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ESTIMATE OF KNOWN RECOVERABLE RESERVES AND PREPARATION CHARACTERISTICS OF COKING COAL IN FENTRESS COUNTY, TENN.

BY R. W. LOWE, W. L. CRENTZ, AND J. W. MILLER

United States Department of the Interior — June 1956

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* * * * * * * * * **Report of Investigations 5235**

UNITED STATES DEPARTMENT OF THE INTERIOR
Fred A. Seaton, Secretary
BUREAU OF MINES
Thos. H. Miller, Acting Director

Work on manuscript completed September 1955. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Report of Investigations 5235."

June 1956

FOREWORD

Since its creation by the 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 and preparation characteristics determined under the first and second phases of the investigation.

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 may indicate the presence of large reserves of inferred coal in 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 three-eighths inch or more thick, recovered from the mined-out areas in each bed. Thus, it is an over-all 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.

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 AND PREPARATION CHARACTERISTICS OF COKING COAL IN FENTRESS COUNTY, TENN.

by

R. W. Lowe,[1/] W. L. Crentz,[2/] and J. W. Miller[3/]

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Reserves

1. Reserves are estimated in the Nemo, Sewanee, Wilder, and White Oak beds of Fentress County, Tenn. The Wilder is the only bed being mined commercially and contains the largest known reserves. Eleven lesser known beds are present in the county, but not enough information on them was available for estimating the reserves.

2. Known measured and indicated reserves, based on a minimum bed thickness of 14 inches and on 1,800 tons per acre-foot of coal in place, are estimated at 102 million tons as of January 1, 1955. This total includes 66 million tons in beds 28 inches and more thick.

3. Recoverable reserves of coal are estimated in beds 28 inches and more thick, about the minimum now being mined by hand loading onto conveyors in the Appalachian region. The estimated recovery for all beds in Fentress County is 62.8 percent. Based on this recovery, the recoverable reserves as of January 1, 1955, are estimated at 41 million tons.

4. This estimate does not fully assess the reserves of Fentress County. Many areas in all beds could not be evaluated because of lack of information. At present, reserves in these areas only can be inferred, which eliminates them from this study.

Analyses

Six channel samples were taken for preparation studies in this investigation. Binders and partings in the mined section of the bed usually were included for washability studies.

Three samples were taken of the Wilder bed, and one each of the Nemo, Sewanee, and White Oak beds.

The samples are high in ash and sulfur but low in moisture, except the Sewanee (Lantana), which has 10.9 percent moisture. The White Oak (Zenith) shows much higher ash than the other samples, but this is because of the inclusion of a parting 4 inches thick in the sample.

Preparation

Mechanical cleaning of coal is not practiced in Fentress County. Coal is handpicked at the mine to prepare a marketable product for domestic and general industrial use.

Float-and-sink tests of the one sample collected in the Nemo bed showed that this deposit is not adaptable to the preparation of a low-sulfur washed coal.

Crushing the coal to 1-1/2-inch top size and then washing will yield a clean coal containing about 10 percent ash and 1.4 percent sulfur. To achieve further substantial reduction in impurities would require a precise separation at a specific gravity considerably below the range used in commercial practice and separate disposal of a large amount of middling material. Crushing to flotation size and then washing might yield a coal that would be chemically satisfactory for metallurgical use. This procedure would entail the separate disposal of large quantities of very fine high-ash and high-sulfur dust that is produced during crushing.

A sample of the Sewanee bed could be obtained only at one place in Fentress County. Float-and-sink tests indicate that the Sewanee bed at this location could be upgraded to yield a clean coal containing about 7 percent ash and 1.4 percent sulfur. These data show that preparation of a clean coal containing 1.25 percent sulfur would be impossible in commercial practices but that a washed product containing about 1.4 percent sulfur could be achieved without undue difficulty. Examination of the float-and-sink data on the Sewanee-bed samples shows an anomaly. Within the gravity range tested all specific-gravity fractions lighter than 1.60 contain increasing amounts of sulfur. This condition eliminates the possibility of separating the coal at a lighter specific gravity than 1.60 to achieve further reduction in sulfur content.

Tests of the three samples of Wilder bed coal show that, although some reduction in ash and sulfur content can be achieved by mechanical cleaning, the washed product would not be chemically suitable for metallurgical use by present standards.

Crushing the coal to flotation size and then washing will not achieve the required sulfur reduction that would permit the clean coal to be considered a potential source of metallurgical coal. In commercial practice it would be virtually impossible to prepare a washed coal containing less than 2 percent sulfur, and at many cleaning plants, the sulfur in the washed product would exceed 3 percent. The high percentage of nonremovable sulfur in the clean coal would eliminate the possibility of preparing satisfactory metallurgical coal from the Wilder bed in Fentress County.

Similar to the Nemo and Sewanee beds, the White Oak bed is virtually unexploited in Fentress County. Only one opening was found in this bed from which a sample could be collected. Examination of the float-and-sink data on the White Oak bed sample shows that the sulfur is distributed rather uniformly throughout the range of gravities used in the float-and-sink test. This condition is not conducive to mechanical cleaning as a means of sulfur reduction.

Even separating the sample at a specific gravity that would be economically unfeasible will not yield a washed product chemically suitable for metallurgical use. Fine crushing and then washing will release some sulfur from the coarser sizes, but the amount released is not enough to permit preparing a low-sulfur clean coal, even after the raw material is crushed to flotation size.

The float-and-sink data on the samples from the Nemo, Sewanee, Wilder, and White Oak beds show that, although clean coals of varying quality can be obtained from these beds, no sample tested was entirely satisfactory from a chemical standpoint for metallurgical usage. The Sewanee and Nemo beds probably could be upgraded to yield a clean coal containing about 1.4 percent sulfur, and they might be considered as chemically suitable for metallurgical use under certain conditions.

INTRODUCTION

The investigation to evaluate the reserves of coking coal is being made by the Bureau of Mines in three parts: (1) To estimate known measured and indicated recoverable reserves of coking coal; (2) to study upgrading of marginal coals through effective preparation; and (3) to study the carbonizing properties of individual coals and coal blends not now widely used for metallurgical cokemaking. The third phase is not covered in this report.

This is the 37th in a series of reports giving the results by counties, of known minable reserves of coking coal. (See Appendix.) This report covers Fentress County, Tenn., one of the northwestern counties of the Tennessee coal field.

The county comprises parts of the following 15-minute quadrangles: Byrdstown, Pall Mall, Barthell, Wilder, Allardt, Helenwood, Maryland, and Deer Lodge. (See fig. 1.)

Topographic mapping in the county still is in progress, and 7-1/2-minute quadrangles are not available to cover the area completely. Except for Byrdstown, no 15-minute quadrangle map is available as such. Most of the county was covered by two 30-minute-quadrangle maps, Standingstone and Wartburg. Pall Mall and Barthell were unmapped in Tennessee until recently. The TVA has mapped the Mayland and Deer Lodge 15-minute areas in 7-1/2-minute quadrants. Each 15-minute area was given a name and number for reference. The Federal Geological Survey is completing the county in 7-1/2-minute quadrangle maps,[4] but it was necessary to rely on aerial photographs in Wilder, Pall Mall, and Barthell quadrangles during most of the field work period. Corresponding TVA numbers and 7-1/2-minute and 30-minute quadrangle names follow:

15-minute area		7-1/2-minute	30-minute
No.	Name	quadrangle names	quadrangle areas
-	Byrdstown	SE. Quarter	-
-	Pall Mall	Pall Mall	-
		Pickett Lake	-
-	Barthell	Elva	-
-	Wilder	NE. Quarter	Standingstone.
		SE. Quarter	Do.
		SW. Quarter	Do.
-	Allardt	Jamestown	Wartburg.
		Stockton	Do.
		Burrville	Do.
		Grimsley	Do.
-	Helenwood	Honey Creek	Do.
		Rugby	Do.
108	Mayland	Clarkrange	Standingstone.
116	Deer Lodge	Jones Knob	Wartburg.

Data on the coal beds of this county were obtained by reconnaissance and from land owners, mine operators, State agencies, and other authentic sources.

ACKNOWLEDGMENTS

The information contained in this report could not have been obtained without the wholehearted cooperation of the officials of companies and individual landowners, whose property records were studied, and their cooperation and courtesy are

4/ Federal Geological Survey, Index to Topographic Mapping in Tennessee.

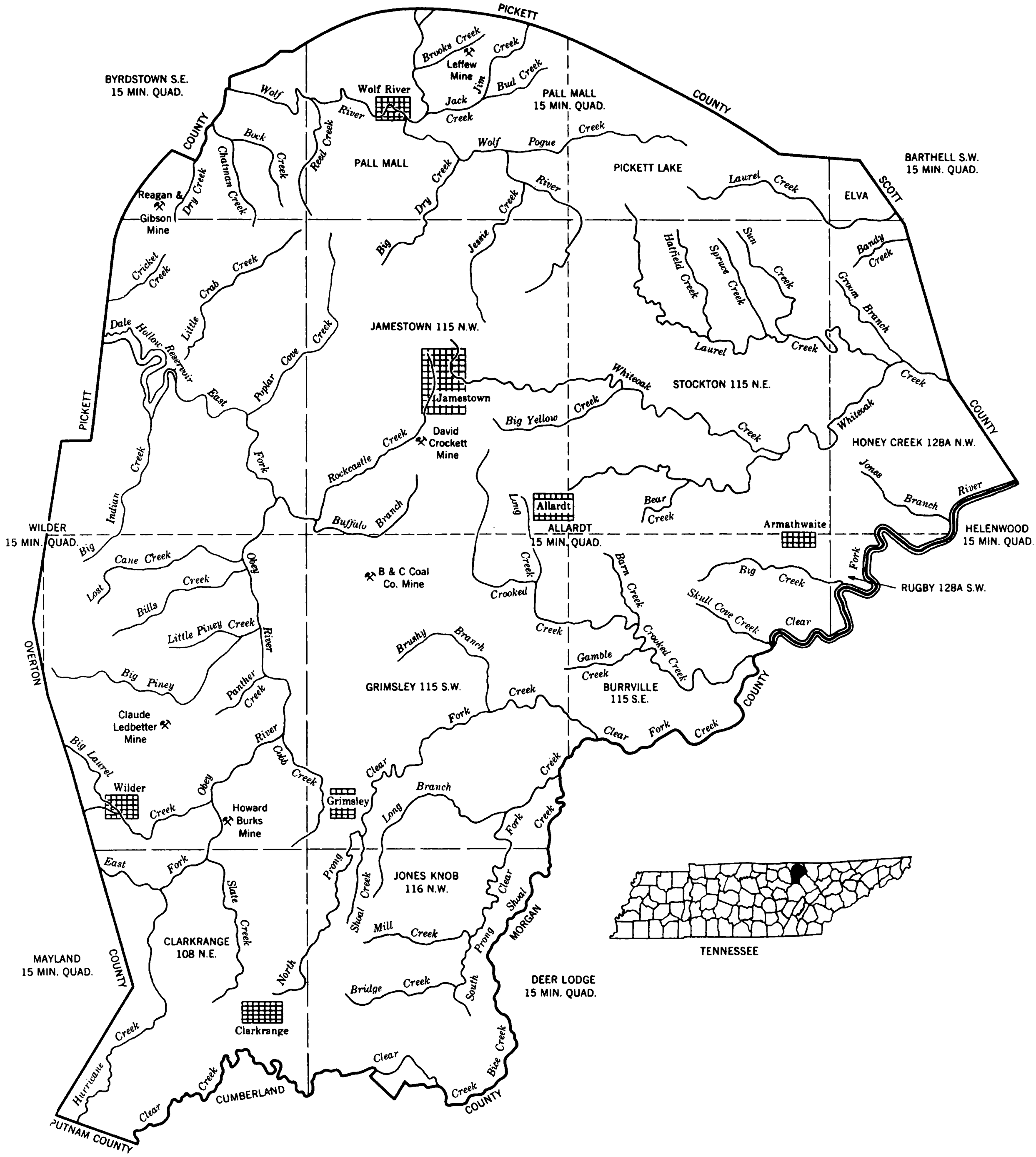

Figure 1. - Key map of Fentress County, Tenn.

