Bureau of Mines
Report of Investigations 5131

ESTIMATE OF KNOWN RECOVERABLE RESERVES AND THE PREPARATION AND CARBONIZING PROPERTIES OF COKING COAL IN OVERTON COUNTY, TENN.

BY LLOYD WILLIAMS, R. F. ABERNETHY,
B. W. GANDRUD, D. A. REYNOLDS, AND D. E. WOLFSON

United States Department of the Interior — May 1955

ESTIMATE OF KNOWN RECOVERABLE RESERVES AND THE PREPARATION AND CARBONIZING PROPERTIES OF COKING COAL IN OVERTON COUNTY, TENN.

BY LLOYD WILLIAMS, R. F. ABERNETHY,
B. W. GANDRUD, D. A. REYNOLDS, AND D. E. WOLFSON

* * * * * * * * * * Report of Investigations 5131

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

May 1955

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 the study, as determined under the second and third phases of the investigation, of the preparation and carbonizing properties of the most important beds and a table of analyses of typical coals from the county.

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 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.

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, drillcore 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
Coal Technologist
Bureau of Mines

ESTIMATE OF KNOWN RECOVERABLE RESERVES AND THE PREPARATION AND CARBONIZING PROPERTIES OF COKING COAL IN OVERTON COUNTY, TENN.

by

Lloyd Williams,[1] R. F. Abernethy,[2] B. W. Gandrud,[3]
D. A. Reynolds,[4] and D. E. Wolfson[4]

CONTENTS

1/ Supervising Solid Fuels Mining Engineer, Branch of Bituminous Coal, Division of Solid Fuels Technology, Region V, Bureau of Mines, Nashville, Tenn.

2/ Chief, Analysis Section, Branch of Bituminous Coal, Division of Solid Fuels Technology, Region V, Bureau of Mines, Pittsburgh, Pa.

3/ Chief, Coal Laboratory, Branch of Bituminous Coal, Division of Solid Fuels Technology, Bureau of Mines, Region V, Tuscaloosa, Ala.

4/ Chemist, Coal Carbonization Section, Branch of Bituminous Coal, Division of Solid Fuels Technology, Region V, Bureau of Mines, Pittsburgh, Pa.

TABLES

ILLUSTRATIONS

SUMMARY AND CONCLUSIONS

Reserves

1. The investigation shows that the bed identified as Wilder in this report is the only bed in Overton County that has produced commercial coal and is the only bed in which coal reserves were estimated for this report. Three other coal horizons were recognized but lacked enough data for reserve estimates.

2. Known measured and indicated reserves of coal, based on a minimum bed thickness of 14 inches and on 1,800 tons per acre-foot of coal in place, are estimated to be 19 million short tons, as of January 1, 1953. Of this total, 10 million tons represents coal 28 inches and more thick. Areas of the Wilder bed were omitted from the estimate because available data relative to the bed characteristics were too meager for making 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 are 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 of the Wilder bed in Overton County, as determined by this investigation, is 58.6 percent. This percentage is based on the total thickness of coal in the bed (less partings 3/8 inch thick or more) rather than on the thickness of the coal mined. Based on the weighted average percentage of recovery for the Wilder bed in Overton County, the recoverable reserves of coal are estimated at 6 million short tons. Overton County cannot be considered one of the major coal-producing counties in the State.

Coal Analyses

Analyses of 16 face and tipple samples and 2 samples of delivered coal from the Wilder bed in Overton County have been tabulated. Fourteen of the samples were taken before July 1947. Three of them were taken in 1953. This coal is of high-volatile-A bituminous rank moderately high in ash and high in sulfur. The analyses show a volatile content range on the moisture-free basis of 34.0 to 39.0 percent, and a sulfur content from 2.5 to 5.2 percent. The ash content ranges from 8.1 to 16.6 percent.

Preparation

Screen-sizing, crushing, and float-and-sink tests were made on the three large channel samples taken from the Wilder bed in 1953. The resulting data show that coal from this bed in Overton County has a high sulfur content, which cannot be reduced enough by mechanical cleaning to make it suitable for use in making metallurgical coke. Even after crushing to a top size of 14-mesh, the float 1.40 fractions from the 3 samples contained 2.16, 2.14, and 1.70 percent sulfur. On the other

hand, the samples were only moderately high in the ash-forming bony constituents, and, after being crushed to a 1-1/2-inch top size, they gave, respectively, 11.9, 9.6, and 8.9 percent ash in the float 1.60 products.

Carbonization

Two samples of Wilder coal from Overton County yielded coke of average shatter strength and tumbler stability but of rather low tumbler hardness. The sulfur content of both samples was too high to class this coal as metallurgical grade under present-day standards, except when blended with major portions of more suitable coal.

INTRODUCTION

The investigation on evaluation of the reserves of coking coal is being made by the Bureau of Mines, in three parts: (1) Estimation of known measured and indicated recoverable reserves of all coking coal, (2) study of methods of upgrading of marginal coals through effective preparation, and (3) study of carbonizing properties of coals and coal blends not now widely used for metallurgical cokemaking.

This is the 28th of a series of reports giving the results of studies, by counties, of known minable reserves of coking coal (see appendix). This report covers Overton County, Tenn., which is in the northern part of the Tennessee coal field. It is the sixth report for Tennessee. All three phases of the investigation are covered in this report.

A small part of Overton County is comprised of portions of the 15-minute Byrdstown and Lillydale quadrangles (see fig. 1). The largest part is a portion of the Standingstone 30-minute quadrangle. The southeast quarter of the Standingstone quadrangle has been resurveyed and divided into 7-1/2-minute quadrangles. Parts of 2 of the 7-1/2-minute quadrangles, Obey City and Clarkrange, are in Overton County. The Standingstone 30-minute quadrangle, including the Obey City and Clarkrange 7-1/2-minute quadrangles, is the only quadrangle partly underlain by coal.

Data on all coal beds in this county were obtained by personal field reconnaissance and from landowners, mine operators, State agencies, and other authentic sources of information. Samples used for analyses and preparation and carbonization studies were obtained from commercial operations in Overton County.

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 studies, and their cooperation and 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 Tennessee Division of Mines and Tennessee Division of Geology, and consulting mining engineers are appreciated. The assistance and cooperation of the State geologist, William D. Hardeman, in this investigation has been particularly helpful and is sincerely appreciated. The work of C. W. Wilson, Jr., Vanderbilt University, Department of Geology, has also contributed to the progress of the investigation and is hereby acknowledged.

The Tennessee Valley Authority, through R. A. Kampmeier, assistant manager of power, and Jack London, chief, Fuel Engineering Section, has made a major contribution to this investigation, and the cooperation and assistance of TVA are gratefully acknowledged.

