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ESTIMATE OF KNOWN RECOVERABLE RESERVES
OF COKING COAL IN BROOKE COUNTY, W. VA.

BY J. J. DOWD, J. M. PROVOST, R. G. TRAVIS,
R. F. ABERNETHY, AND D. A. REYNOLDS

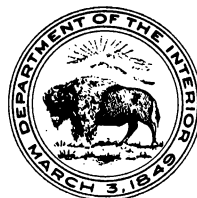
United States Department of the Interior — October 1955

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UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary
BUREAU OF MINES
J. J. Forbes, Director

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FOREWORD

Since its creation by Congress in 1910, the Bureau of Mines has borne a heavy responsibility for technical progress in the mining, preparation, and utilization of our national fuel reserves. Similarly, it has pioneered in scientific studies leading to better health and safety in mining and more efficient conservation of fuel resources.

Conservation means a full but prudent use of the national resources with avoidance of waste. Conservation requires an inventory to determine the extent, availability, and condition of our resources, for without these facts it is impossible for either industry or Government to plan for sustained production and maintenance of the industrial capacity so essential to our peacetime prosperity and wartime survival. This is true particularly of fuels needed for special purposes, such as metallurgical coking coals that must possess certain favorable properties. Heavy use of our limited reserves of good coking coal has resulted in severe depletion and, in some areas, exhaustion of the thickest and best beds.

At the request of the Munitions Board, Department of Defense, the Bureau of Mines made preliminary arrangements early in 1948 for an investigation of known minable reserves of coal that were or could be made suitable for the manufacture of metallurgical coke. In August of that year, actual field work began in the low- and medium-volatile coking coal fields of the Appalachian region, specifically central Pennsylvania and southern West Virginia. As both the economic and technologic factors that determine whether a particular coal can be used for producing metallurgical coke will vary with changing conditions, the investigation was planned to cover three phases:

1. Determination, from available data, of coal reserves with coking properties that occur in beds thick enough and within depths considered economically minable by present methods, together with such additional reserves as may become economically minable under future conditions of improved technology and greater need.

2. Study of the preparation characteristics of the reserves thereby developed to determine (a) which coals are suitable under present standards for producing metallurgical coke either as mined or after beneficiation by conventional preparation methods, and (b) which coals would require special and more intensive treatment in mining, preparation, or both.

3. Study of the carbonizing properties of the reserves thus developed to determine the yield and quality of coke, gas, and chemical products that can be obtained from coals carbonized singly and in blends.

This report is one in a series, by counties, covering in detail the estimated known minable coking-coal reserves determined under the first phase of the investigation. It also includes a general assessment of the carbonizing properties of the most important beds and a table of analyses of typical coals from the county. Publications will be issued later covering in more detail the preparation and carbonization data upon completion of the extensive laboratory work involved in these phases of the survey.

The estimates of coking-coal reserves in these reports were derived from data made available to the Bureau of Mines by coal companies, landowners, Federal, State, and municipal engineers, geologists, land-record officials, and others having authentic records of the occurrence and characteristics of the coal in the respective counties. All of the data were assembled from mine maps, records of core drilling, test pitting and trenching, and related sources of information, for no new core-drilling or geologic exploration was undertaken. Consequently, there are areas covered by these reports wherein the known data now available are inadequate to estimate reserves of measured and indicated coal, as these are defined in the reports. Geologic data also indicate the presence of large reserves of inferred coal in many of these areas, but no estimates of inferred reserves are presented in these reports. As their titles indicate, they include only known, minable reserves of measured and indicated coal and not total estimated reserves of coal. Therefore, any comparison of these and other coal-reserve estimates should be made with this distinction clearly understood.

The percentage recovery shown in these reports is a weighted average, based on the thickness of clean coal, less all partings 3/8-inch or more thick, recovered from the mined-out areas in each bed. Thus, it is an overall net areal percentage recovery that, in many cases, will be lower than the recovery estimated by operators who eliminate from their calculations coal pillars left at property boundaries, under roads, and elsewhere. It is based on all coal removed since the beginning of mining operations and therefore may vary from that of recent operations in which recovery either has been improved substantially by technologic advances or has declined, owing to flooding or other conditions that make it expedient to leave more coal in the ground. As the estimates are dated and represent a factual record of all past operations in the particular area, the percentage recovery and estimate of minable coal may be adjusted by operators to suit their particular conditions at any given time.

These county reports are being published as rapidly as the available data can be found and analyzed. Later, in cooperation with the Federal Geological Survey, results of these studies will be combined with those from a complete geologic investigation of all coal reserves in the areas considered. Then, reports can be published, by States, giving estimates of total reserves, including the geologically inferred reserves that have been omitted herein.

This investigation was made possible only through the complete cooperation of the coal operators, landowners, and others who have made available to the Bureau their confidential records and data relating to mining operations, drill-core and test-pit operations, etc. This cooperation and assistance is appreciated and is gratefully acknowledged. To protect the confidence of data from private records, the Bureau of Mines is assembling and publishing the estimates on a county-wide basis only and will not release any supplementary or more detailed information.

This investigation will serve a triple purpose:

1. By providing an inventory of known, minable reserves of coking coal that are or can be made suitable for the manufacture of metallurgical coke.

2. By providing an inventory of known minable reserves of coal with coking properties but unsuited for metallurgical coking-coal use by present standards and techniques because of high sulfur, high ash, or weakly coking properties. When warranted by economic and technologic developments, these reserves later may be adapted to metallurgical use by suitable preparation, blending, carbonizing, or metallurgical techniques.

3. By ascertaining the approximate location and magnitude of areas in which geologic data indicate the presence of inferred reserves but where exploratory work has been too limited to determine measured and indicated reserves. It is in these areas that more intensive exploratory work is needed in the future to complete the coking-coal inventory.

The first of these objectives is of prime importance for the present and immediate future, and the second for the more distant future. Accomplishment of the third objective will be of major aid to both industry and State and Federal agencies in more effectively planning and executing coal exploratory and testing investigations.

