	33.18	118.88
County total					73.22	95.79	46.26	215.27	153.06	77.61	10.56	241.23	226.28	173.40	56.82	456.50

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 23	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Breathitt County																
Bays:																
Amburgy					10.17	9.83		20.00	20.38	40.79		61.17	30.55	50.62		81.17
Colvin (?)	0.41	0.20		0.61	11.39			11.39					11.80	.20		12.00
Fire Clay					2.04			2.04	1.97			1.97	4.01			4.01
Fire Clay rider					20.79	5.47		26.26	15.07	1.58		16.65	35.86	7.05		42.91
Francis	1.66	6.50	1.06	9.22	12.03	37.69	77.03	126.75	16.16	6.16	2.50	24.72	29.85	50.35	80.49	160.69
Haddix	1.83			1.83	17.13	11.07		28.20	20.54			20.54	39.50	11.07		50.57
Hazard	7.81	5.93	1.23	14.97	49.75	14.55		64.30	30.28			30.28	87.84	20.48	1.23	109.55
Hazard No. 7	3.02	9.33	2.47	14.82	46.53	18.84	1.40	66.77	35.07	1.38		36.45	84.62	29.55	3.87	118.04
Hindman					2.13			2.13	2.62			2.62	4.75			4.75
Skyline	.07	1.09	15.63	16.79	.11	1.98	3.28	5.37	.12	1.98		2.10	.30	5.05	18.91	24.26
Upper Elkhorn No. 3		2.72	.61	3.33	17.16	10.43	3.28	30.87	13.21			13.21	30.37	13.15	3.89	47.41
Total	14.80	25.77	21.00	61.57	189.23	109.86	84.99	384.08	155.42	51.89	2.40	209.71	359.45	187.52	108.39	655.36
Beattyville:																
Uncorrelated									0.32			0.32	0.32			0.32
Upper Elkhorn No. 3	0.19	0.26		0.45		0.09		0.09	.01			.01	.20	0.35		.55
Zachariah									.96			.96	.96			.96
Total	0.19	0.26		0.45		0.09		0.09	1.29			1.29	1.48	0.35		1.83
Blue Diamond:																
Fire Clay	2.84			2.84	14.29			14.29	34.45	1.21		35.66	51.58	1.21		52.79
Haddix	5.46	1.30		6.76	18.48	3.51		21.99	2.09			2.09	26.03	4.81		30.84
Hazard	.82	4.69		5.51	.35	15.22		15.57					1.17	19.91		21.08
Hazard No. 7		3.61	46.18	49.79		1.59	52.93	54.52			6.12	6.12		5.20	105.23	110.43
Hindman					1.98			1.98					1.98			1.98
Total	9.12	9.60	46.18	64.90	35.10	20.32	52.93	108.35	36.54	1.21	6.12	43.87	80.76	31.13	105.23	217.12

Buckhorn:															
Amburgy					2.61			2.61	8.08			8.08	10.69			10.69
Fire Clay	10.99	1.45		12.44	1.46			1.46					12.45	1.45		13.90
Fire Clay rider	72.57	89.86	3.79	166.22	19.05	7.19		26.24	2.19	2.78		4.97	93.81	99.83	3.79	197.43
Francis					1.13	2.19	6.29	9.61	1.39	2.92	3.33	7.64	2.52	5.11	9.62	17.25
Haddix	8.74	17.10	3.51	29.35	30.66	28.86	5.65	65.17	26.67	7.82	.03	34.52	66.07	53.78	9.19	129.04
Hazard	3.99	7.70	5.63	17.32	16.44	18.57	7.22	42.23	15.66	7.46		23.12	36.09	33.73	12.85	82.67
Hazard No. 7	.15	8.66	43.86	52.67	1.55	22.95	18.57	43.07	9.68	16.16		25.84	11.38	47.77	62.43	121.58
Lower Whitesburg					8.71	1.96		10.67	27.06	19.96		47.02	35.77	21.92		57.69
Upper Elkhorn No. 3					1.81	1.20		3.01	5.63	2.06		7.69	7.44	3.26		10.70
Total	96.44	124.77	56.79	278.00	83.42	82.92	37.73	204.07	96.36	59.16	3.36	158.88	276.22	266.85	97.88	640.95
Lee City:																
Amburgy					0.72			0.72	1.54			1.54	2.26			2.26
Copland						6.19	.82	7.01	10.84			10.84	10.84	6.19	0.82	17.85
Francis					.62	9.97	11.54	22.13	2.67			2.67	3.29	9.97	11.54	24.80
Haddix					2.22	12.47	6.28	20.97	18.50			18.50	20.72	12.47	6.28	39.47
Hazard N. 7					1.83	1.74		3.57	5.42			5.42	7.25	1.74		8.99
Lower Whitesburg					19.71			19.71	33.52			33.52	53.23			53.23
Uncorrelated					4.11	3.06		7.17	15.09			15.09	19.20	3.06		22.26
Upper Elkhorn No. 1					3.82			3.82	11.13			11.13	14.95			14.95
Upper Elkhorn No. 3	.78			.78	40.44	6.18		46.62	51.31	2.73		54.04	92.53	8.91		101.44
Zachariah					14.70			14.70	37.54			37.54	52.24			52.24
Total	.78			.78	88.17	39.61	18.64	146.42	187.56	2.73		190.29	276.51	42.34	18.64	337.49
Prestonsburg:																
Amburgy					1.94			1.94					1.94			1.94
Fire Clay	.86			.86	4.07			4.07					4.93			4.93
Francis						3.44		3.44	2.31			2.31	2.31	3.44		5.75
Hazard					2.21			2.21					2.21			2.21
Hazard No. 7					1.02	.34		1.36					1.02	.34		1.36
Hindman							1.00	1.00							1.00	1.00
Upper Elkhorn No. 1					1.88	1.70		3.58	1.42	.37		1.79	3.30	2.07		5.37
Upper Elkhorn No. 3		2.32	.91	3.23		8.53		8.53						10.85	.91	11.76
Total	.86	2.32	.91	4.09	11.12	14.01	1.00	26.13	3.73	.37		4.10	15.71	16.70	1.91	34.32
County total	122.19	162.72	124.88	409.79	407.04	266.81	195.29	869.14	480.90	115.36	11.88	608.14	1,010.13	544.89	332.05	1,887.07

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Carter County																
Grayson:																
Fire Clay					2.54	1.19		3.73	5.21			5.21	7.75	1.19		8.94
Grassy					.91			.91	2.63			2.63	3.54			3.54
Gun Creek					2.57			2.57	6.83			6.83	9.40			9.40
Princess No. 3					12.46	6.52		18.98	23.98			23.98	36.44	6.52		42.96
Princess No. 4					1.37	4.49		5.86	11.33	1.87		13.20	12.70	6.36		19.06
Princess No. 5					13.84	10.29		24.13	27.96	13.10		41.06	41.80	23.39		65.19
Princess No. 5A					1.00			1.00	2.24			2.24	3.24			3.24
Princess No. 6					3.70	4.49		8.19	14.59	17.44	2.54	34.57	18.29	21.93	2.54	42.76
Princess No. 7					6.54	24.52	11.84	42.90	3.09	9.90		12.99	9.63	34.42	11.84	55.89
Princess No. 8					2.18	2.74		4.92	4.44	4.89		9.33	6.62	7.63		14.25
Tom Cooper					14.99	4.11		19.10	9.31	1.79		11.10	24.30	5.90		30.20
Total					62.10	58.35	11.84	132.29	111.61	48.99	2.54	163.14	173.71	107.34	14.38	295.43
Isonville:																
Fire Clay					.96	2.33		3.29	.31	1.10		1.41	1.27	3.43		4.70
Grassy									2.35			2.35	2.35			2.35
Tom Cooper					6.65			6.65	2.54			2.54	9.19			9.19
Total					7.61	2.33		9.94	5.20	1.10		6.30	12.81	3.43		16.24
Olive Hill:																
Fire Clay					1.03	3.03	2.83	6.89	1.85	7.39		9.24	2.88	10.42	2.83	16.13
Grassy									5.04			5.04	5.04			5.04
Gun Creek									3.45			3.45	3.45			3.45
Lee									5.28			5.28	5.28			5.28
Princess No. 3						1.47		1.47		.41		.41		1.88		1.88
Tom Cooper					8.91	22.62	.33	31.80	4.62			4.62	13.53	22.62	.33	36.48
Total					9.94	27.12	3.16	40.22	20.24	7.80		28.04	30.18	34.92	3.16	68.26
Webbville:																
Grassy					.50			.50	4.06			4.06	4.56			4.56
Princess No. 3					4.97	.71		5.68	12.53			12.53	17.50	.71		18.21
Princess No. 4					2.41			2.41	4.62			4.62	7.03			7.03

Princess No. 5					1.60	2.68	8.09	12.37	8.23	11.37	6.08	25.68	9.83	14.05	14.17	38.05
Princess No. 5A					1.95			1.95	7.87			7.87	9.82			9.82
Princess No. 6					1.76			1.76	8.55			8.55	10.31			10.31
Princess No. 7					2.09	14.26	24.69	41.04	4.19	12.58	7.08	23.85	6.28	26.84	31.77	64.89
Princess No. 8									1.14	3.05		4.19	1.14	3.05		4.19
Tom Cooper					5.14	7.93	7.70	20.77	19.45	11.96		31.41	24.59	19.89	7.70	52.18
Total					20.42	25.58	40.48	86.48	70.64	38.96	13.16	122.76	91.06	61.54	53.64	209.24
County total					100.07	113.38	55.48	268.93	207.69	96.85	15.70	320.24	307.76	210.23	71.18	589.17

Clay County

Big Creek:																
Bacon Creek									1.88			1.88	1.88			1.88
Fire Clay		4.43	1.78	6.21	28.34	27.02	3.32	58.68	66.42	8.15		74.57	94.76	39.60	5.10	139.46
Haddix		.82	.95	1.77	.68	1.72	6.04	8.44	5.02	10.16	14.41	29.59	5.70	12.70	21.40	39.80
Hazard									3.01			3.01	3.01			3.01
Jellico		1.36		1.36	16.25	16.18		32.43	42.08	46.89		88.97	58.33	64.43		122.76
Lily	4.38	2.14		6.52	14.67	9.09		23.76	30.12	12.92		43.04	49.17	24.15		73.32
Lower Hamlin	.94	.29		1.23	3.88	5.31	3.31	12.50	23.96	15.84	26.68	66.48	28.78	21.44	29.99	80.21
Mills									2.48			2.48	2.48			2.48
Moss					4.93	1.20		6.13	26.62	4.10		30.72	31.55	5.30		36.85
Total	5.32	9.04	2.73	17.09	68.75	60.52	12.67	141.94	201.59	98.06	41.09	340.74	275.66	167.62	56.49	499.77
Booneville:																
Lily	1.48	3.68		5.16	10.34	8.24		18.58	29.19	5.24		34.43	41.01	17.16		58.17
Moss										3.90		3.90		3.90		3.90
Total	1.48	3.68		5.16	10.34	8.24		18.58	29.19	9.14		38.33	41.01	21.06		62.07
Hyden:																
Fire Clay	2.00	2.12	0.92	5.04	0.07			0.07	0.08			0.08	2.15	2.12	0.92	5.19
Fire Clay rider					3.89			3.89					3.89			3.89
Total	2.00	2.12	0.92	5.04	3.96			3.96	0.08			0.08	6.04	2.12	0.92	9.08
Manchester:																
Blue Gem										3.77		3.77		3.77		3.77
Fire Clay						0.98		0.98		4.59		4.59		5.57		5.57
Jellico					1.07			1.07	18.37	.63		19.00	19.44	.63		20.07
Lily	6.37	24.01	0.32	30.70	30.56	62.01		92.47	41.50	20.49		61.99	78.33	106.51	0.32	185.16
Lower Hamlin										.80		.80		.80		.80
Total	6.37	24.01	0.32	30.70	31.53	62.99		94.52	59.87	30.28		90.15	97.77	117.28	0.32	215.37

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Clay County—Continued																
Pineville:																
Fire Clay	1.41	1.57	0.78	3.76	12.52	13.49	4.09	30.10	13.96	17.31		31.27	27.89	32.37	4.87	65.13
Fire Clay rider	.16	2.90	1.77	4.83	3.27	6.43	1.62	11.32	25.13	6.46		31.59	28.56	15.79	3.39	47.74
Francis									.11	1.02	4.40	5.53	.11	1.02	4.40	5.53
Haddix					2.25	.31		2.56	12.08			12.08	14.33	.31		14.64
Lower Hamlin	.30	2.15		2.45	1.90	8.50		10.40	3.74	20.58		24.32	5.94	31.23		37.17
Mills	.31			.31	.82			.82	.50			.50	1.63			1.63
Upper Hamlin					1.81	1.46		3.27	10.04	3.90		13.94	11.85	5.36		17.21
Total	2.18	6.62	2.55	11.35	22.57	30.19	5.71	58.47	65.56	49.27	4.40	119.23	90.31	86.08	12.66	189.05
County total	17.35	45.57	6.52	69.34	137.15	161.94	18.38	317.47	356.29	186.75	45.49	588.53	510.79	394.16	70.39	975.34
Clinton County																
Byrdstown:																
Beaver Creek							5.81	5.81							5.81	5.81
Pall Mall:																
Beaver Creek						1.04		1.04						1.04		1.04
County total						1.04	5.81	6.85						1.04	5.81	6.85
Elliott County																
Isonville:																
Beattyville									4.79			4.79	4.79			4.79
Colvin									1.38			1.38	1.38			1.38
Fire Clay					4.11	8.33		12.44	10.94	14.48		25.42	15.05	22.81		37.86
Fugate										1.22		1.22		1.22		1.22
Grassy					5.68	8.21		13.89	22.12	18.44		40.56	27.80	26.65		54.45
Gun Creek					1.53	.20		1.73	5.81			5.81	7.34	.20		7.54
Index					4.95	7.39		12.34	11.10	16.21	1.06	28.37	16.05	23.60	1.06	40.71

Nickell									.12			.12	.12			.12
Richardson							0.57	.57			2.61	2.61			3.18	3.18
Tom Cooper	2.50	3.05		5.55	20.03	21.94		41.97	28.53	22.80		51.33	51.06	47.79		98.85
Uncorrelated									3.52			3.52	3.52			3.52
Whitesburg					.17			.17	.58	3.79		4.37	.75	3.79		4.54
Total	2.50	3.05		5.55	36.47	46.07	0.57	83.11	88.89	76.94	3.67	169.50	127.86	126.06	4.24	258.16
Webbville:																
Fire Clay									7.95			7.95	7.95			7.95
Index					3.83	6.64	3.60	14.07	10.67	.77		11.44	14.50	7.41	3.60	25.51
Princess No. 6									1.66			1.66	1.66			1.66
Princess No. 7									1.25			1.25	1.25			1.25
Richardson					.25			.25	3.86	2.39		6.25	4.11	2.39		6.50
Tom Cooper									5.87			5.87	5.87			5.87
Total					4.08	6.64	3.60	14.32	31.26	3.16		34.42	35.34	9.80	3.60	48.74
County total	2.50	3.05		5.55	40.55	52.71	4.17	97.43	120.15	80.10	3.67	203.92	163.20	135.86	7.84	306.90

Floyd County

Harold:																
Fire Clay	*.28	*3.20	*5.36	*8.84	*.58	*20.15	*3.47	*24.20					*.86	*23.35	*8.83	*33.04
									5.66	15.57		21.23	5.66	15.57		21.23
	*.28	*3.20	*5.36	*8.84	*.58	*20.15	*3.47	*24.20	5.66	15.57		21.23	**6.52	**38.92	*8.83	**54.27
Haddix							.33	.33		6.96	4.61	11.57		6.96	4.94	11.90
Peach Orchard									.42	10.47		10.89	.42	10.47		10.89
Richardson							5.41	5.41			5.07	5.07			10.48	10.48
Torchlight						4.36	.91	5.27		4.65	3.94	8.59		9.01	4.85	13.86
Upper Elkhorn No. 1	*1.41	*9.93	*4.72	*16.06	*6.30	*33.85		*40.15					*7.71	*43.78	*4.72	*56.21
									6.14	4.81		10.95	6.14	4.81		10.95
	*1.41	*9.93	*4.72	*16.06	*6.30	*33.85		*40.15	6.14	4.81		10.95	**13.85	**48.59	*4.72	**67.16
Upper Elkhorn No. 2	*2.46	*15.16	*3.75	*21.37	*6.61	*29.35	*2.44	*38.40					*9.07	*44.51	*6.19	*59.77
		.97		.97		4.46		4.46	23.37	10.73		34.10	23.37	16.16		39.53
	*2.46	**16.13	*3.75	**22.34	*6.61	**33.81	*2.44	**42.86	23.37	10.73		34.10	**32.44	**60.67	*6.19	**99.30
Upper Elkhorn No. 3	*3.86	*11.57	*4.31	*19.74	*20.85	*99.64		*120.49					*24.71	*111.21	*4.31	*140.23
									9.55	29.38		38.93	9.55	29.38		38.93
	*3.86	*11.57	*4.31	*19.74	*20.85	*99.64		*120.49	9.55	29.38		38.93	**34.26	**140.59	*4.31	**179.16
Upper Whitesburg					3.30			3.30	6.47			6.47	9.77			9.77
Williamson									7.82			7.82	7.82			7.82
Total	*8.01	**40.83	*18.14	**66.98	**37.64	**191.81	**12.56	**242.01	59.43	82.57	13.62	155.62	**105.08	**315.21	**44.32	**464.61

