IOWA GEOLOGICAL SURVEY

IOWA CITY, IOWA

H. GARLAND HERSHEY, *Director and State Geologist*

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COAL RESOURCES OF IOWA

by

E. R. LANDIS

with a section on the geologic setting

by

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Iowa Geological Survey

Prepared cooperatively by the U. S. Geological Survey
and Iowa Geological Survey

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COAL RESOURCES OF IOWA

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ABSTRACT

Coal-bearing rocks of Pennsylvanian age underlie about 20,000 square miles, or approximately 36 percent, of the total area of the State of Iowa. Available data permit estimation of coal reserves for about 2,056 square miles and delineation of an additional 2,018 square miles that cannot be quantitatively evaluated but possibly contain coal beds of minable thickness. The coal reserves of Iowa were estimated on an individual-bed basis and were classified according to the characteristics of the coal and the abundance and reliability of data.

Total estimated original reserves are 7,236.54 million short tons, of which 1,846.17 million short tons are categorized as measured and indicated reserves in beds more than 42 inches thick.

Total recorded production through 1963 was about 356.28 million tons. Assuming 50-percent recoverability, about 712.56 million tons have been mined and lost in mining, leaving remaining reserves of about 6,524 million tons, of which about 3,262 million tons are recoverable.

INTRODUCTION

Early settlers followed the courses of major streams where they found outcropping coal beds, which they utilized as a source for domestic fuel. The recorded history of coal mining in Iowa dates from 1840 (Lees, 1909a). By 1890, coal mining, which kept pace with population increase, was a major industry in the south-central part of the State. After annual coal production reached a peak of almost 9 million tons in 1917, it steadily declined to its present level of about 1 million tons per year. Despite recorded production of more than 356 million tons, a large reserve of coal is still present in the State of Iowa.

Since 1947, the U. S. Geological Survey and agencies of many of the coal-producing States have been evaluating coal resources as part of a nationwide inventory of this vital energy material. The estimated coal reserves of Iowa, as presented here, will be included in this inventory. Also, it is hoped that the report will help revive interest in an important, but recently neglected, resource of the State of Iowa.

The present study by the U. S. Geological Survey, in cooperation with the Iowa Geological Survey, began in 1961. Data used in preparing the estimate of coal reserves were gathered from published and unpublished reports and records of the Iowa Geological Survey and from the State Coal Mine Inspection Department. In addition, much information was contributed by individuals and mining companies. The Iowa Geological Survey published two comprehensive reports on the coal resources, Keyes (1894) and Hinds (1909), but neither included a detailed reserve estimate. The works of these men and of other geologists who reported on coal mining and resources in individual countries (largely in "Annual Reports of the Iowa Geological Survey") have been invaluable in preparing the present report.

The stratigraphic nomenclature used in this report is that of the Iowa Geological Survey, and is not necessarily that of the U. S. Geological Survey.

The author is indebted to many individuals and organizations for cooperation, information, and assistance. Special thanks are due the staff of the Iowa Geological Survey, particularly

H. Garland Hershey, C. N. Brown, and O. J. Van Eck, for much help and many courtesies.

W. Dean Aubrey, Iowa State Mine Inspector, compiled maps showing names and locations of mines and of mined-out areas. Madeline Cobb, Secretary to the State Mine Inspector, also assisted by compiling much of the information.

METHODS OF PREPARING RESERVE ESTIMATES

Preparation of a detailed reserve estimate involves certain procedures and definitions, discussed in detail by Averitt (1961), that have been established to standardize, insofar as possible, the reappraisal of the coal resources of the United States. The following discussion of methods of preparing reserve estimates applies specifically to the present report.

As used in this report, coal reserves, which are sometimes called "known coal resources," can be defined as that part of the total amount of coal in the ground (the total resource) that has been determined to be present by mapping and/or exploration and that can be quantitatively evaluated according to selected parameters. According to Averitt (1961, p. 13), "* * * the word 'reserves' means estimated quantities of coal in the ground within stated limits of minimum bed thickness and maximum overburden thickness. As thus defined, the word has no direct economic connotation, although the selected limits of the various reserve categories have economic application." In this report the word "resources" is used when both known and unknown, measurable and unmeasurable, quantities are being discussed.

Classification According to Characteristics of the Coal

The rank and weight of the coal, the thickness and areal extent of the coal beds, and the thickness of the overburden are the characteristics used in the classification of coal reserves.

Rank of Coal

American coals are ranked in accordance with the specifications of the American Society of Testing Materials (1964), which are reproduced as table 1.

The coal of Pennsylvanian age in the Western Interior Coal Field of the United States, which includes the coal of Iowa, is mainly of bituminous rank. Although some of the coal has been ranked as high as high-volatile A bituminous and some as low as subbituminous B (Fieldner and others, 1939) nearly all of the analyzed samples are high-volatile C bituminous on the basis of moist, mineral-matter-free B.T.U. and agglomerating properties. In this report it is assumed for computation purposes that all Iowa coal is bituminous. For detailed coal analyses see

Table 1.—CLASSIFICATION OF COALS BY RANK[1]
American Society for Testing Materials

Class	Group	Fixed Carbon Limits, per cent (Dry, Mineral-Matter-Free Basis)		Volatile Matter Limits, per cent (Dry, Mineral-Matter-Free Basis)		Calorific Value Limits, Btu per pound (Moist,[2] Mineral-Matter-Free Basis)		Agglomerating Character
		Equal or Greater Than	Less Than	Equal or Greater Than	Less Than	Equal or Greater Than	Less Than	
I. Anthracitic	1. Meta-anthracite	98	....	....	2	....	....	....
	2. Anthracite	92	98	2	8	....	....	....
	3. Semianthracite	86	92	8	14	....	....	Nonagglomerating[3]
II. Bituminous	1. Low volatile bituminous coal	78	86	14	22	....	....	[illegible]
	2. Medium volatile bituminous coal	69	78	22	31	....	....	[illegible]
	3. High volatile A bituminous coal	....	69	31	....	14 000[4]	....	Commonly agglomerating[5]
	4. High volatile B bituminous coal	....	....	....	....	13 000[4]	14 000	Commonly agglomerating[5]
	5. High volatile C bituminous coal	....	....	....	....	11 500	13 000	Commonly agglomerating[5]
						10 500	11 500	Agglomerating
III. Subbituminous	1. Subbituminous A coal	....	....	....	....	10 500	11 500	Nonagglomerating
	2. Subbituminous B coal	....	....	....	....	9 500	10 500	....
	3. Subbituminous C coal	....	....	....	....	8 300	9 500	....
IV. Lignitic	1. Lignite A	....	....	....	....	6 300	8 300	....
	2. Lignite B	....	....	....	....	....	6 300	.... [illegible]

[1] This classification does not include a few coals, principally nonbanded varieties, which have unusual physical and chemical properties and which come within the limits of fixed carbon or calorific value of the high-volatile bituminous and subbituminous ranks. All of these coals either contain less than 48 per cent dry, mineral-matter-free fixed carbon or have more than 15,500 moist, mineral-matter-free British thermal units per pound.

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

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

[4] Coals having 69 per cent or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of calorific value.

[5] It is recognized that there may be nonagglomerating varieties in these groups of the bituminous class, and there are notable exceptions in high volatile C bituminous group.

Savage (1905), Wilder (1909), Lees and Hixson (1909), Hixson (1914), Lord and others (1913), Rice and others (1921), Fieldner and others (1942), Flynn (1949), Jerger and May (1951), Snyder and Aresco (1953), Aresco and Haller (1953a and 1953b), and Aresco, Haller and Abernethy (1955, 1956a, 1956b, 1957, 1958, 1959, 1960, 1961, and 1963).

Weight of Coal

The average weight of bituminous coal of low to medium ash content, based on many specific gravity determinations, is taken as 1,800 tons per acre-foot or 1,152,000 tons per square mile-foot. This weight has been used in calculating the coal reserves of Iowa.

Thickness of Beds

In order to relate coal reserves data to commercial potential, most estimates prepared by the U. S. Geological Survey are divided into three categories according to the thickness of the coal. For bituminous coal they are:

Thin	14 to 28 inches
Intermediate	28 to 42 inches
Thick	more than 42 inches

Coal in the thin category, though considered minable, is of little present economic interest. In the United States during 1960, only 2.3 percent of the underground mines, which supplied only 1.4 percent of the total production, and about 9 percent of the strip mines utilized coal beds less than 2 feet thick (Young and Anderson, 1962, tables 1 and 7).

Coal of intermediate thickness can be mined with the aid of some types of mechanical loading equipment; coal in the thick category can be mined with all types of mechanical cutting and loading equipment. According to Young and Anderson (1962, p. 1), 62 percent of the coal produced in 1960 came from beds 3-6 feet thick.

Thicknesses used in calculating coal reserves commonly are derived either from isopach maps or from weighted average thicknesses; for Iowa they were derived from both. In many coal-bearing areas, bed-thickness data are confined to the outcrops of coal beds; lack of laterally spaced data between out-

crops precludes preparation of meaningful thickness maps. In most parts of Iowa available information was adequately distributed to permit construction of isopach maps; derivation of weighted average thicknesses was usually confined to segments of reserve categories between equal-thickness lines. However, in some parts of Iowa stratigraphic posiltions of coal beds are not known sufficiently to permit accurate correlation of coal beds over any considerable lateral distance. In those areas where all the information was derived from mines, as in eastern Monroe County and in central Mahaska County, considerable doubt remains as to the stratigraphic position of the coal beds that were mined.

Partings more than three-eighths of an inch thick were omitted in determining the thickness of coal beds. Beds or parts of beds made up of alternating layers of thin coal and impurities were omitted if the impurities constituted more than one-half the thickness of the bed. Benches of coal less than the minimum thickness of 14 inches were also omitted if they were separated from the main bed by thick partings that normally would not be mined. Coal beds split by a parting were omitted if neither bench had the required minimum thickness of 14 inches and if the parting was as thick or thicker than the thinner of the two benches.

Areal Extent of Beds

Information about the areal extent of the coal beds of Pennsylvanian age in Iowa, derived in large part from mines, shows that the thicker parts of most beds are of relatively limited extent. The older reports commonly referred to "coal basins" rather than "coal beds," implying that areas with thick coal beds were areally separated discrete entities that could not be stratigraphically related to each other. More recent data, particularly from drill holes, indicate that the concept of persistent stratigraphic horizons at which coal beds may or may not be present at any particular point best explains the observed facts. Although at present correlation of many coal beds is difficult and impossible for some, these problems will be solved as our knowledge of the stratigraphy of the Pennsylvanian rocks of Iowa increases.

In general, relatively limited areas of coal 14 inches thick or more are delineated. The outer boundaries of these areas are

derived by extrapolation of the rate of thickening or thinning as observed from data points, and by geologic inference based on the habit of the particular coal bed and of other coal beds in the same area.

Thickness of Overburden

Coal reserves commonly are divided into categories based on the thickness of overburden, in feet, as follows: 0-1,000, 1,000-2,000, and 2,000-3,000. Thinner overburden categories may be used locally to satisfy the needs of special areas or situations. Because nearly all the known or speculative coal beds of Iowa are at depths of less than 1,000 feet, the estimated reserves have not been classified as to thickness of overburden. Pertinent information relating to thickness and type of overburden is included in the discussion of individual counties.

Classification According to Abundance and Reliability of Data

Measured and Indicated Reserves

Most measured and indicated reserves estimated for Iowa are contained in bodies of coal within ½ mile of points of information, though the spacing of observations ranged from ¼ to 1 mile, depending on what was known or could be assumed about the character of the individual coal bed. In many coal-bearing areas of the United States, measured and indicated reserves are classified separately but it was not considered feasible to do this in Iowa because of the very lenticular nature of most of the coal beds.

Inferred Reserves

Inferred reserves are contained in bodies of coal whose inner boundaries are generally bodies of measured and indicated reserves and whose outer boundaries are based largely on projection of information on the basis of geologic inference. Most of the inferred reserves estimated in Iowa are no less than ½ mile and no more than 1 mile from the closest data point. Coal indicated by isolated drill holes or groups of drill holes in which coalbed continuity or thicknesses are in doubt has been classified as inferred. The outer boundaries of these areas commonly are no more than ½ mile from drill holes. Areas having sufficient data for construction of isopach maps commonly do not contain very

large amounts of inferred coal because the data points are closely spaced within areas where the thickness of the coal bed exceeds 14 inches.

Areas Omitted from Reserve Estimates

The available information allows delineation of many areas in Iowa in which reserves were not estimated but which may contain coal beds more than 14 inches thick. These areas fall into two classes: (1) those that are adjacent to and are extensions of areas containing inferred coal, but for which there are no data on the thickness and character of coal; and (2) those based on evidence of the presence of coal of unknown thickness, stratigraphic position, or continuity—these are largely areas around isolated drill holes. The basic difference between these areas and areas of inferred coal is that current data do not permit quantitative estimation on an individual-bed basis.

Distinction Between Original, Remaining, and Recoverable Reserves

Original Reserves

Original reserves are the reserves in the ground before the beginning of mining operations and include coal that has been mined and lost in mining, coal that is in the weathered zone near the outcrop, and coal that is left under cultural features such as urban and suburban areas, roads, railroads, and pipelines. The coal reserves of Iowa, as estimated for this report, are original reserves, because maps showing mined-out areas are unavailable for many parts of the State, cultural features are transient, and coal is mined and lost in mining every year. An estimation of original reserves is the first step in making a meaningful coal inventory because it provides the basis from which remaining and recoverable reserves may be calculated at any time, present or future. Therefore, unless otherwise specifically stated, all coal reserve estimates in this report are original reserves.

Remaining Reserves

For every ton of coal produced in mining, a certain amount of coal is left unmined, in pillars, roof, or floor; is discarded as undersize; is lost in washing; or is unrecoverable due to the presence of cultural features or other mining in the area. The

ratio of the coal actually produced to the sum of the coal actually produced and the coal lost in mining or unrecoverable is expressed in percentage as the recoverability factor. For areas where precise information is inadequate or unavailable, the Geological Survey has adopted a standard recoverability factor of 50 percent. This factor is believed to adequately compensate for the coal lost directly in mining and indirectly due to unrecoverability, and to be representative for Iowa as a whole. Thus, the remaining reserves of an area are the original reserves minus twice the reported amount of coal mined in the area.

Recoverable Reserves

Recoverable reserves are derived from remaining reserves by assuming that for each ton of coal that will be produced in the future, another quantity of coal will be lost in mining or be unrecoverable. Thus, applying the standard recoverability factor of 50 percent, the recoverable reserves of an area are one-half the remaining reserves.