RALPH L. BROWN
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**ESTIMATE OF KNOWN RECOVERABLE RESERVES OF COKING COAL
IN BROOKE COUNTY, W. VA.**

by

J. J. Dowd, ^{1/} J. M. Provost, ^{2/} R. G. Travis, ^{2/} R. F. Abernethy, ^{3/}
and D. A. Reynolds ^{4/}

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CONCLUSIONS

1. The Pittsburgh bed is the most important bed in Brooke County and virtually the entire production of coal in the county comes from this bed.
2. Known measured and indicated reserves in all beds, based on a minimum thickness of 14 inches and 1,800 tons per acre-foot of coal in place, are estimated at 191 million short tons as of January 1, 1954. Of this total, 190 million short tons are in beds 28 inches and more thick. Areas in each bed were omitted from the estimate because available data relative to the bed characteristics are too meager to make an estimate that conforms with the definitions of measured and indicated coal adopted for this study. Should future drilling or development prove reserves in these areas, such reserves should be added to the total estimated reserves.
3. Recoverable reserves of coal have been estimated in beds 28 inches and more thick. This thickness is about the minimum now being mined by hand loading onto conveyors in the Appalachian region. The weighted average recovery for all beds in Brooke County, as determined by this investigation, is 54.7 percent. This percentage is based on the total thickness of coal (less partings 3/8 inch thick or more) in the bed rather than on the thickness of the coal mined. Based on the weighted average percentage of recovery for all beds in Brooke County, the recoverable reserves are estimated at 104 million short tons as of January 1, 1954.
4. The Pittsburgh bed coal in Brooke County is of high-volatile A bituminous rank.
5. The Pittsburgh bed coal is strongly coking, but in Brooke County, most of the coal is too high in sulfur to be suitable for the manufacture of good metallurgical coke by present standards.

INTRODUCTION

The investigation to evaluate the reserves of coking coal was planned to cover three phases: (1) Estimation of known measured and indicated recoverable reserves of all coking coal; (2) study of methods of upgrading marginal coals through effective preparation; and (3) study of carbonizing properties of coals and coal blends not now widely used for metallurgical coke making.

This is the 30th of a series of reports giving results of studies by counties under part (1) of the investigation. (See appendix.) This report covers Brooke County, W. Va., which comprises parts of Steubenville and Wheeling quadrangles. (See fig. 1.)

A base map for each bed in each quadrangle was made to the scale 1 inch equals 1,200 feet. Maps of mines, locations of drill holes, bed and total coal thicknesses, and the outcrop of the bed were plotted on the maps. With all available data plotted, isopach lines were drawn to limit areas of known reserves in beds up to 14 inches thick, 14 to 28 inches thick, 28 to 42 inches thick, and over 42 inches thick. These areas of coal reserves also were divided into "measured" and "indicated" categories. All areas in each thickness range and in each reserve category, mined-out areas, areas excluded from the estimate but which may contain reserves based on geologic inference, and areas outside of the outcrop were measured by planimeter on the base maps. Estimates of total reserves 14 inches and more thick for individual beds were prepared from these data.

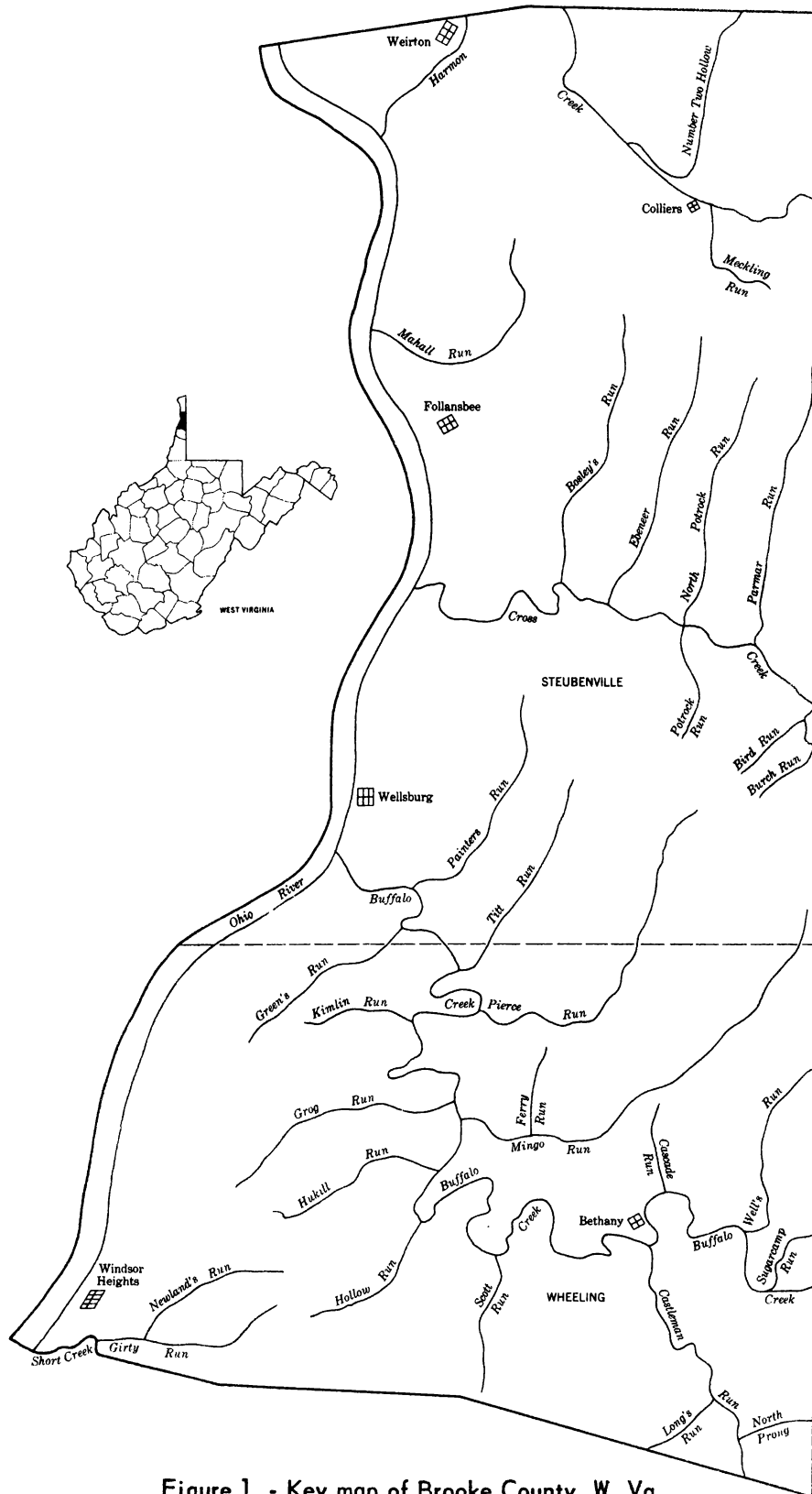


Figure 1. - Key map of Brooke County, W. Va.