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Floyd County—Continued																
Hindman:																
Fire Clay	*.16	*5.14	*11.92	*17.22	*10.35	*4.19	*1.93	*16.47					*10.51	*9.33	*13.85	*33.69
Upper Elkhorn No. 1	*.36	*15.07	*19.00	*34.43	*.82	*11.28	*17.00	*29.10					*1.18	*26.35	*36.00	*63.53
Upper Elkhorn No. 2	*3.30	*8.99	*3.48	*15.77	*26.96	*5.78	*1.85	*34.59					*30.26	*14.77	*5.33	*50.36
Upper Elkhorn No. 3	*.23	*3.04	*6.02	*9.29	*22.55	*37.93	*3.54	*64.02					*22.78	*40.97	*9.56	*73.31
Total	*4.05	*32.24	*40.42	*76.71	*60.68	*59.18	*24.32	*144.18					*64.73	*91.42	*64.74	*220.89
Paintsville:																
Upper Elkhorn No. 3	*0.27			*0.27									*0.27			*0.27
Pikeville:																
Fire Clay					*9.89	*10.14	*6.43	*26.46					*9.89	*10.14	*6.43	*26.46
									5.14	6.16		11.30	5.14	6.16		11.30
					*9.89	*10.14	*6.43	*26.46	5.14	6.16		11.30	**15.03	**16.30	*6.43	**37.76
Hamlin	*.04	*6.61	*4.46	*11.11		*10.13	*.93	*11.06					*.04	*16.74	*5.39	*22.17
Upper Elkhorn No. 1	*6.00	*65.97	*14.27	*86.24	*28.35	*96.81	*8.20	*133.36					*34.35	*162.78	*22.47	*219.60
									3.00			3.00	3.00			3.00
	*6.00	*65.97	*14.27	*86.24	*28.35	*96.81	*8.20	*133.36	3.00			3.00	**37.35	*162.78	*22.47	**222.60
Upper Elkhorn No. 2	*6.84	*47.57	*28.25	*82.66	*30.14	*85.45	*22.67	*138.26					*36.98	*133.02	*50.92	*220.92
Upper Elkhorn No. 3	*1.62	*48.57	*66.77	*116.96	*13.57	*43.33	*6.48	*63.38					*15.19	*91.90	*73.25	*180.34
Williamson							3.93	3.93	5.32	3.05	5.02	13.39	5.32	3.05	8.95	17.32
Total	*14.50	*168.72	*113.75	*296.97	*81.95	*245.86	**48.64	**376.45	13.46	9.21	5.02	27.69	**109.91	**423.79	**167.41	**701.11
Prestonsburg:																
Fire Clay	*1.08	*15.25	*9.43	*25.76	*13.29	*17.36	*6.05	*36.70					*14.37	*32.61	*15.48	*62.46
Upper Elkhorn No. 1	*.71	*3.87	*.08	*4.66	*53.94	*26.00	*5.90	*85.84					*54.65	*29.87	*5.98	*90.50

Upper Elkhorn No. 2	-------	*2.17	*2.51	*4.68	*22.74	*14.08	*2.43	*39.25	-------	-------	-------	-------	*22.74	*16.25	*4.94	*43.93
	-------	-------	-------	-------	-------	-------	-------	-------	8.97	-------	-------	8.97	8.97	-------	-------	8.97
	-------	2.17	*2.51	*4.68	*22.74	*14.08	*2.43	*39.25	8.97	-------	-------	8.97	**31.71	*16.25	*4.94	**52.90
Upper Elkhorn No. 3	*3.18	*53.75	*21.31	*78.24	*66.57	*141.04	*7.81	*215.42	-------	-------	-------	-------	*69.75	*194.79	*29.12	*293.66
Williamson	-------	-------	-------	-------	.27	-------	-------	.27	-------	-------	-------	-------	.27	-------	-------	.27
Total	*4.97	*75.04	*33.33	*113.34	**156.81	*198.48	*22.19	**377.48	8.97	-------	-------	8.97	**170.75	*273.52	*55.52	**499.79
County total	*31.80	**316.83	*205.64	**554.27	**337.08	**695.33	**107.71	**1,140.12	81.86	91.78	18.64	192.28	**450.74	**1,103.94	**331.99	**1,886.67

Greenup County

Ceredo:																
Princess No. 3	-------	-------	-------	-------	-------	-------	-------	-------	9.24	-------	-------	9.24	9.24	-------	-------	9.24
Princess No. 4	-------	-------	-------	-------	-------	-------	-------	-------	3.68	-------	-------	3.68	3.68	-------	-------	3.68
Princess No. 5	-------	-------	-------	-------	2.11	0.53	-------	2.64	3.39	0.68	-------	4.07	5.50	1.21	-------	6.71
Princess No. 5B	-------	-------	-------	-------	4.50	-------	-------	4.50	5.61	-------	-------	5.61	10.11	-------	-------	10.11
Princess No. 6	-------	-------	-------	-------	-------	-------	-------	-------	2.66	-------	-------	2.66	2.66	-------	-------	2.66
Princess No. 7	-------	-------	-------	-------	.14	7.87	0.69	8.70	-------	-------	-------	-------	.14	7.87	0.69	8.70
Total	-------	-------	-------	-------	6.75	8.40	0.69	15.84	24.58	0.68	-------	25.26	31.33	9.08	0.69	41.10
Grayson:																
Fire Clay	-------	-------	-------	-------	0.39	-------	-------	0.39	10.91	-------	-------	10.91	11.30	-------	-------	11.30
Grassy	-------	-------	-------	-------	2.49	-------	-------	2.49	4.18	-------	-------	4.18	6.67	-------	-------	6.67
Gun Creek	-------	-------	-------	-------	2.39	-------	-------	2.39	7.65	-------	-------	7.65	10.04	-------	-------	10.04
Princess No. 3	-------	-------	-------	-------	41.47	12.18	0.77	54.42	21.17	2.47	0.77	24.41	62.24	14.65	1.54	78.83
Princess No. 4	-------	-------	-------	-------	-------	4.05	.75	4.80	19.67	-------	-------	19.67	19.67	4.05	.75	24.47
Princess No. 5	-------	-------	-------	-------	1.69	3.13	.67	5.49	8.34	3.52	-------	11.86	10.03	6.65	.67	17.35
Princess No. 5A	-------	-------	-------	-------	-------	-------	-------	-------	2.42	-------	-------	2.42	2.42	-------	-------	2.42
Princess No. 6	-------	-------	-------	-------	-------	-------	-------	-------	2.57	1.23	-------	3.80	2.57	1.23	-------	3.80
Princess No. 7	-------	-------	-------	-------	.27	1.41	3.78	5.46	.78	-------	.67	1.45	1.05	1.41	4.45	6.91
Princess No. 8	-------	-------	-------	-------	-------	-------	.47	.47	.26	-------	-------	.26	.26	-------	.47	.73
Tom Cooper	-------	-------	-------	-------	9.83	.87	-------	10.70	12.04	-------	-------	12.04	21.87	.87	-------	22.74
Total	-------	-------	-------	-------	58.53	21.64	6.44	86.61	89.99	7.22	1.44	98.65	148.52	28.86	7.88	185.26
Greenup:																
Grassy	-------	-------	-------	-------	-------	-------	-------	-------	0.56	-------	-------	0.56	0.56	-------	-------	0.56
Gun Creek	-------	-------	-------	-------	0.14	2.27	-------	2.41	3.31	-------	-------	3.31	3.45	2.27	-------	5.72
Lee	-------	-------	-------	-------	-------	-------	-------	-------	-------	4.41	-------	4.41	-------	4.41	-------	4.41
Princess No. 3	-------	-------	-------	-------	19.61	3.30	-------	22.91	.82	.95	-------	1.77	20.43	4.25	-------	24.68
Princess No. 4	-------	-------	-------	-------	3.56	2.80	0.25	6.61	1.60	-------	-------	1.60	5.16	2.80	0.25	8.21
Princess No. 5	-------	-------	-------	-------	-------	-------	-------	-------	1.04	-------	-------	1.04	1.04	-------	-------	1.04
Princess No. 6	-------	-------	-------	-------	-------	.84	-------	.84	-------	-------	-------	-------	-------	.84	-------	.84
Tom Cooper	-------	-------	-------	-------	1.33	-------	-------	1.33	6.53	-------	-------	6.53	7.86	-------	-------	7.86
Total	-------	-------	-------	-------	24.64	9.21	0.25	34.10	13.86	5.36	-------	19.22	38.50	14.57	0.25	53.32

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Greenup County—Continued																
Ironton:																
Princess No. 3					1.58			1.58	4.52			4.52	6.10			6.10
Princess No. 5									1.17			1.17	1.17			1.17
Princess No. 6						0.42	0.18	.60	.65		0.58	1.23	.65	0.42	0.76	1.83
Total					1.58	0.42	0.18	2.18	6.34		0.58	6.92	7.92	0.42	0.76	9.10
County total					91.50	39.67	7.56	138.73	134.77	13.26	20.2	150.05	226.27	52.93	9.58	288.78
Harlan County																
Big Stone Gap:																
Collier	*1.79	*62.94	*20.24	*84.97	*6.50	*63.10		*69.60					*8.29	*126.04	*20.24	*154.57
									10.13	8.08		18.21	10.13	8.08		18.21
	*1.79	*62.94	*20.24	*84.97	*6.50	*63.10		*69.60	10.13	8.08		18.21	**18.42	**134.12	*20.24	**172.78
Cornett	*4.92	*9.04	*28.29	*42.25		*9.47	*2.19	*11.66					*4.92	*18.51	*30.48	*53.91
									1.88	14.14	5.04	21.06	1.88	14.14	5.04	21.06
	*4.92	*9.04	*28.29	*42.25		*9.47	*2.19	*11.66	1.88	14.14	5.04	21.06	**6.80	**32.65	**35.52	**74.97
"D"	*.69	*33.90	*12.11	*46.70									*.69	*33.90	*12.11	*46.70
									4.15	47.04	7.01	58.20	4.15	47.04	7.01	58.20
	*.69	*33.90	*12.11	*46.70					4.15	47.04	7.01	58.20	**4.84	**80.94	**19.12	**104.90
Darby	*1.69	*31.66	*71.00	*104.35		*56.53		*56.53					*1.69	*88.19	*71.00	*160.88
Fire Clay	*5.86			*5.86	*1.89			*1.89					*7.75			*7.75
									7.97			7.97	7.97			7.97
	*5.86			*5.86	*1.89			*1.89	7.97			7.97	**15.72			**15.72
Harlan	*3.72	*28.06	*55.35	*87.13	*.21	*53.99	*35.23	*89.43					*3.93	*82.05	*90.58	*176.56
									12.93			12.93	12.93			12.93
	*3.72	*28.06	*55.35	*87.13	*.21	*53.99	*35.23	*89.43	12.93			12.93	**16.86	*82.05	*90.58	**189.49
High Splint	*1.46	*2.12	*115.13	*118.71		*.82		*.82					*1.46	*2.94	*115.13	*119.53
Imboden	*1.65	*14.57	*45.31	*61.53			*87.54	*87.54					*1.65	*14.57	*132.85	*149.07
									12.55	12.33		24.88	12.55	12.33		24.88
	*1.65	*14.57	*45.31	*61.53			*87.54	*87.54	12.55	12.33		24.88	**14.20	**26.90	*132.85	**173.95

Kellioka	*4.42	*9.27		*13.69								*4.42	*9.27		*13.69
									27.36	21.62	48.98	27.36	21.62		48.98
	*4.42	*9.27		*13.69					27.36	21.62	48.98	**31.78	**30.89		**62.67
Lower Split of Harlan	*14.66	*25.29	*23.51	*63.46	*34.18			*34.18				*48.84	*25.29	*23.51	*97.64
									1.16	19.04	20.20	1.16	19.04		20.20
	*14.66	*25.29	*23.51	*63.46	*34.18			*34.18	1.16	19.04	20.20	**50.00	**44.33	*23.51	**117.84
Low Splint			*.98	*.98		*.66		*.66					*.66	*.98	*1.64
Total	*40.86	*216.85	*371.92	*629.63	*42.78	*184.57	*124.96	*352.31	78.13	122.25	12.05	212.43	**161.77	**523.67	**508.93	**1,194.37
Cornettsville:															
Amburgy									5.95	4.86		10.81	5.95	4.86		10.81
Fire Clay									5.34			5.34	5.34			5.34
Hazard	0.22	0.18	3.90	4.30		4.52	5.12	9.64					.22	4.70	9.02	13.94
Hazard No. 7					.044			.44	5.88	2.90		8.78	6.32	2.90		9.22
Upper Elkhorn No. 3									1.28			1.28	1.28			1.28
Total	0.22	0.18	3.90	4.30	0.44	4.52	5.12	10.08	18.45	7.76		26.21	19.11	12.46	9.02	40.59
Hagan:															
Collier	*0.31	*1.86	*17.79	*19.96		*2.44	*11.37	*13.81					*0.31	*4.30	*29.16	*33.77
Fire Clay		*.64	*5.58	*6.22										*.64	*5.58	*6.22
Harlan	*.15	*23.91	*27.88	*51.94									*.15	*23.91	*27.88	*51.94
Total	*0.46	*26.41	*51.25	*78.12		*2.44	*11.37	*13.81					*0.46	*28.85	*62.62	*91.93
Harlan:															
Collier	*5.20	*0.90	*1.04	*7.14		*1.87	*0.64	*2.51					*5.20	*2.77	*1.68	*9.65
											0.51	0.51			.51	.51
	*5.20	*.90	*1.04	*7.14		*1.87	*.64	*2.51			.51	.51	*5.20	*2.77	**2.19	**10.16
Cornett			*1.25	*1.25		*.38	*.89	*1.27						*.38	*2.14	*2.52
Darby	*6.43	*4.84		*11.27		*2.91	*5.65	*8.56					*6.43	*7.75	*5.65	*19.83
									2.44	9.86	2.67	14.97	2.44	9.86	2.67	14.97
	*6.43	*4.84		*11.27		*2.91	*5.65	8.56	2.44	9.86	2.67	14.97	**8.87	**17.61	**8.32	**34.80
Fire Clay		*4.18	*7.65	*11.83			*4.44	*4.44						*4.18	*12.09	*16.27
	.22	.90		1.12	1.57	4.66		6.23	6.28	21.39	2.65	30.32	8.07	26.95	2.65	37.67
	.22	**5.08	*7.65	**12.95	1.57	4.66	*4.44	**10.67	6.28	21.39	2.65	30.32	8.07	**31.13	**14.74	**53.94
Fire Clay rider					2.97	.42		3.39	6.84	1.93		8.77	9.81	2.35		12.16
Francis			1.31	1.31		.86	4.60	5.46	2.62	1.53	.93	5.08	2.62	2.39	6.84	11.85
Haddix			.61	.61		2.45	.11	2.56	.36	16.79		17.15	.36	19.24	.72	20.32
Harlan	*6.32	*31.17	*15.95	*53.44	*1.76	*9.15		*10.91					*8.08	*40.32	*15.95	*64.35
									8.65	5.85		14.50	8.65	5.85		14.50
	*6.32	*31.17	*15.95	*53.44	*1.76	*9.15		*10.91	8.65	5.85		14.50	**16.73	**46.17	*15.95	**78.85
Hindman		.48	1.37	1.85	.28	2.89	6.68	9.85		4.59	11.24	15.83	.28	7.96	19.29	27.53
Imboden		*4.76		*4.76										*4.76		*4.76
										20.83		20.83		20.83		20.83
		*4.76		*4.76						20.83		20.83		**25.59		**25.59
Kellioka									6.92	14.39	4.74	26.05	6.92	14.39	4.74	26.05
Lower Hamlin					1.74			1.74	6.11			6.11	7.85			7.85