Methods of Recording Data and Making Calculations

In general, for this report all coal reserves were estimated on a county-by-county basis. All available data pertaining to the geology and coal resources of the county were plotted on base maps, generally at a scale of 1 inch equals 1 mile. After synthesis and integration of the data, thickness maps were constructed for each bed by using 14-, 28-, and 42-inch isopachs and by classifying reserves according to the abundance and reliability of data. After assignment of weighted average thicknesses to the several categories thus outlined, the areas were measured with a polar planimeter to obtain the acreage underlain by coal. The tonnages were calculated by multiplying the number of acres by the weighted average thickness by 1,800 (the weight of bituminous coal in tons per acre-foot). The figures thus obtained were then tabulated by county, coal bed, and township, and placed in categories according to thickness and reliability of information.

Limitation of Estimates

This report utilizes all known and available information pertaining to the coal resources of Iowa. However, the reserves figures presented must be considered provisional because (1)

information is meager or absent for large areas of the State known to be underlain by coal-bearing rocks of Pennsylvanian age; and (2) available information is inadequate or of doubtful validity in many areas containing coal reserves. Future geologic studies, mining, and drilling will yield additional data that probably will necessitate modification of the coal reserves estimates presented herein.

SUMMARY OF RESERVES

The estimated original coal reserves of Iowa total 7,236.54 million short tons, of which 3,500.72 million tons is classed as measured and indicated reserves and 3,735.82 million tons is classed as inferred. A total area of about 1,316,040 acres in 37 counties was included in the reserve calculations; an additional area of about 1,291,830 acres in 44 counties is indicated by the currently available information to be favorable for the presence of coal beds more than 14 inches thick. The estimated original reserves are summarized by county in table 2 and are listed in detail in table 17.

Table 2.—Original coal reserves (in millions of short tons) of Iowa, by county and reserve class and areas (in acres) included and omitted in reserve estimate

County	Measured and Indicated Reserves	Inferred Reserves	Total Reserves	Area of Reserve Estimate	Favorable Area
Adair	2.11	7.12	9.23	2,350	14,390
Adams	34.81	86.50	121.31	53,780	32,020
Appanoose	196.88	483.33	680.21	166,630	28,240
Boone	158.81	84.98	243.79	39,470	15,950
Calhoun	.....	.....	.....	.....	16,300
Carroll	.....	.....	.....	.....	12,430
Cass	0.37	2.79	3.16	10,600	7,480
Clarke	.....	0.42	0.42	80	6,740
Dallas	70.49	79.09	149.58	26,760	14,720
Davis	40.96	72.75	113.71	18,430	11,000
Decatur	39.88	172.48	212.36	23,360	57,870
Fremont	1.33	10.00	11.33	4,650	41,070
Greene	16.81	29.69	46.50	9,270	10,870
Guthrie	33.37	41.00	74.37	20,300	28,470
Hamilton	13.30	24.72	38.02	6,780	9,070
Hardin	5.00	6.75	11.75	1,840	.....
Henry	1.48	2.15	3.63	620	340
Jasper	102.51	91.81	194.32	30,820	15,070
Jefferson	52.48	74.49	126.97	22,630	29,880
Keokuk	77.54	63.08	140.62	16,220	6,800
Lee	4.88	11.38	16.26	4,490	1,770
Lucas	186.31	296.42	482.73	80,020	33,940
Madison	.....	.....	.....	.....	23,810
Mahaska	335.24	188.74	523.98	68,540	23,710
Marion	443.31	201.85	645.16	104,170	28,020
Marshall	4.15	14.91	19.06	3,430	2,490
Mills	.....	.....	.....	.....	6,250
Monroe	540.51	344.32	884.83	129,270	33,800
Montgomery	0.78	20.21	20.99	9,620	162,100
Muscatine	1.03	2.95	3.98	1,680	420

Table 2.—Original coal reserves (in millions of short tons) of Iowa, by county and reserve class and areas (in acres) included and omitted in reserve estimate—Continued

County	Measured and Indicated Reserves	Inferred Reserves	Total Reserves	Area of Reserve Estimate	Favorable Area
Page	25.98	91.14	117.12	49,220	286,650
Polk	572.18	177.68	749.86	92,960	14,760
Pottawattamie					10,880
Poweshiek	0.25	0.47	0.72	280	2,550
Ringgold					4,740
Scott	2.89	3.90	6.79	1,760	1,270
Story	37.83	82.68	120.51	16,570	48,590
Taylor	10.63	41.64	52.27	19,360	55,850
Union					43,170
Van Buren	53.14	74.73	127.87	22,610	16,610
Wapello	165.01	199.34	364.35	59,460	27,860
Warren	149.97	281.15	431.12	89,010	60,260
Wayne	51.91	299.66	351.57	97,090	24,660
Webster	66.50	69.50	136.09	16,170	17,460
Total	3,500.72	3,735.82	7,236.54	1,316,040	1,291,830

Also listed in table 2 are the total area of the county underlain by coal included in estimated reserves and the additional area within each county that the available information indicates to be favorable for the presence of coal beds 14 inches or more thick. Reserves were estimated in 37 counties; 7 additional counties are listed in which no coal reserves could be estimated but which contain favorable areas.

Plate 1 (in pocket) is a map of Iowa showing the areal distribution of the estimated reserves as classified by abundance and reliability of data, areas that may contain coal of potential economic interest, and the distribution of the coal-bearing Pennsylvanian rocks of Iowa.

The total recorded coal production of Iowa through 1963, as shown in tables 14 and 15 combined, is about 356.28 million tons. Assuming that for each ton of coal produced another ton has been made unrecoverable, the remaining reserves of the State are about 6,524 million tons. Again assuming 50 percent recoverability in the future, the recoverable reserves of Iowa, estimated and categorized by individual bed, are about 3,262 million tons.

The distribution of estimated coal reserves in Iowa by thickness is shown on figure 1. The thick category includes more total reserves and more measured and indicated reserves than

does the intermediate category, which in turn includes more total reserves and more measured and indicated reserves than does the thin category.

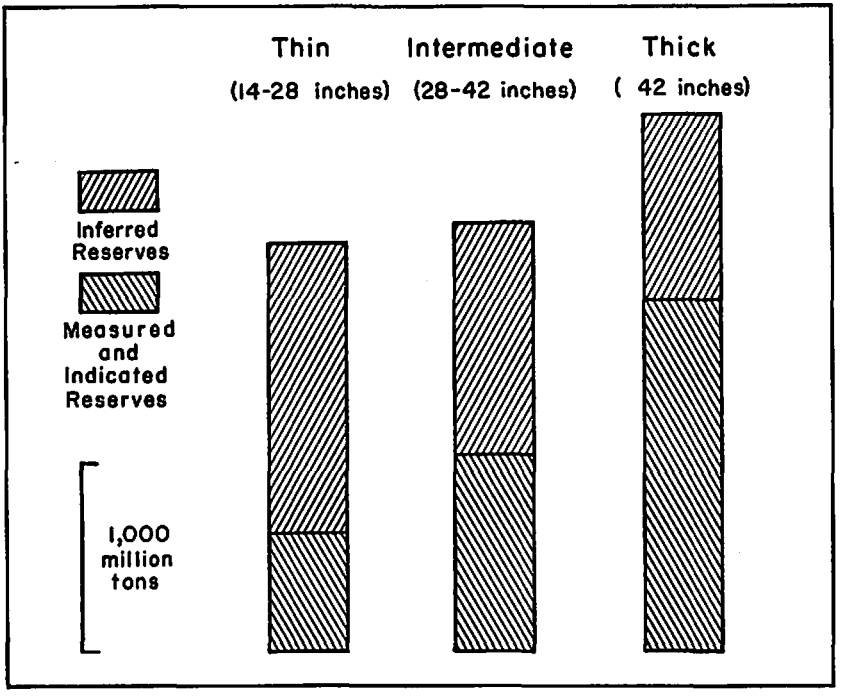

Figure 1. Estimated coal reserves by thickness category.

The total area of Iowa underlain by rocks of Pennsylvanian age is variously cited as 24,250 square miles (Lees, 1927a, p. 74), 19,000 square miles (Hinds, 1909, p. 30), 20,00 square miles (Keyes, 1894, p. 33), and 23,100 square miles (Averitt, 1961, p. 58). An assumed area of about 20,000 square miles would appear to be a conservative estimate. The reserves estimated in the present study are within an area of 1,316,040 acres or about 2,056 square miles, and an additional area of about 1,291,830 acres or about 2,018 square miles possibly are underlain by coal. Therefore, reserves were estimated in about 10 percent of the area underlain by Pennsylvanian rocks and an additional 10 percent is indicated by the currently available information to be favorable for the presence of resources of potential economic interest. Certainly the total coal resources of Iowa are much

larger than the known resources, or reserves, that can be estimated and categorized on an individual-bed basis. It seems reasonable to assume that the amounts of coal may be nearly equal in the area in which reserves were estimated, in the area outlined as favorable for potential coal resources, and in the remainder of the area (80 percent of the total) underlain by coal-bearing Pennsylvanian rocks. On the basis of these assumptions, the total potential original coal resources of Iowa are estimated to be about 21,000 million tons.

COMPARISON OF PAST AND PRESENT ESTIMATES

Author	Area included in estimate (Square miles)	Estimated Original Reserves (Millions of short tons)
Campbell and Parker (1909)	12,560	29,160
Lees (1927a)	12,750	29,950
This report (1963);		
Individual bed estimate	2,056	7,236.54
Total potential resource estimate	20,000	21,000

No detailed estimate of Iowa coal reserves on a bed-by-bed, original reserve basis has been previously made. Past estimates of the coal resources of Iowa were highly generalized and were based solely on an assumed total area underlain by coal of potential economic interest and on an assumed average thickness of coal within that area. The estimate of Campbell and Parker (1909), the most frequently quoted, included coal 14 inches or more thick in an area of 12,560 square miles. They mentioned an additional area of 5,640 square miles of possible coal but apparently they did not include it in their estimate. The estimate of Lees (1927a, p. 74) covers 11,250 square miles of "Des Moines beds which are not covered by Missouri or Cretaceous strata." Lees used an assumed average thickness of 4 feet of coal which he believed would give a content of 4,000 tons of coal per acre, or a total of 28,800 million tons. In addition Lees estimated that about 1,500 square miles is underlain by the Nodaway coal bed having an average thickness of 1.2 feet. The estimated 1,150 million tons in the Nodaway bed plus the 28,800 million tons gave an overall total of 29,950 million tons. As Lees'

assumed weight of coal seems much too small by present standards, he may have been applying a recoverability factor not stated.

The present detailed estimate is smaller than the older generalized estimates and covers a much smaller area. The ratio is about one-fourth as much reserves in about one-sixth as much area. The very generalized estimate of total potential coal resources of Iowa, discussed earlier in this report, may be more directly comparable to the older reserves estimates of Campbell and Parker and of Lees because it attempts to estimate the total amount of coal of potential economic interest in the part of Iowa underlain by rocks that are known to be coal bearing. The estimated total potential original coal resources of about 21,000 million tons are less than the earlier estimates, but the figure is derived by extension of the detailed bed-by-bed reserve estimate and may, therefore, represent a more realistic appraisal of the total known and undiscovered coal resources of Iowa.

GEOLOGIC SETTING

By Orville Van Eck

Rocks ranging in age from Precambrian to Recent are present in the State of Iowa but the coal resources evaluated in this report are all in rocks of Pennsylvanian age. The Pennsylvanian System underlies most of southern and southwestern Iowa, an area totaling about 20,000 square miles or more, and is unconformably overlain in places by rock units of Permian(?), Cretaceous, and Quaternary age. Rocks of the Ordovician, Devonian, and Mississippian Systems are unconformably overlain by the rocks of Pennsylvanian age.

Post-Pennsylvanian Rocks

Although the Pennsylvanian System underlies nearly one-third of Iowa, the Pennsylvanian rocks are exposed at the surface in only a very small part of that area. The surface material throughout most of Iowa is stratified and unstratified sand, silt, clay, pebbles, and boulders deposited during one or more of the glacial or interglacial stages of the Pleistocene Epoch. These deposits, related to one or more of the four major advances of continental glaciers in the northern United States, fill depressions developed on the pre-glacial surface by pre-existing streams or by agencies of the glaciers themselves. The glacial deposits are as much as several hundred feet thick in some areas and are an effective deterrent to coal resource exploration and development in several ways: (1) They commonly conceal the coal-bearing rocks; (2) most water wells in southern and southwestern Iowa obtain usable water from the glacial deposits and the wells seldom penetrate into the Pennsylvanian rocks; and (3) coal mining can be difficult and dangerous in areas where channels, now filled with water-bearing glacial materials, have been cut deeply into the underlying coal-bearing rocks.