ACKNOWLEDGMENTS

The information contained in this report could not have been obtained without the whole-hearted cooperation of the officials of the companies and individual landowners whose property records were studied, and their cooperation and the courtesies extended are gratefully acknowledged. The advice and assistance of the Coal Resources Committees of both the National Bituminous Coal Advisory Council and American Institute of Mining and Metallurgical Engineers, members of the staffs of the Federal Geological Survey, West Virginia Geological Survey, and West Virginia Department of Mines, coal-operator associations, and consulting mining engineers are appreciated.

PREMISES AND DEFINITIONS OF TERMS USED

As estimate of coal reserves is the opinion of an individual or group of individuals based on certain premises and limitations adopted for that estimate. Therefore, to compare estimates, it is necessary to compare not only the final results but also the premises on which the estimates are based. The definitions "measured" coal and "indicated" coal used in this report have been agreed upon by the Bureau of Mines and the Federal Geological Survey. The premises and definitions of terms follow:

Coking coal. - All bituminous coals in the Appalachian region are potentially coking and, therefore, until the carbonization tests in part (3) of the study have been completed to determine the coking quality of the coals, all known reserves of coal in the county are included as coking coal. This should not be construed to mean that all coals included in this report are suitable for the manufacture of metallurgical coke according to present-day standards. However, the general trend is toward the use of lower quality coals for metallurgical purposes.

Unit area. - The unit area used in estimating reserves is the 5-minute rectangle of the 15-minute topographic quadrangle. The estimates for the nine 5-minute rectangles of a quadrangle are combined on a county basis.

Bed-thickness range. - Reserves in each coal bed are tabulated in bed-thickness ranges, as follows:

- 14 to 28 inches.
- 28 to 42 inches.
- 42 inches and more.

These measurements represent total bed thickness, including all coal and partings in the bed. If the top or bottom bench of a coal bed is separated from the remainder of the bed by a parting of equal or greater thickness and usually is not mined, such bench and partings are omitted in determining the bed thickness.

Measured coal. - Measured coal is coal for which tonnage is computed from dimensions revealed in outcrops, mine workings, and drill holes. The points of observation and measurement are so closely spaced, and the thickness and extent of the coal are so well defined that the computed tonnage is judged to be accurate within 20 percent or less of the true tonnage. Although the spacing of the points of observation necessary to demonstrate continuity of coal will vary in different regions according to the habit of the coal beds, the points of observation are, in general, about 1/2 mile apart. The outer limit of a block of measured coal,

therefore, shall be about 1/4 mile from the last point of positive information (that is, roughly, one-half the distance between points of observation).

Where no data are available other than measurements along the outcrop, but where the continuity of the outcrop is measured in miles and suggests the presence of coal at great distances in from the outcrop, a smooth line drawn roughly 1/2 mile in from the outcrop shall be used to mark the limit under cover of a block of coal that also can be classed as measured.

Indicated coal. - Indicated coal is coal for which tonnage is computed partly from specific measurements and partly from projection of visible data for a reasonable distance on geologic evidence. In general, the points of observation are about 1 mile apart but may be as much as 1-1/2 miles for beds of known geologic continuity. For example, if drilling on 1/2-mile centers has proved a block of measured coal of fairly uniform thickness and extent, the area of measured coal, according to the judgment of the estimator, is larger than the actual area of drilling by as much as 1/4 mile on all sides. If, from geologic evidence, the bed is believed to have greater continuity, the area of measured coal is surrounded by a belt of indicated coal, which, according to the judgment of the appraiser, may be as much as 1-1/2 miles wide.

Where no data are available other than measurements along the outcrops, but where the continuity of the outcrop is measured in miles and suggests the presence of coal at great distances in from the outcrop, two lines drawn roughly parallel to the outcrop, one 1/2 mile in from the outcrop and one 2 miles in from the outcrop, define a block of coal that may be classed as indicated.

Inferred coal. - As no estimate of reserves has been made from geologic inference alone, inferred coal is not included in this report. This category often contains the largest reserves.

Areas excluded from estimate. - In each bed are areas in which coal may be present but for which reserves have not been estimated. There are too few or no bed sections from drill holes, mine workings, or coal outcrops in the area on which to base estimates that would qualify under the definitions of "measured" or "indicated" reserves. These areas may contain additional geologically inferred reserves, and thus correspond approximately to areas of inferred reserves.

Overburden. - All known reserves in Brooke County are under less than 2,000 feet of overburden.

Thickness of coal. - In computing the volume of reserves in each thickness category for each bed, the total thickness of clean coal in the bed section is used. If the top or bottom bench of coal described under definition of "bed-thickness range" usually is not mined, the thickness of the bench is not used to compute the volume of reserves. A weighted average thickness in each thickness category for each 5-minute rectangle of each bed is computed.

Weight of coal. - Estimated coal in place is based on 1,800 short tons per acre-foot.

Percentage of recovery. - The weighted average percentage of recovery is computed for each bed in each quadrangle. The total number of tons of coal produced from each mine is obtained from either the mine operator or the published reports of the West Virginia Department of Mines. An estimate is made of the tons of coal originally in place in the mined-out area of each mine. The percentage of recovery

for each mine is the ratio of the total number of tons produced from a mine (to January 1, 1954, the date of this estimate) to the total tons originally in place in the mined-out area. The weighted average percentage of recovery for all mines in the same bed in a quadrangle is the percentage of recovery used in calculating recoverable reserves for that bed in the quadrangle. If total mine production figures are not available from any source, the percentage recovery is estimated by comparison with mining in beds of the same thickness and with similar mining conditions.