gratefully acknowledged. The advice and assistance of the Coal Resources Committee of both the National Bituminous Coal Advisory Council and the American Institute of Mining and Metallurgical Engineers, and members of the staffs of the Tennessee Division of Mines and the Tennessee Division of Geology are appreciated. The assistance and cooperation of State geologist William D. Hardeman and of C. W. Wilson, Jr., of Vanderbilt University Department of Geology are sincerely appreciated.

The Tennessee Valley Authority, through R. A. Kampmeier, Assistant Manager of Power, and E. P. Ericson, Chief, Fuels Branch, has made a major contribution to the investigation, and the cooperation and assistance are gratefully acknowledged.

PART I. - ESTIMATE OF KNOWN RECOVERABLE RESERVES

by

R. W. Lowe

Premises and Definitions of Terms Used

An 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 Federal 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 carbonization tests in part 3 of the study are made 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 15-minute topographic quadrangle. All unit-area estimates within the county are combined to give the county total estimates.

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 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 one-half mile apart. The outer limit of a block of measured coal, therefore, shall be about one-fourth 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 one-half mile in from the outcrop shall be used to mark the limit under cover of a block of coal that can also 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.

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 correspond approximately to areas of inferred reserves and frequently contain significant quantities of coal.

Overburden. - This includes all of the material that overlies the coal bed. All known reserves in Fentress County are under less than 650 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 in computing volume of reserves. A weighted average thickness, in each thickness category, is computed to be used for limited areas, not to exceed a 7-1/2-minute quadrangle.

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 usually is computed for each bed in each 15-minute 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 Tennessee Division 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, 1955, 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 15-minute 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 other beds of 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, and 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 by hand loading onto conveyors. Certain areas in some of the beds in this county may not be considered economically minable at present because of conditions considered adverse today.

Methods Used to Compute Reserves

A base map for each coal bed for each 15-minute quadrangle was prepared to the scale 1 inch equals 2,000 feet. This scale was adopted as it is the scale of both the TVA and the Federal Geological Survey 7-1/2-minute quadrangles that are the latest topographic maps available.

Mine workings, locations of drill holes, outcrops and thicknesses of beds, and total clean-coal thicknesses were plotted on the base maps. Isopach lines then 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 category, mined-out areas, areas excluded from the estimate but which may contain reserves based on geologic inference, and areas outside the outcrop were measured by planimeter on the base maps. These areas were adjusted to conform with the theoretical area based on Federal Coast and Geodetic Survey data for each quadrangle. Estimates of total reserves 14 inches and more thick for individual beds were prepared from these data. A map was prepared for each bed from the work maps in which the areas of known coal up to 14 inches thick and 14 to 28 inches thick were combined and shown as reserves in beds less than 28 inches thick. Areas of known coal 28 to 42 inches thick and over 42 inches thick were combined and shown as reserves in beds over 28 inches thick.

Because of the irregularity of the coal beds caused by abrupt changes in thickness, the distance from the last known point of measurement for measured coal usually did not exceed 500 feet and for indicated coal not more than 1,000 feet.

Description of Coal Measures

About 77 percent of Fentress County is underlain with coal measures that have a maximum thickness of about 700 feet on the southeast side and 225 feet on the northwest side of the county. Almost all of the measures are of the Lee group. The overlying Briceville formation is thin where it occurs in the eastern part of the county. The Christmas coal of this formation was found near the northeast corner of the Stockton quadrangle.

The revised stratigraphic column shown in figure 2 of this report was furnished by the Tennessee Division of Geology. If differs from those in some of the previous reports of this series, particularly Putnam and Overton counties. (See Appendix.) The differences involve the positions of the Sewanee and Warren Point sandstones, the positions of the Sewanee and Lantana coal beds, and the nomenclature of the Lower Wilder (Richland) coal bed. The correlations shown in the stratigraphic column of this report on reserves in Fentress County are the results of more recent geologic work of the Tennessee Division of Geology and therefore supersede the correlations given in previous reports of this series. These changes do not affect the reserve estimates of the reports in any way. Also, before the Tennessee Division of Geology adopted the names for the coal beds as used in this report, the Sewanee and White Oak beds were called the Lantana and Zenith, respectively.

Figure 2 shows 15 coal horizons, but only 4 or 5 beds have promise for commercial development, even on a limited scale. Reserve estimates were made for the Nemo, Sewanee, Wilder, and White Oak beds.

Nemo Bed

(See fig. 3 and table 1)

The Nemo coal occurs in a thin shale interval in the Rockcastle sandstone. This coal is found widely in the county but is not a continuous bed. It is dull, laminated, and friable. The bed section measured at the David Crockett mine was 26 inches of laminated coal. Sections of the bed in areas of recoverable reserves follow:

Central Part of County

Material	Inches
COAL	12
Parting	2
COAL	20
Thickness	34

Northern Part of County

Material	Inches
COAL	29
Thickness	29

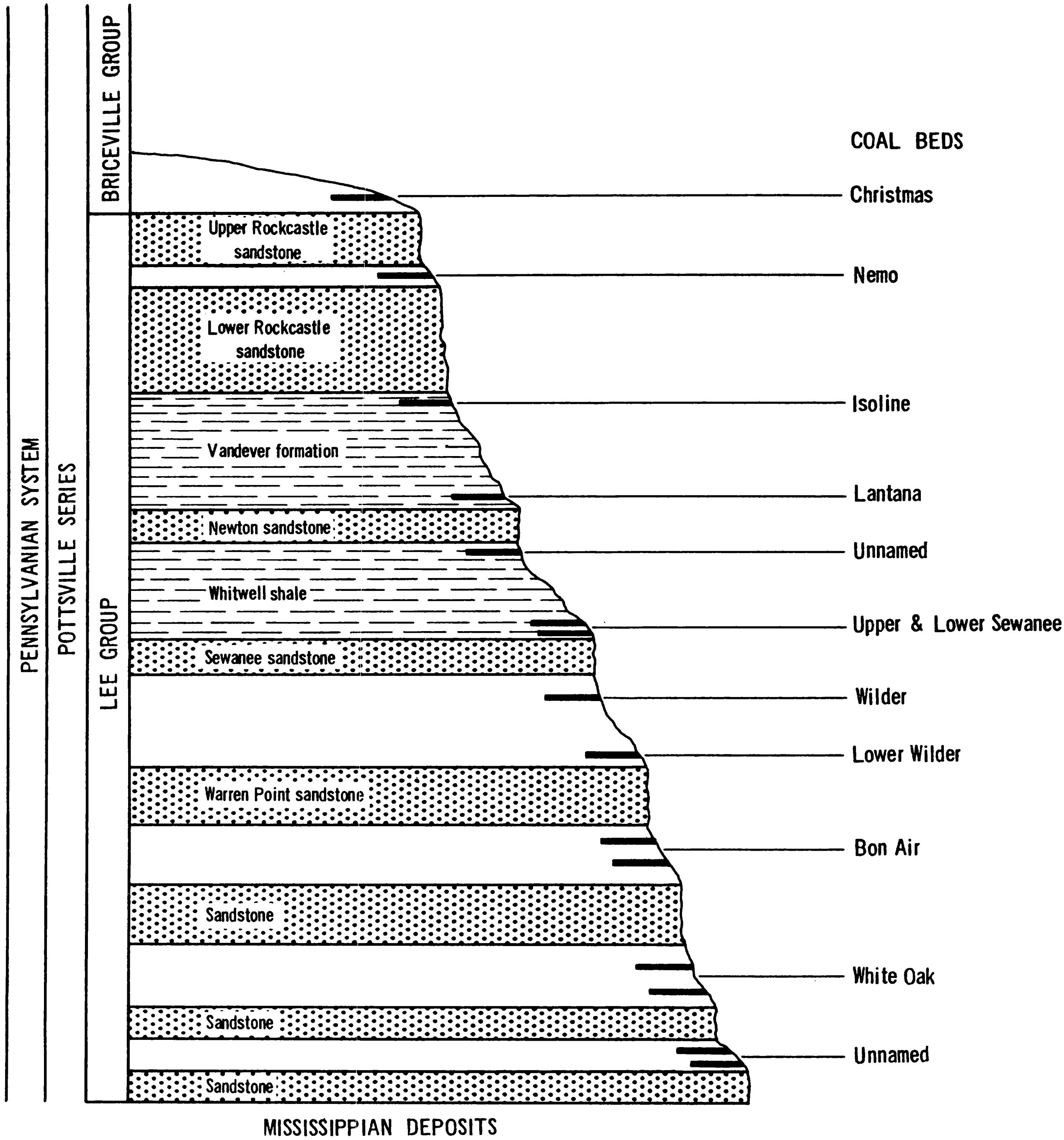

Figure 2. - Composite section of coal measures of Fentress County, Tenn.
(After Tennessee Division of Geology)