Underlying the glacial deposits in parts of western Iowa are sandstone, dark shale, limy shale and limestone of the Dakota Sandstone, Graneros Shale, Greenhorn Limestone, and Carlisle Shale, all of Cretaceous age. The Cretaceous rocks may have been deposited over most of the western part of the State but if so they were largely removed by pre-glacial erosion. Though

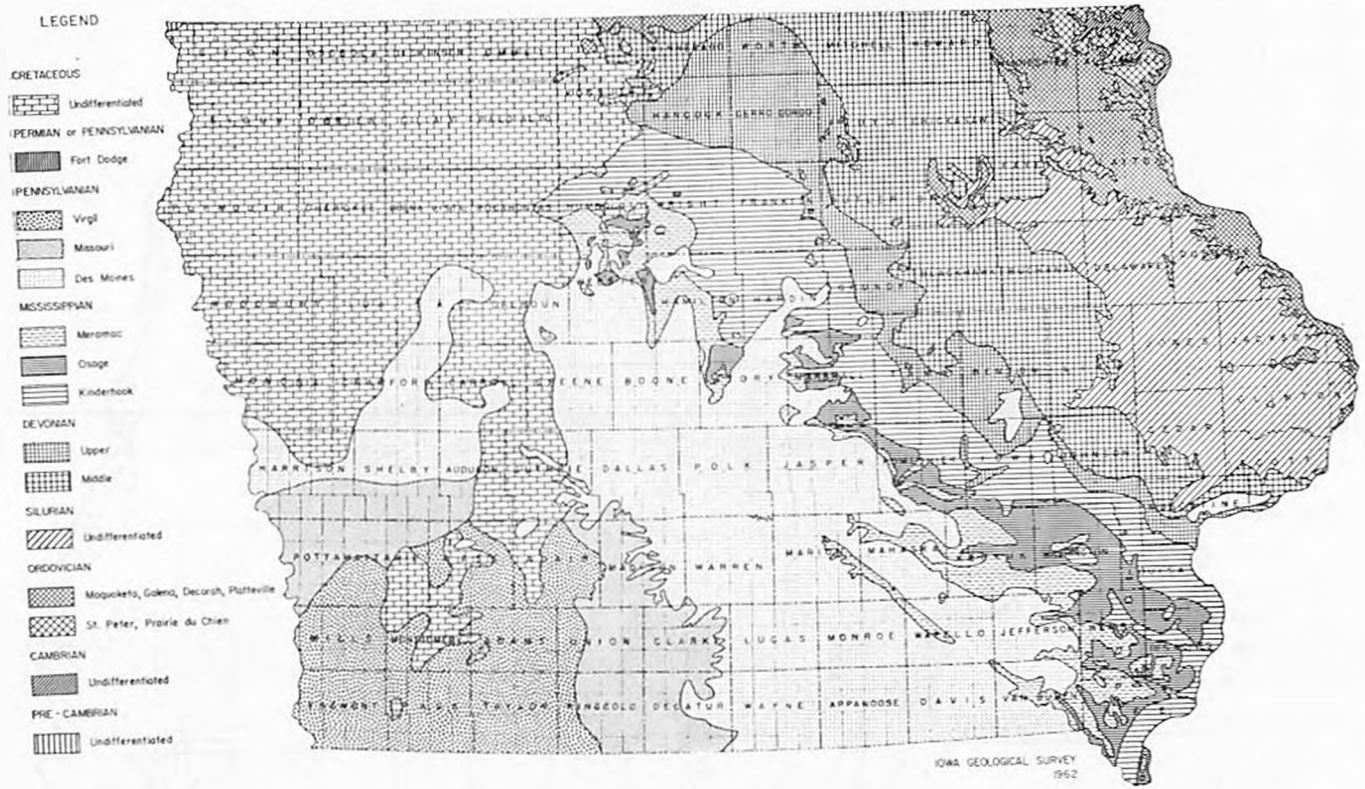

FIGURE 2.--PRELIMINARY GEOLOGIC MAP OF IOWA

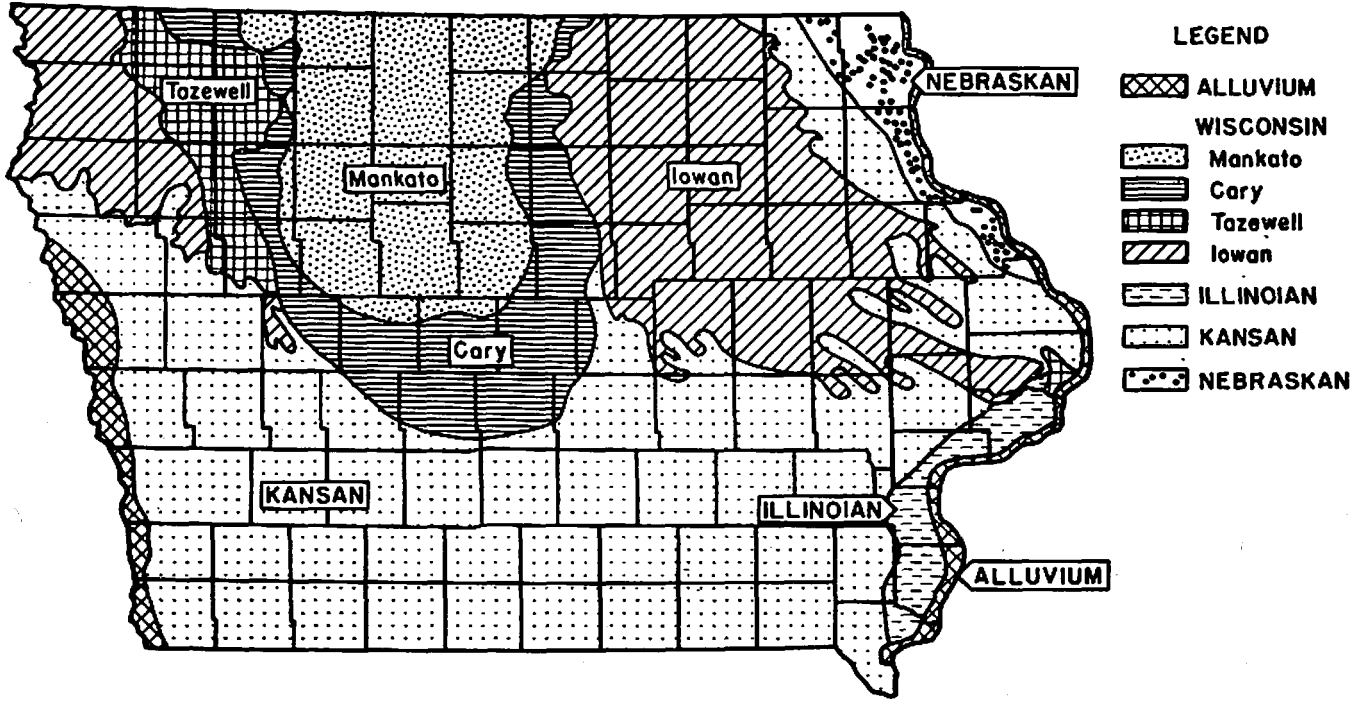

FIGURE 3.-- GLACIAL GEOLOGY OF IOWA

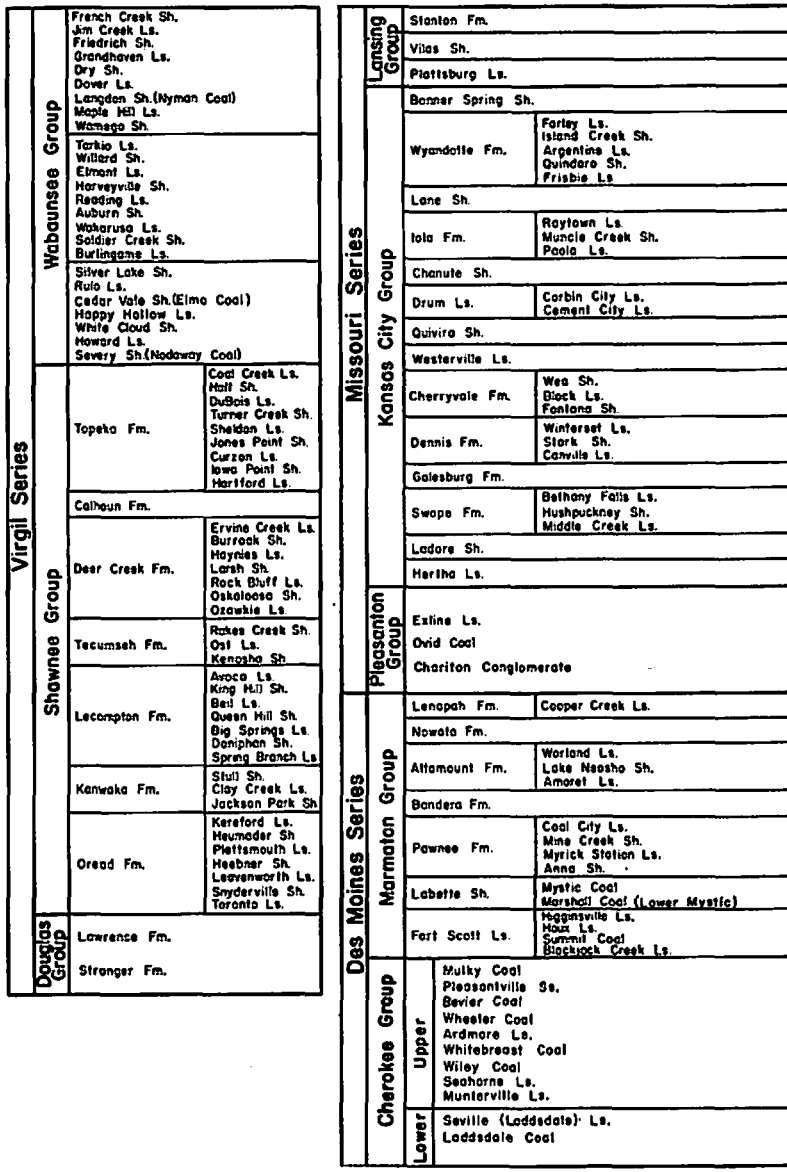

Figure 4.—Nomenclature of Pennsylvanian rocks in Iowa.

only very rarely exposed, the rocks of Cretaceous age underlie most of northwestern Iowa and isolated erosional remnants are preserved at many places in southwestern Iowa. The preserved Cretaceous rocks, which unconformably overlie the older coal-bearing rocks, rarely are more than 100 feet thick.

In the northern part of Webster County in central Iowa the coal-bearing rocks of Pennsylvanian age are overlain unconformably by gypsum and red shale and sandstone of the Fort Dodge Formation of Permian(?) age. The maximum thickness of the gypsum is about 30 feet and the maximum known thickness of the overlying red shale and sandstone is about 50 feet. The Fort Dodge underlies an area of more than 20 square miles in Webster County but is not preserved elsewhere.

Pennsylvanian Rocks

Rocks of the Pennsylvanian System in Iowa comprise three series in which nine groups of strata are recognized.

Although coaly rocks are present throughout most of the system, the coal beds of economic interest are confined to the Wabaunsee Group of the Virgil Series and the Marmaton and Cherokee Groups of the Des Moines Series.

Virgil Series

The Virgil Series is composed, in descending order, of the Wabaunsee, Shawnee, and Douglas Groups. The lower boundary of the Virgil, at the base of the Douglas Group, is obscure in Iowa, and generally cannot be determined. As a result, the Douglas has been expanded to include rocks formerly included in the uppermost group of the Missouri Series, the Pedee. The term Pedee Group is now abandoned and the rocks are treated as an entity—the Douglas Group of the Virgil Series.

Wabaunsee Group.—The Wabaunsee Group in Iowa comprises the beds above the top of the Topeka Formation of the Shawnee Group and below the unconformity at the base of the Cretaceous System or the unconsolidated glacial materials of the Pleistocene Series of the Quaternary System. Shale is the most abundant rock type in the Wabaunsee Group, with siltstone, sandstone, limestone, and coal making up a minor part of the group. Although generally very thin, the limestones are typically per-

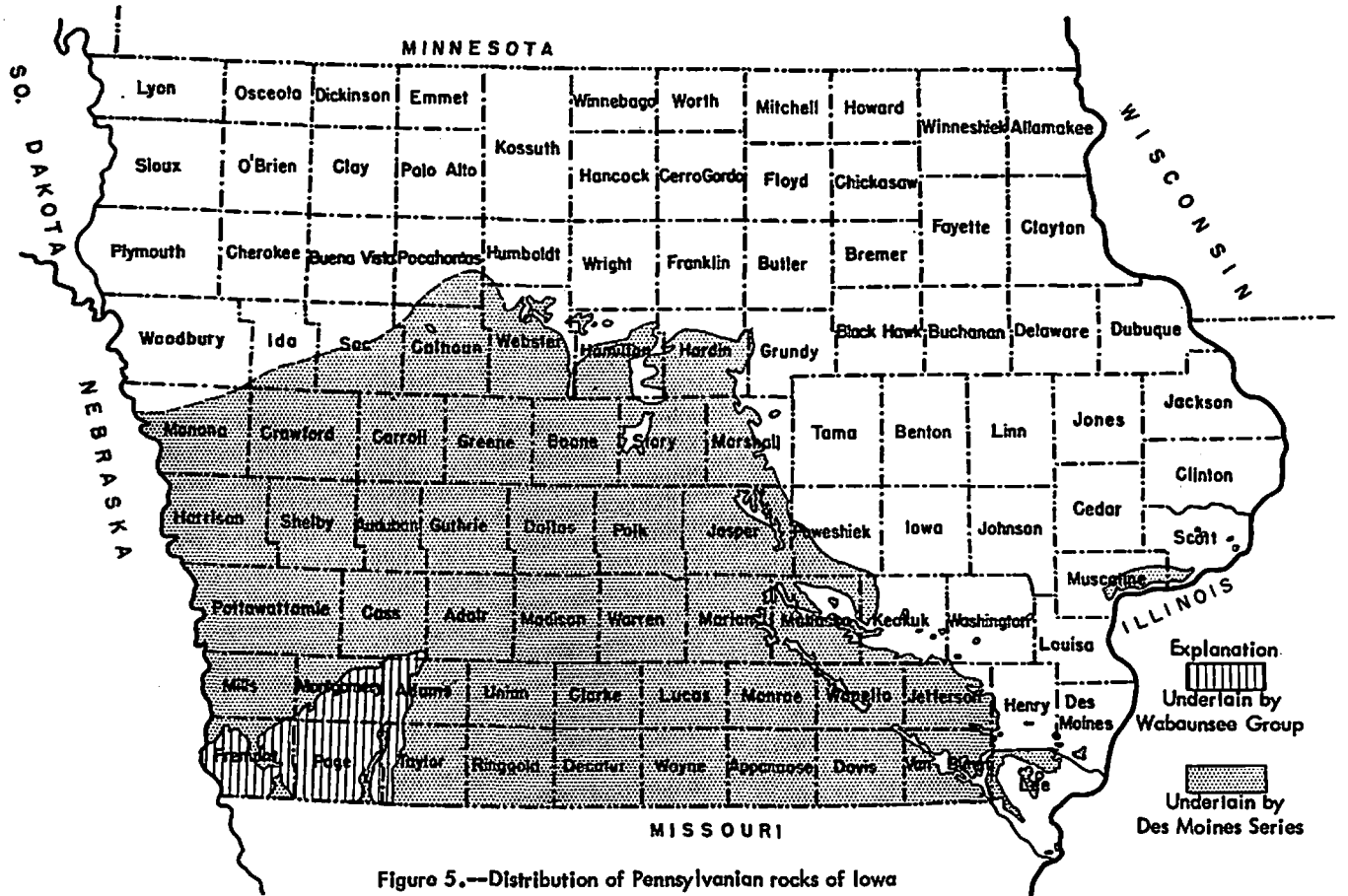

Figure 5.--Distribution of Pennsylvanian rocks of Iowa

sistent. Rocks of this group are present only in Adams, Cass, Montgomery, Taylor, Page, and Fremont Counties in southwestern Iowa. A maximum thickness of 210 feet has been found in drilling.