All coal remaining for any reason within the mined-out area of a mine is considered a loss. No distinction is made between avoidable or unavoidable losses. Included in these losses is some coal considered too thin to mine, also coal that legally is required to be left unmined, such as coal under some highways, railroads, rivers, coal left to protect gas and oil wells, and coal left in barrier pillars between mines and adjacent to property boundaries.

Recoverable reserves. - The recoverable reserves are estimated tons of unmined coal in beds 28 inches and more thick, as of the date of the estimate, multiplied by the percentage of recovery. Twenty-eight inches is about the minimum thickness of coal being mined mechanically (hand-loaded conveyors). Some areas in some of the beds in this county may not be considered economically minable at present because of conditions considered adverse today.

COAL RESERVES

Detailed estimates of known measured and indicated reserves of coal in Brooke County, W. Va., as of January 1, 1954, are given in tables 1 to 3, inclusive.

Table 4 is a recapitulation by beds in Brooke County. Reserves in all beds 14 inches and more thick are estimated to be 191,375,000 short tons. Of this total, 190,320,000 short tons is in beds 28 inches and more thick.

The weighted average percentage of recovery for each bed, or the estimated percentage recovery where no production records are available, is shown in column 19 of tables 1 to 3, inclusive. The highest average recovery is 55.0 percent for the Pittsburgh bed, and the lowest is 50.0 percent for the Waynesburg bed.

The weighted average recovery for all beds in the county is 54.7 percent. Based on this recovery, the known recoverable reserves 28 inches and more thick are estimated at 104,119,000 short tons as of January 1, 1954. It must be remembered that these estimates are the known reserves only. Extensive drilling and prospecting to secure additional information may prove larger reserves in the county.

BROOKE COUNTY

TABLE 1. - RESERVES IN WASHINGTON BED, January 1, 1954

Quadrangle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Area of quadrangle in county, acres	Areas excluded from estimate, $\frac{1}{2}$ acres	Area outside outcrop, acres	Underlain by coal 0" to 14" thick, acres	Coal over 14" thick, in place originally, acres	Mined out, acres	Coal over 14" thick remaining, acres	Measured Indicated	Estimated coal reserves, in tons of 2,000 lb.						Total reserves, in tons of 2,000 lb.				Percentage recoverable, including all mining losses	Estimated recoverable reserves 28" and more thick, thousands of tons
									14" to 28" thick		28" to 42" thick		Over 42" thick		14" and more thick		28" and more thick			
									Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons		
Wheeling	26,160	1,363	24,587	-	210	-	210	Measured Indicated	210	717	-	-	-	-	210	717	-	-	-	-
								Total	210	717	-	-	-	-	210	717	-	-	-	-
								Measured Indicated	210	717	-	-	-	-	210	717	-	-	-	-
								Total	210	717	-	-	-	-	210	717	-	-	-	-
Total	26,160	1,363	24,587	-	210	-	210	Total	210	717	-	-	-	-	210	717	-	-	-	-

TABLE 2. - RESERVES IN WAYNESBURG BED, January 1, 1954

Quadrangle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Area of quadrangle in county, acres	Areas excluded from estimate, $\frac{1}{2}$ acres	Area outside outcrop, acres	Underlain by coal 0" to 14" thick, acres	Coal over 14" thick, in place originally, acres	Mined out, acres	Coal over 14" thick remaining, acres	Measured Indicated	Estimated coal reserves, in tons of 2,000 lb.						Total reserves, in tons of 2,000 lb.				Percentage recoverable, including all mining losses	Estimated recoverable reserves 28" and more thick, thousands of tons
									14" to 28" thick		28" to 42" thick		Over 42" thick		14" and more thick		28" and more thick			
									Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons		
Wheeling	26,160	7,263	16,825	-	2,072	3	2,069	Measured Indicated	90	338	1,671	9,023	308	2,125	2,069	11,486	1,979	11,148	-	5,574
								Total	90	338	1,671	9,023	308	2,125	2,069	11,486	1,979	11,148	2/50.0	5,574
								Measured Indicated	90	338	1,671	9,023	308	2,125	2,069	11,486	1,979	11,148	-	5,574
								Total	90	338	1,671	9,023	308	2,125	2,069	11,486	1,979	11,148	2/50.0	5,574
Total	26,160	7,263	16,825	-	2,072	3	2,069	Total	90	338	1,671	9,023	308	2,125	2,069	11,486	1,979	11,148	2/50.0	5,574

TABLE 3. - RESERVES IN PITTSBURGH BED, January 1, 1954

Quadrangle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Area of quadrangle in county, acres	Areas excluded from estimate, $\frac{1}{2}$ acres	Area outside outcrop, acres	Underlain by coal 0" to 14" thick, acres	Coal over 14" thick, in place originally, acres	Mined out, acres	Coal over 14" thick remaining, acres	Measured Indicated	Estimated coal reserves, in tons of 2,000 lb.						Total reserves, in tons of 2,000 lb.				Percentage recoverable, including all mining losses	Estimated recoverable reserves 28" and more thick, thousands of tons
									14" to 28" thick		28" to 42" thick		Over 42" thick		14" and more thick		28" and more thick			
									Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons		
Wheeling	26,160	-	5,774	-	20,386	5,288	15,098	Measured Indicated	-	-	-	-	10,533	92,406	10,533	92,406	10,533	92,406	-	50,823
								Total	-	-	-	-	4,565	39,716	4,565	39,716	4,565	39,716	-	21,844
								Measured Indicated	-	-	-	-	15,098	132,122	15,098	132,122	15,098	132,122	55.0	72,667
								Total	-	-	-	-	4,429	43,123	4,429	43,123	4,429	43,123	-	23,718
Steubenville	32,758	-	18,322	-	14,436	9,622	4,814	Measured Indicated	-	-	-	-	385	3,927	385	3,927	385	3,927	-	2,160
								Total	-	-	-	-	4,814	47,050	4,814	47,050	4,814	47,050	55.0	25,878
								Measured Indicated	-	-	-	-	14,962	135,529	14,962	135,529	14,962	135,529	-	74,541
								Total	-	-	-	-	4,950	43,643	4,950	43,643	4,950	43,643	-	24,004
Total	58,918	-	24,096	-	34,822	14,910	19,912	Total	-	-	-	-	19,912	179,172	19,912	179,172	19,912	179,172	55.0	98,545

$\frac{1}{2}$ No information available from core drilling, mine workings, or coal outcrops on which to base estimates of measured and indicated reserves. These areas may contain additional geologically inferred reserves.