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Harlan County—Continued																
Harlan—Continued																
Low Splint			*7.03	*7.03			*3.28	*3.28							*10.31	*10.31
											4.97	4.97			4.97	4.97
			*7.03	*7.03			*3.28	*3.28			4.97	4.97			**15.28	**15.28
Pardee			*.15	*.15											*.15	*.15
											6.65	6.65			6.65	6.65
			*.15	*.15							6.65	6.65			**6.80	**6.80
Total	**18.17	**47.23	**36.36	**101.76	**8.32	**25.59	**26.29	**60.20	40.22	97.16	34.36	171.74	**66.71	**169.98	**97.01	**333.70
Nolansburg:																
Collier	*9.18	*41.56	*19.53	*70.27		*46.34		*46.34					*9.18	*87.90	*19.53	*116.61
									86.49	42.48		128.97	86.49	42.48		128.97
	*9.18	*41.56	*19.53	*70.27		*46.34		*46.34	86.49	42.48		128.97	**95.67	**130.38	*19.53	**245.58
Cornett	*3.19	*94.5	*19.37	*32.01	*0.78	*9.01	*18.19	*27.98					*3.97	*18.46	*37.56	*59.99
"D"	*.55	*1.63	*4.04	*6.22									*.55	*1.63	*4.04	*6.22
									3.05	7.44	1.30	11.79	3.05	7.44	1.30	11.79
	*.55	*1.63	*4.04	*6.22					3.05	7.44	1.30	11.79	**3.60	**9.07	**5.34	**18.01
Darby	*15.42	*91.71	*15.62	*122.75	*.62	*57.75		*58.37					*16.04	*149.46	*15.62	*181.12
									24.59	12.18		36.77	24.59	12.18		36.77
	*15.42	*91.71	*15.62	*122.75	*.62	*57.75		*58.37	24.59	12.18		36.77	**40.63	**161.64	*15.62	**217.8
Fire Clay	*1.14	*10.40	*12.10	*23.64	*11.70	*18.38	*6.84	*36.92					*12.84	*28.78	*18.94	*60.56
									21.52	18.13		39.65	21.52	18.13		39.65
	*1.14	*10.40	*12.10	*23.64	*11.70	*18.38	*6.84	*36.92	21.52	18.13		39.65	**34.36	**46.91	*18.94	**100.21
Gin Creek					9.69	9.38	2.63	21.70	10.93	7.16		18.09	20.62	16.54	2.63	39.79
Harlan	*17.41	*44.35	*98.45	*160.21		*9.38	*60.59	*69.97					*17.41	*53.73	*159.04	*230.18
									44.17	18.44	8.92	71.53	44.17	18.44	8.92	71.53
	*17.41	*44.35	*98.45	*160.21		*9.38	*60.59	*69.97	44.17	18.44	8.92	71.53	**61.58	**72.17	**167.96	**301.71
Hazard						61.11	11.92	73.03						61.11	11.92	73.03
High Splint	*.12	*3.22	*33.39	*36.73		*3.41		*3.41					*.12	*6.63	*33.39	*40.14
Imboden		*1.41		*1.41										*1.41		*1.41
		1.17	.33	1.50		9.60		9.60	8.91	35.47		44.38	8.91	46.24	.33	55.48
		**2.58	.33	**2.91		9.60		9.60	8.91	35.47		44.38	8.91	**47.65	.33	**56.89
Kellioka	*4.91	*1.46		*6.37									*4.91	*1.46		*6.37

									10.94			10.94	10.94			10.94
	*4.91	*1.46		*6.37					10.94			10 94	**15.85	*1.46		**17.31
Low Splint	*.45	*27.44	*18.17	*46.06	*3.39	*28.97	*6.08	*38.44					*3.84	*56.41	*24.25	*84.50
									8.11			8.11	8.11			8.11
	*.45	*27.44	*18.17	*46.06	*3.39	*28.97	*6.08	*38.44	8.11			8.11	**11.95	*56.41	*24.25	**92.61
Pardee	*.25	*5.22	*43.86	*49.33		*2.25	*7.59	*9.84					*.25	*7.47	*51.45	*59.17
									.61	9.24	.39	10.24	.61	9.24	.39	10.24
	*.25	*5.22	*43.86	*49.33		*2.25	*7.59	*9.84	.61	9.24	.39	10.24	**.86	**16.71	**51.84	**69.41
Wax	*6.03	*7.79	*12.12	*25.94	*3.91	*4.54	*3.58	*12.03					*9.94	*12.33	*15.70	*37.97
									11.73	3.91		15.64	11.73	3.91		15.64
	*6.03	*7.79	*12.12	*25.94	*3.91	*4.54	*3.58	*12.03	11.73	3.91		15.64	**21.67	**16.24	*15.70	**53.61
Total	*58.65	**246.81	**276.98	**582.44	**30.09	**260.12	**117.42	**407.63	231.05	154.45	10.61	396.11	**319.79	**661.38	**405.01	**1,386.18
Sneedville:																
Collier	*0.51			*0.51									*0.51			*.51
									0.59			0.59	.59			.59
	*.51			*.51					.59			.59	**1.10			**1.10
Harlan	*.21			*.21									*.21			*.21
									.31			.31	.31			.31
	*.21			*.21					.31			.31	**.52			**.52
Total	*0.72			*0.72					0.90			0.90	**1.62			**1.62
County total	**119.08	**537.48	**740.41	**1,396.97	**81.63	**477.24	**285.16	**844.03	368.75	381.62	57.02	807.39	**569.46	**1,396.34	**1,082.59	**3,048.39

Jackson County

Livingston:																
Barren Fork	0.61	8.68		9.29	3.71	23.23		29.94	5.03	17.64		22.67	9.35	49.55		58.90
Beaver Creek	.82	1.35		2.17	11.92	14.80		26.72	20.91	8.78		29.69	33.65	24.93		58.58
Hudson	.52	1.70	0.54	2.76	6.70	11.65	0.28	18.63	19.05	16.89		35.94	26.27	30.24	0.82	57.33
Uncorrelated									3.99			3.99	3.99			3.99
Total	1.95	11.73	0.54	14.22	22.33	49.68	0.28	72.29	48.98	43.31		92.29	73.26	104.72	0.82	178.80
Tyner:																
Barren Fork	0.78	2.89		3.67	13.16	18.96		32.12	23.27	13.37		36.64	37.21	35.22		72.43
Beaver Creek		1.47		1.47	2.48	12.17		14.65	5.24	29.09		34.33	7.72	42.73		50.45
Uncorrelated	.42	.16		.58	9.20	5.38		14.58	23.84	6.27		30.11	33.46	11.81		45.27
Total	1.20	4.52		5.72	24.84	36.51		61.35	52.35	48.73		101.08	78.39	89.76		168.15
County total	3.15	16.25	0.54	19.94	47.17	86.19	0.28	133.64	101.33	92.04		193.37	151.65	194.48	0.82	346.95

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Johnson County																
Dingus:																
Mine Fork	0.10			0.10									0.10			0.10
Harold:																
Haddix						0.75	3.73	4.48		8.72		8.72		9.47	3.73	13.20
Peach Orchard					0.96		2.50	3.46		5.30	1.15	6.45	0.96	5.30	3.65	9.91
Richardson							.45	.45			2.60	2.60			3.05	3.05
Torchlight			0.80	0.80			4.92	4.92			2.03	2.03			7.75	7.75
Upper Elkhorn No. 2						2.61		2.61	6.20			6.20	6.20	2.61		8.81
Upper Elkhorn No. 3										5.04		5.04		5.04		5.04
Upper Whitesburg					2.84			2.84	4.61			4.61	7.45			7.45
Total			0.80	0.80	3.80	3.36	11.60	18.76	10.81	19.06	5.78	35.65	14.61	22.42	18.18	55.21
Inez:																
Fire Clay					5.73	3.01		8.74	20.02	20.64		40.66	25.75	23.65		49.40
Haddix			1.70	1.70		6.45	16.87	23.32		22.26	12.87	35.13		28.71	31.44	60.15
Lower Whitesburg	0.94	0.76		1.70	14.40	3.28		17.68	30.53	1.27		31.80	45.87	5.31		51.18
Peach Orchard							4.22	4.22	1.38		19.85	21.23	1.38		24.07	25.45
Richardson							2.01	2.01			5.02	5.02			7.03	7.03
Torchlight						.94	6.63	7.57		5.40	1.09	6.49		6.34	7.72	14.06
Upper Elkhorn No. 2						3.86		3.86	16.06			16.06	16.06	3.86		19.92
Upper Elkhorn No. 3	2.88	12.94	2.15	17.97	3.52	36.36	3.29	43.17	.14	62.30		62.44	6.54	111.60	5.44	123.58
Upper Whitesburg	2.60			2.60	14.71			14.71	28.16			28.16	45.47			45.47
Total	6.42	13.70	3.85	23.97	38.36	53.90	33.02	125.28	96.29	111.87	38.83	246.99	141.07	179.47	75.70	396.24
Paintsville:																
Fire Clay	1.43	2.51		3.94	13.73	15.81	1.49	31.03	33.05	9.90		42.95	48.21	28.22	1.49	77.92
Haddix						.97	.61	1.58	4.92	7.35		12.27	4.92	8.32	.61	13.85
Lower Whitesburg									1.74			1.74	1.74			1.74
Mine Fork	.09			.09	.95			.95	5.18			5.18	6.22			6.22

Upper Elkhorn No. 3	8.78	41.50	0.84	51.12	55.32	65.48	.18	120.98	50.17	5.52		55.69	114.27	112.50	1.02	227.79
Total	10.30	44.01	0.84	55.15	70.00	82.26	2.28	154.54	95.06	22.77		117.83	175.36	149.04	3.12	327.52
Prestonsburg:																
Upper Elkhorn No. 3	0.40	1.75		2.15	3.70	19.30	1.95	24.95	2.18	2.68		4.86	6.28	23.73	1.95	31.96
Williamson					5.21			5.21	3.43			3.43	8.64			8.64
Total	0.40	1.75		2.15	8.91	19.30	1.95	30.16	5.61	2.68		8.29	14.92	23.73	1.95	40.60
County total	17.22	59.46	5.49	82.17	121.07	158.82	48.85	328.74	207.77	156.38	44.61	408.76	346.06	374.66	98.95	819.67

Knott County

Bays:																
Amburgy					0.31			0.31	0.93			0 93	1.24			1.24
Colvin					4.15			4.15					4.15			4.15
Fire Clay Rider					1.75			1.75	1.56			1.56	3.31			3.31
Francis			0.81	0.81		4.53	1.89	6.42		1.77	2.08	3.85		6.30	4.78	11.08
Haddix					2.51			2.51					2.51			2.51
Hazard	0.06			.06	3.27			3.27	3.77			3.77	7.10			7.10
Hazard No. 7					.35			.35	.42			.42	.77			.77
Skyline			.04	.04		.21	.48	.69		.07	.04	.11		.28	.56	.84
Upper Elkhorn No. 3						2.07	1.22	3.29	2.78	4.74		7.52	2.78	6.81	1.22	10.81
Total	0.06		0.85	0.91	12.34	6.81	3.59	22.74	9.46	6.58	2.12	18.16	21.86	13.39	6.56	41.81
Blue Diamond:																
Fire Clay	24.92	8.58		33.50	52.53	26.55		79.08	40.46	0.50		40.96	117.91	35.63		153.54
Haddix	5.99	21.32	2.69	30.00	19.94	15.26	0.73	35.93	1.17			1.17	27.10	36.58	3.42	67.10
Hazard		1.39	12.22	13.61	9.92	22.37		32.29	3.29	5.33		8.62	13.21	29.09	12.22	54.52
Hazard No. 7		17.02	122.17	139.19	1.09	47.26	55.13	103.48	.11	.07	1.24	1.42	1.20	64.35	178.54	244.09
Hindman			21.52	21.52	6.78	10.18	33.25	50.21		2.39	4.94	7.33	6.78	12.57	59.71	79.06
Upper Elkhorn No. 3		13.42	3.64	17.06	9.98	40.46		50.44		2.65		2.65	9.98	56.53	3.64	70.15
Total	30.91	61.73	162.24	254.88	100.24	162.08	89.11	351.43	45.03	10.94	6.18	62.15	176.18	234.75	257.53	668.46
Total	30.91	61.73	162.24	254.88	100.24	162.08	89.11	351.43	45.03	10.94	6.18	62.15	176.18	234.75	257.53	668.46
Cornettsville:																
Amburgy									4.22	24.26		28.48	4.22	24.26		28.48
Fire Clay	3.66	10.74	2.00	16.40	3.67	5.90	2.18	11.75					7.33	16.64	4.18	28.15
Francis	1.00	.63	.05	1.68	1.45	1.56	2.69	5.70		2.57		2.57	2.45	4.76	2.74	9.95
Hazard	.61	.74		1.35	1.40	5.23		6.63	1.63	3.66		5.29	3.64	9.63		13.27
Hazard No. 7			12.18	12.18		.37	5.82	6.19		3.23	1.50	4.73		3.60	19.50	23.10
Hindman			6.43	6.43			1.94	1.94			2.28	2.28			10.65	10.65
Total	5.27	12.11	20.66	38.04	6.52	13.06	12.63	32.21	5.85	33.72	3.78	43.35	17.64	58.89	37.07	113.60

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Knott County—Continued																
Hindman:																
Auburgy					*74.75	*32.32		*107.07					*74.75	*32.32		*107.07
									20.47	3.77		24.24	20.47	3.77		24.24
					*74.75	*32.32		*107.07	20.47	3.77		24.24	**95.22	**36.09		**131.31
Fire Clay	*103.03	*127.30	*72.03	*302.36	*20.58	*12.36	*2.28	*35.22					*123.61	*139.66	*74.31	*337.58
Hazard No. 7		*7.27	*7.74	*15.01	*9.88	*38.17	*32.63	*80.68					*9.88	*45.44	*40.37	*95.69
									9.28	11.41	2.08	22.77	9.28	11.41	2.08	22.77
		*7.27	*7.74	*15.01	*9.88	*38.17	*32.63	*80.68	9.28	11.41	2.08	22.77	**19.16	**56.85	**42.45	**118.46
Hindman			*.32	*.32											*.32	*.32
Upper Elkhorn No. 1	*3.65	*10.53	*13.90	*28.08	*74.56	*32.38	*4.77	*111.71					*78.21	*42.91	*18.67	*139.79
									14.50			14.50	14.50			14.50
	*3.65	*10.53	*13.90	*28.08	*74.56	*32.38	*4.77	*111.71	14.50			14.50	**92.71	*42.91	*18.67	**154.29
Upper Elkhorn No. 2	*37.75	*40.29	*2.37	*80.41	*83.34	*43.79		*127.13					*121.09	*84.08	*2.37	*207.54
									14.32	1.56		15.88	14.32	1.56		15.88
	*37.75	*40.29	*2.37	*80.41	*83.34	*43.79		*127.13	14.32	1.56		15.88	**135.41	**85.64	*2.37	**223.42
Upper Elkhorn No. 3	*22.31	*154.36	*68.61	*245.28	*8.70	*118.01	*34.37	*161.08					*31.01	*272.37	*102.98	*406.36
									38.17	14.87		53.04	38.17	14.87		53.04
	*22.31	*154.36	*68.61	*245.28	*8.70	*118.01	*34.37	*161.08	38.17	14.87		53.04	**69.18	**287.24	*102.98	**459.40
Upper Whitesburg	*9.69	*1.21		*10.90	*45.79	*21.44		*67.23					*55.48	*22.65		*78.13
									3.75	2.94		6.69	3.75	2.94		6.69
	*9.69	*1.21		*10.90	*45.79	*21.44		*67.23	3.75	2.94		6.69	**59.23	**25.59		**84.82
Total	*176.43	*340.96	*164.97	*682.36	*317.60	*298.47	*74.05	*690.12	100.49	34.55	2.08	137.12	**594.52	**673.98	**241.10	**1,509.60
Pikeville:																
Amburgy					*0.82			*0.82					*0.82			*0.82
Fire Clay						*2.81		*2.81						*2.81		*2.81
Upper Elkhorn No. 1					*2.12			*2.12					*2.12			*2.12
									2.11			2.11	2.11			2.11
					*2.12			*2.12	2.11			2.11	**4.23			**4.23

Upper Elkhorn No. 2	*1.96	*1.97		*3.93	*.04	*4.99		*5.03					*2.00	*6.96		*8.96
Upper Elkhorn No. 3	*.44	*2.89	*8.09	*11.42		*.48		*.48					*.44	*3.37	*8.09	*11.90
Total	*2.40	*4.86	*8.09	*15.35	*2.98	*8.28		*11.26	2.11			2.11	**7.49	**13.14	*8.09	**28.72
Prestonsburg:																
Fire Clay					*0.48	*0.04		*0.52					*0.48	*0.04		*0.52
Upper Elkhorn No. 3		*1.37		*1.37										*1.37		*1.37
Upper Whitesburg					*.66			*.66					*.66			*.66
Total		*1.37		*1.37	*1.14	*0.04		*1.18					*1.14	*1.41		*2.55
Whitesburg:																
Amburgy	*1.20	*25.21		*26.41	*6.53			*6.53					*7.73	*25.21		*32.94
									1.93	21.48		23.41	1.93	21.48		23.41
	*1.20	*25.21		*26.41	*6.53			*6.53	1.93	21.48		23.41	**9.66	**46.69		**56.35
Fire Clay	*2.25	*27.90	*19.56	*49.71									*2.25	*27.90	*19.56	*49.71
Hazard No. 7			*.24	*.24		*3.86	*11.36	*15.22						*3.86	*11.60	*15.46
Upper Elkhorn No. 2									.28	1.73		2.01	.28	1.73		2.01
Upper Elkhorn No. 3						*1.82		*1.82						*1.82		*1.82
									7.70			7.70	7.70			7.70
						*1.82		*1.82	7.70			7.70	7.70	*1.82		**9.52
Upper Whitesburg					*3.81	*6.15		*9.96					*3.81	*6.15		*9.96
									10.28	2.12		12.40	10.28	2.12		12.40
					*3.81	*6.15		*9.96	10.28	2.12		12.40	**14.09	**8.27		**22.36
Total	*3.45	*53.11	*19.80	*76.36	*10.34	*11.83	*11.36	*33.53	20.19	25.33		45.52	**33.98	**90.27	*31.16	**155.41
County total	**218.52	**474.14	**376.61	**1,069.27	**451.16	**500.57	**190.74	**1,142.47	183.13	111.12	14.16	308.41	**852.81	**1,085.83	**581.51	**2,520.15