Three coals have been recognized in the Wabaunsee of Iowa. They are, in descending order, the Nyman coal, which occurs near the top of the Table Creek Shale, the Elmo coal, which marks the top of the Cedar Vale Shale, and the Nodaway coal, which underlies the persistent Howard Limestone. Neither the Nyman nor the Elmo coals reach sufficient thickness to be of any economic significance, but both are important stratigraphic markers. The Nodaway coal has been mined rather extensively in Adams, Page, and Taylor counties. The Nodaway has a maximum thickness of about 3 feet, and it also is an excellent stratigraphic marker.

Shawnee Group.—The Shawnee Group includes beds from the base of the Oread Formation to the top of the Topeka Formation, and is a well differentiated segregation in which relatively thick limestones and a distinctive type of cyclic sedimentation are prominent features. In contrast to the Douglas Group below, and the Wabaunsee Group above, the Shawnee has comparatively minor shale units. The maximum known thickness of the Shawnee is 180 feet.

Douglas Group.—The Douglas Group described here is expanded to include the rocks formerly included in the Pedee Group, which term is now abandoned. The expanded Douglas extends to the top of the Missouri Series, and consists of the Lawrence Formation above, and the Stranger Formation below. In practice it is usually difficult to differentiate these formations.

In general, this group is composed of gray silty shales and siltstones with a calcareous zone near the center and a maroon shale near the top. Where seen in outcrop in western Madison and eastern Adair Counties this group is about 18 feet thick but in subsurface rocks up to 80 feet thick have been assigned to it.

Missouri Series

The Missouri Series contains the Lansing, Kansas City, and Pleasanton Groups, in order from the youngest to oldest.

Lansing Group.—The Lansing Group occupies the interval between the base of the Douglas Group and the top of the Kansas City Group and is composed of two limestones and an intervening shale. Although generally poorly exposed, the Stanton Limestone at the top, the Vilas Shale, and the Plattsburg Limestone at the base have been recognized in Iowa. The maximum known thickness of the group is about 50 feet.

Kansas City Group.—This group of rocks consists of limestones and shales extending from the top of the Bonner Springs Shale at the top of the group to the base of the Hertha Limestone. Much like the Shawnee Group of the Virgil Series, the Kansas City Group is marked by a preponderance of limestone over shale, and cyclic sedimentation is evident, although not as completely developed. The maximum known thickness of the group is 215 feet.

Pleasanton Group.—The upper boundary of this group is at the base of the Hertha Limestone of the Kansas City Group, and the lower boundary is the unconformity that marks the break in sedimentation between the Missouri and Des Moines Series. The lower boundary is indefinite over much of Iowa, but in some parts of the State the unconformity is placed at the base of the Chariton Conglomerate (Cline, 1941, p. 70).

In Iowa the Pleasanton Group is composed primarily of shales with some sandstone, thin limestones, and minor amounts of coal. None of the coals are thick enough to be of any economic interest. The group is not well enough understood that formations can be differentiated, but locally the Exline Limestone and Ovid coal can be recognized. The average thickness of the group is about 40 feet.

Des Moines Series

The Des Moines Series of Iowa makes up the lower part of the Pennsylvanian System, from the unconformity at its base to the unconformity that occurs at the base of the Pleasanton Group of the Missouri Series. In Iowa, the Des Moines has been divided into the Marmaton and Cherokee Groups.

Marmaton Group.—The upper limit of this group coincides with the unconformity that marks the top of the Des Moines Series, and the lower limit is the base of the Blackjack Creek

Limestone of the Fort Scott Formation. The group consists chiefly of alternating layers of shale and limestone, with some sandstone and coal, and includes in descending order the Lenapah, Nowata, Altamont, Bandera, Pawnee, Labette, and Fort Scott Formations.

Lenapah Formation.—This formation is represented in Iowa by the Cooper Creek Limestone. It is characteristically white to light gray and has a brecciated appearance with dense limestone fragments in a light grayish-green, argillaceous matrix. The known maximum thickness is about 7 feet. Cline (1941, p. 65) correlated this unit with the ledge known to the miners of Appanoose County as the "floating rock" (Bain, 1896, p. 382).

Nowata Formation.—The thick sequence of shale and sandstone beneath the Cooper Creek Limestone and above the Worland Limestone is called the Nowata Formation, although this may include part of the overlying Lenapah Formation as recognized in Missouri. However, in Iowa there is no obvious break in sedimentation that would justify differentiation.

At the southern end of the outcrop belt, in Appanoose County, a coal streak is present in the upper part of the shale, but it does not persist northward. The Nowata attains its maximum thickness of about 80 feet in Madison County.

Altamont Formation.—The Altamont is made up of the Worland Limestone, the Lake Neosho Shale, and the Amoret Limestone.

The uppermost member, the Worland Limestone, is composed typically of thin wavy beds separated by green-gray fossiliferous shale seams and scattered pockets of green shale. This member was called the "Fifty-foot limestone" by Bain (1896). The maximum development of the Worland is in Appanoose County, where it attains a thickness of about 8 feet.

Underlying the Worland is the Lake Neosho Shale. The upper part of the shale is dark gray and fossiliferous. Beneath the dark gray shale is a persistent coal streak underlain by a clay that is gray above and red below.

The basal member of the Altamont is the Amoret Limestone. Outcrops of the Amoret are restricted to Madison County where it thins from a maximum thickness of 2 feet to isolated nodules

embedded in underclay in a short distance. Cline has described the Amoret in this area as essentially a *Chaetetes* biostrome.

Bandera Formation.—The Bandera Formation comprises the rocks between the Altamont and the Pawnee Formations. The only member of the Bandera Shale in Iowa that has received a name is the Lonsdale coal (St. John, 1870, p. 282) which has been locally mined in Dallas and southeastern Guthrie Counties. Where the Amoret Limestone of the overlying Altamont Formation is missing, it is not possible to differentiate the Lake Neosho Shale from the Bandera. Where the Amoret is present, the Bandera generally consists of a fossiliferous shale overlying the coal, which in most localities is represented by a carbonaceous streak. Beneath the coal is a red clay mottled with green.

Pawnee Formation.—The Pawnee is made up of the Coal City Limestone, the Mine Creek Shale, the Myrick Station Limestone, and the Anna Shale, in descending order.

The Coal City Limestone is named for exposures in the bluff of the Chariton River near Coal City in southeastern Appanoose County (Cline, 1941, p. 64). Throughout the outcrop area in Iowa it is a massive bed of blue-gray, fine-textured limestone. It contains *Chaetetes*, fusulinids, and brachiopods. Locally very large crinoid stems are so abundant as to form a coquinoid limestone. In the type locality the Coal City is about 2 feet thick, but it thickens toward the northwest, where 4.5 feet have been measured in Dallas County. Locally, however, it is much thinner. This is the limestone that the miners called the "Seventeen-foot limestone," in reference to its position about 17 feet above the Mystic coal in Appanoose County (Bain, 1896, p. 378).

Next below the Coal City Limestone is the Mine Creek Shale. In Appanoose County, it consists of about 6.5 feet of gray shale, which includes a coal smut near the top and a thin underclay, underlain by a reddish-brown shale. To the northwest, in Madison County, the Mine Creek reaches a thickness of 37 feet, where a sandstone is developed in the upper part of the member. The coal smut persists throughout the area of outcrop in Iowa.

The Myrick Station Limestone, which underlies the Mine Creek Shale, is the first prominent limestone above the Labette Shale and it was known in older reports as the "Mystic caprock." In Guthrie and Boone Counties the Myrick Station is a 1-foot ledge of dense bluish-gray limestone. In Appanoose County the

unit is about 2 feet thick and is overlain by 3 feet of fossiliferous gray shale that contains nodular limestone.

Locally in Madison County the Anna Shale is present at the base of the Pawnee Formation. Its upper bed is olive-colored shale that weathers buff and contains a hash of fossil fragments. Below this is a dark-gray platy shale with light-gray fucoidal markings. The lowermost shales are dark gray to black, hard and slaty with thin gray lime concretions and bands in the upper part, and are soft and clayey in the lower part. The total thickness of the Anna Shale is only about 2 feet.

Labette Formation.—The Labette Formation comprises all the rocks between the Pawnee and the Fort Scott Formations. It has not been divided into members but two distinctive units have been named. These are the Mystic coal, which occurs near the top of the formation and the Lower Mystic, or Marshall, coal.

In Appanoose County the Labette, as described by Cline (1941, p. 67), is composed of a 2-foot thick black slaty shale overlying the Mystic coal and its 1-foot-thick ash-gray underclay. The Mystic is consistently 32 to 33 inches thick in the coal fields of Appanoose County, and it is marked by three persistent thin clay partings. These partings persist into Illinois, where the Mystic is correlated with the Herrin (No. 6) coal and into Missouri where it is correlated with the Lexington coal (Weller, Wanless, Cline, Stookey, 1942, p. 1591).

It is Cline's opinion (Weller, Wanless, Cline, Stookey, 1942, p. 1591) that the Mystic splits northwestward in Iowa, the split probably occurring at one of the clay partings. Northwestward along the outcrop there is a thickening of the Labette brought about by the occurrence of a sandstone between the Mystic and Lower Mystic or Marshall coals, and by the thickening of associated shales.

Fort Scott Formation.—The Fort Scott, the lowermost formation of the Marmaton Group, is made up of the rocks between the Labette Formation and the Cherokee Group. This formation has not been completely differentiated in Iowa, but in descending order the following members have been identified: Higginsville Limestone, Houx Limestone, Summit coal, and Blackjack Creek Limestone.

The Higginsville Limestone persists from Madison through Appanoose Counties as a medium-gray, finely crystalline massive ledge about 2 feet thick. Northwest from Madison County in Dallas and Guthrie Counties, the ledge is divided into two layers by a thin green calcareous shale. The upper layer is massive, and the lower nodular.

A shale section underlies the Higginsville, and in the exposures in Appanoose County a carbonaceous zone is found immediately below the limestone. In Madison County this zone is a reddish-brown shale containing a profusion of large ostracodes. This shale is about 15 feet thick in Appanoose County and about 7 feet thick in Madison County.

The Houx Limestone is persistent and maintains its position from Madison County southward into Missouri. It is light to dark gray, characteristically earthy, and very fossiliferous, with *Composita, Derbyia,* and *Chonetes.* The thickness varies from 8 inches in the south to 4 inches in Madison County. Underlying the Houx is a shale that varies greatly in thickness, with the greater thickness in the south.

Included in the shale underlying the Houx Limestone is the Summit coal. Although commercially important in Missouri and in Illinois, where it is correlated with the Springfield (No. 5) coal, in Iowa the Summit is a mere smut where present, and is missing from the northwestern part of the zone of outcrop.

The Blackjack Creek Limestone, the basal member of the Fort Scott Formation, is one of the thickest and most persistent limestones in the Des Moines Series in Iowa. It is light gray to light blue-gray, weathers brown to buff and varies from massive to slabby structure. In the south, where the overlying shale is more completely developed, this limestone is 1 foot thick, but where typically developed, it is about 4 feet thick.

Cherokee Group.—In Iowa, the rocks between the Marmaton Group and the Mississippian System comprise the Cherokee Group of the Des Moines Series. The Cherokee of Iowa may include parts of the Atoka or Morrow Series, but the Iowa Geological Survey has not differentiated them.

Dark carbonaceous shale, clay, and siltstone predominate in the Cherokee, with sandstone secondary in importance. The group also contains a number of thick coal beds. Limestone beds

constitute only a very minor part of the total thickness, but can be very persistent and serve as valuable stratigraphic markers. The rocks of this group were deposited in the cyclic sequence that is typical of the Pennsylvanian of this region. However, the sequence is much less complex than is found in the cyclothems of younger groups. In contrast to the other cyclothems, where marine deposits are predominant, cyclothems of the Cherokee Group generally have equal or greater amounts of continental deposits, and the marine phase is comparatively less well developed.

The coal beds in this group are in general not continuous over large areas and appear to have been developed in isolated basins. The earliest sediments of this group were deposited on an erosional surface that locally had considerable relief, and this in part may have had a controlling influence on the development of the coal swamps. Although the coal beds of recoverable thickness are not continuous, the coal horizons are persistent and a careful search will generally reveal at least a carbonaceous clay or a coal smut at the proper relative stratigraphic position in most outcrops.

For purposes of discussion, the Cherokee Group has been divided informally into the Upper Cherokee and the Lower Cherokee. A number of the more persistent rock units, including the coal beds, of the Upper Cherokee have been named (fig. 4) and correlated with rock units of adjacent States (Weller, Wanless, Cline, and Stookey, 1942). Much of the stratigraphic data used in this discussion of the Upper Cherokee is from the unpublished work of L. M. Cline, although his proposed nomenclature has not been followed.

Upper Cherokee.—The uppermost coal in the Upper Cherokee is the Mulky. Although it is usually only a few inches thick, its position can generally be determined by associated beds that are persistent throughout the outcrop belt. Beneath the Blackjack Creek Limestone of the Marmaton Group, and overlying the Mulky, there is typicaly about 2 feet of fossiliferous greenish-gray shale overlying a dark-gray to black shale that contains a profusion of ash-gray phosphatic concretions and a zone of black limestone concretions near the middle. The Mulky underclay is about 3 feet thick, and is underlain by a thin but persistent basal sandstone that locally thickens where it occupies erosional chan-

nels. The Mulky coal has been correlated with the Summum (No. 4) coal of Illinois and the basal sandstone is the Pleasantview Sandstone of the Carbondale Formation of Illinois (Weller and others, 1942, p. 1590).

About 30 feet below the base of the Pleasantview Sandstone is the Bevier coal. Normally the intervening beds are made up of shale that is reddish brown near the top, light gray in the mid-portion, and carbonaceous in the lower part, although in places greenish-gray micaceous sandstones occur in the shale. In a number of places the Pleasantview has replaced the shale, the Bevier coal, and deeper strata.

The next deeper coal is the Wheeler, and the rocks between the Wheeler and the Bevier vary in thickness and lithology. In Dallas County this interval is about 30 feet and is made up largely of sandstone and siltstone. To the east the interval thins to about 1 foot and becomes largely shale and clay. Between the Wheeler coal and the underlying Ardmore Limestone is an interval that ranges from about 3 to 20 feet. Where thin this interval is made up of the underclay of the coal, but where it thickens the underclay is underlain by crossbedded sandstone.