$\frac{2}{2}$ Estimated

TABLE 4. - Recapitulation of reserves, Brooke County, W. Va.,
January 1, 1954

Bed	Thousands of tons		Recoverable ^{1/}	
	In beds 14 inches and more thick	In beds 28 inches and more thick	Percentage	Thousands of tons
Washington	717	-	-	-
Waynesburg	11,486	11,148	2/50.0	5,574
Pittsburgh	179,172	179,172	55.0	98,545
Total	191,375	190,320	54.7	104,119

^{1/} Based on reserves in beds 28 inches and more thick.

^{2/} Estimated.

Tucker^{5/} estimated the original reserves of coal in Brooke County by beds. No areas of reserves are given and neither is the average thickness of each bed or the area mined out in each bed given. Only tonnages for the beds were tabulated as follows:

Bed	Short tons
Pittsburgh	130,000,000
Bakerstown	30,000,000
Mahoning	50,000,000
Lower Freeport	50,000,000
Upper Kittanning	50,000,000
No. 5 Block (Lower Kittanning).	50,000,000
Total	360,000,000

It should be noted that the Tucker estimate does not include reserves for beds above the Pittsburgh. The Bureau estimate gives reserves for the Washington and Waynesburg beds above the Pittsburgh but no reserves for beds below the Pittsburgh. There was not enough information from diamond-drill holes on the lower beds to make estimates for the lower beds. Thus, only a comparison of estimates based on reserves in the Pittsburgh bed can be made.

The Annual Report of the Department of Mines, West Virginia, for 1952 shows that the total quantity of coal mined in Brooke County to January 1953 is 69,813,208 tons. It is estimated that 1,500,000 tons was mined in 1953, making a total of 71,313,208 tons mined to January 1954. Except for a very insignificant amount, this entire production was from the Pittsburgh bed. A comparison of the Bureau of Mines estimate with the Tucker estimate brought up to January 1954 by deducting the production and mining losses to 1954 from the original reserves is given in table 5.

^{5/} Headlee, A. J., and Nolting, J. P., Jr., Characteristics of Minable Coals of West Virginia: West Virginia Geol. Survey, vol. 13, 1940, p. 244.

TABLE 5. - Comparison of Pittsburgh-bed reserve estimates,
Brooke County, W. Va.

		Tucker	Bureau of Mines
Original reserve estimate	tons	130,000,000	<u>1/</u> 307,203,000
Mined to January 1, 1954	do.	71,313,208	71,313,208
Recovery by mining	percent	-	54.7
Mining losses	do.	-	45.3
Mining losses to January 1954	tons	56,717,686	56,717,686
Production plus mining losses to January 1954	do.	128,030,894	128,030,894
Remaining reserves, January 1954 ..	do.	1,969,000	179,173,000

1/ Recorded production plus mining losses to January 1954, added to estimated remaining reserve.

COAL BEDS

The coal beds occurring in Brooke County in which known recoverable reserves have been estimated for this report are, in descending order:

Washington
Waynesburg
Pittsburgh

The Washington bed is in the Dunkard series, and the Waynesburg and Pittsburgh beds are in the Monongahela series, Pennsylvanian period.6/

The Pittsburgh bed is the important bed in the county. Nearly the entire production to date from Brooke County has come from this bed and it also has the largest known reserve of any bed in the county. Coal beds other than those for which estimates have been prepared, occur in the county but enough data were not available to estimate the reserves.

Maps have been prepared for the Washington, Waynesburg, and Pittsburgh beds. (See figs. 2, 3, and 4.)

The characteristics of the mapped coal beds are shown by bed sections taken from diamond-drill logs, mine maps, and outcrop data furnished by owners, lessees of the coal, and published reports of the West Virginia Geological Survey. All of the bed sections given are within the areas of recoverable reserves 28 inches and more thick (black areas on the maps). They have been selected to show bed characteristics throughout the areas and to indicate the irregularity of the beds.

Descriptions of the coal beds that have been mapped and the selected bed sections follow:

Washington Bed

(See fig. 2 and table 1)

The Washington bed is a very impure and thin bed in the southern part of the county. None of the coal was found to be as much as 28 inches thick and, therefore, no bed sections are given.

6/ See work cited in footnote 5, pp. 3-14.