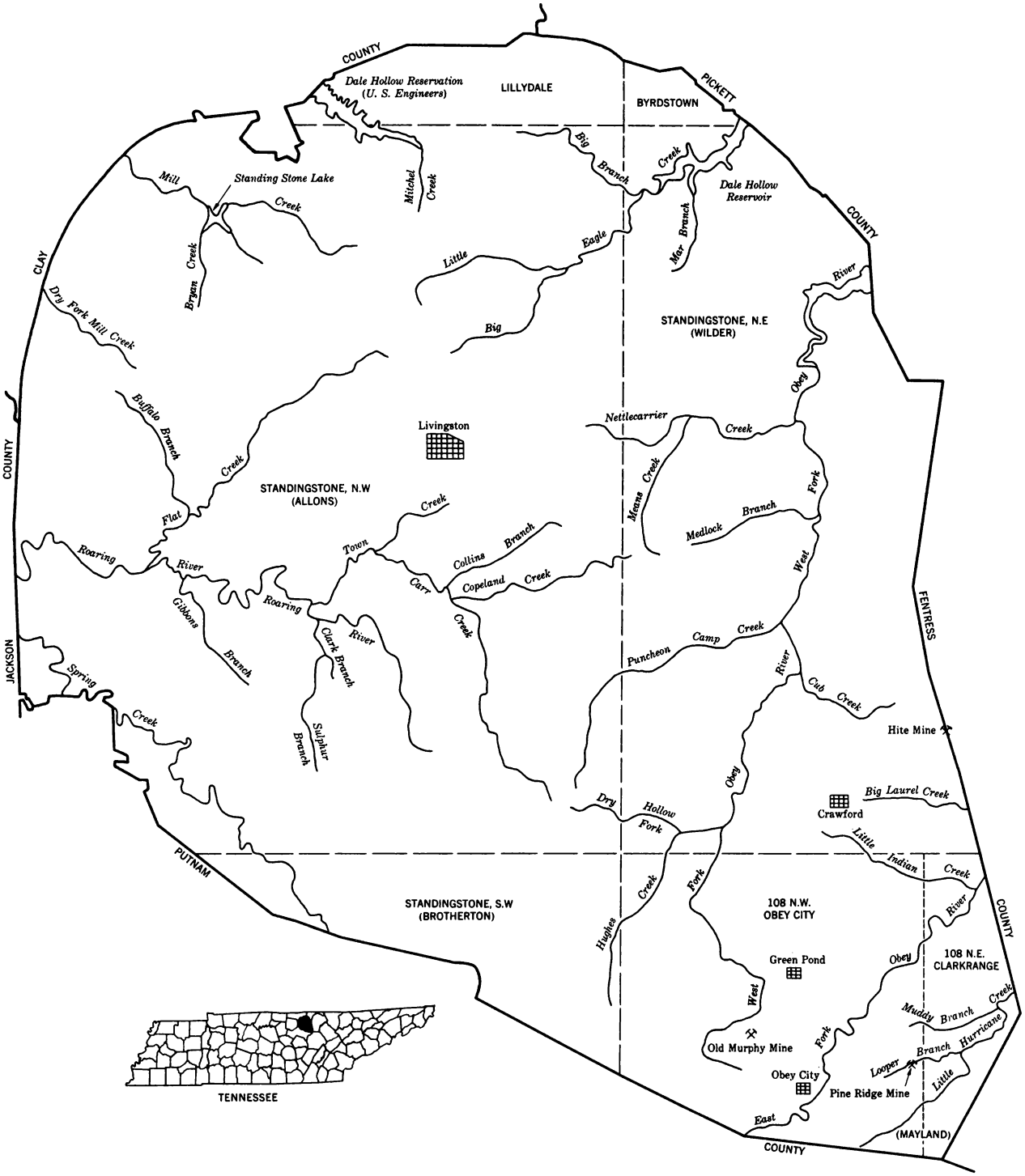

Figure 1. - Key map of Overton County, Tenn.

The investigation was conducted in Region V of the Federal Bureau of Mines. The cooperation of the staff assigned to the work, especially Robert W. Lowe, mining engineer, who did the field work, is appreciated and acknowledged.

ESTIMATION OF KNOWN RECOVERABLE RESERVES

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, in order to make a comparison between 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. All known reserves of coal in the county are considered as coking coal in preparing the reserve estimates. The results of this survey establish the coking qualities of the coal. The possibilities of using these coals for metallurgical cokemaking are discussed in the preparation and carbonization portions of this report.

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 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 within 20 percent or less of the true tonnage. Although the spacing of the points of observation necessary to demonstrate continuity of coal beds will vary 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, 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.

However, the irregularity and discontinuity of the coal beds in Overton County necessitated limiting measured coal to within approximately 500 feet from points of observation. Data from mine workings and shallow drilling above the outcrop showed wide variability of bed thickness within relatively short distances, necessitating this deviation from previous reports.

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 one-half-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 one-fourth 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, 2 lines drawn roughly parallel to the outcrop, one one-half mile in from the outcrop and one 2 miles in from the outcrop, define a block of coal that may be classed as indicated.

However, the discontinuity of the beds in Overton County necessitated limiting indicated coal to approximately twice the distance of measured coal, or 1,000 feet. These findings are corroborated in a statement by former professor of geology5/ in Vanderbilt University. "The average thickness of the seam (Wilder) was - but it varied considerably from this by thickening in the sags or troughs in the floor and thinning across the ridges that intervene between the troughs. The sags or troughs vary from a few feet to about 1,200 feet each."

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 selections 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 Overton County are under less than 300 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 the computation of 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.

5/ Glen, L. C., The Northern Tennessee Coal Field: State of Tennessee Div. of Geology, Bull. 33B, 1925, p. 376.

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 usually 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 Tennessee Division of Mines. This percentage for the whole of Overton County was obtained by calculating the ratio of the total number of tons produced from the county (as of January 1, 1953) to the total tons originally in place in the mined-out area. This ratio is the precentage of recovery used in calculating recoverable reserves for the Wilder bed in Overton County.

All coal remaining for any reason within the mined-out area of a mine is considered a loss. No distinction is made between avoidable and 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 the 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. Some areas in the Wilder bed 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 the Wilder bed was prepared for each 15-minute quadrangle area to the scale of 1 inch equals 2,000 feet. This scale was adopted, as it is the scale of the TVA 7-1/2-minute quadrangles that are the latest topographic maps available. A 15-minute quadrangle is composed of four 7-1/2-minute quadrangles, each covering an area 7-1/2 minutes of longitude by 7-1/2 minutes of latitude. The 15-minute quadrangles are identified by the TVA number, when available; the corresponding 7-1/2-minute quadrangles are identified by name[6/] or directional quarter of the 15-minute quadrangle number. Names for the unpublished 15-minute quadrangles are available only on special Geological Survey index maps for administrative planning. These are identified in this report by directional quarter of the published 30-minute quadrangle. The key map is divided into 15-minute quadrangles and, where available, is subdivided into 7-1/2-minute quadrangles (see fig. 1), which are identified by the 7-1/2-minute name and the directional quarter of the 15-minute quadrangle number.

Overton County comprises parts of the following 15-minute quadrangles and the corresponding 7-1/2-minute and 30-minute quadrangles:

15-minute area		7-1/2-minute area	
Number	Name	quadrangle names	30-minute area
	Lillydale		
	Byrdstown		
	Allons		Standingstone
	Wilder		Do.
	Brotherton		Do.
108	Mayland	Obey City, Clarkrange	Do.

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

No. 108, or Mayland, is available in 7-1/2-minute quadrangle maps (Obey City and Clarkrange) on a scale of 1 inch equals 2,000 feet. The others were pantographed to that scale. Aerial photos were used to map coal outcrops in detail in areas where only 30-minute quadrangles were available. Coal reserves were estimated in the Allons, Wilder, and Mayland (108) 15-minute quadrangles. The Wilder coal bed in the Brotherton quadrangle was excluded from the estimate because of lack of data. The Lillydale and Byrdstown quadrangles lie outside of the coal measures.

Mine workings, locations of drill holes, outcrop and thickness of bed, and total clean-coal thickness were plotted on the base maps. Isopach lines were then drawn to limit areas of known unmined reserves where the bed is 0 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 that may contain reserves based only on geologic inference, and areas outside the outcrop were measured by planimeter on the base maps. These areas were adjusted to conform to theoretical values determined by United States Coast and Geodetic Survey for each quadrangle. Estimates of total reserves 14 inches and more thick for the Wilder bed were prepared from these data.

Description of Deposits

There has been no comprehensive geological study of all the coal measures of the county, but a considerable volume of information was available from earlier reports[7/][8/] and from recent detailed mapping by a professor of geology[9/] at Vanderbilt University.

The thickness of coal-bearing strata of Overton County does not exceed 400 feet and represents a top fraction of the Lee group. The Lee corresponds approximately to the New River and Pocahontas groups of the Pottsville series in the West Virginia classification of the Pennsylvanian system.

The topmost formation is the Rockcastle sandstone, which maintains a fairly consistent elevation. (See fig. 2.) In the southern part of the county it remains only on the high hills, but north of Green Pond it is more prevalent. The horizon of the Isoline coal is just below this sandstone and is at or near the top of the Vandever shale. The observed maximum thickness of the coal was 5 inches. The Isoline is not considered to contain any recoverable reserves. The Lantana coal is at the bottom of the Vandever shale. This coal has been identified in only a few areas in the southern part of the county. The bed is very irregular in continuity and thickness. A maximum thickness of 34 inches was noted. Small-scale mining has been conducted in at least three places. This bed may contain considerable reserves as yet unknown. The Bon Air sandstone, which serves as a marker, is immediately below the Vandever shale. In many areas the sandstone is either absent or very thin, especially north of Obey City. This causes difficult correlation because there is

---

7/ Safford, James M., Report on Coal Lands of Crawford et al in Fentress and Contiguous Counties, 1888, 18 pp. (unpublished).

8/ Glenn, L. C., The Northern Tennessee Coal Field; State of Tennessee Div. of Geology, Bull. 33B, 1925, 478 pp.

9/ Wilson, C. W., Mayland Quadrangle: Tennessee Div. of Geology (in press).