The Ardmore Limestone is the best developed limestone in the Cherokee Group. It is an exceptionally widespread unit that maintains approximately the same characteristics over an area reaching from Oklahoma into Iowa. Along the line of outcrop in Iowa from the Missouri line northwestward into Guthrie County, and also in subsurface, it persists with so little change that it is a valuable stratigraphic marker. The Ardmore Limestone consists typically of two thin limestones separated by shale. The upper limestone is generally about 2 feet thick and is in two beds separated by a thin shale and contains an abundance of *Marginifera,* but in the northwestern part of the area it thickens to about 8 feet and divides into several beds with shale partings. The shale that separates the upper and lower limestone is consistently about 6 feet thick, is blue gray to black, and selenitic. The lower limestone is blue gray, dense, closely jointed, sideritic, and contains *Marginifera.* It is usually about 6 inches thick but locally it becomes a nodular zone or is absent.

Underlying the Ardmore Limestone and above the Whitebreast coal is a persistent black slaty shale that contains numerous small round-to almond-shaped ash-gray phosphatic concretions

that locally give the shale a pimply appearance. The thickness is about 2 feet. At some localities in Monroe County about 2 feet of dark-brown shale lies between this black shale and the Whitebreast coal. Cline (written communication) states that this brown shale is the equivalent of the Francis Creek Shale of Illinois that contains the world-famous Mazon Creek flora.

The Whitebreast coal of Iowa is the equivalent of the Colchester (No. 2) coal of Illinois and the Croweburg coal of Missouri. From Wapello to Dallas Counties it is usually about 12 to 18 inches thick, but it thins to about 1 or 2 inches to the north and west. Beneath the underclay of the Whitebreast there is generally about 3 feet of soft micaceous sandstone, although locally this may be developed as a thicker channel sandstone.

A series of thin beds below the Whitebreast coal contain two very thin zones of coal smut that are probably equivalents of the Abingdon and Greenbush coals of Illinois. The rocks associated with these coal smut zones are commonly gray, red, or variegated fissile shale and clay.

The next lower coal of possible economic importance is the Wiley. A few feet of shale and siltstone overlie the coal, which in turn is underlain by a prominent underclay that in places contains a nodular fresh-water type limestone. At most localities in Iowa the Wiley underclay rests directly on the Seahorne Limestone, which characteristically is dense, blue-gray, and sideritic, and contains *Marginifera*. A thickness of about one foot is normal for the Seahorne, but at some localities in Davis and Monroe Counties this is increased by the addition of an algal zone above. According to Cline (written communication), at a few outcrops in southwestern Marion and eastern Warren Counties the position of the Seahorne is marked by an ocherous zone in the underclay of the Wiley coal.

Typically the Seahorne Limestone rests directly on a thin but persistent coaly zone that seldom exceeds one-half inch in thickness, but locally a few inches to several feet of limy fossiliferous shale intervenes. Underlying the coaly zone is about 2 feet of variegated underclay that is in turn underlain by about 4 feet of thinly bedded gray shale with irregular splotches and rather even bands of hematite red parallel to the bedding. The lower few inches of the shale is obscurely bedded, calcareous and fossil-

iferous, and may be a weathered phase of the underlying Munterville Limestone.

The Munterville is probably the oldest persistent limestone in the Pennsylvanian of Iowa. Although thin, averaging about 4 to 6 inches, it constitutes a recognizable unit. It is gray, somewhat earthy, is typically very hard and dense, and weathers yellowish to purplish brown on the exterior. It is closely jointed and tends to disintegrate into rounded nodules on weathered outcrop. The presence of glauconite helps in distinguishing it from other thin limestones of similar appearance a short distance above it in the section. The Munterville contains abundant *Marginifera, Composita,* chonetids, productids, and fusulinids.

Immediately underlying the Munterville Limestone is a calcareous and fossiliferous shale. In the southwestern part of the outcrop area in Wapello County it is only about 2 feet thick, but it thickens northwestward to about 12 feet in Dallas County. Where thin the shale is gray and platy, and where thick it is red and green mottled, thin-bedded and platy, and is dark gray near the base. This dark-gray part commonly includes a thin discontinuous earthy limestone that contains *Marginifera.* Underlying this calcareous and fossiliferous shale is a coal bed—herein called the Munterville coal for lack of a better name—that is identifiable over a large part of central Iowa. The underclay of this coal ranges in thickness from 3 to 9 feet. In northern Monroe and Lucas Counties the upper part of the clay contains a zone of nodular fresh-water limestone.

At the base of the underclay of the Munterville coal there is typically present a few inches of sandstone that is quite distinctive. It is white, fine grained, and contains minute fragments of carbonized wood. The grains commonly show secondary enlargement which gives the rock a glistening appearance. At some places, as along the South Raccoon River in Dallas County, this sandstone is developed as a channel phase and it cuts deeply into underlying rocks. A thickness of 45 feet of channel sandstone has been measured at Redfield, Dallas County.

This sandstone is herein considered to be the basal unit in the Upper Cherokee.

Lower Cherokee.—In general, the lower part of the Cherokee is distinguished from the higher beds by the relative scarcity of key horizons that are useful in correlation. The coal beds of this

part of the section are lenticular, and are locally represented by carbonaceous streake or ferruginous zones. The shale units are variable in thickness and the lateral variation in lithology is tremendous. The marine limestone beds are characteristically represented by isolated concretionary masses in the shale, and with few exceptions show no lithologic features by which they can be identified. Sandstone beds are lenticular and most resemble one another so closely that they are of little value for correlation except over short distances. Under these circumstances few correlations have been made in this part of the section.

The only formally named unit is the Seville Limestone, which has also been called the Laddsdale in southern Iowa. Where recognized in outcrop in southeastern Iowa the Seville is dark gray, hard, earthy and fossiliferous and contains the oldest fusulinid fauna thus far found in Iowa. The limestone is extremely lenticular and locally grades into fossiliferous sandstone. The Seville forms the caprock for the Laddsdale coal near the abandoned town of Laddsdale in northeastern Davis County.

COAL BEDS OF IOWA

Coal beds of past and possible future economic interest are in the Wabaunsee Group of the Virgil Series and in the Marmaton and Cherokee Groups of the Des Moines Series. The coal beds discussed in this report and their estimated original reserves in millions of short tons are listed by bed and by county in table 3 (in pocket).

Wabaunsee Group

Nodaway coal bed.—The distribution of rocks in the Wabaunsee Group is shown on figure 6. The Nodaway, lying at the base of the Wabaunsee Group, is the only coal bed in the Group that is of minable thickness over an area of sufficient size to permit reserve calculations. The bed is persistent throughout most of the area of the Wabaunsee Group shown on figure 6, but is less than 14 inches thick in the western part of the area.

Thickness of coal in the Nodaway bed ranges from 0 to 3 feet, but it is generally about 14 to 18 inches in the six counties of southwestern Iowa for which reserves were estimated.

Elmo coal bed.—A very small tonnage of coal has been mined from the Elmo coal bed, but available information indicates that the bed is very lenticular and is generally less than 14 inches thick. No coal reserves were estimated.

Nyman coal bed.—The Nyman coal bed is in the upper part of the Wabaunsee Group. The area in which the Nyman may possibly be present is smaller than the areas of the Nodaway and Elmo coal beds. The bed has been opened for mining at several places but it is generally less than 14 inches thick and is very lenticular. No reserves were estimated.

Marmaton Group

The Marmaton Group contains several persistent coal beds, the best known of which is the Mystic. The strata of the Marmaton Group are much more persistent than are those of the underlying Cherokee Group, and though the coal beds are generally thin they are identifiable over large areas.

Lonsdale coal bed.—The Lonsdale coal bed, although generally very thin, is identifiable over a fairly large part of central and southern Iowa. Reserves were estimated in Dallas and Guthrie Counties, where the Lonsdale has been mined in the past.

Mystic coal bed.—The Mystic coal bed is probably the best known coal bed in Iowa. Its remarkable constancy and thickness over several counties of southern Iowa and northern Missouri are notable among the coal beds of the Des Moines Series.

In central Iowa the Mystic loses some of its identifying characteristics; it is absent or very thin over large areas and seems to split into two beds, the Upper Mystic and the Lower Mystic. The Lower Mystic has been called the Marshall coal in some areas.

Reserves were estimated for the Mystic in five counties, for the Upper Mystic in one county, and for the Lower Mystic in two counties (table 3). In Dallas and Adair Counties reserves assigned to uncorrelated Marmaton coal beds are probably near or at the stratigraphic position of the Mystic coal bed. Estimated original reserves of the Mystic exceed 1,000 million tons (table 3) and the bed is the most important in southern Iowa.

Cherokee Group

Most of the estimated coal reserves of Iowa are in beds of the Cherokee Group. Though these coal beds are characteristically very lenticular, individual lenses are commonly as much as 5 feet thick. Correlation of some of the beds is difficult or impossible because of the lack of continuity and identifying characteristics of more than local significance. However, many of the beds can be related to other coal beds or other rock units of the Cherokee Group on the basis of stratigraphic position. In the following discussion of individual beds (table 3) many correlations are made, suggested, or implied. Subsequent stratigraphic work may prove some of the correlations incorrect, but the general stratigraphic framework is believed to be valid.

In this report the Cherokee Group has been informally divided into the Upper Cherokee and Lower Cherokee. Many of the more persistent strata of the Upper Cherokee, including the coal beds, have been named (Weller and others, 1942) and correlated

with rock units of adjacent States. The rock units of the Lower Cherokee are mostly unnamed and the stratigraphic relations are imperfectly known.

Upper Cherokee Coal Beds

Reserves were estimated for six coal beds (table 3). In general, the coal beds of the Upper Cherokee are thinner but are more widespread and more easily identified than those of the Lower Cherokee. Because the stratigraphy is reasonably well known, the position of an Upper Cherokee coal bed can be identified by reference to associated strata even where the coal bed itself is absent.

Mulky coal bed.—The Mulky coal bed near the top of the Upper Cherokee is fairly persistent but thin over most of central and southern Iowa. Reserves were estimated only for Lucas County, though the bed was identified in many other counties.

Bevier coal bed.—The Bevier, which has also been called the Bedford, is the most variable of the six principal coal beds of the Upper Cherokee. A channel sandstone whose normal stratigraphic position is a short distance above the Bevier replaces the Bevier in places and makes interpretation of the stratigraphic relations difficult. In some areas, the Bevier is easily confused with the Wheeler coal bed, which normally lies a short distance below the Bevier. Reserves in the Bevier coal bed were estimated in four counties in southern and central Iowa (table 3).

Wheeler coal bed.—The same channel sandstone that locally replaces the Bevier also locally replaces the Wheeler. In general, however, the Wheeler bed or its stratigraphic position can be recognized because of the stratigraphic relationship to the very persistent Ardmore Limestone which is a short distance below the Wheeler. The Wheeler is commonly thin and reserves were estimated in only Lucas, Polk and Warren Counties.

Bevier-Wheeler coal bed.—In Dallas and Monroe Counties, reserves were estimated for a coal bed near the stratigraphic position of the Bevier and Wheeler coal beds, but the available information was not sufficient to allow exact correlation and the reserves are grouped, as they may be either or both of the named beds.

Whitebreast coal bed.—Beneath the very persistent Ardmore Limestone is the persistent Whitebreast coal which commonly exceeds 14 inches in thickness. Because of its proximity to the Ardmore Limestone the Whitebreast is probably the most easily identified coal bed in the Cherokee Group. Coal reserves were estimated in nine counties (table 3).

Wiley coal bed.—Though several thin and unimportant coal beds lie between the Wiley and Whitebreast coal beds, the Wiley is generally identifiable by its relation to the underlying Seahorne and Munterville Limestones and the overlying Whitebreast coal bed and Ardmore Limestone. Reserves of coal were estimated in four counties (table 3); elsewhere the bed is too thin for reserve estimation.

Munterville coal bed.—The Munterville coal bed, like the Whitebreast, occupies a stratigraphic position a short distance below an important limestone-bearing interval. However, the Munterville coal is not as persistent as the Whitebreast coal, and the Seahorne and Munterville Limestones that in many places are present a short distance above the coal are not as prominent, or as persistent, as the Ardmore Limestone. Even so, the Seahorne and Munterville Limestones, the associated Munterville coal bed, and the sandstone beneath the coal, are commonly identifiable. The base of the sandstone below the Munterville coal is also the base of the Upper Cherokee. The Munterville coal bed is generally thin but reserves were estimated in seven counties (table 3); correlation of the bed is tentative in five of these counties.

Uncorrelated coal beds.—In Decatur County, reserves were estimated for a bed whose stratigraphic relations are obscure but which is possibly in the Upper Cherokee.

Lower Cherokee Coal Beds

The stratigraphy of the Lower Cherokee in Iowa is virtually unknown, both because stratigraphic relations are very complex and because data are insufficient in several critical areas. No rock units have been continuously traced very far, and few have been given formal names. Consequently, the lateral relations of coal beds of minable thickness are doubtful or unknown in many areas; correlations made or suggested between noncontiguous

areas for which reserves estimates have been made must be considered provisional and subject to change.

In the preceding discussion of the coal beds of the Wabaunsee, Marmaton, and Upper Cherokee Groups, the beds were considered in descending stratigraphic order. This arrangement is not entirely possible with the beds of the Lower Cherokee, but is used in the following review wherever feasible. Stratigraphic distances between beds are cited in some places, but only for relative orientation because all stratigraphic distances between Lower Cherokee coal beds can range widely in short horizontal distances.

No. 7 bed of Lucas County.—Reserves were estimated for this bed in only a small part of Lucas County; it was not identified elsewhere. Possibly this bed is the Munterville coal, as it is only about 15 feet below the Munterville Limestone, and the sandstone that is the basal unit of the Upper Cherokee is inconspicuous in parts of Lucas County. However, in the absence of reliable stratigraphic information the bed is considered separately.

No. 5 bed of Lucas County.—This bed is about 50 feet below the Munterville Limestone in Lucas County and about 40 to 60 feet above the major coal bed called, in this report, the Lower coal-Ford coal. The bed extends into Monroe County and possible equivalents are present in Marion, Wapello, Van Buren, Polk, Jasper, and Dallas Counties. Beds near this stratigraphic position in Warren, Mahaska, and Davis Counties are too thin for estimation of reserves.