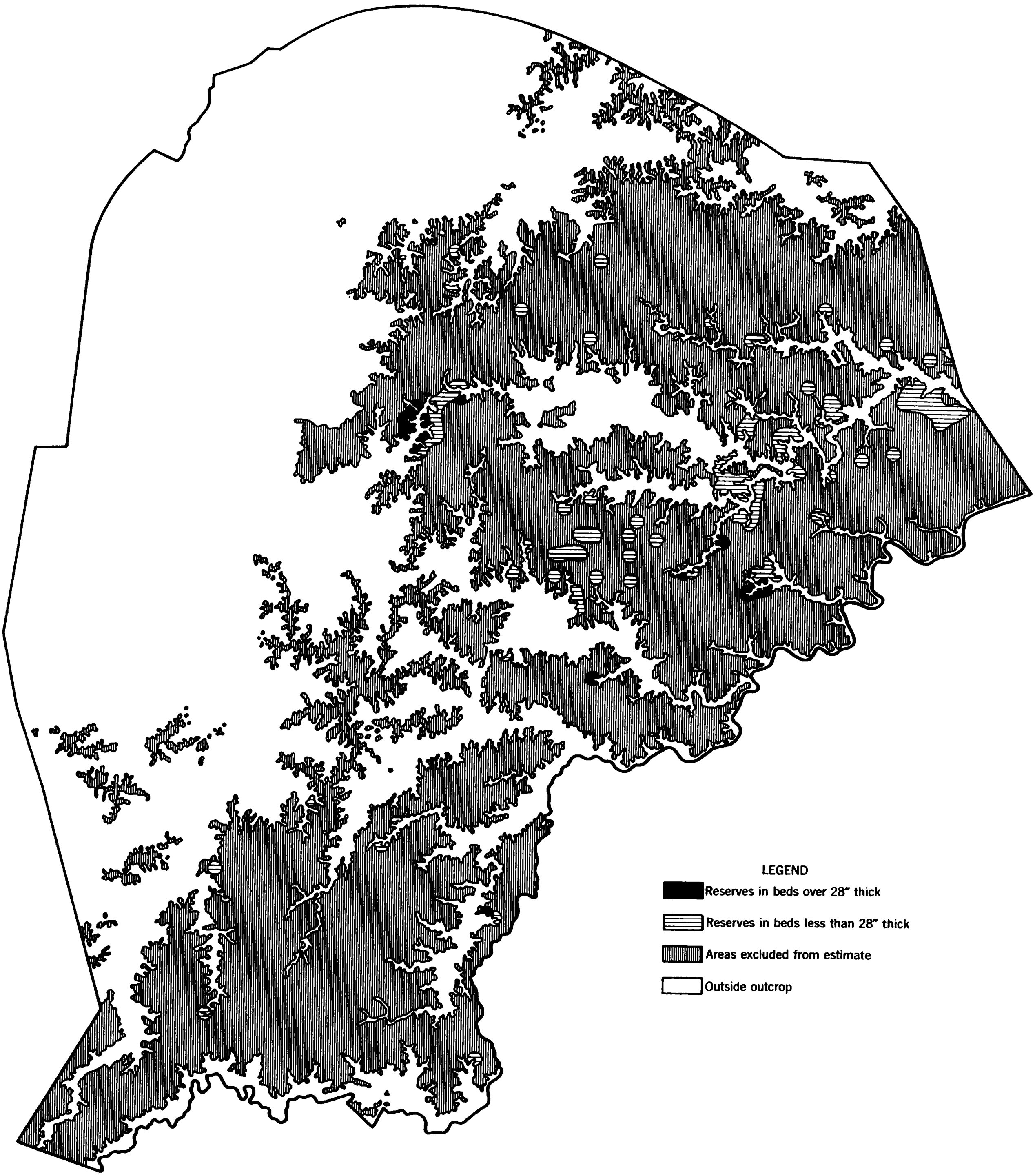

Figure 3. - Nemo bed, Fentress County, Tenn., January 1, 1955.

Sewanee Bed

(See fig. 4 and table 2)

The Sewanee coal also is discontinuous and is not identified easily. It appears to be about 20 to 40 feet above the Wilder horizon, and 40 to 60 feet below an unnamed bed. The best development is in the western part of the county, where sometimes the Sewanee is mistaken for the Wilder bed. The two Sewanee coals seem to be represented by a single bed throughout most of the county. A bed prospected on Crooked Creek and also on White Oak Creek of the South Fork of the Cumberland, is believed to be the unnamed bed of the stratigraphic column above the Sewanee. The sample of Sewanee coal taken at the Howard Burks mine was only 24-1/2 inches thick. This bed section and one in the area of recoverable reserves follow:

Western Part of County

Material	Inches
COAL	2-1/4
Sulfur	1
COAL	21-1/4
Thickness	24-1/2

Material	Inches
COAL	40
Thickness	40

Wilder Bed

(See fig. 5 and table 3)

The Wilder is the most persistent coal bed in the county. All commercial production of the county now comes from this bed. Coal of minable thickness occurs in areas of variable extent, and because the bed is irregular in thickness thorough prospecting should be done before development is undertaken.

The bed may be absent in much of the southern part of the county due to early erosion, but it is present in the vicinity of Rockcastle Creek, Buffalo Branch, and farther east. Northeast of Jamestown the bed is thin, but at the west end of the long ridge between East Fork of Obey and Wolf Rivers there is a remnant of a well-developed basin.

Sections taken at the Regan and Gibson, the B and C, and the Claude Ledbetter mines were 43-1/4, 47-1/2, and 47-1/4 inches thick, respectively. These sections and others in areas of recoverable reserves follow:

Northern Part of County

Material	Inches
COAL	14-3/4
Sulfur band	3/4
COAL	20-1/4
Sulfur	1-1/2
Coal with pyrite	4
Sulfur band	2
Thickness	43-1/4

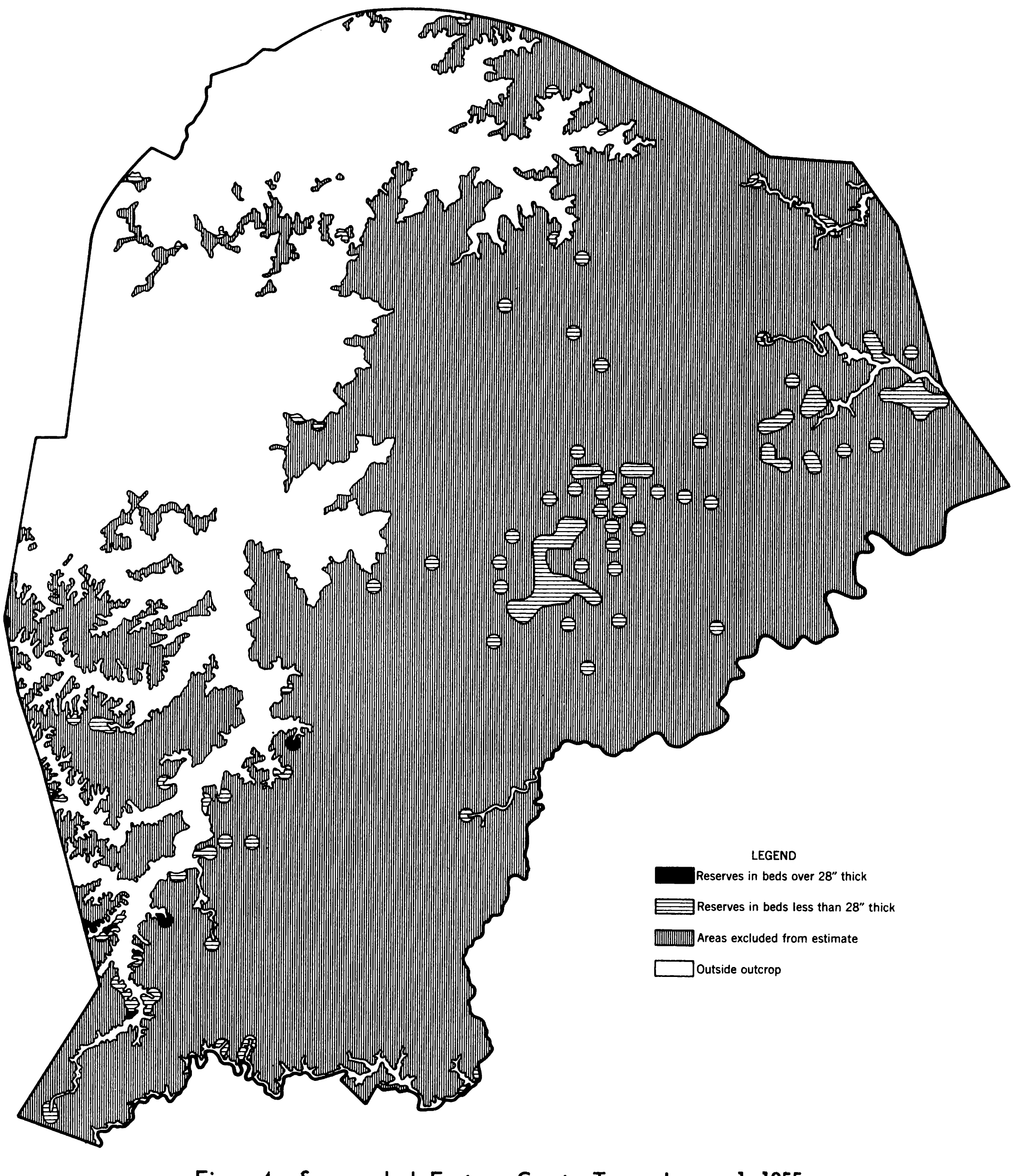

Figure 4. - Sewanee bed, Fentress County, Tenn., January 1, 1955.