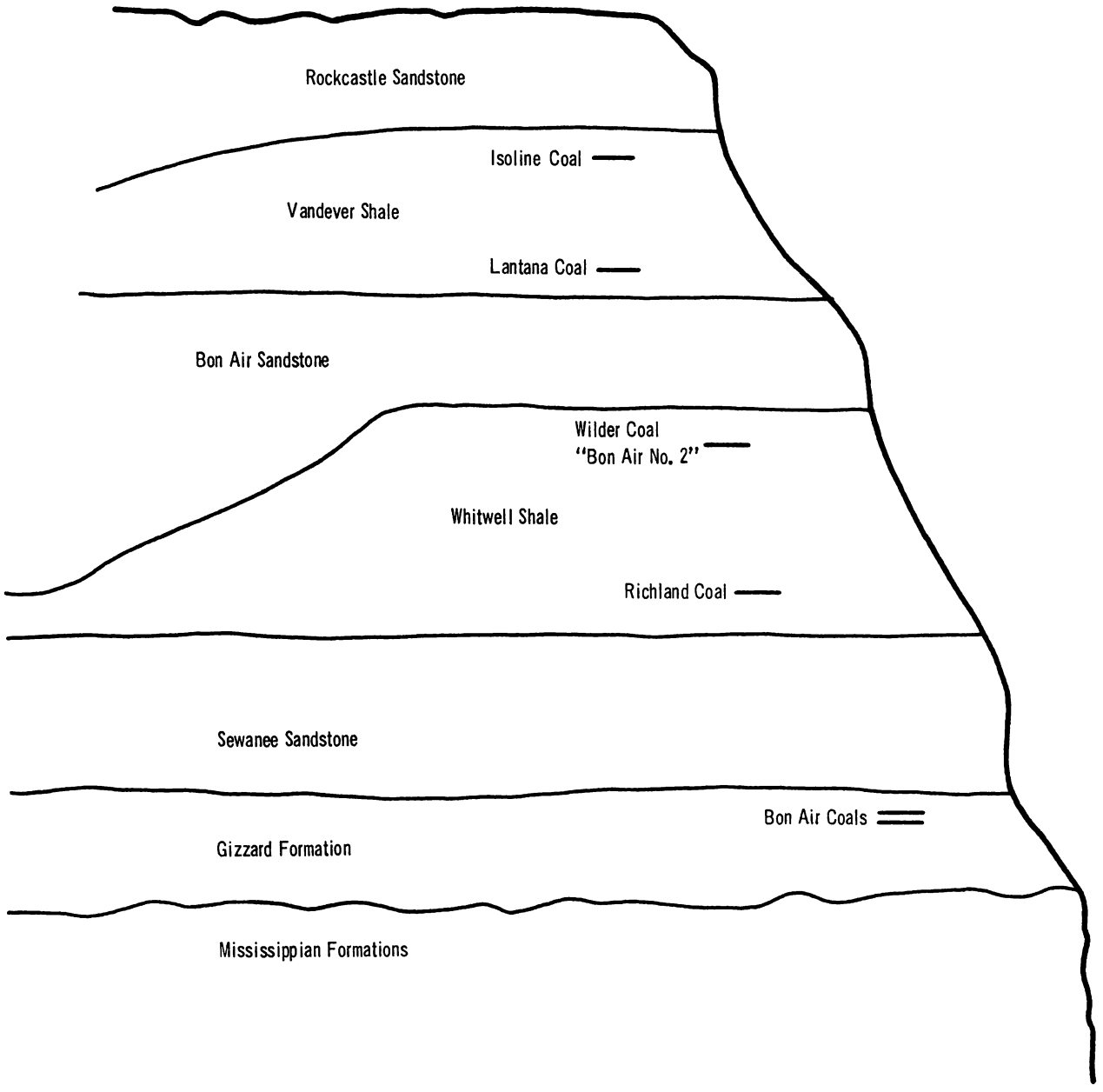

Figure 2. - Typical stratigraphic section of the coal measures in Overton County, Tenn.
(After Tennessee Division of Geology)

no persistent identifiable marker between the Lantana and Wilder coal. The latter bed occurs in the Whitwell shale below the Bon Air sandstone. Want areas and thinning and thickening of the coals add to the uncertainty. Below the Wilder bed and just above the Sewanee conglomerate is the horizon of the Richland bed. It was found in minable thickness in only two places in the county. No reserves are calculated for this bed. Two prospect pits identified in this bed reportedly had 18 and 24 inches of coal. Safford[10] reported the coal to be 4 feet thick in an opening, probably in this bed, at the head of Moredock Branch, which enters the West Fork Obey River from the east 1 mile down river from the mouth of Puncheon Creek. Glenn,[11] however, reports it as being only 18 to 28 inches thick in a 125-foot drift in the same area. Glenn identifies it as the Wilder coal, but its position is just above a 50-foot sandstone overlying the Mississippian formations, which indicates that it is the Richland coal. The most recent opening on Moredock Creek, now abandoned, shows coal ranging 21 to 34 inches in thickness. Credible but unverified reports say that this coal was noted in a recent drilling for water at Crawford and was over 4 feet thick. Although the coal was found in other nearby wells, it was reportedly not of workable thickness. About 2 miles northward from the Moredock occurrence, two prospect pits show the coal to be 14 and 18 inches thick.

Immediately below the Richland coal is the generally massive Sewanee conglomerate, the first prominent stratum above the limestone. Below the Sewanee conglomerate is the Gizzard formation, which contains the horizon of the true Bon Air coals, not noted anywhere in the county. Only an average of 35 feet of strata comprises the Gizzard formation that intervenes between the base of the Sewanee conglomerate and the top of the Mississippian limestone. It is very likely that the Gizzard formation is absent throughout much of Overton County; therefore, the possibilities of reserves in the Bon Air coal or coals are not promising.

Wilder Bed (See fig. 3, and tables 1 and 2).

The horizon of the Wilder bed extends over 12 percent of the county, and the bed is often referred to as Bon Air No. 2.[12] It is the most predominant bed in the county and the only one for which reserves were estimated. The horizon of the Wilder bed occurs in a shale zone below the Bon Air sandstone and is very persistent. The bed seems to have been subject to erosion before the Bon Air sandstone was laid down, as the sandstone is known to form the roof of the coal in places and cut it out entirely in others.

In Overton County the Wilder coal is the most extensively mined coal bed. It occurs in basins of varying size and shape. The basin at Crawford seems to be a relatively large one, and the coal attains a thickness of 6 feet. This basin has been extensively mined; however, the mined area does not show the irregular outline of the whole basin. Mining methods normally used often prevent mining in the irregular extensions of the basin. Coal basins surrounding the Crawford-Wilder basin are less favorable for sustaining mining operations with conventional mining methods. To the north, west, and south, only smaller basins with thinner coal have been found.

10/ See work cited in footnote 7.
11/ See work cited in footnote 8, pp. 366-367.
12/ The Wilder bed is locally known in parts of Overton County as the Bon Air No. 2, although this bed is now known to be much younger than the true Bon Air coal of White County.

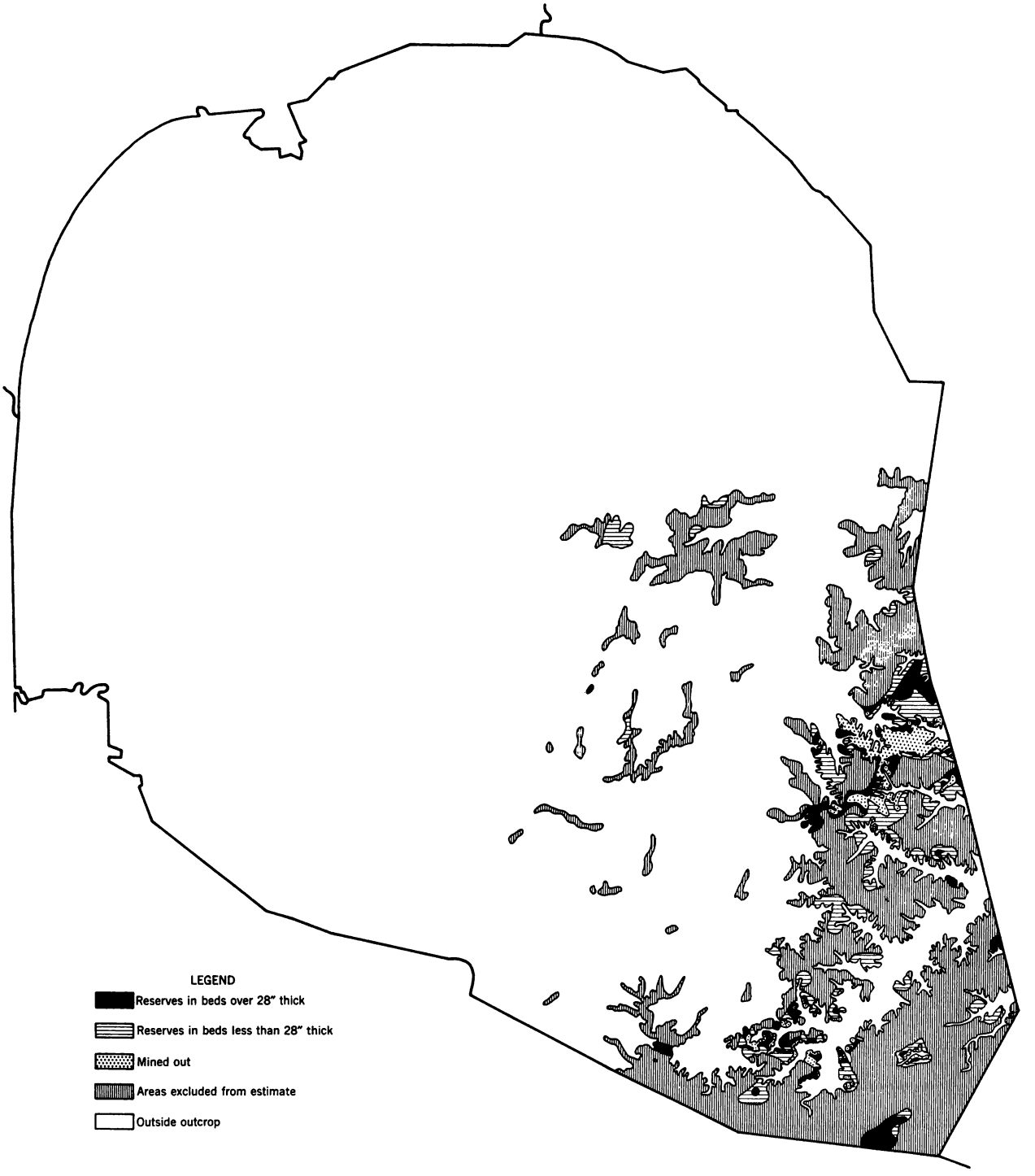

Figure 3. - Wilder bed, Overton County, Tenn., January 1, 1953.