Knox County

Barbourville:																
Blue Gem	27.56			27.56	76.91	0.26		77.17	74.30	5.77		80.07	178.77	6.03		184.80
Fire Clay	.05	0.82	7.34	8.21		3.74	10.56	14.30	8.04	10.39	2.71	21.14	8.09	14.95	20.61	43.65
Fire Clay rider	.05	.59	1.02	1.66	.05	.14	.49	.68		2.51	.43	2.94	.10	3.24	1.94	5.28
Jellico	1.40	.68	3.38	5.46	14.43	13.91	2.27	30.61	40.47	39.48	2.56	82.51	56.30	54.07	8.21	118.58
Lily	.20	.47		.67	5.09	2.80		7.89	32.28	3.20		35.48	37.57	6.47		44.04
Mills										.96		.96		.96		.96
Moss	.69			.69	4.82	5.68		10.50	16.60	48.16		64.76	22.11	53.84		75.95
Uncorrelated					1.25			1.25	9.73			9.73	10.98			10.98
Total	29.95	2.56	11.74	44.25	102.55	26.53	13.32	142.40	181.42	110.47	5.70	297.59	313.92	139.56	30.76	484.24

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Knox County—Continued																
Corbin:																
Blue Gem					16.68	1.04		17.72	15.00	0.11		15.11	31.68	1.15		32.83
Jellico	0.40	3.98	13.33	17.71	2.02	4.22	1.35	7.59	.42	3.75		4.17	2.84	11.95	14.68	29.47
Lily										1.83		1.83		1.83		1.83
Total	0.40	3.98	13.33	17.71	18.70	5.26	1.35	25.31	15.42	5.69		21.11	34.52	14.93	14.68	64.13
Fonde:																
Blue Gem					7.20			7.20	7.72			7.72	14.92			14.92
Fire Clay	0.01	2.59	3.37	5.97		2.00	11.93	13.93		0.07	3.26	3.33	.01	4.66	18.56	23.23
Jellico									6.08			6.08	6.08			6.08
Total	0.01	2.59	3.37	5.97	7.20	2.00	11.93	21.13	13.80	0.07	3.26	17.13	21.01	4.66	18.56	44.23
Manchester:																
Blue Gem									2.36			2.36	2.36			2.36
Fire Clay						2.73	0.55	3.28		4.72		4.72		7.45	0.55	8.00
Jellico					2.55			2.55	19.84			19.84	22.39			22.39
Lower Hamlin										.09		.09		.09		.09
Total					2.55	2.73	0.55	5.83	22.20	4.81		27.01	24.75	7.54	0.55	32.84
Pineville:																
Blue Gem									2.40	1.27		3.67	2.40	1.27		3.67
Fire Clay		4.92	1.40	6.32	5.92	16.79	1.72	24.43	11.52	13.37	0.14	25.03	17.44	35.08	3.26	55.78
Fire Clay rider					6.01	6.97		12.98	11.33	19.01		30.34	17.34	25.98		43.32
Francis									.31	.61	.92	1.84	.31	.61	.92	1.84
Jellico	2.35	5.59		7.94	3.97	9.88		13.85	.07	8.25		8.32	6.39	23.72		30.11
Mills					4.39	1.77		6.16	30.30	3.69		33.99	34.69	5.46		40.15
Moss	4.05	3.50	1.31	8.86	20.11	14.80	1.66	36.57	38.09	9.75	.41	48.25	62.25	28.05	3.38	93.68
Upper Hamlin						.03	.62	.65	.53	2.08	.90	3.51	.53	2.11	1.52	4.16
Total	6.40	14.01	2.71	23.12	40.40	50.24	4.00	94.64	94.55	58.03	2.37	154.95	141.35	122.28	9.08	272.71
County total	36.76	23.14	31.15	91.05	171.40	86.76	31.15	289.31	327.39	179.07	11.33	517.79	535.55	288.97	73.63	898.15

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Laurel County

Barbourville:															
Jellico					1.15			1.15	1.40			1.40	2.55		2.55
Corbin:															
Lily						1.63		1.63	1.45	8.41		9.86	1.45	10.04	11.49
Dykes:															
Barren Fork					2.72	2.64		5.36	11.26			11.26	13.98	2.64	16.62
Livingston:															
Barren Fork						0.18		0.18	4.36	2.26		6.62	4.36	2.44	6.80
Beaver Creek	0.41	0.49		0.90	4.29	2.23		6.52	18.10			18.10	22.80	2.72	25.52
Hudson					.26	1.61		1.87	.48	3.22		3.70	.74	4.83	5.57
Lily					.93	.59		1.52	1.70			1.70	2.63	.59	3.22
Total	0.41	0.49		0.90	5.48	4.61		10.09	24.64	5.48		30.12	30.53	10.58	41.11
London:															
Barren Fork					10.16	7.00		17.16	40.34	6.77		47.11	50.50	13.77	64.27
Lily	1.45	7.25		8.70	45.50	34.19		79.69	43.14	1.75		44.89	90.09	43.19	133.28
Total	1.45	7.25		8.70	55.66	41.19		96.85	83.48	8.52		92.00	140.59	56.96	197.55
Manchester:															
Blue Gem					0.80			0.80	6.96			6.96	7.76		7.76
Fire Clay										0.36		0.36		0.36	0.36
Jellico						2.49	1.94	4.43	.60	8.42		9.02	.60	10.91	1.94 13.45
Lily	2.08	0.77	1.31	4.16	15.46	1.67		17.13	15.89	4.30		20.19	33.43	6.74	1.31 41.48
Total	2.08	0.77	1.31	4.16	16.26	4.16	1.94	22.36	23.45	13.08		36.53	41.79	18.01	3.25 63.05
County total	3.94	8.51	1.31	13.76	81.27	54.23	1.94	137.44	145.68	35.49		181.17	230.89	98.23	3.25 332.37

Lawrence County

Dingus:															
Peach Orchard									0.78			0.78	0.78		0.78
Tom Cooper									4.69			4.69	4.69		4.69
Total									5.47			5.47	5.47		5.47
Inez:															
Fire Clay	0.85			0.85	16.06			16.06	26.58			26.58	43.49		43.49
Fire Clay rider	1.35			1.35	5.44			5.44	11.22			11.22	18.01		18.01
Peach Orchard	.63			.63	6.02	0.49	6.55	13.06	16.96	22.26	15.39	54.61	23.61	22.75	21.94 68.30
Richardson						.19	.60	.79		.93	.23	1.16		1.12	.83 1.95
Whitesburg					4.60			4.60	9.01			9.01	13.61		13.61
Total	2.83			2.83	32.12	0.68	7.15	39.95	63.77	23.19	15.62	102.58	98.72	23.87	22.77 145.36

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Lawrence County—Continued																
Isonville:																
Fire Clay						0.29		0.29		3.61		3.61		3.90		3.90
Peach Orchard					0.25			.25	1.29			1.29	1.54			1.54
Richardson											0.21	.21			0.21	.21
Tom Cooper										2.02		2.02		2.02		2.02
Total					0.25	0.29		0.54	1.29	5.63	0.21	7.13	1.54	5.92	0.21	7.67
Louisa:																
Fire Clay					0.74			0.74	10.84			10.84	11.58			11.58
Peach Orchard					2.59	1.91		4.50	20.42	10.45		30.87	23.01	12.36		35.37
Princess No. 6									2.53			2.53	2.53			2.53
Princess No. 8					7.77	16.74	1.38	25.89	35.64			35.64	43.41	16.74	1.38	61.53
Richardson					3.93	1.70	12.05	17.68	29.83	15.41		45.24	33.76	17.11	12.05	62.92
Torchlight					4.49	12.67	6.03	23.19	23.62	5.70		29.32	28.11	18.37	6.03	52.51
Total					19.52	33.02	19.46	72.00	122.88	31.56		154.44	142.40	64.58	19.46	226.44
Paintsville:																
Fire Clay					5.62			5.62	4.99			4.99	10.61			10.61
Tom Cooper									1.55			1.55	1.55			1.55
Total					5.62			5.62	6.54			6.54	12.16			12.16
Webbville:																
Fire Clay						5.35		5.35	20.29			20.29	20.29	5.35		25.64
Peach Orchard					6.34	2.96		9.30	30.83			30.83	37.17	2.96		40.13
Princess No. 6									9.70			9.70	9.70			9.70
Princess No. 7					2.34	3.80	4.61	10.75	9.32	4.72	6.44	20.48	11.66	8.52	11.05	31.23
Princess No. 8						.95		.95	13.27			13.27	13.27	.95		14.22
Princess No. 10									1.19			1.19	1.19			1.19
Richardson						3.09	17.50	20.59		37.23		37.23		40.32	17.50	57.82

Tom Cooper									4.44			4.44	4.44			4.44
Total					8.68	16.15	22.11	46.94	89.04	41.95	6.44	137.43	97.72	58.10	28.55	184.37
County total	2.83			2.83	66.19	50.14	48.72	165.05	288.99	102.33	22.27	413.59	358.01	152.47	70.99	581.47
Lee County																
Beattyville:																
Barren Fork					0.05			0.05	5.43			5.43	5.48			5.48
Beaver Creek	2.91	2.95	0.22	6.08	14.39	4.58		18.97	28.75	7.68		36.43	46.05	15.21	0.22	61.48
Jellico									.08	1.49		1.57	.08	1.49		1.57
Lily	.29	1.15		1.44	2.63	1.33		3.96	4.34	.88		5.22	7.26	3.36		10.62
Uncorrelated	1.52	1.09		2.61	9.16	6.45	0.50	16.11	11.64	6.01		17.65	22.32	13.55	.50	36.37
Total	4.72	5.19	0.22	10.13	26.23	12.36	0.50	39.09	50.24	16.06		66.30	81.19	33.61	0.72	115.52
Irvine:																
Barren Fork					3.28			3.28	6.02			6.02	9.30			9.30
Beaver Creek		2.82	1.71	4.53	4.77	13.11	5.62	23.50	12.69	24.52	10.41	47.62	17.46	40.45	17.74	75.65
Total		2.82	1.71	4.53	8.05	13.11	5.62	26.78	18.71	24.52	10.41	53.64	26.76	40.45	17.74	84.95
County total	4.72	8.01	1.93	14.66	34.28	25.47	6.12	65.87	68.95	40.58	10.41	119.94	107.95	74.06	18.46	200.47
Leslie County																
Big Creek:																
Fire Clay	.64	.51	2.33	3.48	7.64	14.09	12.38	34.11	11.35	.36		11.71	19.63	14.96	14.71	49.30
Upper Hamlin									.42		.20	.62	.42		.20	.62
Total	.64	.51	2.33	3.48	7.64	14.09	12.38	34.11	11.77	.36	.20	12.33	20.05	14.96	14.91	49.92
Buckhorn:																
Amburgy	.78	.32		1.10	4.02	.17		4.19	6.28			6.28	11.08	.49		11.57
Fire Clay					.27			.27					.27			.27
Fire Clay rider	8.02	10.37		18.39	8.39	1.60		9.99	9.33			9.33	25.74	11.97		37.71
Francis					.49	1.31		1.80		1.17		1.17	.49	2.48		2.97
Hazard	1.51	13.43	4.76	19.70	.48	18.99	.60	20.07		.76		.76	1.99	33.18	5.36	40.53
Hazard No. 7	1.67	4.11	.78	6.56	3.04	.01		3.05	2.92			2.92	7.63	4.12	.78	12.53
Upper Elkhorn No. 3										5.50		5.50		5.50		5.50
Total	11.98	28.23	5.54	45.75	16.69	22.08	.60	39.37	18.53	7.43		25.96	47.20	57.74	6.14	111.08

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Leslie County—Continued																
Cornettsville:																
Amburgy		2.49		2.49		9.44		9.44	40.50	55.52		96.02	40.50	67.45		107.95
Fire Clay	1.18	14.46	2.17	17.81	11.27	53.06	.38	64.71	10.60	15.73	23.46	49.79	23.05	83.25	26.01	132.31
Francis	.17		4.92	5.09	.31	.38	4.25	4.94	.88		2.34	3.22	1.36	.38	11.51	13.25
Hazard	8.31	23.76	35.35	67.42	4.21	20.71	6.43	31.35	4.76	.87		5.63	17.28	45.34	41.78	104.40
Hazard No. 7	.75	2.03	.96	3.74	9.28	6.39	2.28	17.95	4.27	3.19	.13	7.59	14.30	11.61	3.37	29.28
Hindman			3.26	3.26							1.52	1.52			4.78	4.78
Upper Elkhorn No. 3					2.14	4.80		6.94	22.41	19.50		41.91	24.55	24.30		48.85
Total	10.41	42.74	46.66	99.81	27.21	94.78	13.34	135.33	83.42	94.81	27.45	205.68	121.04	232.33	87.45	440.82
Harlan:																
Fire Clay	2.35	18.63	3.31	24.29	13.98	41.54	3.37	58.89	71.68	26.99		98.67	88.01	87.16	6.68	181.85
Fire Clay rider	3.00	1.66		4.66	15.70	4.47		20.17	78.81	7.59	2.46	88.86	97.51	13.72	2.46	113.69
Francis			2.14	2.14	4.62	9.41	4.22	18.25	12.07	16.66	9.67	38.40	16.69	26.07	16.03	58.79
Haddix		.12	1.08	1.20	.79	3.86		4.65	14.26	5.91		20.17	15.05	9.89	1.08	26.02
Hindman			.28	.28	1.60	3.00	13.17	17.77	.73	6.01	18.82	25.56	2.33	9.01	32.27	43.61
Lower Hamlin									27.82			27.82	27.82			27.82
Upper Hamlin					2.77			2.77	18.04	1.19		19.23	20.81	1.19		22.00
Upper Whitesburg					1.53			1.53	9.37			9.37	10.90			10.90
Total	5.35	20.41	6.81	32.57	40.99	62.28	20.76	124.03	232.78	64.35	30.95	328.08	279.12	147.04	58.52	484.68
Hyden:																
Amburgy	2.33	12.13		14.46	20.84	15.07		35.91	12.70	10.03		22.73	35.87	37.23		73.10
Fire Clay	74.79	74.94	72.22	221.95	51.22	18.26	4.37	73.85	33.43	31.62		65.05	159.44	124.82	76.59	360.85
Fire Clay rider	7.37	9.12	6.91	23.40	110.35	87.80	15.26	213.41	27.76	3.41		31.17	145.48	100.33	22.17	267.98
Hazard		13.83	3.80	17.63	50.54	74.97	14.78	140.29	27.96	24.99	6.12	59.07	78.50	113.79	24.70	216.99
Hazard No. 7					25.13	32.97	13.51	71.61	11.74	15.46	.22	27.42	36.87	48.43	13.73	99.03
Hindman									19.01	10.32	24.92	54.25	19.01	10.32	24.92	54.25
Lower Whitesburg	14.09	3.31	1.17	18.57	17.31			17.31	2.52			2.52	33.92	3.31	1.17	38.40
Total	98.58	113.33	84.10	296.01	275.39	229.07	47.92	552.38	135.12	95.83	31.26	262.21	509.09	438.23	163.28	1,110.60

Nolansburg:																
Hazard							3.44	3.44							3.44	3.44
Pineville:																
Fire Clay		.34	.64	.98	.89	3.22	.53	4.64	3.17	2.27		5.44	4.06	5.83	1.17	11.06
Fire Clay rider		.04	2.07	2.11	.10	.68	4.12	4.90	3.74	.50	1.87	6.11	3.84	1.22	8.06	13.12
Francis						.86	.18	1.04	1.13	.77	.51	2.41	1.13	1.63	.69	3.45
Haddix					.72	1.21		1.93	4.99	.16		5.15	5.71	1.37		7.08
Hindman							.11	.11			2.74	2.74			2.85	2.85
Lower Whitesburg					.15			.15					.15			.15
Upper Hamlin					.26	.50		.76	.36	4.11		4.47	.62	4.61		5.23
Total		.38	2.71	3.09	2.12	6.47	4.94	13.53	13.39	7.81	5.12	26.32	15.51	14.66	12.77	42.94
County total	126.96	205.60	148.15	480.71	370.04	428.77	103.38	902.19	495.01	270.59	94.98	860.58	992.01	904.96	346.51	2,243.48