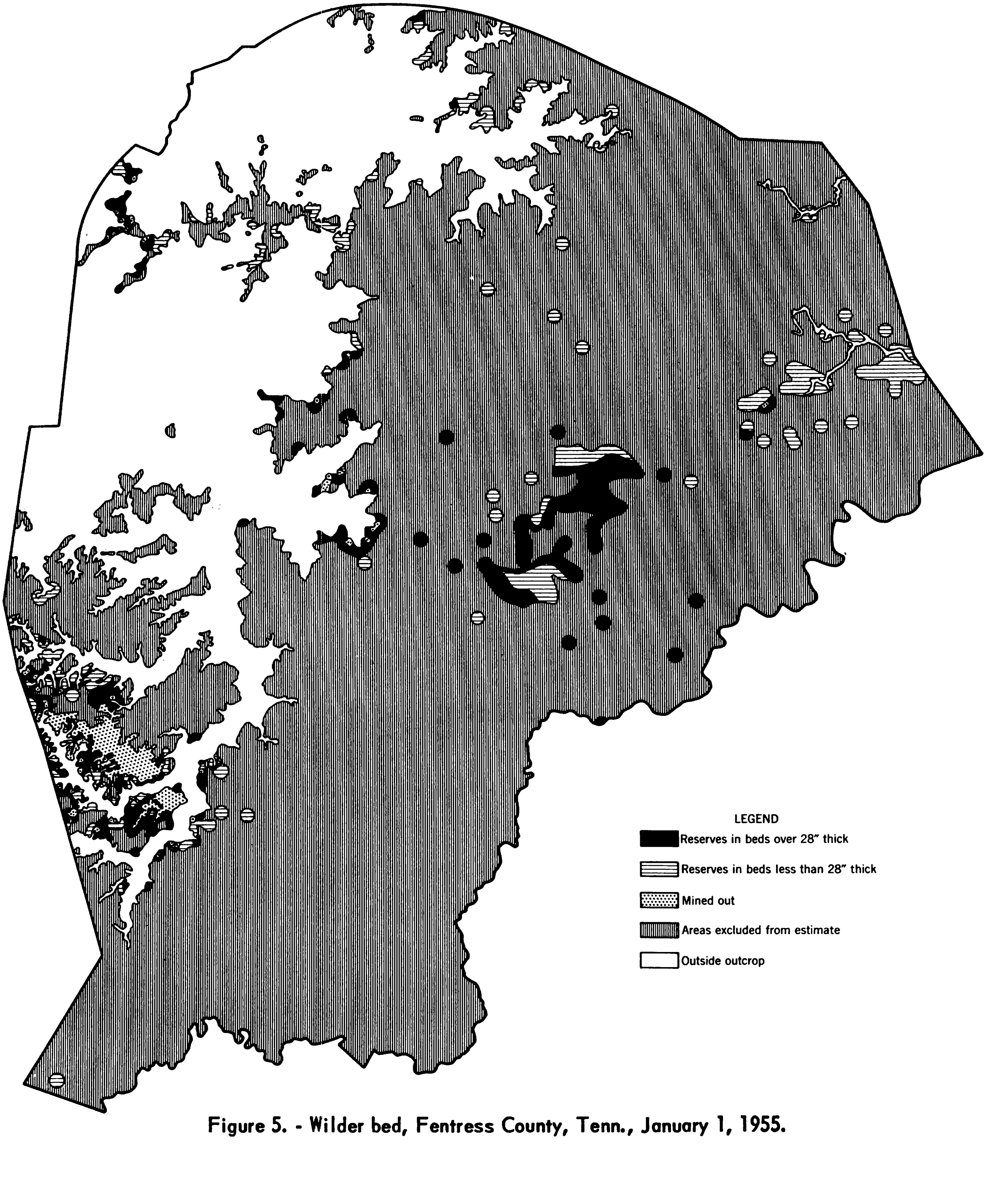

Figure 5. - Wilder bed, Fentress County, Tenn., January 1, 1955.

Central Part of County

Material	Inches
Coal with bony bands	47-1/2
Thickness	47-1/2

Material	Inches
COAL	53
Impure coal	4
Thickness	57

Western Part of County

Material	Inches
COAL	11
Bone	2-1/2
COAL	33-3/4
Thickness	47-1/4

Material	Inches
COAL	52
Rash	3
Thickness	55

White Oak Bed

(See fig. 6 and table 4)

The reserves that have been estimated in this report as in the White Oak bed are in a bed that occurs about 95 to 120 feet below the Wilder coal. Normally it is the fourth coal below the Wilder. It was mined at Zenith in two slope mines and more recently in a small way at one opening on Wolf River. Some drill holes in the Allardt quadrangle prove minable reserves, but most of the drill holes that went below the Wilder bed in this quadrangle show upper Mississippian formations that preclude the deposition of the White Oak coal. Mississippian formations also show close below the Wilder horizon, from the head of Buffalo Cove to the head of Poplar Cove where the White Oak horizon is again found. The horizon is present in Lints Cove and farther south along both sides of East Fork.

A sample was taken for preparation studies from the Leffew mine where the bed was 26-3/4 inches thick. This bed section and one other in the area of recoverable reserves follow:

Northern Part of County

Material	Inches
Coal with pyrite bands	9
Shale	4
COAL	5-1/2
Bone	1
COAL	7-1/4
Thickness	26-3/4

Eastern Part of County

Material	Inches
COAL	38
Thickness	38

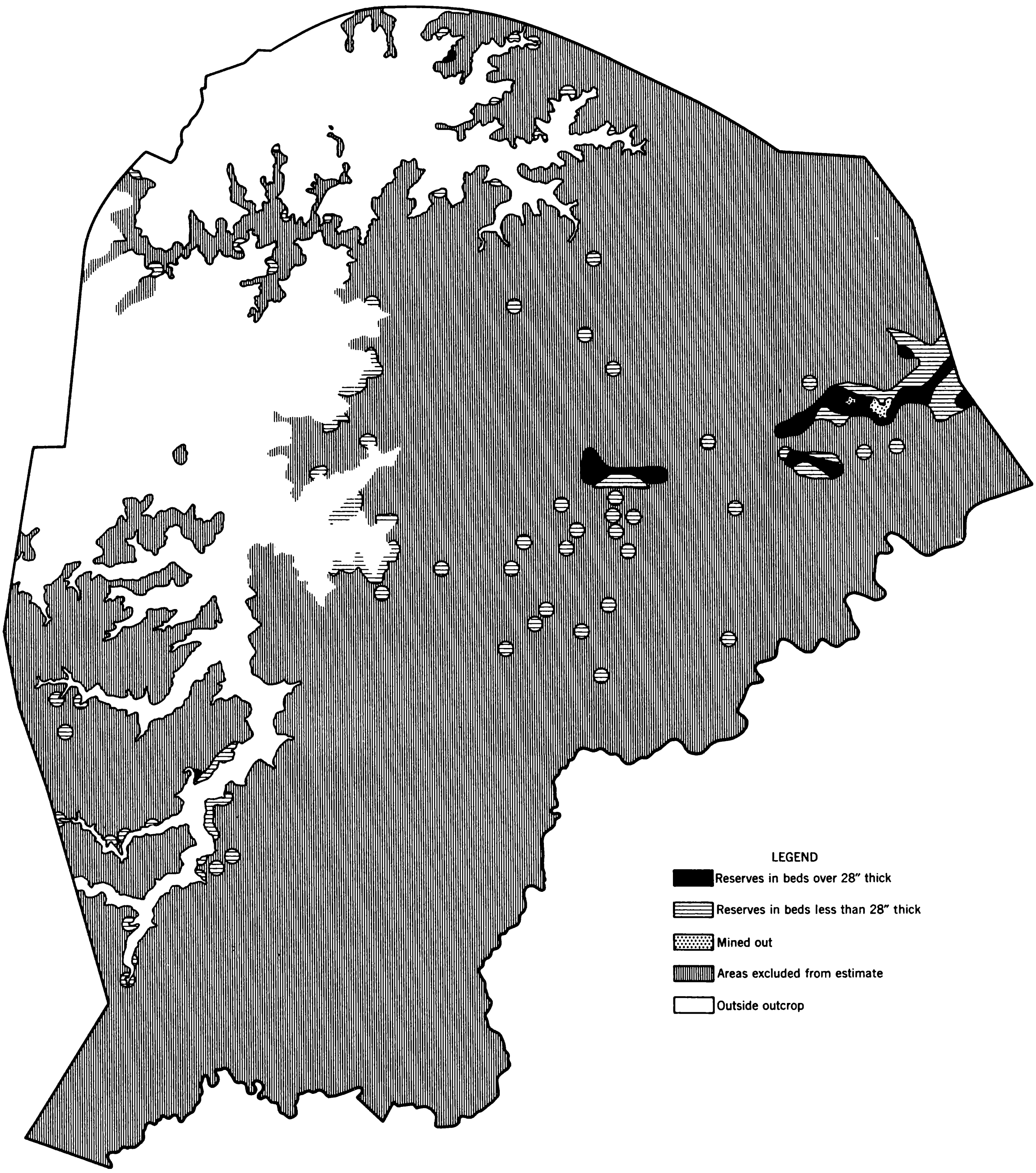

Figure 6. - White Oak bed, Fentress County, Tenn., January 1, 1955.

There is a record of mining in another bed in the eastern part of the county that has been called the White Oak.5/ This is the second coal below the Wilder, in a normal section. It is usually a low-sulfur, rather low-ash coal, but the minable extent was small. The bed was thin where observed and measured at the head of Poplar Cove, and there was not enough information on it to make an estimate of reserves.

Coal Reserves

Detail estimates of measured and indicated reserves in Fentress County, as of January 1, 1955, are given in tables 1 to 4, inclusive. Table 5 is a recapitulation of reserves. Total known reserves 14 inches and more thick are estimated at 101,724,000 tons. Of this total 65,900,000 tons is in beds 28 inches and more thick. The estimated average recovery for all beds in the county is 62.8 percent. Based on this figure, the known recoverable reserves 28 inches and more thick are estimated to be 41,347,000 tons as of January 1, 1955.

This is not a complete assessment of the coal deposits of the county. Reserves in parts of 4 beds out of 15 are estimated, leaving large areas unestimated because of lack of information. These areas may have reserves that can be inferred only, which excludes them from this estimate. The 11 beds for which no estimates have been made are not likely to have significant reserves of recoverable coal; however, the coal deposits of the county are so irregular in thickness and continuity that coal of minable thickness may be present in any or all the beds. Much more drilling is needed before complete estimates may be made for these beds.

Analyses of Fentress County Coals

Table 6 gives chemical analyses of coal, arranged by beds, in descending stratigraphic order. These analyses are of samples that were taken for preparation tests during this study and are published here for the first time. The samples have been subjected to screening and float-and-sink tests to indicate more accurately the quality of coal that could be obtained by the application of modern coal-cleaning methods.

The White Oak coal analysis shows a high ash content because a 4-inch parting in the bed was included in the sample taken for washability studies.

5/ Glenn, L. C., The Northern Tennessee Coal Field: Tennessee Div. Geol. Bull. 33-B, 1925, pp. 280, 281, 288.