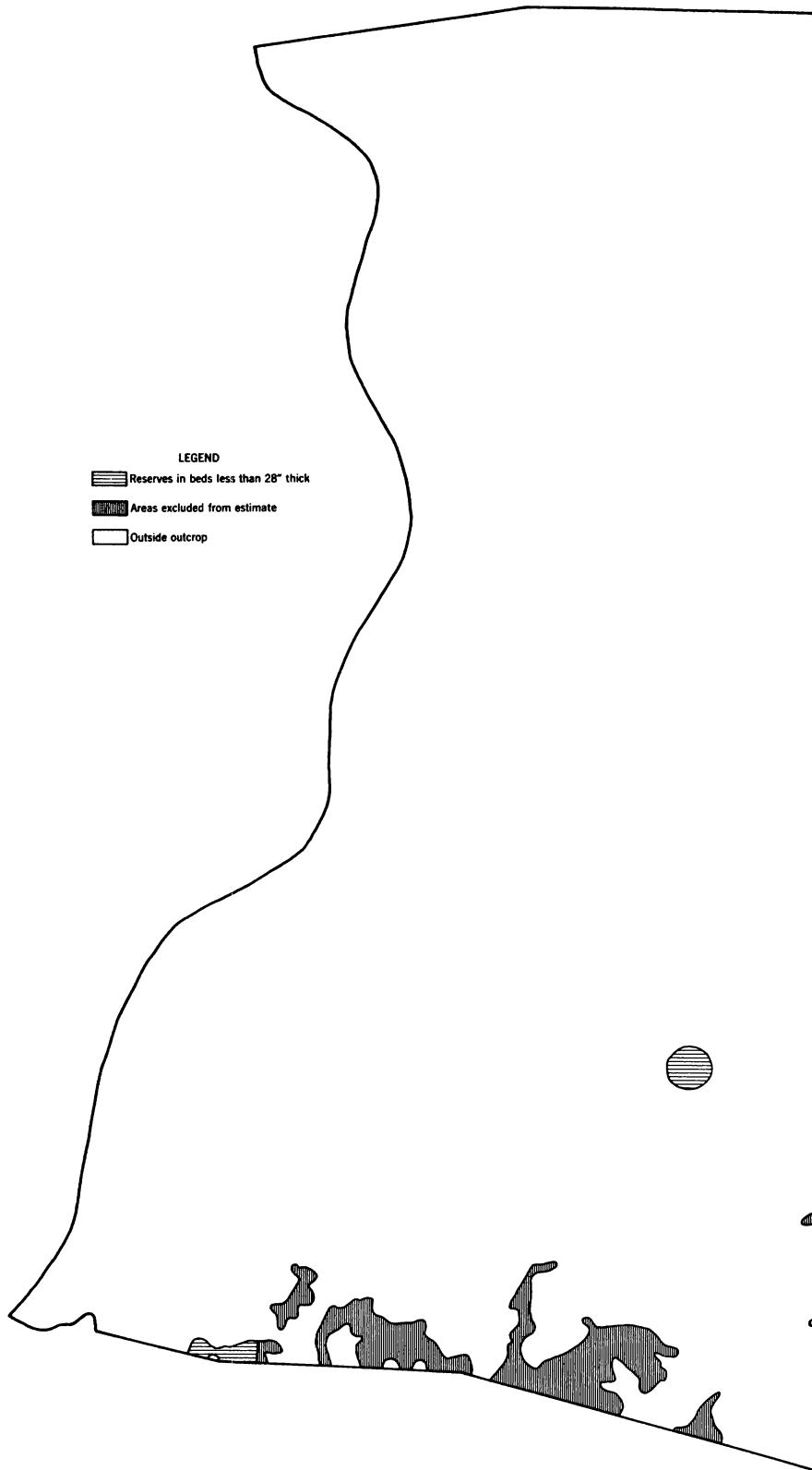


Figure 2. - Washington bed, Brooke County, W. Va., January 1, 1954

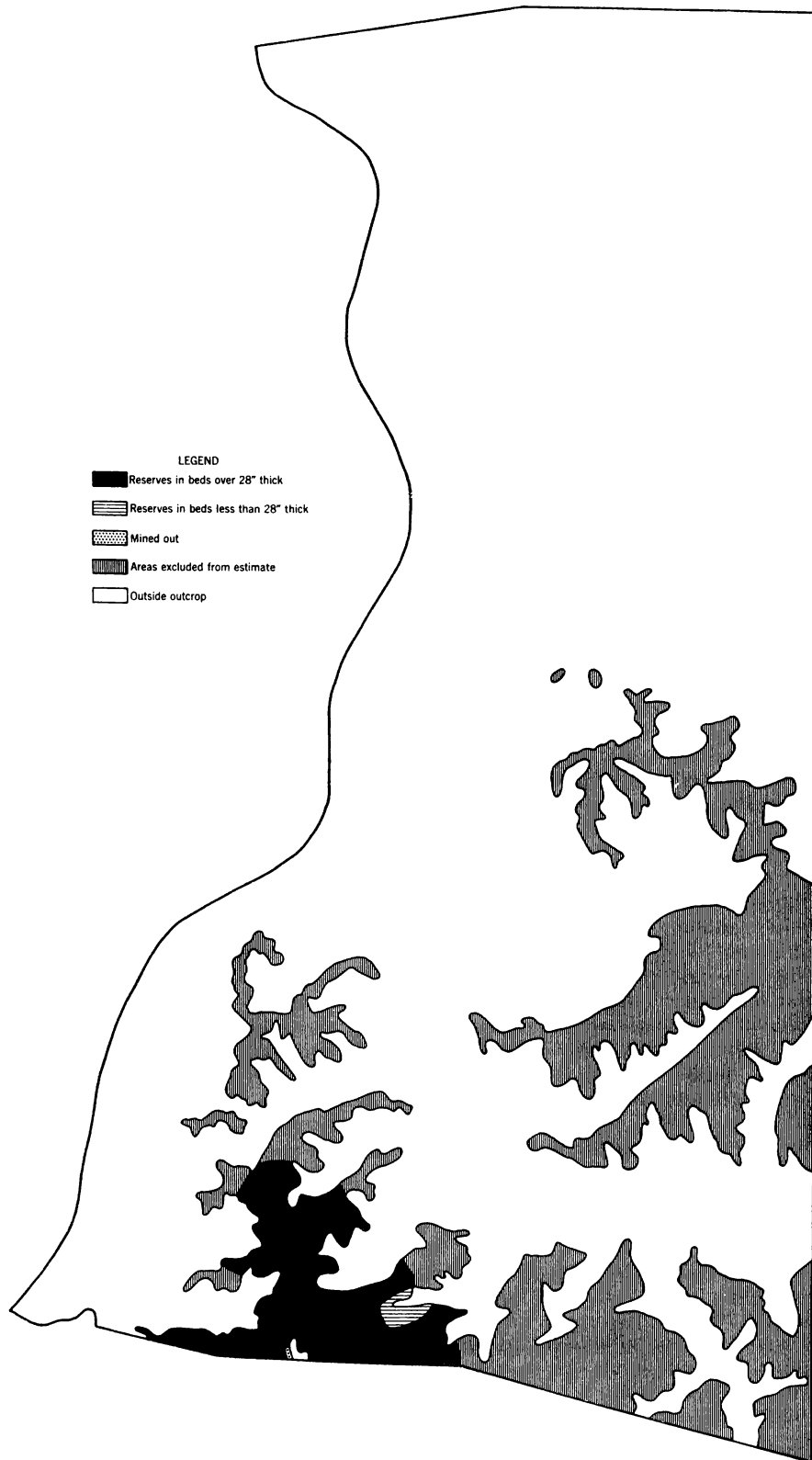


Figure 3. - Waynesburg bed, Brooke County, W. Va., January 1, 1954



Figure 4. - Pittsburgh bed, Brooke County, W. Va., January 1, 1954

Waynesburg Bed

(See fig. 3 and table 2)