Lower coal-Ford coal.—In Lucas County the Lower coal-Ford coal bed, so called in this report, is about 90 to 110 feet below the Munterville Limestone, but in general the interval seems to thin both north and east of Lucas County. Typical of all coal beds of the Lower Cherokee, this bed cannot be traced continuously very far in any one area, but coal beds are present at a similar stratigraphic position in many parts of central and south-central Iowa. Correlation of beds in other areas with the Lower coal-Ford coal is very tenuous in places and may prove to be erroneous. The Lower coal of Lucas County (Lugn, 1927) extends into Monroe and Marion Counties and is correlated with the Ford coal of northern Warren and southern Polk Counties (Tilton, 1896; and Bain, 1897b). The Ford coal is identifiable, in places only tentatively, in Jasper, Dallas, and Guthrie Counties. Beds at a

similar stratigraphic position are present in Mahaska, Poweshiek, Wapello, Jefferson, Van Buren, and Davis Counties. The Lower coal-Ford coal bed, whose estimated original reserves exceed 2,700 million tons (table 3), is by far the most important coal bed in Iowa from a resource standpoint.

Bed 16-25 feet below the Lower coal-Ford coal.—Reserves were estimated in Marion county for a bed 16-25 feet below the Lower coal-Ford coal bed; a very thin bed was noted at a similar stratigraphic position in other places in Warren, Lucas, and Monroe Counties.

Manbeck coal bed.—This bed, named for the Manbeck mine south of Des Moines (Bain, 1897b), is thick and fairly persistent in southern Polk County, where its average distance below the Ford coal is 45 feet. The bed is tentatively correlated, on the basis of similar stratigraphic positions, with beds in Jasper and northern Marion Counties; with the lower of the two main coal beds of central Mahaska County; with the lowest outcropping coal bed in northeastern Monroe County; with the coal called Upper bed at Boone (Beyer, 1896) in Boone and western Story Counties; and with some coal beds in central and eastern Story County.

Hastie Plus coal bed.—The Hastie Plus coal bed, named in this report, is fairly persistent in southern Polk County, where it lies about 43 feet below the Manbeck coal and about 30 feet above a major coal bed called the Hastie. The Hastie Plus is tentatively correlated with a coal called the Lower bed at Boone (Beyer, 1896), which is present in northwestern Polk, Boone, Dallas, and western Story Counties (table 3); the uppermost of three uncorrelated beds in northern Polk County may be the Hastie Plus. In Warren County reserves were estimated for a bed about 85 to 90 feet below the Lower coal-Ford coal and a very non-persistent bed is present about 85 to 110 feet below the Lower coal-Ford coal of Marion County. These uncorrelated beds may be equivalent to the Hastie Plus.

Hastie coal bed.—The Hastie coal bed of southern Polk County (Bain, 1897b), together with its probable and possible correlatives in other counties, is the most important coal bed of central Iowa from the standpoint of estimated reserves and past production. The Hastie is at an average distance of 30 feet below the Hastie Plus bed in southern Polk County. The bed is in

Dallas, Marshall, and Story Counties and is correlated with the lowest bed mined in the Madrid area of southern Boone, northeastern Dallas, and northwestern Polk Counties. The Hastie may be equivalent to the middle bed of three uncorrelated beds in northern Polk County, to a bed about 125 feet below the Ford coal in Warren County, and to some uncorrelated beds in the Lower Cherokee of central and south-central Iowa. The Hastie bed is nonpersistent and its thickness generally changes very abruptly, but wherever sufficient stratigraphic information is available the Hastie is generally identifiable, or its absence is obvious. The Hastie is the lowest coal bed in central Iowa whose distribution is not generally greatly affected by relief on the top of the underlying rocks of Mississippian age. Original reserves exceeding 470 million tons were estimated for the Hastie bed (table 3).

Unnamed and uncorrelated beds below the Hastie coal bed.—At least three and possibly four coal beds are below the Hastie coal. The unconformity at the top of the underlying Mississippian rocks has considerable relief in parts of Iowa and the distribution of coal beds below the Hastie is apparently related to the hills and valleys that developed on the Mississippian rocks during pre-Pennsylvanian erosion. In Marshall County reserves were estimated for a bed about 15 feet below a bed correlated with the Hastie, and for a bed that may be at an even lower stratigraphic position. In southern Polk County two beds are present about 28 and 70 feet below the Hastie but no reserves were estimated. In northern Polk County reserves were estimated for a bed 40 to 45 feet below a bed tentatively correlated with the Hastie. In north-central Polk County a thin coal bed, for which no reserves were estimated, is about 30 feet below the stratigraphic position of the Hastie coal bed. Reserves were estimated for an uncorrelated coal bed in Dallas County that is probably below the Hastie coal position.

Laddsdale coal bed.—This bed, which is named for the Laddsdale Mines near the Wapello-Davis County line (Hinds, 1909, p. 304), is about 80 feet below the Munterville Limestone near Ottumwa in Wapello County and is present at many places in eastern Iowa. Correlation of the bed from one area to another must be considered tentative because of a general lack of information and because Pennsylvanian rocks of eastern Iowa are often very thin and discontinuous. Correlation of the Laddsdale

with coal beds in central Iowa is impossible with the present data, although it seems that the bed is at a stratigraphic position somewhere between the top of the Lower coal-Ford coal horizon and the Hastie Plus coal horizon. In places in eastern Iowa the Laddsdale is overlain by a fusulinid-bearing limestone (Thompson, 1934), but both limestone and the coal bed are nonpersistent and are commonly unidentifiable away from the outcrop areas along the Des Moines River. Reserves were estimated for the Laddsdale coal and beds tentatively correlated with it in Wapello, Jefferson, Henry, Davis, and Van Buren Counties. The Rock Island No. 1 coal bed of Muscatine and Scott Counties is a possible correlative of the Laddsdale and its reserves are grouped with the Laddsdale (table 3). Reserves were estimated in Keokuk and eastern Mahaska Counties for a bed or beds that may be at the stratigraphic position of the Laddsdale, but which might actually represent the underlying Cliffland bed (table 3).

Original reserves exceeding 483 million tons were assigned to the Laddsdale (table 3), but some of these reserves may be in the Cliffland bed that underlies the Laddsdale in parts of southeastern Iowa.

Cliffland coal bed.—The Cliffland coal bed, named herein for a community southeast of Ottumwa in Wapello County, is about 25 feet below the Laddsdale coal bed in southern Wapello County and is almost as persistent as the Laddsdale. The bed was not identified west of Wapello County. Reserves were estimated for beds correlated with the Cliffland in Wapello, Jefferson, Henry, and Davis Counties, and some of the reserves estimated for coal beds in eastern Mahaska and Keokuk Counties are possibly in the Cliffland though the reserves are grouped with the Laddsdale bed in table 3.

Uncorrelated coal beds.—Reserves were estimated in 17 counties (table 3) for coal beds that are considered to be uncorrelated because their stratigraphic relation to the previously discussed named beds is unknown or very doubtful. Undoubtedly some or all of these uncorrelated beds will be correlated with named beds of nearby areas as the Pennsylvanian System of Iowa becomes better known.

COAL RESOURCES OF SOUTH-CENTRAL IOWA

South-central Iowa, comprised of Union, Clarke, Ringgold, Appanoose, Wayne, Decatur, Lucas, Monroe, Madison, Warren, Marion, and Mahaska Counties, contains about 58 percent of the estimated original coal reserves of Iowa even though no reserves were estimated for 3 (Union, Ringgold, and Madison) of the 12 counties. Monroe County, with almost 885 million tons, is first among the Iowa counties in estimated original reserves and is also first in total recorded production. Appanoose, Marion, and Mahaska Counties rank third, fourth, and fifth, respectively, in estimated original reserves, and third, fifth, and fourth in total recorded production. South-central Iowa produced about 61 percent of the State's total recorded production assignable to individual counties, and over 90 percent of all coal mined in Iowa in recent years.

Glacial materials of Pleistocene age covered the area, but erosion since the Pleistocene has exposed the Pennsylvania coal-bearing rocks in places along all the major and most of the minor streams. Consequently, coal mining as an active industry began by 1860 and has continued to the present. Abundant information on coal resources is available, but integration of much of the data, particularly as related to stratigraphy, is difficult or impossible.

Reserves were estimated in one or more counties of south-central Iowa for most of the major coal beds of the Marmaton and Cherokee Groups. Original reserves exceeding 4,212 million tons (table 4) were estimated for the area, of which almost 1,902 million tons can be classed as recoverable (table 5).

Union County

Union County is almost completely covered with glacial drift and most of the wells drilled in the county stop at or near the top of the Pennsylvanian rocks. The Pennsylvania rocks directly overlain by the drift belong to the Shawnee, Douglas, Lansing, and Kansas City Groups, which contain thin nonpersistent coal beds of less than minable thickness (Hershey and others, 1960).

A few deep wells indicate the presence of coal beds, some of minable thickness, at a depth of more than 600 feet. Two wells drilled in T. 71 N., R. 30 W., indicate as many as 14 coal beds in

Table 4. Original coal reserves (millions of short tons) of south-central Iowa, by county

County	Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
Union	....	....	....	....	....	....	....	....	....	....	....	....
Clarke	....	....	....	....	....	0.42	....	0.42	....	0.42	....	0.42
Ringgold	....	....	....	....	....	....	....	....	....	....	....	....
Appanoose	39.45	157.43	....	196.88	113.70	369.63	....	483.33	153.15	527.06	....	680.21
Wayne	51.91	....	....	51.91	299.66	....	....	299.66	351.57	....	....	351.57
Decatur	6.40	5.58	27.90	39.88	37.35	19.33	115.80	172.48	43.75	24.91	143.70	212.36
Lucas	51.93	33.36	101.02	186.31	147.48	38.18	110.76	296.42	199.41	71.54	211.78	482.73
Monroe	21.84	110.35	408.32	540.51	53.99	114.99	175.34	344.32	75.83	225.34	583.66	884.83
Madison	....	....	....	....	....	....	....	....	....	....	....	....
Warren	62.44	72.50	15.03	149.97	174.82	102.72	3.61	281.15	237.26	175.22	18.64	431.12
Marion	44.97	119.82	278.52	443.31	58.35	93.31	50.19	201.85	103.32	213.13	328.71	645.16
Mahaska	9.90	45.54	279.80	335.24	23.88	47.61	117.25	188.74	33.78	93.15	397.05	523.98
Total	288.84	544.58	1,110.59	1,944.01	909.23	786.19	572.95	2,268.37	1,198.07	1,330.77	1,683.54	4,212.38

Table 5. Remaining and recoverable coal reserves (millions of short tons) of south-cental Iowa, January 1, 1964

County	Estimated original reserves	Production (Table 16 rounded to 0.01 million tons)	Remaining reserves	Recoverable reserves
Union	....	....	....	....
Clarke	0.42	....	0.42	0.2
Ringgold	....	....	....	....
Appanoose	680.21	46.20	587.81	293.9
Wayne	351.57	2.67	346.23	173.1
Decatur	212.36	....	212.36	106.2
Lucas	482.73	13.40	455.93	228.0
Monroe	884.83	63.38	758.07	379.0
Madison	....	....	....	....
Warren	431.12	2.47	426.18	213.1
Marion	645.16	37.04	571.08	285.5
Mahaska	523.98	39.11	445.76	222.9
Total	4,212.38	204.27	3,803.84	1,901.9

the Marmaton and Cherokee Groups between depths of 600 and 1,140 feet, but no valid estimate of thicknesses can be made from the well samples. Another deep well in T. 72 N., R. 29 W., and two shallower wells in T. 72 N., R. 30 W., indicate the presence of fewer coal beds than the two wells first cited. A few coal beds, such as the Whitebreast and Wiley, are in most holes drilled deep enough to penetrate them, and all wells indicate at least one coal bed in the Upper Cherokee. The three deepest wells, those in T. 71 N., R. 30 W., and the well in T. 72 N., R. 29 W., all indicate from three to four coal beds at depths of from nearly 900 feet to about 1,040 feet, in the Lower Cherokee.

No reserves were estimated in Union County because of insufficient data but available information does indicate that an area of about 43,170 acres possibly is underlain by coal beds 14 inches or more thick.

Clarke County

Coal beds of minable thickness are not known to crop out in Clarke County (Tilton, 1916b). Very few wells have penetrated even a part of the Pennsylvanian rocks underlying the county and only two contain traces of coal. A well in T. 72 N., R. 27 W., penetrated to near the base of the Marmaton Group at a depth of about 460 feet and samples from near the bottom of the well contained traces of coal. Another well in the same township contained traces of two coal beds at depths of about 375 and 415 feet, the lowest of which is probably at about the stratigraphic position of the Mystic coal. The well ended in the Blackjack Creek Limestone, the basal unit of the Marmaton Group.

Until more wells in excess of 500 feet are drilled in Clarke County, the coal resource potential of the county will remain unknown. The only coal reserves estimated for Clarke County are an extension of information from Lucas County and are in the Lower coal-Ford coal. A total of about 0.42 million tons of coal are estimated for an area of about 80 acres. An additional area of about 6,740 acres, as indicated by available information, is believed to be favorable for the presence of coal beds 14 inches or more thick.

Ringgold County

No reserves were estimated in Ringgold County as the Pennsylvanian rock units nearest the surface contain no coal

beds of minable thickness (Hershey and others, 1960). Only a few wells have penetrated the strata of Des Moines age that underlie the county. Wells in T. 67 N., R. 29W., and in T. 69 N., R. 28 W., have penetrated deeply enough to indicate a coal bed in the Marmaton Group, possibly at about the stratigraphic position of the Mystic coal bed, at depths of from about 375 to about 780 feet below the surface. An area of about 4,740 acres is estimated to be potentially underlain by coal beds more than 14 inches thick.

Appanoose County

Coal is known to have been mined in Appanoose County since 1857 and possibly was mined prior to that date. Mining was a major industry for many years with as many as 80 to 90 mines operating at the same time (Hinds, 1909, p. 268). Coal production, which reached its peak of more than 1.6 million tons in 1917, decreased to less than 37 thousand tons in 1963.

The Mystic coal bed in the Labette Shale of the Marmaton Group is present throughout most of the county and is noted for its constancy in thickness and character. The Mystic seldom exceeds 3 feet in thickness, and the average thickness in the mines is on the order of 2½ feet. The bed is relatively flat-lying, is generally less than 200 feet below the surface, and is overlain by a persistent limestone bed that forms a roof favorable to the longwall method of mining. All of the estimated coal reserves of the county are in the Mystic bed, for although the presence of coal beds at depths of about 200 feet below the Mystic has been known for many years (Bain, 1896, p. 403), available information is too sparse for reserves to be estimated for those beds. The strata containing the thick coal beds of Monroe, Wapello, and Lucas Counties underlie Appanoose County and might be attractive for future exploration.