FENTRESS COUNTY

TABLE 1. - RESERVES IN NEMO BED, January 1, 1955

15-minute 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, 1/ 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		
115								Measured	-	-	-	-	-	-	-	-	-	-		
(Allardt)	136,350	79,552	51,808	2,365	2,625	-	2,625	Indicated	1,936	6,442	689	3,341	-	-	2,625	9,783	689	3,341		
								Total	1,936	6,442	689	3,341	-	-	2,625	9,783	689	3,341	2/50.0	1,670
116								Measured	-	-	-	-	-	-	-	-	-	-		
(Deer Lodge)	23,094	17,834	5,106	-	154	-	154	Indicated	113	458	41	258	-	-	154	716	41	258		
								Total	113	458	41	258	-	-	154	716	41	258	2/50.0	129
Remaining								Measured	-	-	-	-	-	-	-	-	-	-		
quadrangles	161,919	41,027	119,382	1,510	-	-	-	Indicated	-	-	-	-	-	-	-	-	-	-		
								Total	-	-	-	-	-	-	-	-	-	-	-	-
								Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	2,049	6,900	730	3,599	-	-	2,779	10,499	730	3,599		
Total	321,363	138,413	176,296	3,875	2,779	-	2,779	Total	2,049	6,900	730	3,599	-	-	2,779	10,499	730	3,599	2/50.0	1,799

TABLE 2. - RESERVES IN SEWANEE BED, January 1, 1955

15-minute 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, 1/ 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		
333								Measured	-	-	-	-	-	-	-	-	-	-		
(Byrdstown)	8,595	305	8,224	22	44	-	44	Indicated	44	119	-	-	-	-	44	119	-	-		
								Total	44	119	-	-	-	-	44	119	-	-	-	-
335								Measured	-	-	-	-	-	-	-	-	-	-		
(Pall Mall)	38,507	17,003	21,326	64	114	-	114	Indicated	114	251	-	-	-	-	114	251	-	-		
								Total	114	251	-	-	-	-	114	251	-	-	-	-
334								Measured	-	-	-	-	-	-	-	-	-	-		
(Wilder)	69,590	19,736	49,100	379	375	-	375	Indicated	335	919	40	206	-	-	375	1,125	40	206		
								Total	335	919	40	206	-	-	375	1,125	40	206	2/50.0	103
115								Measured	-	-	-	-	-	-	-	-	-	-		
(Allardt)	136,350	119,033	11,651	3,753	1,913	-	1,913	Indicated	1,844	5,181	69	362	-	-	1,913	5,543	69	362		
								Total	1,844	5,181	69	362	-	-	1,913	5,543	69	362	2/50.0	181
108								Measured	-	-	-	-	-	-	-	-	-	-		
(Mayland)	24,049	19,186	3,717	330	816	-	816	Indicated	615	2,031	181	936	20	135	816	3,102	201	1,071		
								Total	615	2,031	181	936	20	135	816	3,102	201	1,071	2/50.0	536
116								Measured	-	-	-	-	-	-	-	-	-	-		
(Deer Lodge)	23,094	22,296	720	36	42	-	42	Indicated	42	113	-	-	-	-	42	113	-	-		
								Total	42	113	-	-	-	-	42	113	-	-	-	-
Remaining								Measured	-	-	-	-	-	-	-	-	-	-		
quadrangles	21,178	18,939	882	1,357	-	-	-	Indicated	-	-	-	-	-	-	-	-	-	-		
								Total	-	-	-	-	-	-	-	-	-	-	-	-
								Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	2,994	8,614	290	1,504	20	135	3,304	10,253	310	1,639		
Total	321,363	216,498	95,620	5,941	3,304	-	3,304	Total	2,994	8,614	290	1,504	20	135	3,304	10,253	310	1,639	2/50.0	820

1/ 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.

2/ Estimated

FENTRESS COUNTY

TABLE 3. - RESERVES IN WILDER BED, January 1, 1955

15-minute 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, 1/ 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		
333 (Byrdstown)	8,595	376	7,962	13	244	8	236	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	35	110	112	526	89	647	236	1,283	201	1,173		
								Total	35	110	112	526	89	647	236	1,283	201	1,173	2/50.0	587
335 (Pall Mall)	38,507	17,273	20,298	91	845	-	845	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	783	2,278	62	304	-	-	845	2,582	62	304		
								Total	783	2,278	62	304	-	-	845	2,582	62	304	2/50.0	152
334 (Wilder)	69,590	18,506	44,389	698	5,997	2,436	3,561	Measured	834	2,658	1,630	8,696	407	2,717	2,871	14,071	2,037	11,413		
								Indicated	475	1,404	215	1,101	-	-	690	2,505	215	1,101		
								Total	1,309	4,062	1,845	9,797	407	2,717	3,561	16,576	2,252	12,514	69.0	8,635
115 (Allardt)	136,350	117,279	10,489	1,751	6,831	163	6,668	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	1,699	5,007	2,301	11,671	2,668	20,478	6,668	37,156	4,969	32,149		
								Total	1,699	5,007	2,301	11,671	2,668	20,478	6,668	37,156	4,969	32,149	2/69.0	22,183
128A (Helenwood)	19,719	17,551	458	1,280	430	-	430	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	430	1,264	-	-	-	-	430	1,264	-	-		
								Total	430	1,264	-	-	-	-	430	1,264	-	-	-	-
108 (Mayland)	24,049	21,645	1,733	145	526	13	513	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	75	213	387	1,923	51	323	513	2,459	438	2,246		
								Total	75	213	387	1,923	51	323	513	2,459	438	2,246	2/50.0	1,123
Remaining quadrangles	24,553	24,492	61	-	-	-	-	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	-	-	-	-	-	-	-	-	-	-		
								Total	-	-	-	-	-	-	-	-	-	-	-	-
Total	321,363	217,122	85,390	3,978	14,873	2,620	12,253	Measured	834	2,658	1,630	8,696	407	2,717	2,871	14,071	2,037	11,413		
								Indicated	3,497	10,276	3,077	15,525	2,808	21,448	9,382	47,249	5,885	36,973		
								Total	4,331	12,934	4,707	24,221	3,215	24,165	12,253	61,320	7,922	48,386	67.5	32,680

1/ 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.

2/ Estimated

FENTRESS COUNTY

TABLE 4. - RESERVES IN WHITE OAK BED, January 1, 1955

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
15-minute Quadrangle	Area of quadrangle in county, acres	Areas excluded from estimate, 1/ 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		
335 (Pall Mall)	38,507	20,197	17,893	209	208	-	208	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	167	457	41	197	-	-	208	654	41	197		
								Total	167	457	41	197	-	-	208	654	41	197	2/ 50.0	98
334 (Wilder)	69,590	29,869	38,698	500	523	-	523	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	501	1,590	10	57	12	85	523	1,732	22	142		
								Total	501	1,590	10	57	12	85	523	1,732	22	142	2/ 50.0	71
115 (Allardt)	136,350	122,071	9,260	3,210	1,809	-	1,809	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	578	1,719	1,231	6,547	-	-	1,809	8,266	1,231	6,547		
								Total	578	1,719	1,231	6,547	-	-	1,809	8,266	1,231	6,547	2/ 50.0	3,274
128A (Helenwood)	19,719	16,819	-	650	2,250	129	2,121	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	1,093	3,526	1,028	5,390	-	-	2,121	8,916	1,028	5,390		
								Total	1,093	3,526	1,028	5,390	-	-	2,121	8,916	1,028	5,390	2/ 50.0	2,695
108 (Mayland)	24,049	22,598	1,199	221	31	-	31	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	31	84	-	-	-	-	31	84	-	-		
								Total	31	84	-	-	-	-	31	84	-	-	-	-
Remaining quadrangles	33,148	25,756	7,344	48	-	-	-	Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	-	-	-	-	-	-	-	-	-	-		
								Total	-	-	-	-	-	-	-	-	-	-	-	-
								Measured	-	-	-	-	-	-	-	-	-	-		
								Indicated	2,370	7,376	2,310	12,191	12	85	4,692	19,652	2,322	12,276		
Total	321,363	237,310	74,394	4,838	4,821	129	4,692	Total	2,370	7,376	2,310	12,191	12	85	4,692	19,652	2,322	12,276	2/ 50.0	6,138

1/ 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.

2/ Estimated

TABLE 5. - Recapitulation of reserves, Fentress County, Tenn., January 1, 1955

Bed	Thousands of tons: In beds 14 inches and more thick	Thousands of tons: In beds 28 inches and more thick	Recoverable[1/]: Percent	Recoverable[1/]: Thousands of tons
Nemo	10,499	3,599	2/50.0	1,799
Sewanee	10,253	1,639	2/50.0	820
Wilder	61,320	48,386	67.5	32,680
White Oak	19,652	12,276	2/50.0	6,138
Total	101,724	65,900	62.8	41,437

1/ Based on 28 inches and more thick.

TABLE 6. - Analyses of Fentress County coals

Mine	Bed	Kind of sample[1/]	As-received Moist.	Dry basis Vol.	Dry basis F.C.	Dry basis Ash	Dry basis Sul.	Dry basis B.t.u.
1	2	3	4	5	6	7	8	9
David Crockett	Nemo	M	4.3	34.5	51.4	14.1	2.6	12,510
Howard Burks	2/Sewanee	M	10.9	35.2	51.9	12.9	2.3	12,170
Regan and Gibson ..	Wilder	M	1.8	36.6	49.2	14.2	5.0	12,870
B & C Coal Co.	do.	M	2.3	35.5	47.7	16.8	4.9	12,250
Claude Ledbetter ..	do.	M	1.7	37.7	49.6	12.7	3.8	13,110
Marion Leffew	3/White Oak	M	3.0	30.5	38.1	31.4	2.1	9,730

1/ M = Mine sample.
2/ Known previously as Lantana.
3/ Known previously as Zenith.

PART II. - PREPARATION CHARACTERISTICS OF FENTRESS COUNTY, TENN., COAL

by

W. L. Crentz and J. W. Miller

Test Procedure

To determine the washability of Fentress County coal, six face samples were collected in the Nemo, Sewanee, Wilder, and White Oak beds. Only the Wilder bed is commercially important in Fentress County, and three samples were collected in this bed over a wide area to reflect possible variations in bed quality in different parts of the county. The other three samples were taken in prospect openings and very small domestic mines that have been opened to meet a limited demand for house coal. The location of mines from which washability samples were collected is shown in figure 1.

The face samples were collected in the conventional manner, except that binders and partings in the mined section of the bed usually were included in the sample, even though the extraneous matter would be removed normally on the picking table. The samples were crushed to 1-1/2 inch top size, and a riffled portion of the 1-1/2-inch by 0 sample was screened at 100-mesh. The 1-1/2-inch by 100-mesh coal was float-and-sink tested. To determine the effect of crushing upon the release of impurities, the remainder of the 1-1/2-inch by 0 sample was crushed to 3/8-inch top size and riffled. Half of the 3/8-inch by 0 crushing was dedusted over a 100-mesh sieve, and the 3/8-inch by 100-mesh coal was float-and-sink tested. The duplicate portion of the 3/8-inch by 0 test loat was crushed to 14-mesh top size and dedusted to remove the 100-mesh by 0 dust, and the 14- by 100-mesh sample was tested. The flowsheet (fig. 7) shows the steps taken in preparing samples for the float-and-sink test. As the difficulty of cleaning coal usually increases with a decrease in particle size, crushing to a finer than 1-1/2-inch top size was confined to those samples that failed to yield a coarse coal float product that would be chemically suitable for metallurgical use. Likewise, when an examination of the float-and-sink data on the 1-1/2-inch crushing indicated that crushing to 3/8-inch top size would have insignificant effect on the release of impurities, the 3/8-inch crushing was omitted, and the sample was crushed to 14-mesh top size.