The Waynesburg bed occurs usually as a multiple bed and, in this county is dirty. No commercial mines are being operated in the bed because of the poor quality of the coal as compared with the Pittsburgh bed. Sections of the bed in areas of recoverable reserves follow:

Southern Part of County

<u>Material</u>	<u>Inches</u>	<u>Material</u>	<u>Inches</u>
COAL	22	COAL	22
Shale	1	Shale	1/2
COAL	3	COAL	9
Shale	1	Shale	5-1/2
COAL	1	COAL	7
Shale	1/4	Thickness	<u>44</u>
COAL	8-1/2	COAL	32
Shale	1/4	Parting	4
COAL	4	COAL	8
Shale	1	Thickness	<u>44</u>
COAL	6		
Thickness	<u>48</u>		
COAL	22	COAL	<u>36</u>
Parting	1/2	Thickness	<u>36</u>
COAL	9		
Thickness	<u>31-1/2</u>		

Pittsburgh Bed

(See fig. 4 and table 3)

This bed is by far the most important bed in the county and has been the source of virtually all coal produced in Brooke County. Most of the coal now being mined in the county is used for power plant steam coal. Sections of the bed in areas of recoverable reserves follow:

Northern Part of County

<u>Material</u>	<u>Inches</u>	<u>Material</u>	<u>Inches</u>
COAL	30-1/2	COAL	30-1/4
Parting	1/2	Parting	1/2
COAL	4-1/2	COAL	7
Parting	1	Parting	1/2
COAL	12-1/2	COAL	11
Parting	1/2	Thickness	<u>49-1/4</u>
COAL	6-1/2		
Thickness	<u>56</u>		

<u>Material</u>	<u>Inches</u>	<u>Material</u>	<u>Inches</u>
COAL	6	COAL	41
Parting	2	Parting	1/2
COAL	33	COAL	3
Parting	1	Parting	1/2
COAL	<u>19</u>	COAL	<u>14</u>
Thickness	61	Thickness	59

Southern Part of County

<u>Material</u>	<u>Inches</u>	<u>Material</u>	<u>Inches</u>
COAL	5	COAL	8
Parting	2	Parting	1
COAL	17	COAL	12
Parting	4	Parting	4
COAL	12	COAL	14
Parting	4	Parting	4
COAL	<u>22</u>	COAL	<u>24</u>
Thickness	66	Thickness	67
COAL	54-1/2	COAL	32
Parting ^{1/}	<u>10-1/2</u>	Bony coal	2
Thickness	65	COAL	10
COAL	52	Bony coal	8
Shale ^{1/}	<u>28</u>	COAL	<u>22</u>
Thickness	80	Thickness	74

^{1/} Number and positions of partings in bed not known.

ANALYSES OF BROOKE COUNTY COALS

The chemical analyses in table 6 are for samples from the Pittsburgh bed. They are listed alphabetically according to the nearest town to the mine and represent mine and run-of-mine tipple samples. The coal, classified according to rank, belongs in the high-volatile A bituminous group. These analyses have been published.^{7/}

TABLE 6. - Analyses of Brooke County coals

Location	Bed	Rank	Kind of sample ^{1/}	As-	Dry basis				
				received	Moist.	Vol.	F.C.	Ash	Sul.
1	2	3	4	5	6	7	8	9	10
Beech Bottom ...	Pittsburgh	Hvab	T	4.2	38.4	50.4	11.2	3.2	13,170
Colliers	do.	do.	M	4.4	39.1	52.4	8.5	2.7	13,540
Wellsburg	do.	do.	T	4.1	39.1	49.5	11.4	4.6	13,090
Do.	do.	do.	T	4.2	39.2	52.5	8.3	2.8	13,580
Windsor Heights	do.	do.	M	4.2	38.2	51.9	9.9	2.9	13,380

^{1/} T = tipple sample; M = mine sample.

^{7/} Price, P. H., Heck, E. T., Toenges, A. L., Anderson, R. L., Snyder, N. H., Cooper, H. M., Abernethy, R. F., Tarpley, E. C., and Swingle, R. J., Analyses of West Virginia Coals: Bureau of Mines Tech. Paper 626, 1942, 341 pp.

COKING PROPERTIES OF PANHANDLE DISTRICT COALS
(Hancock, Brooke, Ohio, and Marshall Counties)

Coals from the Panhandle District of West Virginia generally are too high in sulfur to be acceptable at present for the manufacture of metallurgical coke. The Pittsburgh bed, which contains a major part of the reserves in this part of the State, contains increasingly higher percentages of sulfur as the bed extends westward from the Monongahela river, reaching as high as 4 percent in the vicinity of Wheeling.^{8/} The excellence of this bed in the Connellsville District of Pennsylvania and the Fairmont District of West Virginia does not characterize it in the Panhandle, even though its ash content may be readily lowered by modern methods of preparation. In this region, most of the bed contains more than 2.27 percent sulfur and preparation studies have shown that Pittsburgh coal so high in sulfur should not now be considered for the production of metallurgical coke.^{9/}

^{8/} McGraw-Hill Publishing Company, Keystone Coal Buyers Manual: New York, N. Y., 1952, 738 pp.; see p. 391.

^{9/} Fraser, Thomas, Crentz, W. L., and Bailey, A. L., High-Sulfur Pittsburgh Coal: Upgrading in Southwestern Pennsylvania and Northern West Virginia: Bureau of Mines Bull. 483, 1950, 70 pp.