Letcher County

Big Stone Gap:																
Cornett			*0.64	*0.64											*0.64	*0.64
										2.40	0.67	3.07		2.40	.67	3.07
			*.64	*.64						2.40	.67	3.07		2.40	**1.31	**3.71
High Splint			*2.79	*2.79		*1.13		*1.13						*1.13	*2.79	*3.92
Imboden		*3.62	*5.41	*9.03		*1.24	*5.76	*7.00						*4.86	*11.17	*16.03
Kellioka		*4.96		*4.96		*3.15		*3.15						*8.11		*8.11
										5.87		5.87		5.87		5.87
		*4.96		*4.96		*3.15		*3.15		5.87		5.87		**13.98		**13.98
Upper Elkhorn No. 3			*7.51	*7.51											*7.51	*7.51
Total		*8.58	*16.35	*24.93		*5.52	*5.76	*11.28		8.27	0.67	8.94		**22.37	**22.78	**45.15
Cornettsville:																
Amburgy	1.31	0.80		2.11	3.59	4.62		8.21	31.85	10.12		41.97	36.75	15.54		52.29
Fire Clay	.70	24.25	7.86	32.81	17.92	22.00	4.55	44.47	2.23			2.23	20.85	46.25	12.41	79.51
Francis										1.56		1.56		1.56		1.56
Hazard		3.20	30.38	33.58	1.76	4.85	9.09	15.70	.04	1.33	0.67	2.04	1.80	9.38	40.14	51.32
Hazard No. 7		.80	4.98	5.78	.71	1.91	6.82	9.44	1.39	1.98	2.57	5.94	2.10	4.69	14.37	21.16
Total	2.01	29.05	43.22	74.28	23.98	33.38	20.46	77.82	35.51	14.99	3.24	53.74	61.50	77.42	66.92	205.84

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Letcher County—Continued																
Hindman:																
Amburgy	*2.76			*2.76	*7.26			*7.26					*10.02			*10.02
Elkhorn Leader					*3.12			*3.12					*3.12			*3.12
Fire Clay			*14.13	*14.13		*0.46	*2.78	*3.24						*0.46	*16.91	*17.37
Hazard No. 7			*.66	*.66											*.66	*.66
									0.77	0.46		1.23	.77	.46		1.23
			*.66	*.66					.77	.46		1.23	.77	.46	*.66	**1.89
Upper Elkhorn No. 2	*6.61			*6.61									*6.61			*6.61
									1.23			1.23	1.23			1.23
	*6.61			*6.61					1.23			1.23	**7.84			**7.84
Upper Elkhorn No. 3	*.33	*9.39	*10.17	*19.89		*.10	*.05	*.15					*.33	*9.49	*10.22	*20.04
Upper Whitesburg	*.62	*.13		*.75	*3.06			*3.06					*3.68	*.13		*3.81
									4.36	.95		5.31	4.36	.95		5.31
	*.62	*.13		*.75	*3.06			*3.06	4.36	.95		5.31	**8.04	**1.08		**9.12
Total	*10.32	*9.52	*24.96	*44.80	*13.44	*0.56	*2.83	*16.83	6.36	1.41		7.77	**30.12	**11.49	*27.79	*69.40
Nolansburg:																
Fire Clay						*0.38		*0.38						*0.38		*0.38
										10.78		10.78		10.78		10.78
						*.38		*.38		10.78		10.78		**11.16		**11.16
Hazard			5.42	5.42		3.01	6.38	9.39		3.85	.82	4.67		6.86	12.62	19.48
Upper Hamlin			*.27	*.27			*5.63	*5.63							*5.90	*5.90
Total			**5.69	**5.69		**3.39	**12.01	**15.40		14.63	.82	15.45		**18.02	**18.52	**36.54
Pikeville:																
Amburgy					*1.93			*1.93					*1.93			*1.93
									1.76			1.76	1.76			1.76
					*1.93			*1.93	1.76			1.76	**3.69			**3.69
Elkhorn Leader					*.08			*.08					*.08			*.08
Fire Clay			*0.87	*0.87		*3.13	*3.36	*6.49						*3.13	*4.23	*7.36
Upper Elkhorn No. 2									.96			.96	.96			.96

Upper Elkhorn No. 3		*0.61	*10.18	*10.79		*.38	*.82	*1.20						*.99	*11.00	`11.99
Total		*0.61	*11.05	*11.66	*2.01	*3.51	*4.18	*9.70	2.72			2.72	**4.73	*4.12	*15.23	**24.08
Pound:																
Amburgy	*5.67	*11.58	*16.89	*34.14	*3.50	*30.03	*2.55	*36.08					*9.17	*41.61	*19.44	*70.22
									10.91	7.32		18.23	10.91	7.32		18.23
	*5.67	*11.58	*16.89	*34.14	*3.50	*30.03	*2.55	*36.08	10.91	7.32		18.23	**20.08	**48.93	**19.44	**88.45
Elkhorn Leader	*5.00	*.46		*5.46									*5.00	*.46		*5.46
									10.39			10.39	10.39			10.39
	*5.00	*.46		*5.46					10.39			10.39	**15.39	*.46		**15.85
Fire Clay	*.08	*.31	*25.26	*25.65			*13.15	*13.15					*.08	*.31	*38.41	*38.80
										5.39		5.39		5.39		5.39
	*.08	*.31	*25.26	*25.65			*13.15	*13.15		5.39		5.39	*.08	**5.70	*38.41	**44.19
Haddix			*.98	*.98											*.98	*.98
Imboden									3.65			3.65	3.65			3.65
Kellioka									2.97			2.97	2.97			2.97
Lower Elkhorn	*3.06	*4.40		*7.46	*2.52	*3.97		*6.49					*5.58	*8.37		*13.95
									16.39			16.39	16.39			16.39
	*3.06	*4.40		*7.46	*2.52	*3.97		*6.49	16.39			16.39	**21.97	*8.37		**30.34
Upper Elkhorn No. 1			*.45	*.45	*51.62	*.65		*52.27					*51.62	*.65	*.45	*52.72
									15.17			15.17	15.17			15.17
			*.45	*.45	*51.62	*.65		*52.27	15.17			15.17	**66.79	*.65	*.45	**67.89
Upper Elkhorn No. 2					*15.60			*15.60					*15.60			*15.60
									11.18			11.18	11.18			11.18
					*15.60			*15.60	11.18			11.18	**26.78			**26.78
Upper Elkhorn No. 3	*1.31	*10.37	*81.06	*92.74		*.84		*.84					*1.31	*11.21	*81.06	*93.58
Upper Hamlin			*.85	*.85	*.49		*1.16	*1.65					*.49		*2.01	*2.50
									1.87	.33		2.20	1.87	.33		2.20
			*.85	*.85	*.49		*1.16	*1.65	1.87	.33		2.20	**2.36	.33	*2.01	**4.70
Upper Whitesburg	*1.60	*12.88	*4.74	*19.22	*1.08	*5.82	*1.23	*8.13					*2.68	*18.70	*5.97	*27.35
									3.69			3.69	3.69			3.69
	*1.60	*12.88	*4.74	*19.22	*1.08	*5.82	*1.23	*8.13	3.69			3.69	**6.37	**18.70	**5.97	**31.04
Total	*16.72	*40.00	*130.23	*186.95	*74.81	*41.31	*18.09	*134.21	76.22	13.04		89.26	**167.75	**94.35	*148.32	**410.42
Whitesburg:																
Amburgy	*4.03	*0.21	*3.41	*7.65	*28.17	*18.56	*2.64	*49.37					*32.20	*18.77	*6.05	*57.02
									63.38	16.85	1.77	82.00	63.38	16.85	1.77	82.00
	*4.03	*.21	*3.41	*7.65	*28.17	*18.56	*2.64	*49.37	63.38	16.85	1.77	82.00	**95.58	**35.62	**7.82	**139.02
Collier									6.25			6.25	6.25			6.25
Darby									1.22	.37		1.59	1.22	.37		1.59
Elkhorn Leader	*17.62	*5.95	*1.30	*24.87	*29.35	*9.88		*39.23					*46.97	*15.83	*1.30	*64.10
									21.67			21.67	21.67			21.67
	*17.62	*5.95	*1.30	*24.87	*29.35	*9.88		*39.23	21.67			21.67	**68.64	*15.83	*1.30	**85.77
Fire Clay		*15.42	*58.05	*73.47	*3.25	*12.62	*50.31	*66.18					*3.25	*28.04	*108.36	*139.65
									6.06	38.58	1.35	45.99	6.06	38.58	1.35	45.99
		*15.42	*58.05	*73.47	*3.25	*12.62	*50.31	*66.18	6.06	38.58	1.35	45.99	**9.31	**66.62	**109.71	**185.64

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Letcher County—Continued																
Whitesburg—Con.																
Haddix			*10.50	*10.50		*2.53	*6.70	*9.23						*2.53	*17.20	*19.73
										4.62		4.62		4.62		4.62
			*10.50	*10.50		*2.53	*6.70	*9.23		4.62		4.62		**7.15	*17.20	**24.35
Harlan	*.35			*.35	*2.67	*8.83		*11.50					*3.02	*8.83		*11.85
									3.41			3.41	3.41			3.41
	*.35			*.35	*2.67	*8.83		*11.50	3.41			3.41	**6.43	*8.83		**15.26
High Splint		*.47	*.24	*.71										*.47	*.24	*.71
									1.18			1.18	1.18			1.18
		*.47	*.24	*.71					1.18			1.18	1.18	*.47	*.24	**1.89
Imboden	*.54	*1.23	*64.12	*65.89	*.42	*5.30	*21.98	*27.70					*.96	*6.53	*86.10	*93.59
									10.87			10.87	10.87			10.87
	*.54	*1.23	*64.12	*65.89	*.42	*5.30	*21.98	*27.70	10.87			10.87	**11.83	*6.53	*86.10	**104.46
Kellioka									14.63			14.63	14.63			14.63
Low Splint									0.73	8.99	11.17	20.89	0.73	8.99	11.17	20.89
Upper Elkhorn No. 2					*32.82	*2.75		*35.57					*32.82	*2.75		*35.57
									22.04	9.09		31.13	22.04	9.09		31.13
					*32.82	*2.75		*35.57	22.04	9.09		31.13	**54.86	**11.84		**66.70
Upper Elkhorn No. 3	*1.98	*50.75	*155.40	*208.13	*31.67	*39.22	*23.92	*94.81					*33.65	*89.97	*179.32	*302.94
									25.36	8.09	24.59	58.04	25.36	8.09	24.59	58.04
	*1.98	*50.75	*155.40	*208.13	*31.67	*39.22	*23.92	*94.81	25.36	8.09	24.59	58.04	**59.01	**98.06	**203.91	**360.98
Upper Hamlin			*6.42	*6.42	*.10	*1.18	*11.62	*12.90					*.10	*1.18	*18.04	*19.32
									1.19	6.45		7.64	1.19	6.45		7.64
			*6.42	*6.42	*.10	*1.18	*11.62	*12.90	1.19	6.45		7.64	**1.29	**7.63	*18.04	**26.96
Upper Whitesburg	*.03	*13.48	*8.88	*22.39	*18.77	*13.39		*32.16					*18.80	*26.87	*8.88	*54.55
									47.74	2.82		50.56	47.74	2.82		50.56
	*.03	*13.48	*8.88	*22.29	*18.77	*13.39		*32.16	47.74	2.82		50.56	**66.54	**29.69	*8.88	**105.11
Total	*24.55	*87.51	*308.32	*420.38	*147.22	*114.26	*117.17	*378.65	225.73	95.86	38.88	360.47	**397.50	**297.63	**464.37	**1,159.50
County total	**53.60	**175.27	**539.82	**768.69	**261.46	**201.93	**180.50	**643.89	346.54	148.20	43.61	538.35	**661.60	**525.40	**763.93	**1,950.93

McCreary County

Barthell:																
Barren Fork					2.26	2.01		4.27					2.26	2.01		4.27
Beaver Creek	0.80	2.56	6.33	9.69	24.43	65.38	37.69	127.50					25.23	67.94	44.02	137.19
Hudson	.45	2.71	1.08	4.24	17.36	34.28	28.21	79.85					17.81	36.99	29.29	84.09
Stearns No. 1½		.15	2.18	2.33	3.52	3.68	5.89	13.09	1.83			1.83	5.35	3.83	8.07	17.25
Total	1.25	5.42	9.59	16.26	47.57	105.35	71.79	224.71	1.83			1.83	50.65	110.77	81.38	242.80
Burnside:																
Barren Fork					0.65	1.38		2.03	0.43	3.08		3.51	1.08	4.46		5.54
Beaver Creek							4.50	4.50	4.69			4.69	4.69		4.50	9.19
Total					0.65	1.38	4.50	6.53	5.12	3.08		8.20	5.77	4.46	4.50	14.73
Cumberland Falls:																
Barren Fork	1.74	4.54		6.28	22.55	18.28		40.83	37.07	56.66		93.73	61.36	79.48		140.84
Beaver Creek							10.01	10.01		.12	14.60	14.72		.12	24.61	24.73
Total	1.74	4.54		6.28	22.55	18.28	10.01	50.84	37.07	56.78	14.60	108.45	61.36	79.60	24.61	165.57
Jellico:																
Jellico										0.47		0.47		0.47		0.47
Lily						2.17		2.17		1.84		1.84		4.01		4.01
Total						2.17		2.17		2.31		2.31		4.48		4.48
Stearns:																
Bacon Creek					1.87			1.87					1.87			1.87
Barren Fork	2.22			2.22	1.35			1.35					3.57			3.57
Beaver Creek	1.44	1.96	7.45	10.85	1.47	3.60	2.56	7.63	1.92	0.80		2.72	4.83	6.36	10.01	21.20
Blue Gem					2.72			2.72	5.30			5.30	8.02			8.02
Hudson	2.11	.80	1.87	4.78	.28	1.52	2.98	4.78					2.39	2.32	4.85	9.56
Jellico					1.46	.32		1.78	6.54	.81		7.35	8.00	1.13		9.13
Lily	4.26	.11		4.37	21.33			21.33	33.33			33.33	58.92	.11		59.03
Stearns No. 1½	4.10	3.69	1.05	8.84									4.10	3.69	1.05	8.84
Uncorrelated					3.34			3.34	14.11			14.11	17.45			17.45
Total	14.13	6.56	10.37	31.06	33.82	5.44	5.54	44.80	61.20	1.61		62.81	109.15	13.61	15.91	138.67
County total	17.12	16.52	19.96	53.60	104.59	132.62	91.84	329.05	105.22	63.78	14.60	183.60	226.93	212.92	126.40	566.25

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Magoffin County																
Bays:																
Gun Creek	2.11	1.58		3.69	24.86	6.03		30.89	36.31	1.52		37.83	63.28	9.13		72.41
Fire Clay	5.43	5.17		10.60	34.10	5.68		39.78	4.07			4.07	43.60	10.85		54.45
Fire Clay Rider					.93			.93	2.11			2.11	3.04			3.04
Fugate	.04	.31		.35	10.30	3.27	0.04	13.61	5.53	.97		6.50	15.87	4.55	0.04	20.46
Haddix						1.24		1.24	5.69			5.69	5.69	1.24		6.93
Hamlin	.46			.46	10.04			10.04	3.25			3.25	13.75			13.75
Hidman									2.99	.34		3.33	2.99	.34		3.33
Index	.95	3.75		4.70	10.22	8.68		18.90	5.18			5.18	16.35	12.43		28.78
Oakley	2.69	10.02	1.49	14.20	13.05	49.73	6.00	68.78	24.27	3.01		27.28	40.01	62.76	7.49	110.26
Prater	.84	1.09		1.93	7.67	7.28	.37	15.3	1.57			1.57	10.08	8.37	.37	18.82
Skyline		.68	5.85	6.53	.12	1.13	2.11	3.36	.84	.22	.69	1.75	.96	2.03	8.65	11.64
Tom Cooper					1.80			1.80	2.30			2.30	4.10			4.10
Whitesburg	1.73			1.73	5.36			5.36	8.74			8.74	15.83			15.83
Total	14.25	22.60	7.34	44.19	118.45	83.04	8.52	210.01	102.85	6.06	.69	109.60	235.55	111.70	16.55	363.80
Cannel City:																
Fugate					0.85			0.85					0.85			0.85
Grassy									1.72			1.72	1.72			1.72
Gun Creek					1.60			1.60	.38			.38	1.98			1.98
Oakley	0.66			0.66	.11			.11					.77			.77
Tom Cooper									1.71			1.71	1.71			1.71
Total	0.66			0.66	2.56			2.56	3.81			3.81	7.03			7.03
Dingus:																
Colvin	4.81	1.38		6.19	5.31			5.31					10.12	1.38		11.50
Fire Clay	30.45	2.46		32.91	17.85			17.85	9.44			9.44	57.74	2.46		60.20
Fugate					4.28	.29		4.57	.63			.63	4.91	.29		5.20
Grassy	.77			.77	5.10			5.10	5.99			5.99	11.86			11.86
Gun Creek	.24			.24	2.04			2.04					2.28			2.28
Hamlin									1.40			1.40	1.40			1.40
Index					8.06			8.06	2.48			2.48	10.54			10.54