All samples were tested on specific gravities of 1.30, 1.35, 1.40, 1.45, 1.50, 1.55, and 1.60. Tests were made with carbon tetrachloride mixed with white gasoline or bromoform, depending upon the desired specific gravity.

The float-and-sink test for determining the washing characteristics of coal has been used for many years, and descriptions of the procedure have appeared frequently in the literature. Coe[6] has explained carefully the compilation and interpretation of washability data. In examining the float-and-sink data on face samples, it must be emphasized that these data are not to be construed as representative of the quality of product loaded at the operation where the sample was taken, but rather as an indication of bed quality in the general geographical area. The face sample, in some instances, represents full-seam recovery. In some mines certain inferior portions of the bed are left in place to improve the quality of output, especially where a band of inferior coal occurs between the shale roof and the top of the better coal.

6/ Coe, G. D., and Explanation of Washability Curves for the Interpretation of Float-and-Sink Data on Coal: Bureau of Mines Inf. Circ. 7045, 1938, 10 pp.

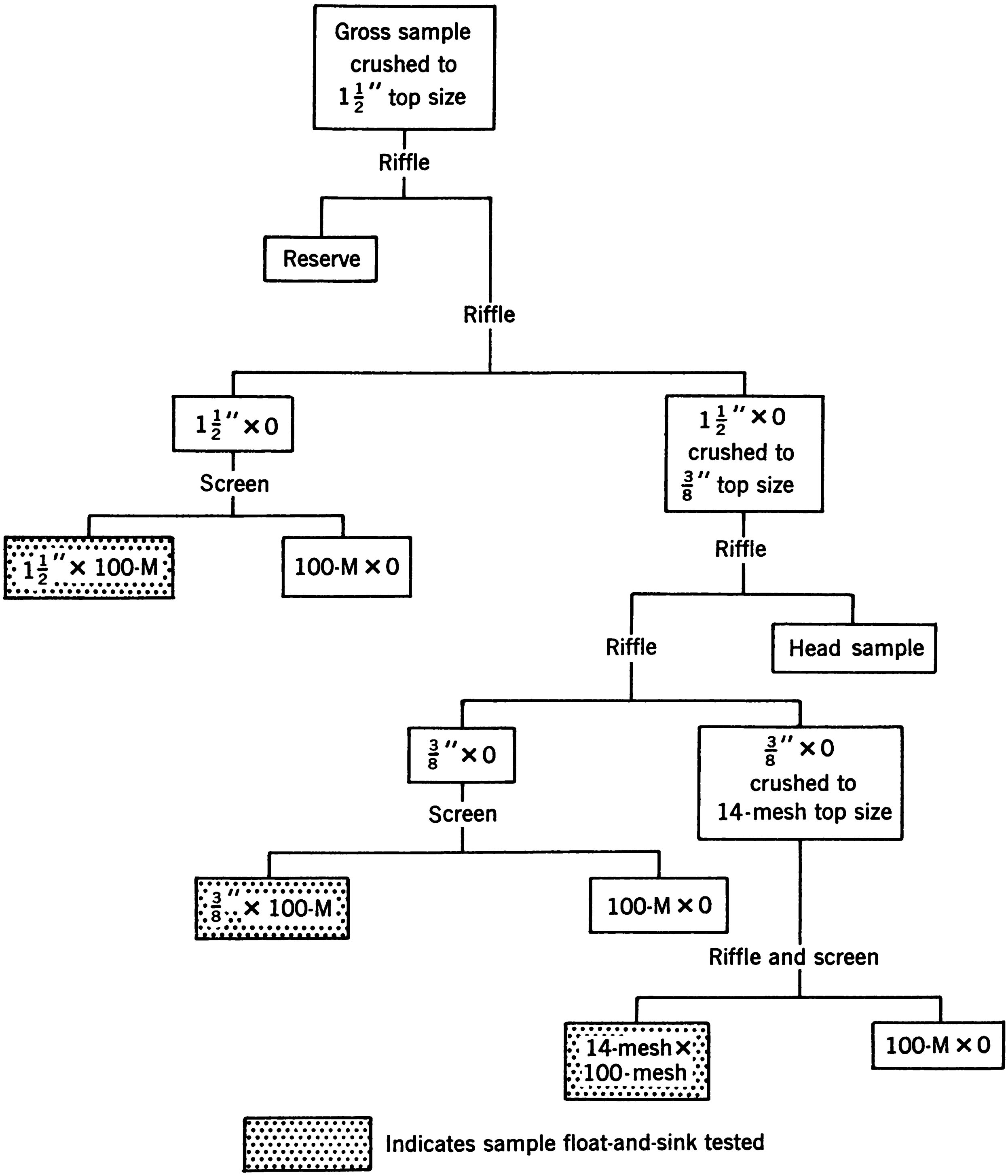

Figure 7. - Flow diagram showing preparation of samples.

To expedite the float-and-sink test, the 100-mesh by 0 dust was removed from all samples before separation into specific-gravity fractions. It would be uneconomical to discard this dust, and to include the material in the washed coal would increase somewhat the ash and sulfur percentages shown in the washability data for the dedusted coal samples. Usually the quantity of fine dust produced during crushind does not become a serious problem unless the coal is crushed finer than 1-1/2-inch top size.

In interpreting washability characteristics of coal from float-and-sink data it must be remembered that these data are based on precise specific-gravity separations, which are approached but not equaled in commercial practice. Washing efficiency usually decreases with decreasing particle size of the washery feed. During washing, even in an efficient modern preparation plant, it is to be expected that some refuse will be misplaced in the clean coal and that some clean coal will be rejected with the refuse.

Experimental Results

Nemo Bed

A face sample was taken at a small domestic mine, known as the Crockett mine, 1 mile wouthwest of Jamestown, Tenn., near the center of Fentress County. This mine is operated by the owner of the property mainly as a source of house coal to supply the fuel needs of the operator. At this location the bed is only 26 inches thick and is overlain by 4-1/2 inches of draw slate immediately under a sandstone roof. The draw slate is left in place during mining and is not included in the washability sample. Float-and-sink data on the sample, after it has been crushed to 1-1/2-inch top size, are given in table 7. Separating the sample at 1.60 specific gravity produces a float coal containing 11.5 percent ash and 1.74 percent sulfur, with a rejection of 7.3 percent of the sample as sink material. Tables 8 and 9 show the float-and-sink data after the sample is crushed to 3/8-inch and 14-mesh top size, respectively. Crushing the sample to 3/8-inch top size and separating at 1.60 specific gravity yields a float coal containing 10.0 percent ash and 1.42 percent sulfur. To prepare a float coal containing less than 1.30 percent sulfur would require a very precise separation at a specific gravity lighter than 1.40. In addition to the operational difficulty of washing coal at this low gravity of separation, the yield recovery of material of the desired quality would be only about 70 percent of the sample. Table 9 shows that, when the sample is crushed to 14-mesh top size and separated at 1.60 specific gravity, a float product can be prepared containing 9.1 percent ash and 1.28 percent sulfur. Although the product probably would be chemically suitable for metallurgical use, the handling of this fine material in the preparation plant would be difficult. Assuming that the float-and-sink results could be duplicated in commercial practice, disposal of the minus-100-mesh material produced during crushing must be considered. After the face sample is crushed to 14-mesh top size, about 18 percent of the sample is finer than 100-mesh. This 100-mesh by 0 fraction contains 16.4 percent ash and 3.59 percent sulfur, which, if added to the cleaned 14- by 100-mesh size, would increase the sulfur of the mixture to 1.75 percent.

A thorough study of the float-and-sink data on coal from the Crockett mine indicates that, if this sample is representative of the bed throughout the county, the Nemo bed in Fentress County is not particularly adaptable to the preparation of a low-sulfur washed coal. A washed coal containing about 1.4 percent sulfur and about 10 percent ash could be prepared without great difficulty, but further removal of impurities could be achieved only by the separate disposal of large quantities of high-sulfur dust.

Sewanee Bed

The sample of Sewanee-bed coal was taken in a prospect opening known as the Howard Burks mine, 6 miles north of Clarkrange, Tenn., in the southern portion of Fentress County. Here the bed is 24 inches thick and contains a rather persistent sulfur binder about 1 inch thick near the top of the coal bed. Table 10 shows the results of the float-and-sink tests made on the face sample after it was crushed to 1-1/2-inch top size and the minus-100-mesh dust removed. Separating the coal at 1.60 specific gravity yields a float coal containing 7.3 percent ash and 1.36 percent sulfur. Examination of the float-and-sink data reveals a peculiar sulfur pattern. Once the 1.60-specific gravity sink material is removed, the lighter specific-gravity fractions contain an increasing percentage of sulfur. This condition negates the possibility of further sulfur reduction by separating the sample at a lighter specific gravity. Crushing to a finer size did not aid in sulfur reduction. Althoug it would not be possible to attain a float product containing 1.25 percent or less sulfur from the sample under investigation, an easy washing operation would yield a product that probably would be chemically suitable for metallurgical use.

Wilder Bed

The Wilder bed is the only deposit in Fentress County that has been exploited commercially to a significant degree. Virtually all of commercial coal production of Fentress County has been taken from this bed. The Wilder bed usually is about 4 feet thick and frequently contains bands of pyrite sometimes 1 inch or more thick.

A face sample was taken at the Regan and Gibson mine, operated by a company of the same name, 5 miles southeast of Moodyville, Tenn., in the northwest corner of Fentress County. The bed thickness at this mine is about 43 inches. At the bottom of the bed, where sampled, 4 inches of coal separates 2 solid bands of pyrite, each about 2 inches thick. During mining, this portion of the bed is not loaded and, therefore, it has been excluded from the washability sample. Float-and-sink data on the sample, after it has been crushed to 1-1/2-inch top size, are given in table 11. Separating the sample at 1.60 specific gravity yields a float coal containing 12.1 percent ash and 3.07 percent sulfur. Further examination of the float-and-sink data reveals the impracticability of upgrading this coal to meet metallurgical standards. To prepare a clean coal containing less than 2 percent sulfur would require a separation at a 1.30 specific gravity where only 4.1 percent of the sample floats.