OVERTON COUNTY

TABLE 1. - RESERVES IN WILDER (BON AIR NO. 2) COAL BED, January 1, 1953

15' 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		
Standingstone, N.W. (Allons)	142,249	658	141,286	11	294	-	294	Measured	-	-	-	-	-	-	-	-	-	-		-
								Indicated	280	613	-	-	14	92	294	705	14	92		54
								Total	280	613	-	-	14	92	294	705	14	92	58.6	54
Standingstone, N.E. (Wilder)	70,942	9,455	57,217	604	3,666	1,217	2,449	Measured	111	386	139	757	17	120	267	1,263	156	877		314
								Indicated	1,335	4,424	761	3,817	86	591	2,182	8,832	847	4,408		2,583
								Total	1,446	4,810	900	4,574	103	711	2,449	10,095	1,003	5,285	58.6	3,097
108 (Mayland)	36,694	16,807	17,129	622	2,136	221	1,915	Measured	140	464	80	411	-	-	220	875	80	411		241
								Indicated	896	3,101	799	4,408	-	-	1,695	7,509	799	4,408		2,583
								Total	1,036	3,565	879	4,819	-	-	1,915	8,384	879	4,819	58.6	2,824
Remaining quadrangles	28,623	182	28,441	-	-	-	-	Measured	-	-	-	-	-	-	-	-	-	-		-
								Indicated	-	-	-	-	-	-	-	-	-	-		-
								Total	-	-	-	-	-	-	-	-	-	-	-	-
								Measured	251	850	219	1,168	17	120	487	2,138	236	1,288		755
								Indicated	2,511	8,138	1,560	8,225	100	683	4,171	17,046	1,660	8,908		5,220
Total	278,508	27,102	244,073	1,237	6,096	1,438	4,658	Total	2,762	8,988	1,779	9,393	117	803	4,658	19,184	1,896	10,196	58.6	5,975

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.

TABLE 2. - Analyses of coal from Overton County, Tenn.

Town and mine	Bed	Rank[1]	Size of coal	Approx. tons sampled	Kind of sample[2]	Proximate, percent: As received: Moisture	Proximate, percent: Dry coal: Volatile matter	Fixed carbon	Ash	Ultimate, percent: Dry coal: Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calorific value: B.t.u., as received basis	B.t.u., dry basis	Number of analyses averaged	Ash-softening temperature, °F.	Number of ash-softening temperatures averaged	Agglomerating index	Free-swelling index	Hardgrove grindability index	Date
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Samples taken in 1953																							
Monterey (Putnam Co.):																							
Old Murphy	Wilder	Hvab	-	-	M	2.6	35.7	48.5	15.8	4.6	-	-	-	-	12,090	12,410	1	-	-	-	-	-	June 4, 1953
Pine Ridge	do.	do.	-	-	M	1.8	37.4	50.3	12.3	4.7	-	-	-	-	12,830	13,060	1	-	-	-	-	-	June 2, 1953
Wilder:																							
Hite	do.	do.	-	-	M	2.3	37.8	49.9	12.3	4.6	-	-	-	-	12,760	13,060	1	-	-	-	-	-	June 3, 1953
Samples taken during fiscal year 1950																							
Cliff Springs:																							
Cliff Springs	Wilder or Bon Air No.2	-	Run-of-mine	2,584	D	4.6	34.4	49.0	16.6	5.2	-	-	-	-	11,850	12,420	10	2,090	2	Cf to Cg	-	-	Fis. yr. 1950
Samples taken before July 1947																							
Crawford:																							
A & B	do.	-	4-inch lump	35	T	2.4	37.4	53.8	8.8	2.7	5.1	76.3	1.5	5.6	13,450	13,780	1	2,330	1	Cf	-	-	Oct. 29, 1941
Do.	do.	-	2- by 4-inch	30	T	2.4	36.7	52.5	10.8	3.2	-	-	-	-	13,090	13,410	1	2,220	1	Cf	-	-	Do.
Do.	do.	-	2-inch nut and slack	45	T	3.6	34.0	50.1	15.9	3.5	-	-	-	-	12,070	12,520	1	2,420	1	Cf	-	-	Do.
Blue Gem	do.	-	5-inch lump	10	T	2.3	39.0	52.9	8.1	2.3	5.3	77.0	1.5	5.8	13,580	13,900	1	2,530	1	Cf	-	-	Do.
Do.	do.	-	3- by 5-inch	11	T	2.3	37.9	51.6	10.5	3.3	-	-	-	-	13,150	13,450	1	2,310	1	Cf	-	-	Do.
Do.	do.	-	2- by 5-inch	167	D	1.7	38.4	51.2	10.4	2.7	-	-	-	-	13,290	13,510	-	-	-	Cf	-	-	1941 - 1942
Do.	do.	-	2- by 3-inch	12	T	2.5	37.2	50.5	12.3	3.2	-	-	-	-	12,890	13,220	1	2,450	1	Cf	-	-	Oct. 29, 1941
Do.	do.	-	2-inch nut and slack	40	T	3.4	36.1	50.9	13.0	3.0	-	-	-	-	12,610	13,050	1	2,330	1	Cf	-	-	Do.
Davidson (Fentress Co.):																							
Brier Hill Collieries Co. No. 1	Wilder	Hvab	-	-	M	3.0	36.3	54.9	8.8	2.5	4.9	75.8	1.5	6.5	13,190	13,600	2	2,390	1	-	-	-	Aug. 30, 1919
Brier Hill Collieries Co. No. 2	do.	do.	-	-	M	3.9	35.1	55.6	9.3	2.8	4.8	75.6	1.4	6.1	12,980	13,500	2	2,270	1	-	-	-	Do.
Highland Junction(Fentress Co.):																							
Overton	do.	-	-	-	M	3.4	36.8	52.5	10.7	3.3	5.1	74.8	1.4	4.7	12,990	13,450	3	2,160	1	-	-	-	Feb. 10, 1915
Monterey (Putnam Co.):																							
Bill's Branch	do.	Hvab	-	-	M	2.6	37.9	49.9	12.2	4.0	5.0	72.0	1.3	5.5	12,750	13,090	3	2,180	1	-	-	-	May 18, 1921
Peacock	do.	do.	-	-	M	3.0	37.3	52.4	10.3	2.8	5.2	74.8	1.3	5.6	13,120	13,540	3	2,440	3	-	-	-	Do.
Obey City:																							
Obey River	do.	-	-	-	M	2.6	37.0	50.4	12.6	3.9	-	-	-	-	12,870	13,210	1	2,180	1	-	-	-	Feb. 11, 1915

1/ Hvab - High-volatile-A bituminous.
2/ M - Mine sample.
D - Delivered sample.
T - Tipple sample.

Recoverable reserves occur in the southeastern part of the county. Sections of the bed in this area follow:

Material	Inches
COAL	3
Sulfur kidneys	1
COAL	19
Sulfur kidneys	1
COAL	6
Total	13/30

Material	Inches
COAL	12
Sulfur kidneys	1-1/2
COAL	28
Sulfur kidneys	2
COAL	8-1/2
Total	14/52

COAL	30
Sulfur kidney rash	4
Total	15/34

Coal Reserves

Detailed estimates of known measured and indicated reserves of coal in the Wilder bed in Overton County, Tenn., as of January 1, 1953, are given in table 1. Figure 3 shows the location and extent of the Wilder bed in the county and is divided into 5 areas: (1) Beds 28 inches and more thick, (2) beds less than 28 inches thick, (3) mined out areas, (4) areas excluded from the estimate, and (5) outside the outcrop. Any inferred reserves would be found in areas excluded from estimate. Reserves of coal 14 inches and more thick are estimated at 19,185,000 tons as of January 1, 1953. Of this total, 10,196,000 tons represents coal 28 inches and more thick.