APPENDIX

Completed reports giving results of studies by counties under part (1) of the investigation follow:

DOWD, J. J., TURNBULL, L. A., TOENGES, A. L., COOPER, H. M., ABERNETHY, R. F., REYNOLDS, D. A., and FRASER, THOMAS. Estimate of Known Recoverable Reserves of Coking Coal in Cambria County, Pa. Bureau of Mines Rept. of Investigations 4734, 1950, 25 pp.

DOWD, J. J., TURNBULL, L. A., TOENGES, A. L., COOPER, H. M., ABERNETHY, R. F., REYNOLDS, D. A., and CRENTZ, W. L. Estimate of Known Recoverable Reserves of Coking Coal in Indiana County, Pa. Bureau of Mines Rept. of Investigations 4757, 1950, 22 pp.

DOWD, J. J., TURNBULL, L. A., TOENGES, A. L., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Pike County, Ky. Bureau of Mines Rept. of Investigations 4792, 1951, 34 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Armstrong County, Pa. Bureau of Mines Rept. of Investigations 4801, 1951, 20 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Westmoreland County, Pa. Bureau of Mines Rept. of Investigations 4803, 1951, 16 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Fayette County, Pa. Bureau of Mines Rept. of Investigations 4807, 1951, 19 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Floyd County, Ky. Bureau of Mines Rept. of Investigations 4813, 16 pp.

DOWD, J. J., TOENGES, A. L., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Jefferson County, Pa. Bureau of Mines Rept. of Investigations 4840, 1952, 18 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Raleigh County, W. Va. Bureau of Mines Rept. of Investigations 4893, 1952, 37 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Knott County, Ky. Bureau of Mines Rept. of Investigations 4897, 1952, 20 pp.

WALLACE, J. J., DOWD, J. J., TAVENNER, W. H., PROVOST, J. M., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in McDowell County, W. Va. Bureau of Mines Rept. of Investigations 4924, 1952, 26 pp.

WALLACE, J. J., DOWD, J. J., TAVENNER, W. H., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Wyoming County, W. Va. Bureau of Mines Rept. of Investigations 4966, 1953, 39 pp.

WALLACE, J. J., DOWD, J. J., WILLIAMS, LLOYD, ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Allegany County, Md. Bureau of Mines Rept. of Investigations 4970, 1953, 18 pp.

- WALLACE, J. J., DOWD, J. J., BOWSER, J. A., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Somerset County, Pa. Bureau of Mines Rept. of Investigations 4998, 1953, 20 pp.
- WALLACE, J. J., DOWD, J. J., TRAVIS, R. G., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Letcher County, Ky. Bureau of Mines Rept. of Investigations 5016, 1953, 26 pp.
- WALLACE, J. J., DOWD, J. J., PROVOST, J. M., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Allegheny County, Pa. Bureau of Mines Rept. of Investigations 5003, 1953, 16 pp.
- WILLIAMS, LLOYD, LOWE, ROBERT, TURNBULL, L. A., CARMAN, E. P., CRENTZ, W. L., REYNOLDS, D. A., and ABERNETHY, R. F. Estimate of Known Recoverable Reserves and the Preparation and Carbonizing Properties of Coking Coal in Putnam County, Tenn. Bureau of Mines Rept. of Investigations 5029, 1954, 21 pp.
- WALLACE, J. J., DOWD, J. J., TRAVIS, R. G., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Harlan County, Ky. Bureau of Mines Rept. of Investigations 5037, 1954, 26 pp.
- WALLACE, J. J., DOWD, J. J., TAVENNER, W. H., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Mingo County, W. Va. Bureau of Mines Rept. of Investigations 5068, 1954, 57 pp.
- WALLACE, J. J., DOWD, J. J., TAVENNER, W. H., PROVOST, J. M., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Mercer County, W. Va. Bureau of Mines Rept. of Investigations 5077, 1954, 20 pp.
- WALLACE, J. J., DOWD, J. J., TRAVIS, R. G., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Perry County, Ky. Bureau of Mines Rept. of Investigations 5083, 1954, 26 pp.
- WILLIAMS, LLOYD, CURTIS, JAMES, GANDRUD, B. W., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves and the Preparation and Carbonizing Properties of Coking Coal in Anderson County, Tenn. Bureau of Mines Rept. of Investigations. (In preparation.)
- WILLIAMS, LLOYD, HERSHEY, R. E., ABERNETHY, R. F., and GANDRUD, B. W. Estimate of Known Recoverable Reserves and the Preparation and Carbonizing Properties of Coking Coal in Marion County, Tenn. Bureau of Mines Rept. of Investigations. (In press.)
- HERSHEY, R. E., WILLIAMS, LLOYD, ABERNETHY, R. F., and GANDRUD, B. W. Estimate of Known Recoverable Reserves and the Preparation and Carbonizing Properties of Coking Coal in Grundy County, Tenn. Bureau of Mines Rept. of Investigations 5148. (In press.)
- WILLIAMS, LLOYD, HERSHEY, R. E., ABERNETHY, R. F., GANDRUD, B. W., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves and the Preparation and Carbonizing Properties of Coking Coal in Sequatchie County, Tenn. Bureau of Mines Rept. of Investigations 5136, 1955, 28 pp.

- WALLACE, J. J., DOWD, J. J., PROVOST, J. M., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Washington County, Pa. Bureau of Mines Rept. of Investigations 5109, 1955, 23 pp.
- WALLACE, J. J., DOWD, J. J., PROVOST, J. M., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Greene County, Pa. Bureau of Mines Rept. of Investigations 5143. (In press.)
- WILLIAMS, LLOYD, HERSHEY, R. E., ABERNETHY, R. F., GANDRUD, B. W., REYNOLDS, D. A., and WOLFSON, D. E. Estimate of Known Recoverable Reserves and the Preparation and Carbonizing Properties of Coking Coal in Overton County, Tenn. Bureau of Mines Rept. of Investigations 5131, 1955, 27 pp.
- BLAYLOCK, D. W., DOWD, J. J., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Clearfield County, Pa. Bureau of Mines Rept. of Investigations. (In preparation.)