Mine Fork	.31			.31	1.31			1.31	3.69			3.69	5.31			5.31
Oakley	2.79	.25		3.04	5.43	.45		5.88	1.07			1.07	9.29	.70		9.99
Tom Cooper	11.95	2.77		14.72	37.18	2.20		39.38	12.19			12.19	61.32	4.97		66.29
Whitesburg	3.00	2.55	.16	5.71	15.76	3.37		19.13	4.33			4.33	23.09	5.92	0.16	29.17
Total	54.32	9.41	.16	63.89	102.32	6.31		108.63	41.22			41.22	197.86	15.72	.16	213.74
Hindman:																
Fire Clay						3.10		3.10						3.10		3.10
Oakley					1.58			1.58					1.58			1.58
Tom Cooper					.11	3.24		3.35					.11	3.24		3.35
Upper Elkhorn No. 1					.51	2.48		2.99					.51	2.48		2.99
Upper Elkhorn No. 2					1.08			1.08					1.08			1.08
Total					3.28	8.82		12.10					3.28	8.82		12.10
Lee City:																
Nickell						0.45		0.45	0.09			0.09	0.09	0.45		0.54
Uncorrelated					0.06			.06	.66			.66	.72			.72
Total					0.06	0.45		0.51	0.75			0.75	0.81	0.45		1.26
Paintsville:																
Fire Clay					4.50	0.53		5.03	4.87			4.87	9.37	0.53		9.90
Mine Fork									1.84			1.84	1.84			1.84
Tom Cooper	.90			0.90	10.03			10.03	13.38			13.38	24.31			24.31
Whitesburg					2.46			2.46	10.58			10.58	13.04			13.04
Total	.90			0.90	16.99	0.53		17.52	30.67			30.67	48.56	0.53		49.09
Prestonburg:																
Fire Clay		1.18		1.18	18.37	17.53		35.90	5.45	2.25		7.70	23.82	20.96		44.78
Fugate			0.94	.94		5.74	9.53	15.27	9.15	9.88		19.03	9.15	15.62	10.47	35.24
Gun Creek					24.31			24.31	20.20			20.20	44.51			44.51
Hamlin	0.84	1.31		2.15	28.57	6.33		34.90	8.58			8.58	37.99	7.64		45.63
Hindman						2.33	1.35	3.68	5.83			5.83	5.83	2.33	1.35	9.51
Index	1.36	1.22	10.05	12.63	15.68	33.63	20.36	69.67	3.72	5.94		9.66	20.76	40.79	30.41	91.96
Oakley					3.40	3.02	1.13	7.55	8.10	3.38		11.48	11.50	6.40	1.13	19.03
Tom Cooper	2.38	7.96	1.00	11.34	35.82	23.27		59.09	17.73	5.82		23.55	55.93	37.05	1.00	93.98
Upper Elkhorn No. 1		1.76		1.76	21.65	17.85		39.50	27.56	5.75		33.31	49.21	25.36		74.57
Whitesburg	3.28	4.22		7.50	14.80	3.80		18.60	3.10			3.10	21.18	8.02		29.20
Total	7.86	17.65	11.99	37.50	162.60	113.50	32.37	308.47	109.42	33.02		142.44	279.88	164.17	44.36	488.41
County total	77.99	49.66	19.49	147.14	406.26	212.65	40.89	659.80	288.72	39.08	.69	328.49	772.97	301.39	61.07	1,135.43

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Martin County																
Harold:																
Fire Clay									3.85			3.85	3.85			3.85
Haddix	0.41	1.66		2.07	3.70	7.27	0.18	11.15	7.62	30.18		37.80	11.73	39.11	0.18	51.02
Hamlin					1.25	1.53		2.78	3.53	12.87		16.40	4.78	14.40		19.18
Peach Orchard	.59	.32		.91	1.78	3.54	21.84	27.16	2.25	4.67	36.83	43.75	4.62	8.53	58.67	71.82
Richardson							10.33	10.33			13.21	13.21			23.54	23.54
Torchlight			1.02	1.02		2.45	37.18	39.63		1.28	20.22	21.50		3.73	58.42	62.15
Williamson									1.35			1.35	1.35			1.35
Total	1.00	1.98	1.02	4.00	6.73	14.79	69.53	91.05	18.60	49.00	70.26	137.86	26.33	65.77	140.81	232.91
Inez:																
Fire Clay	0.71			0.71	8.90	1.13		10.03	12.59			12.59	22.20	1.13		23.33
Fire Clay rider									8.20			8.20	8.20			8.20
Haddix		0.73		.73	2.72	15.41	1.71	19.84	12.78	47.24	10.99	71.01	15.50	63.38	12.70	91.58
Hamlin	.23	1.52	0.17	1.92	2.82	19.88	3.18	25.88		35.74		35.74	3.05	57.14	3.35	63.54
Lower Whitesburg									4.36			4.36	4.36			4.36
Peach Orchard	1.38	1.23	1.37	3.98	10.33	13.90	25.19	49.42	4.14	42.13	57.95	104.22	15.85	57.26	84.51	157.62
Richardson						.38	8.82	9.20		1.31	25.98	27.29		1.69	34.80	36.49
Torchlight		.44	7.07	7.51	.04	10.77	44.22	55.03	.76	7.55	24.54	32.85	.80	18.76	75.83	95.39
Upper Whitesburg									7.60			7.60	7.60			7.60
Total	2.32	3.92	8.61	14.85	24.81	61.47	83.12	169.40	50.43	133.97	119.46	303.86	77.56	199.36	211.19	488.11
Naugatuck:																
Fire Clay		1.39		1.39	7.93	20.28		28.21	21.77	30.83		52.60	29.70	52.50		82.20
Fire Clay rider	1.92	.79		2.71	17.30	21.27		38.57	16.79	20.64		37.43	36.01	42.70		78.71
Haddix					6.14	6.29		12.43	17.96	10.27	5.66	33.89	24.10	16.56	5.66	46.32
Hamlin	.48			.48	3.45			3.45	15.23	6.03		21.26	19.16	6.03		25.19
Peach Orchard			4.41	4.41		2.14	20.03	22.17	1.98	16.43	23.72	42.13	1.98	18.57	48.16	68.71
Torchlight			1.55	1.55	1.39	1.67	8.67	11.73	4.74	16.29	8.26	29.29	6.13	17.96	18.48	42.57
Upper Elkhorn No.3		1.38	3.37	4.75		3.35	13.70	17.05		11.92	29.13	41.05		16.65	46.20	62.85
Williamson						.71		.71	4.49	6.84		11.33	4.49	7.55		12.04
Total	2.40	3.56	9.33	15.29	36.21	55.71	42.40	134.32	82.96	119.25	66.77	268.98	121.57	178.52	118.50	418.59

Williamson:																
Fire Clay		5.11		5.11	2.49	36.58		39.07	1.29	41.01		42.30	3.78	82.70		86.48
Hamlin										3.04		3.04		3.04		3.04
Lower Elkhorn										23.83		23.83		23.83		23.83
Lower Whitesburg	1.86			1.86	6.05	2.93		8.98	33.04			33.04	40.95	2.93		43.88
Peach Orchard		6.72	3.72	10.44		8.63	18.11	26.74		20.81	11.07	31.88		36.16	32.90	69.06
Torchlight		.89	4.09	4.98		1.04	16.81	17.85		.79	19.73	20.52		2.72	40.63	43.35
Williamson						.70		.70		18.52		18.52		19.22		19.22
Total	1.86	12.72	7.81	22.39	8.54	49.88	34.92	93.34	34.33	108.00	30.80	173.13	44.73	170.60	73.53	288.86
County total	7.58	22.18	26.77	56.53	76.29	181.85	229.97	488.11	186.32	410.22	287.29	883.83	270.19	614.25	544.03	1,428.47

Menifee County

Cannel City:																
Beattyville					2.96			2.96	0.22			0.22	3.18			3.18
Frenchburg:																
Beattyville					15.50	4.80		20.30	7.44			7.44	22.94	4.80		27.74
County total					18.46	4.80		23.26	7.66			7.66	26.12	4.80		30.92

Morgan County

Bays:																
Haddix						0.30		0.30	0.07			0.07	0.07	0.30		0.37
Cannel City:																
Adele	0.19			0.19	0.39			0.39					0.58			0.58
Fire Clay	8.23	2.75		10.98	2.20	.42		2.62	1.09			1.09	11.52	3.17		14.69
Fugate	1.06	.56		1.62	3.31	.36		3.67					4.37	.92		5.27
Grassy	22.30			22.30	36.47			36.47	15.70			15.70	74.47			74.47
Gun Creek	8.27	14.30		22.57	9.71	6.45		16.16	13.43	0.36		13.79	31.41	21.11		52.52
Index					.40	2.33		2.73	.20			.20	.60	2.33		2.93
Oakley	3.46			3.46	2.45			2.45					5.91			5.91
Tom Cooper	21.05			21.05	23.16			23.16	25.64			25.64	69.85			69.85
Total	64.56	17.61		82.17	78.09	9.56		87.65	56.06	0.36		56.42	198.71	27.53		226.24
Dingus:																
Fire Clay	5.93	0.39	1.56	7.88	3.26	2.40		5.66	5.49	0.40		5.89	14.68	3.19	1.56	19.43
Fugate					1.97			1.97					1.97			1.97
Hamlin					1.59			1.59	10.44			10.44	12.03			12.03
Index	5.43			5.43	13.22	1.58		14.80	51.10	32.70		83.80	69.75	34.28		104.03
Mine Fork	.34			.34	.98			.98	2.15			2.15	3.47			3.47
Oakley	.61			.61	1.91			1.91	2.46	4.75		7.21	4.98	4.75		9.73
Richardson			2.68	2.68			1.43	1.43			2.79	2.79			6.90	6.90
Tom Cooper	4.39	2.94		7.33	13.97	14.37		28.34	8.78	38.51		47.29	27.14	55.82		82.96
Total	16.70	3.33	4.24	24.27	36.90	18.35	1.43	56.68	80.42	76.36	2.79	159.57	134.02	98.04	8.46	240.52

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Morgan County—Continued																
Isonville:																
Fire Clay										1.15		1.15		1.15		1.15
Index					0.47			0.47		4.88		4.88	0.47	4.88		5.35
Richardson							0.82	.82			1.20	1.20			2.02	2.02
Tom Cooper									4.74	1.10		5.84	4.74	1.10		5.84
Total					0.47		0.82	1.29	4.74	7.13	1.20	13.07	5.21	7.13	2.02	14.36
Lee City:																
Nickell					1.18			1.18	0.69			0.69	1.87			1.87
Uncorrelated									.42			.42	.42			.42
Total					1.18			1.18	1.11			1.11	2.29			2.29
Paintsville:																
Mine Fork					0.61			0.61	1.29			1.29	1.90			1.90
Tom Cooper									.51			.51	.51			.51
Total					.61			0.61	1.80			1.80	2.41			2.41
County total	81.26	20.94	4.24	106.44	117.25	28.21	2.25	147.71	144.20	83.85	3.99	232.04	342.71	133.00	10.48	486.19
Owsley County																
Beattyville:																
Barren Fork					2.50			2.50	1.38			1.38	3.88			3.88
Beaver Creek									5.13	3.03		8.16	5.13	3.03		8.16
Jellico										1.43		1.43		1.43		1.43
Lily		0.56	0.66	1.22	.64	1.56		2.20	.11	3.71		3.82	.75	5.83	0.66	7.24
Uncorrelated									.09			.09	.09			.09
Total		0.56	0.66	1.22	3.14	1.56		4.70	6.71	8.17		14.88	9.85	10.29	0.66	20.80
Booneville:																
Lily									2.05			2.05	2.05			2.05

Tyner:					0.18			0.18	0.85			0.85	1.03			1.03
Barren Fork										0.34		.34		0.34		.34
Beaver Creek									.10	.44		.54	.10	.44		.54
Uncorrelated																
					0.18			0.18	0.95	0.78		1.73	1.13	0.78		1.91
Total																
County total		0.56	0.66	1.22	3.32	1.56		4.88	9.71	8.95		18.66	13.03	11.07	0.66	24.76
Perry County																
Big Creek:																
Fire Clay									0.22			0.22	0.22			0.22
Blue Diamond:																
Fire Clay	13.96	45.27	23.24	82.57	24.62	12.19		36.81	14.90			14.90	53.48	57.46	23.34	134.28
Haddix	11.43	16.58	4.42	32.43	21.50	8.79		30.29	3.00			3.00	35.93	25.37	4.42	65.72
Hazard	5.35	21.17	3.38	29.90	21.76	41.45		63.21	5.98			5.98	33.09	62.62	3.38	99.09
Hazard No. 7		9.21	209.87	219.08		1.46	20.26	21.72						10.67	230.13	240.80
Hindman		5.81	11.26	17.07	1.55	16.88	16.93	35.36		3.52	3.74	7.26	1.55	26.21	31.93	59.69
Total	30.74	98.04	252.27	381.05	69.43	80.77	37.19	187.39	23.88	3.52	3.74	31.14	124.05	182.33	293.20	599.58
Buckhorn:																
Amburgy					0.15			0.15	4.03			4.03	4.18			4.18
Fire Clay	37.55	19.11		56.66	12.96	3.74		16.70	1.84			1.84	52.35	22.85		75.20
Fire Clay rider	37.77	24.94	0.59	63.30	24.63	2.84		27.47	.88			.88	63.28	27.78	0.59	91.65
Francis						6.69	0.59	7.28		6.97		6.97		13.66	.59	14.25
Haddix	1.48	.87		2.35	4.17	.54		4.71	.75			.75	6.40	1.41		7.81
Hazard	7.32	63.18	14.56	85.06	14.61	25.37	3.50	43.48	.24	3.20	1.43	4.87	22.17	91.75	19.49	133.41
Hazard No. 7	2.79	6.45	104.22	113.46	2.44	3.01	4.33	9.78	5.00	.14		5.14	10.23	9.60	108.55	128.38
Upper Elkhorn No. 3	.06	1.17		1.23	6.31	3.11		9.42	10.65			10.65	17.02	4.28		21.30
Total	86.97	115.72	119.37	322.06	65.27	45.30	8.42	118.99	23.39	10.31	1.43	35.13	175.63	171.33	129.22	476.18
Cornettsville:																
Amburgy	10.38	7.53		17.91	35.71	57.28		92.99	46.82	199.23		246.05	92.91	264.04		356.95
Fire Clay	38.88	84.40	31.47	154.75	38.31	69.48	63.57	171.36	12.29	10.22	23.86	46.37	89.48	164.10	118.90	372.48
Francis	5.36	9.00	13.88	28.24	10.19	15.26	14.49	39.94	3.16	1.34	8.29	12.79	18.71	25.60	36.66	80.97
Hazard	11.00	38.67	109.07	158.74	19.64	28.89	30.50	79.03	2.71	1.71	.46	4.88	33.35	69.27	140.03	242.65
Hazard No. 7	3.11	16.39	42.87	62.37	15.94	22.94	29.27	68.15	6.69	19.32	9.66	35.67	25.74	58.65	81.80	166.19
Hindman			26.20	26.20			13.43	13.43			6.98	6.98			46.61	46.61
Upper Elkhorn No. 3					2.25	17.13		19.38	19.99	20.84		40.83	22.24	37.97		60.21
Total	68.73	155.99	223.49	448.21	122.04	210.98	151.26	484.28	91.66	252.66	49.25	393.57	282.43	619.63	424.00	1,326.06

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Perry County—Continued																
Hyden:																
Fire Clay	0.74			0.74	0.79			0.79	1.73			1.73	3.26			3.26
Fire Clay rider					2.77			2.77	.85			.85	3.62			3.62
Hazard					.18	10.53	8.47	19.18	.26	0.39		.65	.44	10.92	8.47	19.83
Hazard No. 7						5.05	10.85	15.90	.34	.26	4.65	5.25	.34	5.31	15.50	21.15
Hindman											3.58	3.58			3.58	3.58
Total	0.74			0.74	3.74	15.58	19.32	38.64	3.18	0.65	8.23	12.06	7.66	16.23	27.55	51.44
Nolansburg:																
Hazard							1.92	1.92							1.92	1.92
County total	187.18	369.75	595.13	1,152.06	260.48	352.63	218.11	831.22	142.33	267.14	62.65	472.12	589.99	989.52	875.89	2,455.40
Pike County																
Gilbert:																
Millard										0.88		0.88		0.88		0.88
Harold:																
Fire Clay		*0.15	*0.79	*0.94	*5.15	*7.79	*10.96	*23.90					*5.15	*7.94	*11.75	*24.84
									24.88	17.68	4.07	46.63	24.88	17.68	4.07	46.63
		*.15	*.79	*.94	*5.15	*7.79	*10.96	*23.90	24.88	17.68	4.07	46.63	**30.03	**25.62	**15.82	**71.47
Haddix										7.49		7.49		7.49		7.49
Hamlin									1.43			1.43	1.43			1.43
Lower Elkhorn									5.24	8.37		13.61	5.24	8.37		13.61
Peach Orchard		*.18	*.91	*1.09		*1.86		*1.86						*2.04	*.91	*2.95
										2.67	4.33	7.00		2.67	4.33	7.00
		*.18	*.91	*1.09		*1.86		*1.86		2.67	4.33	7.00		**4.71	**5.24	**9.95
Richardson											.42	.42			.42	.42
Torchlight											5.32	5.32			5.32	5.32
Upper Elkhorn No. 1		*1.04	*3.80	*4.84	*1.21	*14.05		*15.26					*1.21	*15.09	*3.80	*20.10
									19.76	25.82	1.83	47.41	19.76	25.82	1.83	47.41
		*1.04	*3.80	*4.84	*1.21	*14.05		*15.26	19.76	25.82	1.83	47.41	**20.97	**40.91	**5.63	**67.51