The weighted average percentage of recovery for the Wilder bed in Overton County is 58.6. This is the ratio of the total number of tons produced in the county to the total tons originally in place in the mined-out areas. Based on this recovery, the known recoverable reserves 28 inches and more thick in Overton County are estimated at 5,978,000 short tons as of January 1, 1953. These reserves cover only a small portion of the possible coal-bearing area of the county. Four percent of the bed area has been mined out. Seventy-nine percent of the Wilder-bed-horizon area was excluded from the estimate for lack of information. This represents possible extensive inferred coal reserves, much of which may be converted to measured and indicated reserves by closely spaced drill holes in areas showing favorable geologic conditions.

Overton County cannot be considered one of the major coal-producing counties in Tennessee. Coal production during 1953 amounted to 141,825 tons.16/ Overton County ranked 9th of the 18 counties recorded as producing coal in that year. This is a

13/ Bed section obtained from channel sample from Pine Ridge mine, taken by representative of the Bureau of Mines June 2, 1953, for coal preparation and carbonization studies in this report.

14/ Bed section obtained from channel sample from Hite mine, taken by representative of the Bureau of Mines June 3, 1953, for coal preparation and carbonization studies in this report.

15/ Bed section obtained from channel sample from Old Murphy mine, taken by representative of the Bureau of Mines June 4, 1953, for coal-preparation studies in this report.

16/ Bureau of Mines, Bituminous coal and lignite in 1953: Mineral Market Summary 2339, 1954, p. 120.

notable increase in annual production rate over the preceding 4 years. Compilation of records indicate that Overton County has produced about 6,255,000[17] tons of coal between 1852 and January 1, 1954. This is about 1.8 percent of the total coal produced in Tennessee, ranking the county 13th in total production of coal.

ANALYSES OF OVERTON COUNTY COAL

Table 2 gives chemical analyses of tipple and mine samples and samples of delivered coal from Overton County. All samples in table 2 are from the Wilder bed, known in some localities of Overton County as the Bon Air No. 2. The table is arranged in accordance with the years in which the samples were collected. The 1953 group was taken specifically for preparation and carbonization tests in connection with the present survey. Each sample for preparation tests was a single face sample and included all partings. The analyses of these samples have not been published previously.

The two sets of analyses of delivered coal (in the fiscal year 1950 and before July 1947) represent coal delivered from the originating source on Government fuel contracts (see columns 1 and 2) assuming that no substitutions were made on the contracts. The tipple samples taken before July 1947 were collected during one shift and subsequently analyzed in connection with Government fuel requirements. The mine samples in this group are in most instances composites of several samples to obtain a mine average.

It should be pointed out that many of the ash analyses in table 2 are determinations made on screened sizes or mine samples that include all partings. These ash determinations are not necessarily those of the pure-coal matter and cannot be used to estimate washed-coal quality. To a much smaller extent, this is also true of the sulfur analyses, and, except for the mine samples taken before July 1947, the ash and sulfur values are not indicative of the extent to which these impurities can be reduced with present-day mechanical methods of cleaning, as they are primarily run-of-mine or raw-coal values. The mine samples in the group taken before July 1947, however, are more indicative of the actual quality of the coal, as they were standard channel samples from which most of the partings had been systematically eliminated. The analyses in table 2 show that the coal from the Wilder bed is of high-volatile-A bituminous rank, moderately high in ash and high in sulfur. On the moisture-free basis, the volatile matter ranges from 34.0 to 39.0 percent and the sulfur from 2.5 to 5.2 percent. The range of the ash analyses is 8.1 to 16.6 percent.

The analyses of the samples taken in 1953 are published in this report for the first time. The analyses of samples taken in fiscal year 1950 and before July 1947 have been published.[18][19]

17/ Compiled partly from Annual Reports of Tennessee Division of Mines, Bureau of Mines Mineral Market Summaries, and unpublished records.

18/ For fiscal year 1950: Snyder, N. H., and Aresco, S. J., Analyses of Tipple and Delivered Samples of Coal (Collected During the Fiscal Years 1948 to 1950 Inclusive): Bureau of Mines Bull. 516, 1953, 133 pp.

19/ For years before July 1947: Fieldner, A. C., Nelson, W. A., Toenges, A. L., Fraser, Thomas, Crentz, W. L., Anderson, R. L., Bell, C. H., Snyder, N. H., Cooper, H. M., Abernethy, R. F., Tarpley, E. C., and Swingle, R. J., Analyses of Tennessee Coals (Including Georgia): Bureau of Mines Tech. Paper 671, 1945, 243 pp.

The samples in the group taken during 1953 have been subjected to crushing, screening, and float-and-sink tests to indicate more accurately the quality of coal obtainable by applying modern methods of coal cleaning to the coals represented by these samples. The results of these tests will be discussed in the following section on Preparation Characteristics.

PREPARATION CHARACTERISTICS OF COAL FROM OVERTON COUNTY, TENN.

Test Procedure

The three samples for preparation tests were obtained from the Old Murphy and Pine Ridge mines of the Bruns Coal Co. and the Hite mine of the Hite & Isobel Coal Co. All of these mines are operating in the Wilder bed. Their locations are shown on the key map, figure 1. Each sample was collected at a working face in the conventional manner, except that all binders and partings in the mined section of the bed were included in the sample, even though some of this extraneous material would normally be removed on the picking tables. The total weight of each sample was about 400 pounds. The samples were placed in steel drums and shipped to the Bureau of Mines laboratory in Pittsburgh, where the crushing, screening, and float-and-sink tests were made.

In the laboratory each sample was crushed to a 1-1/2-inch top size and riffled, 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. One-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 lot 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. 4) shows the steps taken in preparing the samples for the float-and-sink test.

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

The float-and-sink test for determining the washing characteristics of a coal has been used for many years, and descriptions of the procedure have appeared frequently in the literature. The construction of washability charts and the interpretation of float-and-sink data have been explained carefully by Coe.[20/]

The 100-mesh by 0 dust was removed from all samples before separation into specific-gravity fractions to expedite the float-and-sink test. In commercial practice it is wasteful to discard this dust, but including it in the washed coal increases somewhat the ash and sulfur percentages shown in the washability data for the dedusted coal samples. Usually the quantity of fine dust produced during crushing does not become a serious problem unless the coal is crushed finer than 1-1/2-inch top size.

In interpreting preparation characteristics of coal from float-and-sink data, it must be remembered that these data are based on precise specific-gravity separations that are approached but not equaled in commercial practice. 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.

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

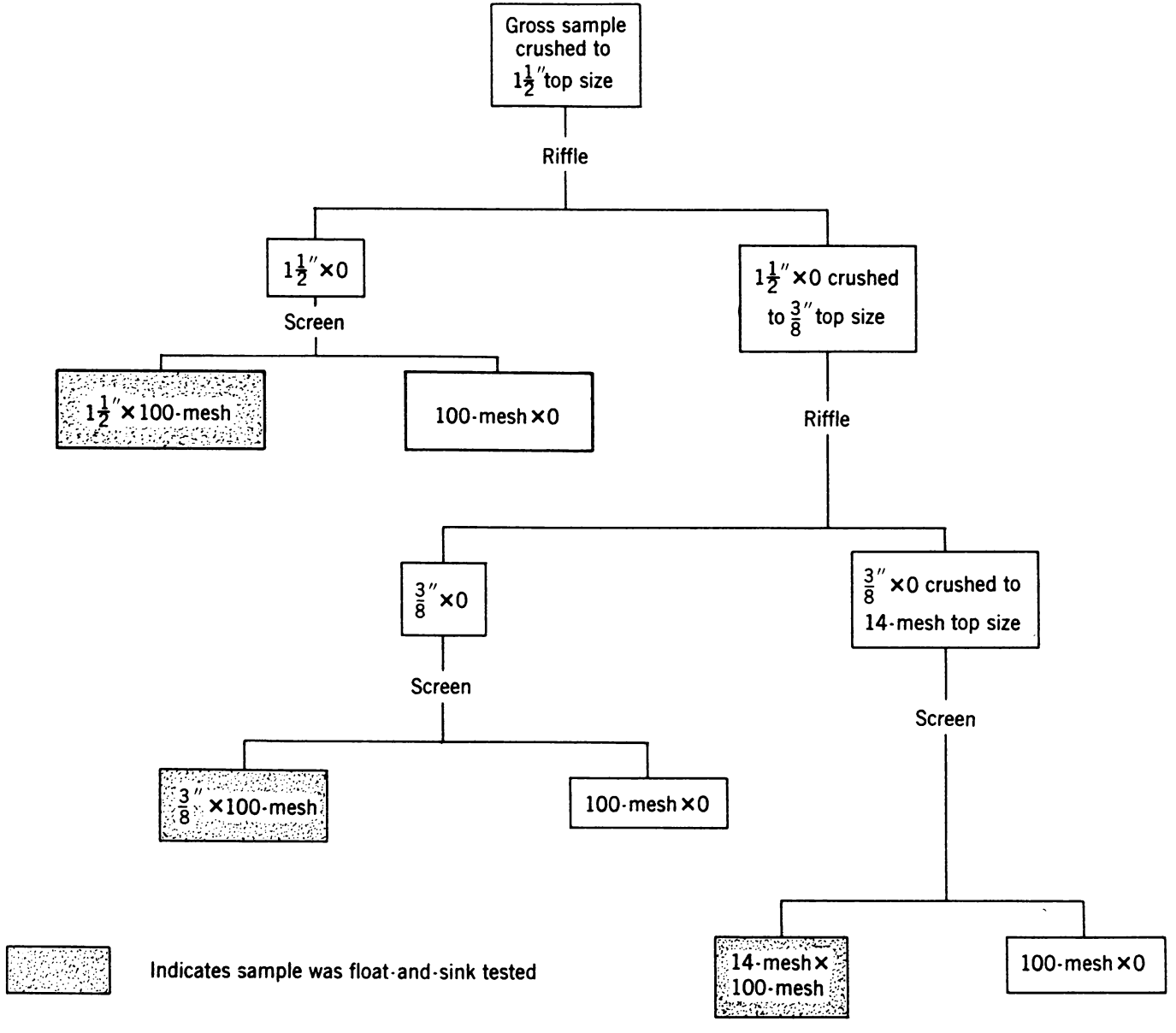

Figure 4. - Flow diagram, showing preparation of samples.