TABLE 7. - Washing characteristics of face sample, Crockett mine, Nemo bed. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100-mesh (98.9 percent of sample)	Under - 1.30	13.3	13.3	3.5	3.5	1.31	1.31
	1.30 to 1.35	32.6	45.9	7.3	6.2	1.55	1.48
	1.35 to 1.40	25.1	71.0	12.8	8.5	1.77	1.58
	1.40 to 1.45	11.6	82.6	18.0	9.9	2.11	1.66
	1.45 to 1.50	5.7	88.3	22.6	10.7	2.29	1.70
	1.50 to 1.55	3.3	91.6	27.0	11.3	2.37	1.72
	1.55 to 1.60	1.1	92.7	28.9	11.5	3.37	1.74
	Over - 1.60	7.3	100.0	43.4	13.8	12.09	2.50
100-mesh by 0 (1.1 percent of sample)				24.0		4.89	

TABLE 8. - Washing characteristics of face sample, Crockett mine, Nemo bed. Sample crushed to 3/8-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
3/8-inch by 100-mesh (91.9 percent of sample)	Under - 1.30	26.6	26.6	3.4	3.4	1.06	1.06
	1.30 to 1.35	30.3	56.9	7.6	5.6	1.31	1.19
	1.35 to 1.40	15.7	72.6	13.1	7.3	1.68	1.30
	1.40 to 1.45	8.5	81.1	18.2	8.4	2.06	1.38
	1.45 to 1.50	5.2	86.3	22.4	9.2	1.82	1.40
	1.50 to 1.55	2.7	89.0	26.4	9.8	1.81	1.42
	1.55 to 1.60	1.2	90.2	28.9	10.0	1.91	1.42
	Over - 1.60	9.8	100.0	45.2	13.5	10.33	2.30
100-mesh by 0 (8.1 percent of sample)				20.9		4.29	

TABLE 9. - Washing characteristics of face sample, Crockett mine, Nemo bed. Sample crushed to 14-mesh top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
14- by 100-mesh (81.9 percent of sample)	Under - 1.30	32.4	32.4	2.8	2.8	1.04	1.04
	1.30 to 1.35	21.2	53.6	6.6	4.3	1.22	1.11
	1.35 to 1.40	13.4	67.0	11.6	5.8	1.40	1.17
	1.40 to 1.45	8.6	75.6	16.4	7.0	1.62	1.22
	1.45 to 1.50	6.4	82.0	20.7	8.0	1.67	1.26
	1.50 to 1.55	3.3	85.3	24.9	8.7	1.68	1.27
	1.55 to 1.60	1.8	87.1	26.9	9.1	1.73	1.28
	Over - 1.60	12.9	100.0	44.2	13.6	8.78	2.25
100-mesh by 0 (18.1 percent of sample)				16.4		3.59	

TABLE 10. - Washing characteristics of face sample, Howard Burks mine, Sewanee bed. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100-mesh (97.8 percent of sample)	Under - 1.30	26.2	26.2	5.1	5.1	1.56	1.56
	1.30 to 1.35	38.9	65.1	5.7	5.5	1.37	1.45
	1.35 to 1.40	14.1	79.2	8.0	5.9	1.22	1.41
	1.40 to 1.45	5.0	84.2	14.2	6.4	1.12	1.39
	1.45 to 1.50	3.0	87.2	19.2	6.8	.92	1.37
	1.50 to 1.55	1.5	88.7	23.4	7.1	.83	1.36
	1.55 to 1.60	.6	89.3	29.6	7.3	.78	1.36
	Over - 1.60	10.7	100.0	53.7	12.2	10.33	2.32
100-mesh by 0 (2.2 percent of sample)				15.6		2.16	

TABLE 11. - Washing characteristics of face sample, Regan and Gibson mine, Wilder bed. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100-mesh (98.3 percent of sample)	Under - 1.30	4.1	4.1	4.2	4.2	1.96	1.96
	1.30 to 1.35	46.2	50.3	9.4	9.0	2.66	2.60
	1.35 to 1.40	29.8	80.1	14.0	10.8	3.08	2.78
	1.40 to 1.45	8.5	88.6	18.2	11.6	4.20	2.92
	1.45 to 1.50	3.2	91.8	21.1	11.9	5.58	3.01
	1.50 to 1.55	1.1	92.9	24.2	12.0	6.85	3.05
	1.55 to 1.60	.4	93.3	25.4	12.1	7.64	3.07
	Over - 1.60	6.7	100.0	47.2	14.4	30.28	4.90
100-mesh by 0 (1.7 percent of sample)				13.5		4.32	

Float-and-sink data in table 12 reveal the washing characteristics of the face sample after it has been crushed to 14-mesh top size. Even crushing the sample to flotation size will not result in significant reduction in ash and sulfur. Separating the 14- by 100-mesh coal at 1.60 specific gravity produces a float coal containing 11.2 percent ash and 2.57 percent sulfur. Only the 1.30-specific-gravity float coal analyzes less than 2 percent sulfur, and the yield recovery at this specific gravity is less than 20 percent.

Another face sample was taken in the Wilder bed at the B and C mine, Robert Mills Coal Co., 6 miles west of Jamestown, Tenn. Here the bed is about 4 feet thick and contains bands of bony coal and sulfur. Table 13 shows the results of the float-and-sink tests made on the face sample after crushing to 1-1/2-inch top size. Separating the coal at 1.60 specific gravity yields a float coal containing 14.2 percent ash and 3.37 percent sulfur. These data show that, within the range of specific gravities employed, only the 1.30-specific-gravity float coal contained less than 2 percent sulfur, and at this specific gravity the recovery of float coal was insignificant.

The float-and-sink data in table 14 show the washability of the sample crushed to 14-mesh top size. They also show that fine crushing has little effect upon the quality of the float coal and cannot be employed successfully as a means of achieving significant reductions in ash and sulfur. Separating the 14- by 100-mesh coal at 1.60 specific gravity produces a clean coal containing 12.4 percent ash and 3.11 percent sulfur. Examination of the float products on the lighter specific gravities shows that, even when a large proportion of the raw coal is rejected as refuse and middlings, the percentage of sulfur in the float material would be too high for metallurgical use by present standards.

Table 15 shows the float-and-sink data on a face sample collected at the Claude Ledbetter mine, 4 miles north of Wilder, Tenn., in the southern part of Fentress County. The sample was crushed to 1-1/2-inch top size and dedusted over a 100-mesh sieve before float-and-sink testing. The float-and-sink data show that mechanical cleaning will not upgrade this coal to metallurgical quality, owing to the high percentage of sulfur remaining in the washed coal. Separating the sample at 1.60 specific gravity will yield a float coal containing 11.0 percent ash and 3.50 percent sulfur, with a recovery of 94.7 percent of the sample as float coal.

Similar to the other 2 samples of Wilder-bed coal, only the 1.30 float coal from the Ledbetter mine contains less than 2 percent sulfur. Table 16 shows that this condition holds ture, even when the sample is crushed to flotation size. Although some reduction in ash and sulfur can be achieved by crushing the sample to 14-mesh top size, the product is not improved enough to permit the use of the coal for byproduct-coke making.

The float-and-sink data on these three face samples clearly show the impossibility of preparing a washed coal from the Wilder bed in Fentress County that would be satisfactory from a chemical standpoint for metallurgical use by present standards.

TABLE 12. - Washing characteristics of face sample, Regan and Gibson mine, Wilder bed. Sample crushed to 14-mesh top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
14- by 100-mesh (84.8 percent of sample)	Under - 1.30	19.9	19.9	3.8	3.8	1.80	1.80
	1.30 to 1.35	31.4	51.3	8.8	6.9	2.36	2.14
	1.35 to 1.40	22.1	73.4	14.1	9.0	2.74	2.32
	1.40 to 1.45	9.1	82.5	18.4	10.1	3.21	2.42
	1.45 to 1.50	4.6	87.1	22.1	10.7	3.86	2.50
	1.50 to 1.55	2.3	89.4	25.5	11.1	4.52	2.55
	1.55 to 1.60	.9	90.3	27.1	11.2	5.16	2.57
	Over - 1.60	9.7	100.0	44.3	14.5	25.60	4.81
100-mesh by 0 (15.2 percent of sample)				12.1		4.46	

TABLE 13. - Washing characteristics of face sample, B and C mine, Wilder bed. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100-mesh (97.8 percent of sample)	Under - 1.30	2.3	2.3	3.1	3.1	1.43	1.43
	1.30 to 1.35	24.3	26.6	9.5	8.9	2.27	2.20
	1.35 to 1.40	32.8	59.4	12.7	11.0	3.46	2.89
	1.40 to 1.45	14.2	73.6	16.7	12.1	4.38	3.18
	1.45 to 1.50	7.1	80.7	21.2	12.9	4.78	3.32
	1.50 to 1.55	5.0	85.7	27.5	13.8	4.02	3.36
	1.55 to 1.60	2.5	88.2	30.8	14.2	3.48	3.37
	Over - 1.60	11.8	100.0	40.2	17.3	16.97	4.97
100-mesh by 0 (2.2 percent of sample)				19.9		4.58	

TABLE 14. - Washing characteristics of face sample, B and C mine, Wilder bed. Sample crushed to 14-mesh top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
14- by 100-mesh (83.7 percent of sample)	Under - 1.30	10.4	10.4	2.9	2.9	1.40	1.40
	1.30 to 1.35	20.8	31.2	7.8	6.2	2.38	2.05
	1.35 to 1.40	24.8	56.0	12.4	8.9	3.07	2.50
	1.40 to 1.45	14.6	70.6	16.5	10.5	3.83	2.78
	1.45 to 1.50	7.6	78.2	20.3	11.4	4.56	2.95
	1.50 to 1.55	4.8	83.0	24.1	12.2	5.04	3.07
	1.55 to 1.60	1.5	84.5	27.2	12.4	5.13	3.11
	Over - 1.60	15.5	100.0	42.0	17.0	14.52	4.88
100-mesh by 0 (16.3 percent of sample)				16.7		4.83	

TABLE 15. - Washing characteristics of face sample, Claude Ledbetter mine, Wilder bed. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100-mesh (98.1 percent of sample)	Under - 1.30	7.2	7.2	5.0	5.0	1.70	1.70
	1.30 to 1.35	41.9	49.1	8.4	7.9	2.51	2.39
	1.35 to 1.40	26.9	76.0	11.8	9.3	4.05	2.98
	1.40 to 1.45	10.6	86.6	15.7	10.1	5.19	3.25
	1.45 to 1.50	5.2	91.8	19.5	10.6	6.03	3.41
	1.50 to 1.55	2.2	94.0	22.4	10.9	6.33	3.48
	1.55 to 1.60	.7	94.7	24.5	11.0	6.50	3.50
	Over - 1.60	5.3	100.0	44.0	12.7	12.01	3.95
100-mesh by 0 (1.9 percent of sample)				10.5		3.19	