About 680 million tons of coal is estimated to have been originally present in Appanoose County in an area of about 166,630 acres. Coal beds 14 inches or more thick may be present in an additional area of about 28,240 acres, as indicated by available data.

Wayne County

Wayne County has supported very few mines compared to Appanoose County, its neighbor on the east, though the Mystic

coal bed is known to underlie a large area in the eastern part of the county. The Mystic generally lies at greater depths below the surface in Wayne County than in Appanoose County, and the glacial drift becomes increasingly thicker westward. Both factors have tended to discourage mining and prospecting in Wayne County.

Very little information is available about coal beds below the Mystic, though they are known to be present (Arey, 1910b, p. 234). A well in the southwestern corner of the county reportedly penetrated a thick coal bed at a depth of nearly 600 feet.

Original reserves of about 351 million tons, all in the Mystic coal bed, are estimated for Wayne County in an area of about 97,690 acres. Available data indicate that an additional 24,660 acres of the county may be underlain by coal beds 14 inches or more thick.

Decatur County

Both deep wells and coal prospects long ago showed that coal beds of minable thickness underlie Decatur County (Hinds, 1909, p. 246-253). Two thick beds are reported to be present at depths of about 325 and 225 feet (F. H. Dorheim, 1961, written communication). However, reportedly only one mine, near Davis City, has produced coal in Decatur County.

Though correlation of the strata penetrated in the deep wells and prospects is tentative, the beds in the Davis City mine are at about the stratigraphic positions of the Bevier and Whitebreast coal beds of the Upper Cherokee. Coal reserves were estimated for these two beds, and for another coal bed that occurs about 40 feet below the Whitebreast. The Mystic coal may be present in a well in the northeastern part of the county, and coal beds of uncertain stratigraphic position and thickness are recorded in logs of several other wells in the county.

About 212 million tons is estimated to have been originally present in Decatur County in an area of about 23,360 acres. Information, largely from deep wells, allows delineation of an additional 57,870 acres that may contain coal beds 14 inches or more thick.

Lucas County

Nearly all the coal beds of the Marmaton Group and the Upper Cherokee either crop out or lie at minable depths within Lucas County. The estimated coal reserves are in nine different beds; no reserves were estimated for several deep beds because of the sparseness of data.

Rocks of the Marmaton Group underlie a large part of southwestern and western Lucas County. The Mystic coal bed is identifiable at some places but is generally too thin and of too poor quality to be included in the reserve estimates. The only reserves estimated for the Mystic are in a small area in the southwestern part of the county and are based on information from Wayne County.

The upper part of the Cherokee Group is present throughout most of the county, and the Mulky, Bevier, Wheeler, and Whitebreast coal beds all contain minable coal reserves. The Whitebreast contains considerably more minable coal than the others but all have been mined or prospected in the past.

The Wiley coal bed and a bed called the No. 7 by Lugn (1927) are both traceable over considerable distances. The No. 7 bed, at a stratigraphic position very near that of the Munterville coal bed, is 14 inches or more thick in only a few square miles, but the Wiley contains coal 14 inches or more thick over a much larger area.

Reserves were estimated for two coal beds in the upper part of the Lower Cherokee, and the few deep well records available indicate other beds at greater depths. The coal bed designated No. 5 by Lugn (1927) is minable in a few areas in the northeastern part of the county. More than half the reserves estimated for Lucas County are in a bed which lies about 100 feet below the Munterville Limestone in Lucas County, that Lugn (1927) called the Lower coal bed. The bed, which is fairly persistent and identifiable over a large part of the county, is as much as 7 feet thick locally. It probably is a correlative of the Ford coal of Polk County; thus the bed is designated the Lower coal-Ford coal in this report.

Original reserves of almost 483 million tons of coal 14 inches or more thick are estimated for an area of about 80,020 acres.

An additional area of about 33,940 acres may contain coal 14 inches or more thick.

Monroe County

For many years Monroe County was one of the leading coal-producing counties in the State (Beyer and Young, 1903), but in recent years mining activity has declined markedly, as it has throughout Iowa. The coal resources of the county are far from depleted, though most large areas of thick coal beds have been mined to some extent. Unmined resources of future economic interest fall into three general categories: (1) thick coal beds left in previously mined areas; (2) thin coal beds not yet mined; and (3) thick coal beds that may lie at depth, particularly in the southern and western parts of the county.

Coal reserves estimated for the county are assigned to six different coal beds, but as correlations are very tentative, some of the reserves included within the six cited beds possibly are in coal beds known to be fairly persistent in surrounding counties. Most of the information pertaining to coal in Monroe County is mine data in varying degrees of completeness, and the lack of elevation data creates uncertainty about stratigraphic positions and correlation of the coal beds.

In general, all the coal beds of the Marmaton Group and the Upper Cherokee are thin and nonpersistent but reserves were estimated for the Mystic and Whitebreast coals in a few areas, and for a bed, which because of uncertain correlation, is called the Bevier-Wheeler bed in the reserve tables. In northwestern Monroe County reserves were estimated for a bed called the No. 5 in Lucas County. The bed does not seem to be of minable thickness elsewhere in Monroe County.

Most of the reserves estimated in Monroe County for beds of the Lower Cherokee are assigned to a bed that occupies a stratigraphic position similar to the Lower coal-Ford coal. For reasons mentioned earlier, the assignment of the reserves to this one bed is arbitrary but is the best solution in the absence of information allowing better stratigraphic correlation.

A small amount of reserves was estimated for a bed that was formerly mined along the Des Moines River in the northeastern part of the county. This bed is stratigraphically the lowest coal

that crops out in Monroe County (Beyer and Young, 1903, p. 382) and may be near the horizon of the Manbeck coal.

Almost 885 million tons of coal is estimated to have been originally present in Monroe County in an area of about 129,270 acres. An additional area of about 33,800 acres may contain coal 14 inches or more thick.

Madison County

No coal reserves were estimated in Madison County because the available information indicates that the coal beds that crop out in the county are almost everywhere less than 14 inches thick (Tilton and Bain, 1897, p. 537). A few small mines have produced in years past for local use. Four coal beds have been prospected and locally mined in the eastern part of the county. The Ovid coal, which is near the base of the Pleasanton Group, reportedly is as much as 1 foot thick at a locality southwest of the town of Winterset but is much thinner at all other reported outcrops. The Lonsdale coal, in the upper part of the Marmaton Group, has been prospected and mined at a few places and reportedly is as much as 2 feet thick at an exposure near the town of Patterson and as much as 2.5 feet thick at an old mine in the valley of North Branch of North River, north of Winterset. However, at both localities other information indicates that the amount of coal 14 inches or more thick is probably very small. In eastern Madison county, both the Upper Mystic and Lower Mystic (Marshall) coal beds crop out over a considerable area but are less than 14 inches thick at most places. The Lower Mystic bed is 3 feet thick north of the town of St. Charles but the coal is impure. At another locality south of the town of Bevington a coal bed that may be the Lower Mystic is reported to be 3 feet thick. This bed may be the Mulky coal near the top of the Cherokee Group instead of the Lower Mystic.

Samples from wells indicate the presence of coal beds of the Cherokee Group at depths ranging from 265 to 540 feet. Samples from a well in T. 74 N., R. 27 W., indicate three coal beds, probably in the Upper Cherokee, at depths from 265 to 370 feet. Traces of at least two coal beds at depths from 410 to 515 feet are in a well in T. 75 N., R. 28 W. These beds are either in the lower part of the Upper Cherokee or in the upper part of the Lower Cherokee. A well in T. 76 N., R. 26 W., penetrated two coal beds of the Lower Cherokee at depths of about 425 and 535

feet. Samples from a well in T. 76 N., R. 28 W., contain traces of an unnamed coal below the Worland Limestone, the Lonsdale, Upper Mystic, Lower Mystic, and Summit coal beds, all of which are in the Marmaton Group. No thickness estimate is possible but it is unlikely that more than one of these beds is of minable thickness. Depth ranges from 300 to 420 feet. A well in T. 77 N., R. 26 W., penetrated 13 coal beds at depths from 100 to 515 feet. The uppermost coal bed, tentatively correlated with the Lonsdale coal of the Marmaton Group, was found in samples from a depth of about 100 feet. A coal bed that is at the stratigraphic position of either the Bevier or Wheeler coals, and coal beds tentatively correlated with the Whitebreast and Wiley coals, were penetrated at depths from about 235 to 315 feet. These three beds, plus another bed at about 330 feet, are in the Upper Cherokee. Traces of as many as eight more coal beds were found in samples from the Lower Cherokee. No thickness estimates are possible for any of these beds, and some of the beds indicated by the samples may be "false beds" due to sample lag and sample contamination. Samples from depths of 205 to 275 feet in a well in T. 77 N., R. 28 W. contain traces of a coal bed in the lower part of the Marmaton Group and traces of two coal beds, possibly the Mulky and Bevier, in the Upper Cherokee.

Though no reserves were estimated in Madison County, the foregoing discussion indicates that the Pennsylvanian rocks have considerable coal resource potential. An area of about 23,510 acres is believed to be favorable for the presence of coal beds 14 inches or more thick.

Warren County

Warren County contains a thick sequence of coal-bearing rocks of Pennsylvanian age. Coal reserves were estimated for most of the important coal beds of the Marmaton Group and the Upper Cherokee plus several beds of the Lower Cherokee—a total of nine beds. Several other beds are either known or believed to be present and may be 14 inches or more thick in parts of the county.

The Mystic coal bed, though generally thin or impure, is identifiable at several points in the southwestern part of the county and reserves were estimated in one area where the bed is almost 1½ feet thick. Reserves were estimated for the Bevier and

Wheeler coal beds in scattered areas throughout the central part of the county. The Mulky coal bed is present in some areas, though it is less than 14 inches thick where identified. The Whitebreast coal bed is present over much of the county, but reserves in the bed are mainly in the eastern part of the county where the bed is 14 inches or more thick. The Wiley coal bed contains some minable coal in extreme eastern Warren County but is generally absent or thin over much of the county. The Munterville coal bed, commonly identifiable in central Iowa but usually too thin to be of interest, is over 3½ feet thick at some places in northern Warren County and contains significant amounts of reserves.

Reserves were estimated for three beds in the Lower Cherokee, but information pertaining to the lower two is very sparse. The uppermost of the three is the Lower coal-Ford coal. The bed is persistent and fairly thick over a large area in northeastern Warren County (Tilton, 1896), but drill-hole data in the southern and eastern parts of the county are too sparse to allow evaluation of the reserves potential of the bed in those areas. The lower two beds, one about 85-90 feet below the Ford and the other about 125 feet below the Ford, were penetrated in a few scattered deep drill holes in the central part of the county. Many thick coal beds are at approximately the same stratigraphic positions in Polk County to the north. Deep prospecting in Warren would probably yield significant data about the potential of these beds.

Original reserves of about 431 million tons of coal are estimated in an area of about 89,010 acres in Warren County. An additional area of about 60,260 acres may contain coal beds 14 inches or more thick.

Marion County

In recent years Marion County has led the State in coal production, mainly from large strip-mining operations. Most of the strip mines are in the central and southeastern parts of the county where the glacial drift is thinner and the coal beds crop out along streams tributary to the Des Moines River (Miller, 1901; Hinds, 1909, p. 181).

The stratigraphically highest coal bed for which reserves were estimated in Marion County is the Wiley bed, which reportedly is nearly 2 feet thick at one point in the southwestern part of the county. However, it generally is no more than 1½ feet thick and

it is absent over much of southwestern Marion County. The stratigraphically higher Bevier, Wheeler, and Whitebreast coal beds are identifiable over much of southwestern Marion County, but no reserves were estimated because the beds are almost everywhere less than 1 foot thick. For the same reason, no reserves were estimated for the Munterville coal bed, though it too underlies a large part of the county.

The youngest coal bed containing a significant amount of reserves may be equivalent to the No. 5 bed of Lucas County. It occupies a similar stratigraphic position 20-50 feet above a bed correlated with the Lower coal-Ford coal.

Most of the reserves estimated in Marion County are assigned to a bed correlated with the Lower coal-Ford coal bed. The correlation seems fairly certain in the western part of Marion County but is somewhat tentative in the southeastern part because of a thick northeastward-trending channel sandstone that has cut out the underlying rocks in a belt across the central part of the county.

Some reserves also have been estimated for a bed that occupies a stratigraphic position from 16 to 25 feet below the Lower coal-Ford coal bed in the northwestern and east-central parts of the county. Reserves were estimated for a bed about 45 feet below the Lower coal-Ford coal bed in the northwestern part of the county. This bed may be the Manbeck coal. A few isolated holes reportedly encountered a thick coal bed about 85 to 110 feet below the Lower coal-Ford coal bed, but logs of most drill holes that penetrate the stratigraphic position of the bed report black shale instead of coal. No reserves were estimated for this bed, though it might be worth exploring.

In the northeastern part of the county stratigraphic relations are very uncertain. Reserves were estimated for two uncorrelated beds that are near the middle of the Lower Cherokee. The presence of one of these beds is based on an extension of data from Jasper County on the north. The same bed is known to be the upper of two beds that are present east of the town of Monroe in Jasper County.

Original reserves of about 645 million tons of coal are estimated in Marion County in an area of 104,170 acres. An additional area of about 28,020 acres may contain coal beds 14 inches or more thick.

Mahaska County

In recent years Mahaska County has been second only to Marion County in Iowa coal production and, like Marion, most of the coal is produced by strip operations. Most of the coal mined in Mahaska has been produced from the central and southwestern parts of the county, because in the northern and eastern parts the coal-bearing rocks have been removed by pre-glacial erosion over large areas, and thick deposits of glacial drift overlie the rocks of Pennsylvanian and Mississippian age. Coal is present in isolated areas in northern and eastern Mahaska County, but reserves estimated are small because of insufficient data to delineate the areal extent of the coal beds.

Considerable data, mostly from mines, are available for several small areas in Mahaska County (Bain, 1895a; Hinds, 1909), but as these areas are separated by areas of little or no data correlation of the coal beds with those in Marion County to the west and Wapello County to the south must be considered provisional.

Most of the coal reserves of Mahaska County are provisionally assigned to two coal beds, although more may be involved. The upper, commonly called the Lower coal because of a thin impure bed above it, for which no reserves were estimated (Bain, 1895a, p. 360-362), is tentatively correlated with the Lower coal-Ford coal bed of southeastern Marion County and with a bed that is about 60 feet below the Munterville Limestone in central Wapello County. The lower, herein called the Lowest coal, is about 30-60 feet below the upper bed and may be near the horizon of the Manbeck coal bed of central Iowa.