Experimental Results, Wilder Bed

At the points of sampling in the Old Murphy and Pine Ridge mines, the Wilder bed had a thickness of 2 feet, 10 inches, and 2 feet, 6 inches, respectively. In both places there were noticeable streaks of high-sulfur impurities. In the Hite mine the Wilder bed was 4 feet, 4 inches thick at the point of sampling and had two partings, each several inches thick, of high-sulfur impurities. Tables 3 to 5, 6 to 8, and 9 to 11 show the float-and-sink data for the Old Murphy, Pine Ridge and Hite samples, respectively. The 3 tables for each sample present the results obtained after crushing to top sizes of 1-1/2-inch, 3/8-inch, and 14-mesh. The data tabulations show that all three samples were quite similar as far as ash- and sulfur-elimination possibilities are concerned. The Old Murphy coal contained slightly more bone than the other 2 and gave an ash analysis of 11.9 percent for the 1-1/2-inch by 100-mesh float 1.60 compared with 9.6 and 8.9 percent for the other 2, as shown in tables 3, 6, and 9. Tables 4, 5, 7, 8, 10, and 11 show that crushing to 3/8-inch or even to 14-mesh did not increase appreciably liberation of the ash-forming impurities in any samples. The greatest improvement in ash analysis obtained by crushing from 1-1/2-inch to 14-mesh top size was a reduction from 11.9 to 10.9 percent ash in the float at 1.60 specific gravity in the case of the Old Murphy sample, according to tables 3 and 5.

The ash analyses shown for the float at 1.60 in tables 3, 6, and 9 would not be particularly difficult to obtain in the washed coal with modern coal-washing equipment treating a 1-1/2-inch to 0 feed, and they would be quite acceptable in steam coal and coal for various domestic and industrial purposes and in some instances in coal for metallurgical use. On the other hand, their high sulfur content would probably prevent the coals represented by the samples from the Old Murphy, Hite, and Pine Ridge mines from being used in the manufacture of metallurgical coke. Table 2 shows that the raw-coal samples analyzed 4.6, 4.6, and 4.7 percent sulfur, respectively. These sulfur percentages would have to be reduced drastically before they would be within the permissible range for metallurgical coal, the upper limit of which is usually considered to be about 1.25 percent sulfur. Furthermore, the float-and-sink results in tables 3 to 8 show that it would be difficult to clean either the Old Murphy or Pine Ridge coals to even as low as 2.25 percent sulfur, and table 10 shows that at a top size of 3/8-inch the Hite coal floating at 1.40 specific gravity analyzed 1.91 percent sulfur. The only means available at present for cleaning efficiently at a specific gravity as low as 1.40 is the heavy-medium process, which is unsuitable for the relatively fine sizes below approximately 4-mesh and therefore not applicable to a raw-coal feed crushed to 14-mesh top size. The data in tables 5, 8, and 11 are therefore not particularly significant at this time but do show that crushing to a top size of 14-mesh did not improve the liberation of sulfur very appreciably. Taking all these factors into consideration, it seems logical to conclude that the Wilder bed in Overton County is too highly contaminated with sulfur impurities to merit consideration as a potential source of metallurgical coking coal.

TABLE 3. - Washing characteristics of face sample, Old Murphy mine. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100-mesh (98.5 percent of sample)	Float 1.30	4.6	4.6	4.8	4.8	1.86	1.86
	1.30 - 1.35	41.8	46.4	8.9	8.5	2.30	2.26
	1.35 - 1.40	23.7	70.1	12.6	9.9	2.94	2.49
	1.40 - 1.45	7.7	77.8	16.0	10.5	4.00	2.64
	1.45 - 1.50	3.3	81.1	20.0	10.9	4.16	2.70
	1.50 - 1.55	2.9	84.0	25.3	11.4	3.61	2.73
	1.55 - 1.60	2.2	86.2	30.6	11.9	3.84	2.76
	1.60 - Sink	13.8	100.0	47.8	16.8	22.73	5.51
100-mesh by 0 (1.5 percent of sample)				11.2		3.77	

1/ Moisture-free basis.

TABLE 4. - Washing characteristics of face sample, Old Murphy mine. Sample crushed to 3/8-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
3/8-inch by 100-mesh (91.0 percent of sample)	Float 1.30	17.2	17.2	4.5	4.5	1.80	1.80
	1.30 - 1.35	33.3	50.5	8.7	7.3	2.26	2.10
	1.35 - 1.40	20.8	71.3	13.4	9.1	2.72	2.28
	1.40 - 1.45	7.7	79.0	16.9	9.8	3.44	2.40
	1.45 - 1.50	4.2	83.2	21.0	10.4	3.95	2.47
	1.50 - 1.55	2.8	86.0	24.6	10.8	4.22	2.53
	1.55 - 1.60	1.1	87.1	28.6	11.1	4.45	2.56
	1.60 - Sink	12.9	100.0	47.2	15.7	18.08	4.56
100-mesh by 0 (9.0 percent of sample)				13.9		4.10	

1/ Moisture-free basis.

TABLE 5. - Washing characteristics of face sample, Old Murphy mine. Sample crushed to 14-mesh top size; data in percent

Size	Specific-gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
14- by 100-mesh (84.2 percent of sample)	Float 1.30	23.4	23.4	4.4	4.4	1.75	1.75
	1.30 - 1.35	25.9	49.3	8.7	6.7	2.27	2.02
	1.35 - 1.40	17.2	66.5	13.3	8.4	2.55	2.16
	1.40 - 1.45	10.1	76.6	16.8	9.5	2.85	2.25
	1.45 - 1.50	4.5	81.1	20.4	10.1	3.41	2.31
	1.50 - 1.55	3.2	84.3	23.1	10.6	3.84	2.37
	1.55 - 1.60	1.8	86.1	25.8	10.9	4.36	2.41
	1.60 - Sink	13.9	100.0	47.1	15.9	17.39	4.50
100-mesh by 0 (15.8 percent of sample)				14.5		4.84	

1/ Moisture-free basis.

TABLE 6. - Washing characteristics of face sample, Pine Ridge mine. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100-mesh (98.1 percent of sample)	Float 1.30	14.4	14.4	5.4	5.4	1.70	1.70
	1.30 - 1.35	49.7	64.1	8.8	8.0	2.36	2.21
	1.35 - 1.40	19.5	83.6	12.6	9.1	3.20	2.44
	1.40 - 1.45	3.9	87.5	14.7	9.4	3.59	2.49
	1.45 - 1.50	1.4	88.9	16.0	9.5	4.33	2.52
	1.50 - 1.55	.8	89.7	18.3	9.5	4.07	2.54
	1.55 - 1.60	.4	90.1	18.2	9.6	4.88	2.55
	1.60 - Sink	9.9	100.0	48.8	13.5	26.68	4.94
100-mesh by 0 (1.9 percent of sample)				8.8		3.17	

1/ Moisture-free basis.

TABLE 7. - Washing characteristics of face sample, Pine Ridge mine. Sample crushed to 3/8-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
3/8-inch by 100-mesh (93.6 percent of sample)	Float 1.30	21.0	21.0	4.3	4.3	1.65	1.65
	1.30 - 1.35	43.1	64.1	8.6	7.2	2.33	2.11
	1.35 - 1.40	19.8	83.9	12.4	8.4	3.02	2.32
	1.40 - 1.45	4.4	88.3	15.9	8.8	3.93	2.40
	1.45 - 1.50	1.9	90.2	19.0	9.0	4.30	2.44
	1.50 - 1.55	1.2	91.4	21.0	9.2	5.06	2.48
	1.55 - 1.60	.5	91.9	22.3	9.3	5.85	2.50
	1.60 - Sink	8.1	100.0	50.6	12.6	31.20	4.82
100-mesh by 0 (6.4 percent of sample)				9.3		3.41	

1/ Moisture-free basis.