Upper Elkhorn No. 2	---	*17.80	*7.14	*24.94	*9.62	*16.83	*10.85	*37.30	---	---	---	---	*9.62	*34.63	*17.99	*62.24
	---	*17.80	*7.14	*24.94	*9.62	*16.83	*10.85	*37.30	33.70	19.40	.65	53.75	33.70	19.40	.65	53.75
	---	*17.80	*7.14	*24.94	*9.62	*16.83	*10.85	*37.30	33.70	19.40	.65	53.75	**43.32	**54.03	**18.64	**115.99
Upper Elkhorn No. 3	*1.21	*4.74	*1.92	*7.87	*4.33	*11.18	*11.62	*27.13	---	---	---	---	*5.54	*15.92	*13.54	*35.00
	*1.21	*4.74	*1.92	*7.87	*4.33	*11.18	*11.62	*27.13	15.85	8.57	2.48	26.90	15.85	8.57	2.48	26.90
	*1.21	*4.74	*1.92	*7.87	*4.33	*11.18	*11.62	*27.13	15.85	8.57	2.48	26.90	**21.39	**24.99	**16.02	**61.90
Williamson	*3.11	*3.62	---	*6.73	---	---	---	---	---	---	---	---	*3.11	*3.62	---	*6.73
	*3.11	*3.62	---	*6.73	---	---	---	---	41.28	---	---	41.28	41.28	---	---	41.28
	*3.11	*3.62	---	*6.73	---	---	---	---	41.28	---	---	41.28	**44.39	*3.62	---	**48.01
Total	*4.32	*27.53	*14.56	*46.41	*20.31	*51.71	*33.43	*105.45	142.14	90.00	19.10	251.24	**166.77	**169.24	**67.09	**403.10
Hurley:																
Auxier	*5.79	*9.61	---	*15.40	*15.75	*1.52	---	*17.27	---	---	---	---	*21.54	*11.13	---	*32.67
	*5.79	*9.61	---	*15.40	*15.75	*1.52	---	*17.27	13.29	---	---	13.39	13.39	---	---	13.39
	*5.79	*9.61	---	*15.40	*15.75	*1.52	---	*17.27	13.39	---	---	13.39	**34.93	*11.13	---	**46.06
Bingham	*3.86	*8.31	*42.05	*54.22	*10.15	*17.40	*0.95	*28.50	---	---	---	---	*14.01	*25.71	*43.00	*82.72
	*3.86	*8.31	*42.05	*54.22	*10.15	*17.40	*.95	*28.50	31.90	---	---	31.90	31.90	---	---	31.90
	*3.86	*8.31	*42.05	*54.22	*10.15	*17.40	*.95	*28.50	31.90	---	---	31.90	**45.91	*25.71	*43.00	**114.62
Eagle(?)	*7.22	*12.78	*3.15	*23.15	*34.72	*10.72	---	*45.44	---	---	---	---	*41.94	*23.50	*3.15	*68.59
	*7.22	*12.78	*3.15	*23.15	*34.72	*10.72	---	*45.44	23.95	---	---	23.95	23.95	---	---	23.95
	*7.22	*12.78	*3.15	*23.15	*34.72	*10.72	---	*45.44	23.95	---	---	23.95	**65.89	*23.50	*3.15	**92.54
Elswick	*.59	*1.86	---	*2.45	*4.40	---	---	*4.40	---	---	---	---	*4.99	*1.86	---	*6.85
	*.59	*1.86	---	*2.45	*4.40	---	---	4.40	8.70	---	---	8.70	8.70	---	---	8.70
	*.59	*1.86	---	*2.45	*4.40	---	---	4.40	8.70	---	---	8.70	**13.69	*1.86	---	**15.55
Fire Clay	---	*5.07	*2.15	*7.22	---	*3.73	*2.06	*5.79	---	---	---	---	---	*8.80	*4.21	*13.01
	---	*5.07	*2.15	*7.22	---	*3.73	*2.06	*5.79	.24	---	---	.24	.24	---	---	.24
	---	*5.07	*2.15	*7.22	---	*3.73	*2.06	*5.79	.24	---	---	.24	24	*8.80	*4.21	**13.25
Hagy(?)	*2.95	*3.10	---	*6.05	*4.26	*.52	---	*4.78	---	---	---	---	*7.21	*3.62	---	*10.83
	*2.95	*3.10	---	*6.05	*4.26	*.52	---	*4.78	9.09	---	---	9.09	9.09	---	---	9.09
	*2.95	*3.10	---	*6.05	*4.26	*.52	---	*4.78	9.09	---	---	9.09	**16.30	*3.62	---	**19.92
Lower Elkhorn	---	*4.90	*162.94	*168.84	---	*.95	*25.35	*26.30	---	---	---	---	---	*5.85	*188.29	*194.14
Millard	*9.16	*13.47	*1.03	*23.66	*54.13	*2.38	---	*56.51	---	---	---	---	*63.29	*15.85	*1.03	*80.17
	*9.16	*13.47	*1.03	*23.66	*54.13	*2.38	---	*56.51	27.00	---	---	27.00	27.00	---	---	27.00
	*9.16	*13.47	*1.03	*23.66	*54.13	*2.38	---	*56.51	27.00	---	---	27.00	**90.29	*15.85	*1.03	**107.17
Upper Elkhorn No. 1	*5.41	*5.42	*2.67	*13.50	*15.58	*9.77	---	*25.35	---	---	---	---	*20.99	*15.19	*2.67	*38.85
	*5.41	*5.42	*2.67	*13.50	*15.58	*9.77	---	*25.35	15.71	---	---	15.71	15.71	---	---	15.71
	*5.41	*5.42	*2.67	*13.50	*15.58	*9.77	---	*25.35	15.71	---	---	15.71	**36.70	*15.19	*2.67	**54.56
Upper Elkhorn No. 2	---	*2.94	*6.18	*9.12	*7.90	*13.76	*5.37	*27.03	---	---	---	---	*7.90	*16.70	*11.55	*36.15
	---	*2.94	*6.18	*9.12	*7.90	*13.76	*5.37	*27.03	32.11	---	---	32.11	32.11	---	---	32.11
	---	*2.94	*6.18	*9.12	*7.90	*13.76	*5.37	*27.03	32.11	---	---	32.11	**40.01	*16.70	*11.55	**68.26
Upper Elkhorn No. 3	---	---	---	---	---	---	---	---	11.66	0.70	1.41	13.77	11.66	.70	1.41	13.77
Williamson	*.56	*.23	*.95	*1.74	*.97	*.50	*5.91	*7.38	---	---	---	---	*1.53	*.73	*6.86	*9.12
	*.56	*.23	*.95	*1.74	*.97	*.50	*5.91	*7.38	23.72	.34	---	24.06	23.72	.34	---	24.06
	*.56	*.23	*.95	*1.74	*.97	*.50	*5.91	*7.38	23.72	.34	---	24.06	**25.25	**1.07	*6.86	**33.18
Total	*35.54	*67.69	*221.12	*324.35	*147.86	*61.25	*39.64	*248.75	197.47	1.04	1.41	199.92	**380.87	**129.98	**262.17	**773.02

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Pike County—Continued																
Matewan:																
Auxier	*0.19	*1.54		*1.73	*5.25			*5.25					*5.44	*1.54		*6.98
									15.11	2.90		18.01	15.11	2.90		18.01
	*.19	*1.54		*1.73	*5.25			*5.25	15.11	2.90		18.01	**20.55	**4.44		**24.99
Bingham									5.43			5.43	5.43			5.43
Elswick	*.24	*4.65	*0.50	*5.39	*2.92	*5.09		*8.01					*3.16	*9.74	*0.50	*13.40
									19.11			19.11	19.11			19.11
	*.24	*4.65	*.50	*5.39	*2.92	*5.09		*8.01	19.11			19.11	**22.27	*9.74	*.50	**32.51
Fire Clay	*3.83	*5.05	*13.56	*22.44	*1.17	*5.71	*5.75	*12.63					*5.00	*10.76	*19.31	*35.07
Haddix			*2.87	*2.87			*2.07	*2.07							*4.94	*4.94
Hagy (?)	*.54		*.54	*.54	*2.80			*2.80					*3.34			*3.34
Lower Elkhorn	*.46	*11.23	*110.57	*122.26		*10.03	*3.16	*13.19					*.46	*21.26	*113.73	*135.45
Lower Whitesburg			*2.00	*2.00											*2.00	*2.00
Millard	*3.52	*1.96	*.06	*5.54	*13.83	*7.90	*.22	*21.95					*17.35	*9.86	*.28	*27.49
									30.93			30.93	30.93			30.93
	*3.52	*1.96	*.06	*5.54	*13.83	*7.90	*.22	*21.95	30.93			30.93	**48.28	*9.86	*.28	**58.42
Upper Elkhorn No. 1	*8.79	*60.44	*46.76	*115.99	*3.91	*7.73		*11.64					*12.70	*68.17	*46.76	*127.63
										6.49		6.49		6.49		6.49
	*8.79	*60.44	*46.76	*115.99	*3.91	*7.73		*11.64		6.49		6.49	*12.70	**74.66	*47.76	**134.12
Upper Elkhorn No. 2	*2.77	*20.76	*5.62	*29.15	*9.25	*22.14	*5.36	*36.75					*12.02	*42.90	*10.98	*65.90
									17.41			17.41	17.41			17.41
	*2.77	*20.76	*5.62	*29.15	*9.25	*22.14	*5.36	*36.75	17.41			17.41	**29.43	*42.90	*10.98	**83.31
Upper Elkhorn No. 3	*3.73	*1.68	*8.45	*13.86	*4.63	*2.97	*14.79	*22.39					*8.36	*4.65	*23.24	*36.25
									20.36	.44		20.80	20.36	.44		20.80
	*3.73	*1.68	*8.45	*13.86	*4.63	*2.97	*14.79	*22.39	20.36	.44		20.80	**28.72	**5.09	*23.24	**57.05
Williamson	*5.49	*7.38	*45.48	*58.35	*1.69	*2.93	*16.03	*20.65					*7.18	*10.31	*61.51	*79.00
									11.60			11.60	11.60			11.60
	*5.49	*7.38	*45.48	*58.35	*1.69	*2.93	*16.03	*20.65	11.60			11.60	**18.78	*10.31	*61.51	**90.60
Total	*29.56	*114.69	*235.87	*380.12	*45.45	*64.50	*47.38	*157.33	119.95	9.83		*129.78	**194.96	**189.02	*283.25	**667.23
Pikeville:																
Bingham	*2.04	*2.31		*4.35									*2.04	*2.31		*4.35
									25.89	2.90		28.79	25.89	2.90		28.79
	*2.04	*2.31		*4.35					25.89	2.90		28.79	**27.93	**5.21		**33.14

Fire Clay		*.15	*0.99	*1.14										*.15	*0.99	*1.14
									1.97	4.14		6.11	1.97	4.14		6.11
		*.15	*.99	*1.14					1.97	4.14		6.11	1.97	**4.29	*.99	**7.25
Fire Clay rider			*10.03	*10.03			*4.12	*4.12							*14.15	*14.15
									1.39			1.39	1.39			1.39
			*10.03	*10.03			*4.12	*4.12	1.39			1.39	1.39		*14.15	**15.54
Hamlin			*10.33	*10.33		*3.75	*5.40	*9.15						*3.75	*15.73	*19.48
										1.98		1.98		1.98		1.98
			*10.33	*10.33		*3.75	*5.40	*9.15		1.98		1.98		**5.73	*15.73	**21.46
Lower Elkhorn	*3.52	*9.69	*67.29	*80.50	*2.60	*4.38	*20.85	*27.83					*6.12	*14.07	*88.14	*108.33
									15.06	5.40		20.46	15.06	5.40		20.46
	*3.52	*9.69	*67.29	*80.50	*2.60	*4.38	*20.85	*27.83	15.06	5.40		20.46	**21.18	**19.47	*88.14	**128.79
Peach Orchard		*1.13	*.46	*1.59										*1.13	*.46	*1.59
Upper Elkhorn No. 1	*3.24	*8.96	*1.94	*14.14	*9.92	*24.32	*2.52	*36.76					*13.16	*33.28	*4.46	*50.90
									16.59	24.80		41.39	16.59	24.80		41.39
	*3.24	*8.96	*1.94	*14.14	*9.92	*24.32	*2.52	*36.76	16.59	24.80		41.39	**29.75	**58.08	*4.46	**92.29
Upper Elkhorn No. 2	*.50	*34.52	*135.42	*170.44	*1.10	*21.89	*36.35	*59.34					*1.60	*56.41	*171.77	*229.78
									8.15	3.60		11.75	8.15	3.60		11.75
	*.50	*34.52	*135.42	*170.44	*1.10	*21.89	*36.35	*59.34	8.15	3.60		11.75	**9.75	**60.01	*171.77	**241.53
Upper Elkhorn No. 3	*2.36	*30.72	*96.22	*129.30	*3.78	*25.81	*50.07	*79.66					*6.14	*56.53	*146.29	*208.96
									7.21	12.50		19.71	7.21	12.50		19.71
	*2.36	*30.72	*96.22	*129.30	*3.78	*25.81	*50.07	*79.66	7.21	12.50		19.71	**13.35	**69.03	*146.29	**228.67
Williamson	*.19	*2.76		*2.95	*4.77	*7.00	*11.35	*23.12					*4.96	*9.76	*11.35	*26.07
							2.66	2.66	13.70	.19		13.89	13.70	.19	2.66	16.55
	*.19	*2.76		*2.95	*4.77	*7.00	**14.01	**25.78	13.70	.19		13.89	**18.66	**9.95	**14.01	**42.62
Total	*11.85	*90.24	*322.68	*424.77	*22.17	*87.15	**133.32	**242.64	89.96	55.51		145.47	**123.98	**232.90	**456.00	**812.88
Pound:																
Fire Clay		*0.11	*2.79	*2.90										*0.11	*2.79	*2.90
									0.42	4.36		4.78	0.42	4.36		4.78
		*.11	*2.79	*2.90					.42	4.36		4.78	.42	**4.47	*2.79	**7.68
Lower Elkhorn	*0.09	*11.91	*4.64	*16.64	*0.35	*5.71	*0.37	*6.43					*.44	*17.62	*5.01	*23.07
									3.88			3.88	3.88			3.88
	*.09	*11.91	*4.64	*16.64	*.35	*5.71	*.37	*6.43	3.88			3.88	**4.32	*17.62	*5.01	**26.95
Upper Elkhorn No. 1									1.70			1.70	1.70			1.70
Upper Elkhorn No. 2	*.31	*.37	*7.31	*7.99	*.54	*.58	*3.04	*4.16					*.85	*.95	*10.35	*12.15
									5.61			5.61	5.61			5.61
	*.31	*.37	*7.31	*7.99	*.54	*.58	*3.04	*4.16	5.61			5.61	**6.46	*.95	*10.35	**17.76
Upper Elkhorn No. 3		*.30	*13.37	*13.67		*.61	*4.30	*4.91						*.91	*17.67	*18.58
										6.14		6.14		6.14		6.14
		*.30	*13.37	*13.67		*.61	*4.30	*4.91		6.14		6.14		**7.05	*17.67	**24.72
Upper Whitesburg	*1.15	*.86	*4.45	*6.46									*1.15	*.86	*4.45	*6.46
									1.62			1.62	1.62			1.62
	*1.15	*.86	*4.45	*6.46					1.62			1.62	**2.77	*.86	*4.45	**8.08
Williamson	*2.52	*.68		*3.20	*1.76	*.13		*1.89					*4.28	*.81		*5.09
									4.46			4.46	4.46			4.46
	*2.52	*.68		*3.20	*1.76	*.13		*1.89	4.46			4.46	**8.74	*.81		**9.55
Total	*4.07	*14.23	*32.56	*50.86	*2.65	*7.03	*7.71	*17.39	17.69	10.50		28.19	**24.41	**31.76	*40.27	**96.44