TABLE 16. - Washing characteristics of face sample, Claude Ledbetter mine, Wilder bed. Sample crushed to 14-mesh top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
14- by 100-mesh (85.2 percent of sample)	Under - 1.30	26.0	26.0	4.2	4.2	1.69	1.69
	1.30 to 1.35	29.5	55.5	8.2	6.3	2.31	2.02
	1.35 to 1.40	18.8	74.3	12.2	7.8	3.10	2.29
	1.40 to 1.45	9.0	83.3	15.9	8.7	4.10	2.49
	1.45 to 1.50	4.6	87.9	19.4	9.2	5.02	2.62
	1.50 to 1.55	2.6	90.5	21.8	9.6	6.10	2.72
	1.55 to 1.60	1.1	91.6	23.8	9.8	6.83	2.77
	Over - 1.60	8.4	100.0	38.9	12.2	13.57	3.68
100-mesh by 0 (14.8 percent of sample)				10.8		3.71	

White Oak Bed

The White Oak bed occurs in the northern portion of Fentress County and is second to the Wilder from a reserves standpoint, but the production of coal from this deposit has been negligible. At the time of the field study, only one mine was operating in the White Oak bed. A face sample was taken at the Leffew mine, G. & J. Mining Co., 9 miles north of Jamestown, Tenn., near the Fentress-Pickett County line. The bed at this location is 26 inches thick and contains a 4-inch-thick shale binder near the center of the bed. The shale parting was included in the washability sample. Float-and-sink data on the sample, after it has been crushed to 1-1/2-inch top size, are given in table 17. Separating the sample at 1.60 specific gravity yields a float coal containing 8.5 percent ash and 2.25 percent sulfur, with a rejection of 35.4 percent of the sample as sink material. As the sulfur content of this heavy rock is less than the sulfur content in the various specific-gravity fractions, removal of the 1.60-specific-gravity sink material results in an anomaly. The washed product at 1.60 specific gravity contains more sulfur than that present in the raw coal. Further examination of the float-and-sink data reveals the impracticability of upgrading this coal to metallurgical standards. To obtain a float coal containing 1.25 percent sulfur would require a precise separation at about 1.31 specific gravity where the yield recovery would be about 25 percent of the raw coal. Even increasing the sulfur tolerance in the clean coal to 1.50 percent would not materially increase the recovery of float coal. The quantity of float coal containing 1.50 percent sulfur would be about 40 percent of the raw feed.

Table 18 shows the float-and-sink data on the face sample after it has been crushed to 3/8-inch top size. Significant reduction in the sulfur of the float coals, as a result of crushing, can be seen by comparison of the 1.60-specific-gravity float products. Crushing from 1-1/2- to 3/8-inch top size results in about a 0.4-percent reduction in sulfur and a 1-percent reduction in ash. The possibility of obtaining low-sulfur metallurgical coal, however, is not particularly enhanced.

The effect of still finer crushing on the washability of the sample is shown in table 19. The face sample was crushed to 14-mesh top size, and the 14- by 100-mesh-size float-and-sink tested. Some further reduction in ash and sulfur can be achieved by this finer crushing, but the clean coal probably would be unsuited for metallurgical usage owing to the high sulfur percentage in the various float fractions.

Assuming the Leffew-mine sample to be representative of the White Oak bed throughout Fentress County, the float-and-sink tests indicate that this bed probably would fail to qualify as a satisfactory source of metallurgical coal.

TABLE 17. - Washing characteristics of face sample, Leffew mine, White Oak bed. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100-mesh (98.5 percent of sample)	Under - 1.30	17.5	17.5	3.9	3.9	1.16	1.16
	1.30 to 1.35	29.5	47.0	7.3	6.0	1.91	1.63
	1.35 to 1.40	8.7	55.7	10.9	6.8	3.43	1.91
	1.40 to 1.45	4.1	59.8	13.8	7.3	4.40	2.08
	1.45 to 1.50	2.0	61.8	19.5	7.7	5.18	2.18
	1.50 to 1.55	1.8	63.6	25.4	8.2	4.00	2.23
	1.55 to 1.60	1.0	64.6	30.6	8.5	3.22	2.25
	Over - 1.60	35.4	100.0	75.5	32.2	1.06	1.83
100-mesh by 0 (1.5 percent of sample)				46.2		2.92	

TABLE 18. - Washing characteristics of face sample, Leffew mine, White Oak bed. Sample crushed to 3/8-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
3/8-inch by 100-mesh (89.5 percent of sample)	Under - 1.30	26.7	26.7	3.6	3.6	1.16	1.16
	1.30 to 1.35	24.5	51.2	6.9	5.2	1.76	1.45
	1.35 to 1.40	9.0	60.2	11.0	6.0	2.08	1.54
	1.40 to 1.45	3.5	63.7	14.6	6.5	4.18	1.69
	1.45 to 1.50	2.1	65.8	19.4	6.9	4.84	1.79
	1.50 to 1.55	1.5	67.3	23.6	7.3	4.47	1.85
	1.55 to 1.60	.7	68.0	27.9	7.5	3.16	1.86
	Over - 1.60	32.0	100.0	75.0	29.1	2.11	1.94
100-mesh by 0 (10.5 percent of sample)				47.0		2.89	

TABLE 19. - Washing characteristics of face sample, Leffew mine, White Oak bed. Sample crushed to 14-mesh top size; data in percent

Size	Specific-gravity fraction	Weight		Ash		Sulfur	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
14- by 100-mesh (84.1 percent of sample)	Under - 1.30	31.2	31.2	3.4	3.4	1.12	1.12
	1.30 to 1.35	19.6	50.8	6.6	4.6	1.59	1.30
	1.35 to 1.40	9.3	60.1	10.3	5.5	2.25	1.45
	1.40 to 1.45	3.7	63.8	14.7	6.0	3.12	1.55
	1.45 to 1.50	2.4	66.2	18.3	6.5	3.78	1.63
	1.50 to 1.55	1.4	67.6	22.3	6.8	4.13	1.68
	1.55 to 1.60	.8	68.4	25.3	7.0	4.42	1.71
	Over - 1.60	31.6	100.0	72.2	27.6	2.62	2.00
100-mesh by 0 (15.9 percent of sample)				43.0		2.18	

APPENDIX

Completed reports giving results of studies by counties:

Estimation of Known Recoverable Reserves

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, 16 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, 1951, 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., BOWSHER, 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, JAMES, C. W., 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 5185, 1955, 52 pp.

WILLIAMS, LLOYD, HERSHEY, R. E., 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 5159, 1955, 30 pp.

HERSHEY, ROBERT E., WILLIAMS, LLOYD, and GANDRUD, B. W. Estimate of Known Recoverable Reserves of Coking Coal in Grundy County, Tenn. Bureau of Mines Rept. of Investigations 5148, 1955, 16 pp.

WILLIAMS, LLOYD, HERSHEY, ROBERT 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, 1955, 22 pp.

WILLIAMS, L., 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 5166, 1955, 36 pp.

DOWD, J. J., PROVOST, J. M., TRAVIS, R. G., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Brooke County, W. Va. Bureau of Mines Rept. of Investigations 5160, 1955, 17 pp.

DOWD, J. J., PROVOST, J. M., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Ohio County, W. Va. Bureau of Mines Rept. of Investigations 5171, 1955, 14 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Marshall County, W. Va. Bureau of Mines Rept. of Investigations 5207, 1956, 21 pp.

HERSHEY, R. E., WILLIAMS, L., CRENTZ, W. L., and MILLER, J. W. Estimate of Known Recoverable Reserves and the Preparation Characteristics of Coking Coal in Van Buren County, Tenn. Bureau of Mines Rept. of Investigations 5208, 1956, 25 pp.

BLAYLOCK, D. W., DOWD, J. J., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Clarion County, Pa. Bureau of Mines Rept. of Investigations 5231, 1956, 27 pp.

WILLIAMS, L., and HERSHEY, R. E. Estimate of Known Recoverable Reserves of Coking Coal in Bledsoe County, Tenn. Bureau of Mines Rept. of Investigations. (In press.)

HERSHEY, R. E., WILLIAMS, L., CRENTZ, W. L., MILLER, J. W., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves and the Preparation and Carbonizing Properties of Coking Coal in Claiborne County, Tenn. Bureau of Mines Rept. of Investigations 5229, 1956, 44 pp.

Preparation Studies

CRENTZ, W. L., and STEELE, F. Preparation Characteristics of Coal Occurring in Cambria County, Pa. Bureau of Mines Rept. of Investigations 4747, 1950, 40 pp.

CRENTZ, W. L., STEELE, R., and BAILEY, A. L. Preparation Characteristics of Coal Occurring in Indiana County, Pa. Bureau of Mines Rept. of Investigations 4763, 1951, 33 pp.

_____. Preparation Characteristics of Coal Occurring in Armstrong County, Pa. Bureau of Mines Rept. of Investigations 4788, 1951, 25 pp.

CRENTZ, W. L., BAILEY, A. L., and MILLER, J. W. Preparation Characteristics of Coal from Fayette County, Pa. Bureau of Mines Rept. of Investigations 4815, 1951, 16 pp.

CRENTZ, W. L., BAILEY, A. L., and MILLER, J. W. Preparation Characteristics of Coal Occurring in Westmoreland County, Pa. Bureau of Mines Rept. of Investigations 4823, 1951, 17 pp.

_____. Preparation Characteristics of Coal from Somerset County, Pa. Bureau of Mines Rept. of Investigations 4834, 1951, 23 pp.

_____. Preparation Characteristics of Coal from Clearfield County, Pa. Bureau of Mines Rept. of Investigations 4894, 1952, 27 pp.

CRENTZ, W. L., and MILLER, J. W. Preparation Characteristics of Coal from Pike County, Ky. Bureau of Mines Rept. of Investigations 4910, 1952, 28 pp.

_____. Preparation Characteristics of Coal from Floyd County, Ky. Bureau of Mines Rept. of Investigations 4920, 1952, 21 pp.

_____. Preparation Characteristics of Coal from Jefferson County, Pa. Bureau of Mines Rept. of Investigations 4941, 1953, 21 pp.

_____. Preparation Characteristics of Coal from Knott County, Ky. Bureau of Mines Rept. of Investigations 4993, 1953, 30 pp.

MILLER, J. W., JOLLEY, T. R., and SOKASKI, M. Preparation Characteristics of Coal from Raleigh County, W. Va. Bureau of Mines Rept. of Investigations 5070, 1954, 32 pp.

_____. Preparation Characteristics of Coal from McDowell County, W. Va. Bureau of Mines Rept. of Investigations 5094, 1954, 41 pp.

_____. Preparation Characteristics of Coal from Wyoming County, W. Va. Bureau of Mines Rept. of Investigations 5112, 1955, 26 pp.

_____. Preparation Characteristics of Coal from Letcher County, Ky. Bureau of Mines Rept. of Investigations 5135, 1955, 43 pp.

_____. Preparation Characteristics of Coal from Harlan County, Ky. Bureau of Mines Rept. of Investigations 5140, 1955, 44 pp.

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