TABLE 8. - Washing characteristics of face sample, Pine Ridge mine. Sample crushed to 14-mesh top size; data in percent

Size	Specific-gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
14- by 100-mesh (89.4 percent of sample)	Float 1.30	37.8	37.8	4.4	4.4	1.75	1.75
	1.30 - 1.35	23.5	61.3	9.0	6.2	2.37	2.00
	1.35 - 1.40	16.6	77.9	12.6	7.5	2.68	2.14
	1.40 - 1.45	8.1	86.0	15.4	8.3	3.13	2.23
	1.45 - 1.50	2.7	88.7	18.9	8.6	3.75	2.28
	1.50 - 1.55	1.9	90.6	20.8	8.9	4.34	2.32
	1.55 - 1.60	.4	91.0	24.0	8.9	5.46	2.33
	1.60 - Sink	9.0	100.0	49.1	12.5	28.26	4.67
100-mesh by 0 (10.6 percent of sample)				11.1		4.71	

1/ Moisture-free basis.

TABLE 9. - Washing characteristics of face sample, Hite mine. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100-mesh (98.5 percent of sample)	Float 1.30	18.2	18.2	5.2	5.2	2.07	2.07
	1.30 - 1.35	57.6	75.8	8.3	7.6	2.17	2.15
	1.35 - 1.40	9.7	85.5	12.1	8.1	3.05	2.25
	1.40 - 1.45	4.1	89.6	16.2	8.4	3.68	2.31
	1.45 - 1.50	1.8	91.4	19.1	8.7	3.99	2.35
	1.50 - 1.55	1.2	92.6	22.2	8.8	4.32	2.37
	1.55 - 1.60	.7	93.3	24.7	8.9	4.10	2.39
	1.60 - Sink	6.7	100.0	48.7	11.6	24.91	3.89
100-mesh by 0 (1.5 percent of sample)				10.9		3.93	

1/ Moisture-free basis.

TABLE 10. - Washing characteristics of face sample, Hite mine. Sample crushed to 3/8-inch top size; data in percent

Size	Specific-gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
3/8-inch by 100-mesh (94.1 percent of sample)	Float 1.30	36.4	36.4	5.2	5.2	1.54	1.54
	1.30 - 1.35	36.9	73.3	8.7	7.0	2.01	1.78
	1.35 - 1.40	10.7	84.0	12.4	7.7	2.79	1.91
	1.40 - 1.45	3.9	87.9	15.6	8.0	3.85	1.99
	1.45 - 1.50	2.0	89.9	19.5	8.3	4.25	2.04
	1.50 - 1.55	1.2	91.1	22.7	8.5	4.50	2.07
	1.55 - 1.60	.8	91.9	27.5	8.6	3.87	2.09
	1.60 - Sink	8.1	100.0	51.8	12.1	27.75	4.17
100-mesh by 0 (5.9 percent of sample)				10.8		4.34	

1/ Moisture-free basis.

TABLE 11. - Washing characteristics of face sample, Hite mine. Sample crushed to 14-mesh top size; data in percent

Size	Specific-gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
14- by 100-mesh (87.6 percent of sample)	Float 1.30	47.4	47.4	4.5	4.5	1.49	1.49
	1.30 - 1.35	21.5	68.9	9.0	5.9	1.84	1.60
	1.35 - 1.40	13.4	82.3	13.0	7.1	2.20	1.70
	1.40 - 1.45	4.8	87.1	16.0	7.6	2.89	1.76
	1.45 - 1.50	1.8	88.9	19.3	7.8	3.83	1.80
	1.50 - 1.55	1.6	90.5	21.9	8.0	4.33	1.85
	1.55 - 1.60	1.1	91.6	23.9	8.2	4.58	1.88
	1.60 - Sink	8.4	100.0	49.9	11.7	27.44	4.03
100-mesh by 0(12.4 percent of sample)				11.8		4.93	

1/ Moisture-free basis.

CARBONIZING PROPERTIES OF OVERTON COUNTY COAL

Two samples of Wilder-bed coal were collected to study their carbonizing properties. Channel samples representing the full thickness of minable coal in the bed were taken in the mines under the supervision of Bureau of Mines engineers. These samples, which weigh about 600 pounds each, were transported to the Bureau's Central Experiment Station, Pittsburgh, Pa., in steel drums and prepared for carbonization tests by crushing in the hammer mill. The source of the samples is shown below (see fig. 1):

Coal No.	Bed	Mine	Town	County
638	Wilder	Hite	Twintown	Overton
639	do.	Pine Ridge (strip)	Obey City	Do.

Chemical Composition of Wilder Bed

Table 12 gives chemical analyses, heating value, softening temperature of ash, free-swelling index, agglutinating value, and expansion of coals carbonized. Both ranked as high-volatile-A bituminous because they contained 57.0 and 57.5 percent dry, mineral-matter-free fixed carbon, and their heating values on the moist, mineral-matter-free basis exceeded 14,000 B.t.u. per pound. They contain relatively high proportions of ash, and their sulfur content (3.1 percent) is excessively high for metallurgical use, by present standards. Results of miscellaneous tests show free-swelling indexes of 4-1/2 and 5-1/2, agglutinating values at the 15:1 ratio of silicon carbide to coal of 8.5 and 8.2, and ash-softening temperatures of 2,310° and 2,070° F.

TABLE 12. - Chemical analyses, free-swelling index, agglutinating value, and expansion of coals

Coal No.	638	639
Dry, mineral-matter-free fixed carbon ..... percent	57.0	57.5
Moist, mineral-matter-free heating value ..... B.t.u. per lb.	14,550	14,860
Proximate analysis of coal, percent:		
Moisture	3.1	2.6
Volatile matter	38.0	37.8
Fixed carbon	48.5	49.4
Ash	10.4	10.2
Ultimate analysis of coal, percent:		
Ash	10.4	10.2
Hydrogen	5.2	5.2
Carbon	70.7	72.6
Nitrogen	1.3	1.3
Oxygen	9.3	7.6
Sulfur	3.1	3.1
Softening temperature of ash ..... °F.	2,310	2,070
Free swelling index	4-1/2	5-1/2
Agglutinating value, silicon carbide - coal ratio 15:1	8.5	8.2
Expansion ..... percent	-5.0	-8.0

Carbonizing Properties Determined by the BM-AGA Method

The carbonizing properties were determined by the Bureau of Mines-American Gas Association (BM-AGA) method; duplicate tests were made in the standard 18-inch

retort at 900° C. Yields of coke, gas, tar, light oil, ammonia, and liquor were measured, and the properties of the coke were determined by standard methods of the American Society for Testing Materials. The results given in this report are averages of duplicate tests.

Yields of Carbonization Products

In computing the yields from BM-AGA carbonization tests, United States Gallons (231 cubic inches), and short tons (2,000 pounds) are used. Yields are based upon the coal as carbonized, which is equivalent to the as-received basis unless otherwise stated. The yield, specific gravity, and heating value of the gas (both properties determined) are reported as stripped of light oil, saturated with water vapor at 60° F., and under a pressure equivalent to 30 inches of mercury. Coke, tar, and light oil are reported as percentages, moisture-free, of coal carbonized. The term "light oil" refers to crude product stripped from the gas and does not include the portion that condenses with the tar. The yield of ammonium sulfate is given in pounds per ton of coal and includes total free and fixed ammonia. Liquor includes the fixed ammonia and dry, free ammonia absorbed by it.

Table 13 gives the yields of carbonization products from the 2 samples of Wilder bed and the average yields for 20 high-volatile A coals that have been used in commercial blends to produce metallurgical coke. These 20 coals were sampled for BM-AGA tests in mines known to have supplied coke plants with high-volatile blending coal.

Sample 639 from Pine Ridge mine yields 1.5 percent more coke than the Hite-mine sample (638); as anticipated, the yields of other products are similar because they are of similar chemical composition. They yield less coke than the average high-volatile-A coal, even though they both contain more than 10 percent ash. Their yields of tar and light oil are well above average, and their yields of gas and ammonium sulfate are lower than average.

TABLE 13. - Yields of carbonization products, as-received basis

	Coal No. 638	Coal No. 639	Average for 20 high-volatile A coals[1/]
Yields, percent:			
Coke	66.0	67.5	69.1
Gas	14.7	14.4	
Tar	8.2	7.8	
Light oil	1.52	1.35	
Free ammonia	0.161	0.151	
Sulfur	0.99	1.00	
Liquor	7.9	6.7	
Total	99.5	98.9	
Yields, per ton of coal:			
Gas ... cubic feet	9,800	9,600	10,350
Tar ... gallons	16.7	16.2	13.8
Light oil ... gallons	4.16	3.74	3.15
Ammonium sulfate ... pounds	20.8	20.6	23.9

1/ Tested previously under similar conditions; have been blended commercially to produce metallurgical coke.

Properties of Gas

The heating values of the gases (609 and 610), reported in B.t.u. per cubic foot, are close to the average value of 603 for 39 high-volatile coals tested previously under similar conditions. The hydrogen sulfide contents of the gases are high (1,440 and 1,480 grains per 100 cubic feet), but they are in accord with the sulfur content of these coals.