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Pike County—Continued																
Regina:																
Auxier	*8.40	*13.14	*6.65	*28.19	*39.05	*11.67		*50.72					*47.45	*24.81	*6.65	*78.91
									50.57	0.66	2.77	54.00	50.57	.66	2.77	54.00
	*8.40	*13.14	*6.65	*28.19	*39.05	*11.67		*50.72	50.57	.66	2.77	54.00	**98.02	**25.47	**9.42	**132.91
Bingham	*10.75	*61.79	*26.80	*99.34	*47.64	*6.35	*0.84	*54.83					*58.39	*68.14	*27.64	*154.17
									64.41	18.36		82.77	64.41	18.36		82.77
	*10.75	*61.79	*26.80	*99.34	*47.64	*6.35	*.84	*54.83	64.41	18.36		82.77	**122.80	**86.50	**27.64	**236.94
Elswick		*7.85	*1.33	*9.18		*11.79	*1.59	*13.38						*19.64	*2.92	*22.56
									29.76	8.18		37.94	29.76	8.18		37.94
		*7.85	*1.33	*9.18		*11.79	*1.59	*13.38	29.76	8.18		37.94	29.76	**27.82	*2.92	**60.50
Fire Clay			*.88	*.88		*.32	*3.78	*4.10						*.32	*4.66	*4.98
Hagy(?)	*14.18	*6.30		*20.48	*19.07			*19.07					*33.25	*6.30		*39.55
									16.12	14.65		30.77	16.12	14.65		30.77
	*14.18	*6.30		*20.48	*19.07			*19.07	16.12	14.65		30.77	**49.37	**20.95		**70.32
Lower Elkhorn	*5.69	*42.55	*288.95	*337.19		*6.51	*14.79	*21.30					*5.69	*49.06	*303.74	*358.49
									13.49	14.15		27.64	13.49	14.15		27.64
	*5.69	*42.55	*288.95	*337.19		*6.51	*14.79	*21.30	13.49	14.15		27.64	**19.18	**63.21	*303.74	**386.13
Millard	*68.66	*26.94	*5.72	*101.32	*70.56			*70.56					*139.22	*26.94	*5.72	*171.88
									82.30	7.80		90.10	82.30	7.80		90.10
	*68.66	*26.94	*5.72	*101.32	*70.56			*70.56	82.30	7.80		90.10	**221.52	**34.74	*5.72	**261.98
Upper Banner(?)	*2.43	*4.75	*3.30	*10.48	*2.14	*6.45		*8.59					*4.57	*11.20	*3.30	*19.07
									21.15	15.40		36.55	21.15	15.40		36.55
	*2.43	*4.75	*3.30	*10.48	*2.14	*6.45		*8.59	21.15	15.40		36.55	**25.72	**26.60	*3.30	**55.62
Upper Elkhorn No. 1	*1.26	*4.04	*2.90	*8.20	*1.18	*1.95	*3.21	*6.34					*2.44	*5.99	*6.11	*14.54
									9.12	3.00		12.12	9.12	3.00		12.12
	*1.26	*4.04	*2.90	*8.20	*1.18	*1.95	*3.21	*6.34	9.12	3.00		12.12	**11.56	**8.99	*6.11	**26.66
Upper Elkhorn No. 2	*1.81	*21.62	*70.05	*93.48	*3.08	*24.09	*18.90	*46.07					*4.89	*45.71	*88.95	*139.55
									16.41	15.16		31.57	16.41	15.16		31.57
	*1.81	*21.62	*70.05	*93.48	*3.08	*24.09	*18.90	*46.07	16.41	15.16		31.57	**21.30	**60.87	*88.95	**171.12
Upper Elkhorn No. 3	*.51	*8.38	*4.48	*13.37	*.55	*31.71	*2.99	*35.25					*1.06	*40.09	*7.47	*48.62
									11.31	2.44		13.75	11.31	2.44		13.75
	*.51	*8.38	*4.48	*13.37	*.55	*31.71	*2.99	*35.25	11.31	2.44		13.75	**12.37	**42.53	*7.47	**62.37
Total	*113.69	*197.36	*411.06	*722.11	*183.27	*100.84	*46.10	*330.21	314.64	99.80	2.77	417.21	**611.60	**398.00	**459.93	**1,469.53

Williamson:																
Bingham									9.86			9.86	9.86			9.86
Fire Clay	*1.57	*11.35	*10.57	*23.49	*9.32	*56.99	*22.85	*89.16					*10.89	*68.34	*33.42	*112.65
									29.55	21.10		50.65	29.55	21.10		50.65
	*1.57	*11.35	*10.57	*23.49	*9.32	*56.99	*22.85	*89.16	29.55	21.10		50.65	**40.44	**89.44	*33.42	**163.30
Fire Clay rider									17.68	10.50	1.49	29.67	17.68	10.50	1.49	29.67
Haddix									4.72	5.50	5.64	15.86	4.72	5.50	5.64	15.86
Hamlin		*4.42	*11.05	*15.47	*4.79	*6.34	*13.23	*24.36					*4.79	*10.76	*24.28	*39.83
									12.98	13.95		26.93	12.98	13.95		26.93
		*4.42	*11.05	*15.47	*4.79	*6.34	*13.23	*24.36	12.98	13.95		26.93	**17.77	**24.71	*24.28	**66.76
Lower Elkhorn	*6.81	*30.36	*129.84	*167.01		*45.91	*12.72	*58.63					*6.81	*76.27	*142.56	*225.64
									19.13	70.41	30.39	119.93	19.13	70.41	30.39	119.93
	*6.81	*30.36	*129.84	*167.01		*45.91	*12.72	*58.63	19.13	70.41	30.39	119.93	**25.94	**146.68	**172.95	**345.57
Lower Whitesburg						1.81		1.81		22.11		22.11		23.92		23.92
Millard									15.84	5.05		20.89	15.84	5.05		20.89
Peach Orchard	*1.45	*6.42	*37.29	*45.16	*.15	*5.16	*7.13	*12.44					*1.60	*11.58	*44.42	*57.60
									5.29	14.73	1.44	21.46	5.29	14.73	1.44	21.46
	*1.45	*6.42	*37.19	*45.16	*.15	*5.16	*7.13	*12.44	5.29	14.73	1.44	21.46	**6.89	**26.31	**45.86	**79.06
Torchlight			*.68	*.68											*.68	*.68
		.24	.44	.68		2.39	2.59	4.98		.68	18.60	19.28		3.31	21.63	24.94
		.24	**1.12	**1.36		2.39	2.59	4.98		.68	18.60	19.28		3.31	**22.31	**26.62
Upper Elkhorn No. 1	*14.48	*32.83	*6.28	*53.59	*35.42	*43.19	*1.51	*80.12					*49.90	*76.02	*7.79	*133.71
									72.48	22.32	1.62	96.42	72.48	22.32	1.62	96.42
	*14.48	*32.83	*6.28	*53.59	*35.42	*43.19	*1.51	*80.12	72.48	22.32	1.62	96.42	**122.38	**98.34	**9.41	**230.13
Upper Elkhorn No. 2	*.76	*6.17	*16.21	*23.14	*21.06	*60.89	*31.33	*113.28					*21.82	*67.06	*47.54	*136.42
									34.54	105.54	19.89	159.97	34.54	105.54	19.89	159.97
	*.76	*6.17	*16.21	*23.14	*21.06	*60.89	*31.33	*113.28	34.54	105.54	19.89	159.97	**56.36	**172.60	**67.43	**296.39
Upper Elkhorn No. 3			*2.41	*2.41	*3.22	*2.54	*12.08	*17.84					*3.22	*2.54	*14.49	*20.25
									53.96	53.78	7.06	114.80	53.96	53.78	7.06	114.80
			*2.41	*2.41	*3.22	*2.54	*12.08	*17.84	53.96	53.78	7.06	114.80	**57.18	**56.32	**21.55	**135.05
Williamson	*1.58	*17.89	*65.86	*85.33	*5.08	*36.68	*14.29	*56.05					*6.66	*54.57	*80.15	*141.38
									23.83	19.55	5.45	48.83	23.83	19.55	5.45	48.83
	*1.58	*17.89	*65.86	*85.33	5.08	*36.68	*14.29	*56.05	23.83	19.55	5.45	48.83	**30.49	**74.12	**85.60	**190.21
Total	*26.65	**109.68	**280.63	**416.96	*79.04	**261.90	**117.73	**458.67	299.86	365.22	91.58	756.66	**405.55	**736.80	**489.94	**1,632.29
County total	*225.68	**621.42	**1,518.48	**2,365.58	*500.75	**634.38	**425.31	**1,560.44	1,181.71	632.78	114.86	1,929.35	**1,908.14	**1,888.58	**2,058.65	**5,855.37

Powell County

Clay City:																
Beattyville					2.06	0.98		3.04	0.90			0.90	2.96	0.98		3.94
County total					2.06	0.98		3.04	.90			.90	2.96	.98		3.94

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Pulaski County																
Burnside:																
Beaver Creek	------	------	------	------	------	7.69	------	7.69	6.57	5.79	------	12.36	6.57	13.48	------	20.05
Dykes:																
Barren Fork	0.74	1.71	2.96	5.41	------	7.12	------	7.12	1.49	.23	------	1.72	2.23	9.06	2.96	14.25
Cumberland Falls:																
Beaver Creek	------	------	6.71	6.71	------	.74	25.80	26.54	------	4.36	8.14	12.50	------	5.10	40.65	45.75
County total	0.74	1.71	9.67	12.12	------	15.55	25.80	41.35	8.06	10.38	8.14	26.58	8.80	27.64	43.61	80.05
Rockcastle County																
Dykes:																
Barren Fork	------	------	------	------	------	3.67	------	3.67	6.91	1.52	------	8.43	6.91	5.19	------	12.10
Livingston:																
Barren Fork	------	------	------	------	0.72	2.28	------	3.00	4.03	4.58	------	8.61	4.75	6.86	------	11.61
Beaver Creek	------	0.68	------	0.68	11.19	5.08	------	16.27	31.45	5.08	------	36.53	42.64	10.84	------	53.48
Hudson	------	------	------	------	.26	9.91	1.85	12.02	.56	18.88	------	19.44	.82	28.79	1.85	31.46
Total	------	0.68	------	0.68	12.17	17.27	1.85	31.29	36.04	28.54	------	64.58	48.21	46.49	1.85	96.55
Mt. Vernon:																
Barren Fork	------	------	------	------	2.47	------	------	2.47	4.62	.65	------	5.27	7.09	.65	------	7.74
Beaver Creek	0.37	0.12	------	0.49	7.74	------	------	7.74	13.06	7.67	------	20.73	21.17	7.79	------	28.96
Total	0.37	0.12	------	0.49	10.21	------	------	10.21	17.68	8.32	------	26.00	28.26	8.44	------	36.70
County total	0.37	0.80	------	1.17	22.38	20.94	1.85	45.17	60.63	38.38	------	99.01	83.38	60.12	1.85	145.35

Wayne County

Burnside:															
Beaver Creek					7.71	8.08	3.25	19.04	3.03	0.20		3.23	10.74	8.28	3.25	22.27
Byrdstown:																
Beaver Creek							4.92	4.92							4.92	4.92
Monticello:																
Beaver Creek						.22	1.50	1.72		1.75		1.75		1.97	1.50	3.47
Pall Mall:																
Beaver Creek						6.72		6.72	1.42			1.42	1.42	6.72		8.14
County total					7.71	15.02	9.67	32.40	4.45	1.95		6.40	12.16	16.97	9.67	38.80

Whitley County

Barbourville:																
Blue Gem	0.96			0.96	0.85			0.85	0.40			0.40	2.21			2.21
Corbin:																
Bacon Creek									2.88			2.88	2.88			2.88
Blue Gem	3.00	0.45		3.45	20.57	1.11		21.68	30.64			30.64	54.21	1.56		55.77
Fire Clay							0.60	.60			0.53	.53			1.13	1.13
Jellico	1.40	3.76		5.16	6.72	14.63		21.35	2.69	11.68		14.37	10.81	30.07		40.88
Lily					4.56	4.33		8.89	12.26	.52		12.78	16.82	4.85		21.67
Moss					.06	.15		.21	2.94	.89		3.83	3.00	1.04		4.04
Uncorrelated									5.16			5.16	5.16			5.16
Total	4.40	4.21		8.61	31.91	20.22	.60	52.73	56.57	13.09	.53	70.19	92.88	37.52	1.13	131.53
Fonde:																
Bennett Fork		0.44		0.44		3.20		3.20		1.12		1.12		4.76		4.76
Blue Gem	0.97	0.85		1.82	10.72	6.14		16.86	14.78			14.78	26.47	6.99		33.46
Fire Clay											2.97	2.97			2.97	2.97
Jellico	0.58	1.28		1.86	12.82			12.82	20.37			20.37	33.77	1.28		35.05
Total	1.55	2.57		4.12	23.54	9.34		32.88	35.15	1.12	2.97	39.24	60.24	13.03	2.97	76.24
Jellico:																
Bacon Creek					3.45			3.45	10.78			10.78	14.23			14.23
Blue Gem	8.07			8.07	48.48			48.48	58.24			58.24	114.79			114.79
Fire Clay							0.27	0.27		12.17	4.22	16.39		12.17	4.49	16.66
Jellico	0.10	9.60	1.07	10.77	3.06	70.54	0.72	75.32		41.67	1.07	42.74	3.16	121.81	3.86	128.83
Lily					39.63	7.68		47.31	78.17	15.35		93.52	117.80	23.03		140.83
Total	8.17	9.60	1.07	18.84	94.62	78.22	1.99	174.83	147.19	69.19	5.29	221.67	249.98	157.01	8.35	415.34

TABLE 12.—*Original coal reserves in eastern Kentucky by county, quadrangle, and bed according to abundance, reliability of data, and thickness*—Continued

[In millions of short tons]

Quadrangle and bed	Measured reserves in beds of indicated thickness in inches				Indicated reserves in beds of indicated thickness in inches				Inferred reserves in beds of indicated thickness in inches				Total, each category			Quadrangle- and county totals, all beds
	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	Total	14 to 28	28 to 42	42	
Whitley County—Continued																
Stearns:																
Blue Gem									1.48			1.48	1.48			1.48
Jellico					0.49	1.18		1.67		4.06		4.06	0.49	5.24		5.73
Lily	0.73	0.20		0.93	11.28			11.28	10.24			10.24	22.25	0.20		22.45
Uncorrelated		0.67		0.67	2.44			2.44	2.51			2.51	4.95	0.67		5.62
Total	0.73	0.87		1.60	14.21	1.18		15.39	14.23	4.06		18.29	29.17	6.11		35.28
County total	15.81	17.25	1.07	34.13	165.13	108.96	2.59	276.68	253.54	87.46	8.79	349.79	434.48	213.67	12.45	660.60
Wolfe County																
Bays:																
Fire Clay									0.17			0.17	0.17			0.17
Beattyville:																
Grassy									0.46			0.46	0.46			0.46
Tom Cooper	0.38	1.83		2.21	4.10	3.90		8.00	6.49	7.97		14.46	10.97	13.70		24.67
Uncorrelated									4.45			4.45	4.45			4.45
Zachariah	0.74	4.69	0.75	6.18	8.33	8.90	0.24	17.47	25.82	3.41		29.23	34.89	17.00	0.99	52.88
Zachariah rider	0.53			0.53	0.53			0.53	0.66			0.66	1.72			1.72
Total	1.65	6.52	0.75	8.92	12.96	12.80	0.24	26.00	37.88	11.38		49.26	52.49	30.70	0.99	84.18
Cannel City:																
Adele					0.93	0.12		1.05					0.93	0.12		1.05
Fugate	0.37			0.37	0.20			0.20					0.57			0.57
Grassy	4.19	0.58		4.77	5.39			5.39	2.79			2.79	12.37	0.58		12.95
Gun Creek	0.68	2.90		3.58	5.67	9.10		14.77	2.11	1.18		3.29	8.46	13.18		21.64
Tom Cooper	3.17			3.17	5.00			5.00	2.07			2.07	10.24			10.24
Total	8.41	3.48		11.89	17.19	9.22		26.41	6.97	1.18		8.15	32.57	13.88		46.45

Frenchburg:																
Beattyville					1.49			1.49					1.49			1.49
Lee City:																
Fire Clay					4.98			4.98	6.93			6.93	11.91			11.91
Gun Creek					1.43	0.77		2.20	7.06			7.06	8.49	0.77		9.26
Hamlin					2.02			2.02	8.81			8.81	10.83			10.83
Nickell					2.02	0.91		2.93	4.19			4.19	6.21	0.91		7.12
Tom Cooper					2.56			2.56	6.00			6.00	8.56			8.56
Uncorrelated					14.23			14.23	15.76			15.76	29.99			29.99
Total					27.24	1.68		28.92	48.75			48.75	75.99	1.68		77.67
County total	10.06	10.00	0.75	20.81	58.88	23.70	0.24	82.82	93.77	12.56		106.33	162.71	46.26	0.99	209.96

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