Properties of Coke

Chemical and physical properties of the cokes are given in table 14. Sections of representative full-length pieces are shown in figure 5.

The cokes are less blocky than cokes made from coals of higher fixed-carbon content; they are medium to coarse grained. Both cokes have satisfactorily high 1-1/2-inch shatter and 1-inch tumbler indexes but lower-than-average 1/4-inch tumbler indexes. As the latter index commonly is not increased significantly by blending high-volatile-A with 20 or 30 percent low-volatile coals, the hardness of cokes from blends of Wilder and higher ranking coals may be low enough to detract from their value for blast-furnace use. If the sulfur content of these coals is lowered by a suitable preparation method, they probably can be used as minor constituents of coking blends.

TABLE 14. - Properties of coke

	Coal No. 638	Coal No. 639	Average for 20 high-volatile-A coals[1/]
Apparent specific gravity ...	0.79	0.81	0.85
Porosity	59.5	58.5	-
1-1/2-inch shatter	85	84	78
1-inch tumbler	37	42	38
1/4-inch tumbler	57	56	62
Sulfur ..... percent	2.8	2.8	-

1/ Tested previously under similar conditions; have been blended commercially to produce metallurgical coke.

Expanding Properties

The expanding properties of the Wilder coals were determined in the Bureau of Mines sole-heated oven in which about 40 pounds of coal is heated from the bottom or sole.[21/] The coal is leveled and tamped to a bulk density of about 53 pounds per cubic foot and covered with an insulated plate, which is loaded to apply a pressure of 2.2 pounds per square inch to the coal charge. The upward or downward movement of the cover plate indicates the linear expansion or contraction at test bulk density, which is calculated to percentage expansion at a standard bulk density of 55.0 pounds per cubic foot and 1 percent moisture. The Hite and Pine Ridge coals contracted 5.0 and 8.0 percent, respectively. High-volatile-A coals, unless high in that classification, generally contract more than these two from the Wilder bed.

21/ Auvil, H. S., Davis, J. D., and McCartney, J. T., Expansion of Coal During Coking: Bureau of Mines Rept. of Investigations 3451, 1939, 21 pp.

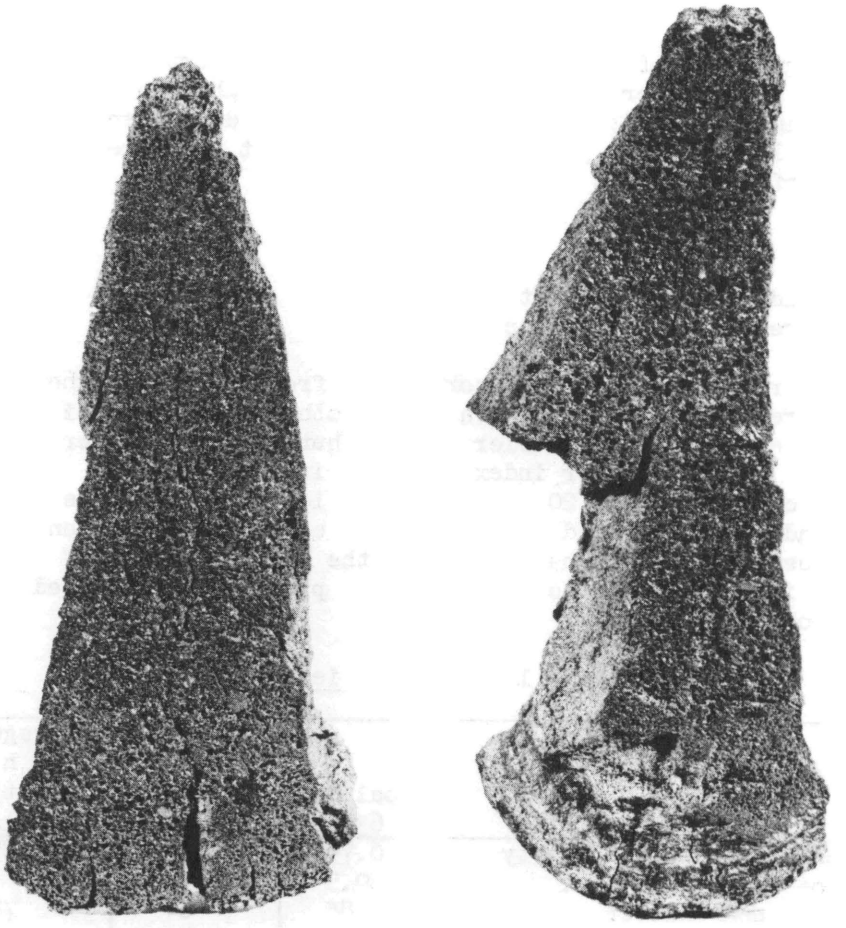

Figure 5. - Sections of 900° C. BM-AGA cokes from Overton County, Tenn., Wilder bed: 1–Hite mine (638); 2–Pine Ridge mine (639).

APPENDIX

Completed reports giving results of studies by counties:

Estimation of Known Recoverable Reserves

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

DOWD, JAMES J., TURNBULL, LOUIS A., TOENGES, ALBERT 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.

DOWD, JAMES J. TURNBULL, LOUIS A., TOENGES, ALBERT L., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Armstrong County, Pa. Bureau of Mines Rept. of Investigations 4801, 1951, 16 pp.

DOWD, JAMES J., TURNBULL, LOUIS A., TOENGES, ALBERT L., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Westmoreland County, Pa. Bureau of Mines Rept. of Investigations 4803, 1951, 16 pp.

DOWD, JAMES J., TURNBULL, LOUIS A., TOENGES, ALBERT L., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Fayette County, Pa. Bureau of Mines Rept. of Investigations 4807, 1951, 19 pp.

DOWD, JAMES J., TURNBULL, LOUIS A., TOENGES, ALBERT L., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Floyd County, Ky. Bureau of Mines Rept. of Investigations 4813, 1951, 16 pp.

DOWD, JAMES J., TOENGES, ALBERT 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.

DOWD, JAMES J., TOENGES, ALBERT L., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Raleigh County, W. Va. Bureau of Mines Rept. of Investigations 4893, 1952, 37 pp.

DOWD, JAMES J., TOENGES, ALBERT L., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Knott County, Ky. Bureau of Mines Rept. of Investigations 4897, 1952, 20 pp.

WALLACE, JOSEPH J., DOWD, JAMES J., TAVENNER, WILLIAM H., PROVOST, JOHN 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, JOSEPH J., DOWD, JAMES J., TAVENNER, WILLIAM 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, JOSEPH J., DOWD, JAMES 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, JOSEPH J. DOWD, JAMES J., BOWSHER, JOHN 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, JOSEPH J., DOWD, JAMES J., TRAVIS, RAYMOND 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, JOSEPH J., DOWD, JAMES J., PROVOST, JOHN 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, JOSEPH J., DOWD, JAMES J., TRAVIS, RAYMOND 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, JOSEPH J., DOWD, JAMES J., TAVENNER, WILLIAM 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, JOSEPH J., DOWD, JAMES J., TAVENNER, WILLIAM H., PROVOST, JOHN 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, JOSEPH J., DOWD, JAMES J., TRAVIS, RAYMOND 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, CURTIS 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. (In preparation.)

WILLIAMS, LLOYD, HERSHEY, ROBERT 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. (In preparation.)

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. (In preparation.)

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. (In preparation.)

WALLACE, JOSEPH J., DOWD, JAMES J., PROVOST, JOHN 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 pages.

WALLACE, JOSEPH J., DOWD, JAMES J., PROVOST, JOHN 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. (In preparation.)

Preparation Studies

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

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

CRENTZ, WILLIAM L., STEELE, FERN, and BAILEY, A. L. Preparation Characteristics of Coal Occurring in Armstrong County, Pa. Bureau of Mines Rept. of Investigations 4788, 1951, 25 pp.

CRENTZ, WILLIAM 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, WILLIAM 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.

CRENTZ, WILLIAM, L., BAILEY, A. L., and MILLER, J. W. Preparation Characteristics of Coal from Somerset County, Pa. Bureau of Mines Rept. of Investigations 4834, 1951, 23 pp.

CRENTZ, WILLIAM L., BAILEY, A. L., and MILLER, J. W. Preparation Characteristics of Coal from Clearfield County, Pa. Bureau of Mines Rept. of Investigations 4894, 1952, 27 pp.

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

CRENTZ, WILLIAM L., and MILLER, J. W. Preparation Characteristics of Coal from Floyd County, Ky. Bureau of Mines Rept. of Investigations 4920, 1952, 21 pp.

CRENTZ, WILLIAM L., and MILLER, J. W. Preparation Characteristics of Coal from Jefferson County, Pa. Bureau of Mines Rept. of Investigations 4941, 1953, 21 pp.

CRENTZ, WILLIAM L., and MILLER, J. W. 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.