In southern Mahaska County, reserves were estimated for a bed tentatively correlated with the Lower coal-Ford coal, on the basis of extension of data from Wapello County. In easternmost Mahaska County reserves were estimated for a bed that lies in both Mahaska and Keokuk Counties, and that is either the Laddsdale or Cliffland coal bed of southeastern Iowa. In northern Mahaska County, reserves were estimated for a bed that extends into Poweshiek County on the north. The bed is tentatively correlated with the upper part of the two main coal beds in central Mahaska County and, therefore, tentatively with the Lower coal-Ford coal.

Original reserves of almost 524 million tons of coal are estimated in an area of about 68,540 acres. The available data indicate that an additional area of about 23,710 acres may contain coal 14 inches or more thick.

COAL RESOURCES OF CENTRAL IOWA

Though central Iowa—which consists of Pocahontas, Humboldt, Wright, Webster, Hamilton, Hardin, Boone, Story, Marshall, Dallas, Polk, and Jasper Counties—has a long coal-mining history, it has produced only a small amount of coal in the recent past. Polk County ranks second in the State in both estimated original reserves and in total recorded production, but its coal-mining industry has been inactive in recent years. Pocahontas, Humboldt, and Wright Counties contain rocks of the coal-bearing Des Moines Series (MacBride, 1899; 1905; and 1910), but they do not contain known coal beds of potential resource value.

The early mining was largely concentrated in a belt along the Des Moines River and its tributaries, where most natural exposures of the coal-bearing rocks occur. Much data about the early mining is available; also, logs of wells drilled in the recent past supply much data on coal resources.

Original reserves of almost 1,663 million tons of coal were estimated in the area (table 6), of which about 732 million tons can be classed as recoverable (table 7).

Webster County

Webster County became a coal producer early in the history of the State of Iowa, but its coal-mining industry has been defunct or nearly so for many years. Most of the mining was done adjacent to the Des Moines River valley, where nearly all of the exposures of coal-bearing rocks occur (Wilder, 1902). The coal beds of Webster County have local names, but the available stratigraphic information will not allow their correlation with the named beds in other parts of Iowa.

In southeastern Webster County, four coal beds are known: (1) The uppermost bed, which is unnamed and for which no reserves were estimated because it is thin and is often absent as a result of preglacial erosion. (2) The Tyson coal bed, which is the youngest coal for which reserves were estimated in the county. The estimated reserves are confined to the southeastern part of the county because, though the bed is identifiable in the central part, it is present only in small, irregular, areas because of preglacial erosion. (3) The Pretty coal bed (called the Big coal and Upper Bituminous bed in the central part of the coun-

Table 6. Original coal reserves (millions of short tons) of central Iowa, by county

County	Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
Webster	22.64	25.91	18.04	66.59	43.30	20.75	5.45	69.50	65.94	46.66	23.49	136.09
Hamilton	4.79	5.07	3.44	13.30	10.10	10.12	4.50	24.72	14.89	15.19	7.94	38.02
Hardin	0.40	1.38	3.22	5.00	0.04	4.68	2.03	6.75	0.44	6.06	5.25	11.75
Boone	38.17	76.74	43.90	158.81	40.35	33.44	11.19	84.98	78.52	110.18	55.09	243.79
Story	3.86	5.82	28.15	37.83	11.07	20.35	51.26	82.68	14.93	26.17	79.41	120.51
Marshall	0.98	2.83	0.34	4.15	3.05	6.16	5.70	14.91	4.03	8.99	6.04	19.06
Dallas	20.06	32.64	17.79	70.49	35.09	31.54	12.46	79.09	55.15	64.18	30.25	149.58
Polk	81.25	177.26	313.67	572.18	66.04	61.64	50.00	177.68	147.29	238.90	363.67	749.86
Jasper	17.19	37.61	47.71	102.51	46.75	28.72	16.34	91.81	63.94	66.33	64.05	194.32
Total	189.34	365.26	476.26	1,030.86	255.79	217.40	158.93	632.12	445.13	582.66	635.19	1,662.98

Table 7. Remaining and recoverable coal reserves (millions of short tons) of central Iowa, January 1, 1964

County	Estimated original reserves	Production (Table 16 rounded to 0.01 million tons)	Remaining reserves	Recoverable reserves
Webster	136.09	4.93	126.23	63.1
Hamilton	38.02	.01	38.00	19.0
Hardin	11.75	.01	11.73	5.9
Boone	243.79	18.88	206.03	103.0
Story	120.51	.03	120.45	60.2
Marshall	19.06	.....	19.06	9.5
Dallas	149.58	14.04	121.50	60.8
Polk	749.86	50.97	647.92	324.0
Jasper	194.32	10.20	173.92	87.0
Total	1,662.98	99.07	1,464.84	732.5

ty), which is about 55 feet below the Tyson, is identifiable over much of the county and contains more estimated reserves than any other bed in the county. This bed was mined extensively in the area south of Fort Dodge. (4) The bed called the Big Seam in southeastern Webster County (the Colburn-Cannel bed of the area south and west of Fort Dodge), is about 35 feet below the Pretty coal bed, and contains almost as much estimated reserves.

In addition to the reserves for the three locally named coal beds, reserves were estimated for an uncorrelated coal bed south of Tara that may be at about the stratigraphic position of the Upper Bituminous bed, and for two uncorrelated beds in the southwestern part of the county that are probably below the Colburn (Cannel) bed. A well in the western part of the county reportedly penetrated coal beds at two different unknown stratigraphic horizons, but nearby wells are not reported to contain coal.

Original reserves of about 136 million tons of coal are estimated in an area of about 16,170 acres. An additional area of about 17,460 acres may contain coal 14 inches or more thick.

Hamilton County

Coal-bearing rocks of Pennsylvanian age underlie about half of Hamilton County (MacBride, 1910), but well records indicate the general absence of minable coal beds. Coal has been mined in the western part of the county from a bed that is probably at the horizon of the Pretty bed of Webster County. This bed contains most of the estimated reserves of Hamilton County. Reserves were also estimated for two other beds at about the stratigraphic positions of the Tyson and Colburn coal beds of Webster County. None of these three coal beds can be correlated with named beds in other parts of the State so the reserves are grouped as uncorrelated in table 3.

Original reserves of about 38 million tons of coal are estimated in an area of about 6,780 acres. Available information indicates that coal 14 inches or more thick may be present in an additional area of about 9,970 acres.

Hardin County

Though available information suggests a considerable area of Pennsylvanian rocks in Hardin County, preglacial erosion prob-

ably has removed most of the Pennsylvania coal-bearing rocks, leaving but a few thin scattered remnants that are now in part masked by glacial drift. Despite the seemingly poor prospects for minable coal in the county, two coal beds have been mined in the eastern part, near Eldora City (Beyer, 1900). The upper bed is the least persistent and is not reported to exceed 1½ feet in thickness. The lower bed attains a thickness of 4 feet at several places and contains almost all the estimated coal reserves of Hardin County. The two beds, though not correlated with beds elsewhere because of a lack of stratigraphic information, are probably in the Lower Cherokee.

A little less than 12 million tons of coal is estimated to have been originally present in an area of about 1,840 acres.

Boone County

Coal has long been mined in central Boone County near the town of Boone, in southern Boone County near Madrid, and in the southwestern part of the county (Beyer, 1896; and Hinds, 1909, p. 74).

Most of the estimated reserves of the county are in a bed herein called the Upper bed at Boone. This bed, which is in the upper part of the Lower Cherokee, is the most persistent bed in the county and is identifiable over much of the central part of the county, adjacent to the Des Moines River. Most of the coal production of the county has come from this bed, which may correlate with the Manbeck coal of Polk County and is so shown in table 3.

A bed called the Lower bed at Boone in this report is present over a large area in the central part of the county. The bed, which may correlate with the Hastie Plus bed of Polk County, lies from 10 to 40 feet below the Upper bed at Boone. It is not as persistent as the Upper bed, therefore estimated reserves are considerably less. Both the Upper and Lower beds at Boone are correlated with beds in eastern Boone County and western Story County.

In the extreme southwestern part of the county three uncorrelated coal beds in the Lower Cherokee were formerly mined near the towns of Dawson and Angus. The beds are in a small area that includes parts of Boone, Greene, and Dallas Counties.

A channel sandstone, probably of about the same age as similar ones in Dallas County, areally separates the coal beds of central Boone County from those near the southern boundary of the county. South of the area underlain by the channel sandstone a small amount of reserves were estimated for beds that are tentatively correlated with the Upper and Lower beds at Boone. In addition, reserves were estimated for a bed, herein called the Highest bed in the area north of Madrid, that may be at or near the horizon of the Munterville coal. A large amount of reserves was estimated for a bed, the lowest bed mined at Madrid, that cannot presently be correlated with certainty but which may be near the horizon of the Hastie bed of Polk County to the southeast.

Original reserves of almost 244 million tons of coal are estimated in an area of about 39,470 acres. An additional area of about 15,950 acres may be underlain by coal 14 inches or more thick.

Story County

Rocks of the Cherokee Group underlie most of Story County and contain considerable quantities of coal. Coal reserves were estimated for four beds.

The stratigraphically highest bed for which reserves were estimated is in the west-central part of the county and may be near or at the stratigraphic position of the Munterville coal bed. Available information, though sparse, indicates that the bed has been removed by preglacial erosion or is not of minable thickness in most of the county.

Three coal beds are known to be present in the area south of Ames, but no reserves were estimated for the uppermost because it is thin and nonpersistent. The middle bed is tentatively correlated with the Hastie Plus coal of Polk County. The Hastie Plus coal is also present in the southern part of Story County. The lowest bed, which underlies the Hastie Plus coal at an average interval of about 25 feet, is the most widespread identifiable bed in the county, and it is correlated with the Hastie coal of Polk County. Reserves were estimated for this bed in the western, central, southern, and eastern parts of the county.

In the central part of the county, coal reserves were estimated in three separate areas for beds otherwise uncorrelated. Prob-

ably some of these reserves should be assigned to the Hastie Plus bed and some to a bed about 35 feet above the Hastie Plus (Manbeck?). However, no correlation or assignment is attempted on the basis of available information.

Two uncorrelated beds about 35 feet apart are in the southeastern corner of the county; they may be the Hastie Plus coal and the Manbeck coal.

Reserves were estimated for two coal beds, about 30 feet apart, that extend into the county from the west and are equivalent to the Upper and Lower beds at Boone. These beds are correlated with the Manbeck and Hastie Plus coal beds.

Comparatively little coal has been mined in Story County (Beyer, 1899; and Hinds, 1909), and most of the information on which reserves estimates are based is derived from records of drill holes, largely water wells. Consequently, very little of the estimated reserves in the county could be classed as measured and indicated reserves, but large areas are outlined as favorable for containing coal beds 14 inches or more thick.

Original reserves of about 120 million tons of coal are estimated in an area of about 16,570 acres. An additional area of about 48,590 acres may contain coal 14 inches or more thick.

Marshall County

Over much of Marshall County, coal-bearing rocks are thin or absent and glacial deposits are thick (Beyer, 1899). Records of drill holes show that the thin remnant of Pennsylvanian rocks in the county is largely barren of coal beds of minable thickness. However, reserves were estimated in a few scattered areas. Adjacent to the western border of the county reserves were estimated for a bed also present in Story County to the west that may be near or at the stratigraphic position of the Hastie bed of Polk County. In the same area, reserves were estimated for a bed that lies about 15 feet below the Hastie bed.

Reserves were estimated for an uncorrelated bed or beds that were formerly mined in the north-central part of the county. The estimate is small because of considerable doubt about lateral extent of this bed or beds, which may be at a lower stratigraphic position than the two beds in the western part of the county.

Original reserves of about 19 million tons of coal are estimated in an area of about 3,430 acres. An additional area of about 2,490 acres may contain coal beds 14 inches or more thick.

Dallas County

The Marmaton and Cherokee Groups are present in full thickness in parts of Dallas County and reserves were estimated for nine named coal beds and for one unnamed coal bed that probably does not correlate with any named bed. In addition, reserves were estimated for eight uncorrelated beds in local areas. Some or all of these uncorrelated beds probably are at or near the stratigraphic positions of named coal beds.

Reserves were estimated for three named and one uncorrelated bed in the Marmaton Group. The Lonsdale, Upper Mystic, and Lower Mystic coal beds crop out, and have been mined and prospected, in scattered areas in the southern part of the county. The uncorrelated bed is present in an isolated area in the central part of the county and very probably represents one of the three named beds.

The Mulky coal bed, the uppermost coal of the Cherokee Group, is present at several places in the southern part of the county. No reserves were estimated for the Mulky because it is not 14 inches or more thick where it has been identified. A small amount of reserves was estimated for beds at the horizons of the Wheeler and Bevier coal beds. Because of uncertain correlation the reserves are combined in this report and assigned to the Bevier-Wheeler bed. The Whitebreast coal is identifiable at many places in the southern part of the county but reserves were estimated for only four areas where the Whitebreast exceeds 14 inches in thickness. In southern Dallas County, the Bevier-Wheeler and Whitebreast coal bed horizons are locally absent because of the channeling action of a sandstone whose usual stratigraphic position is above the Bevier coal bed. Reserves were estimated for the Munterville coal in four areas and the bed may be 14 inches or more thick over a large area not included in the reserves estimates.

Correlation of beds in the Lower Cherokee is, as is generally the case, more tenuous than are the stratigraphic assignments in the Upper Cherokee. The sandstone bed whose usual stratigraphic position is a short distance beneath the Munterville coal

bed has locally removed some of the coal beds that ordinarily are present beneath it. Reserves were estimated for four stratigraphically assigned beds and eight uncorrelated beds, some of which undoubtedly are at the same stratigraphic position as some of the named beds in Dallas or adjacent counties. A bed correlated with the Lower coal-Ford coal is 14 inches or more thick in four known areas in the southern part of the county but the known areas and estimated reserves are small except in the southwestern part of the county near Redfield. A small amount of reserves was estimated for a bed, which lies about 20 feet above the Ford coal bed, that is identifiable in two small areas in the southern and southeastern parts of the county. About half the estimated reserves are based on extension of information from Polk County where the bed is more widespread than it seems to be in Dallas. The bed may be at the stratigraphic position of the No. 5 coal of Lucas County. Beds tentatively correlated with the Hastie coal bed of Polk County are present in two areas in the southern and southeastern parts of the county. In isolated areas in the western and southwestern parts of the county reserves were estimated for beds that lie some place between the Hastie coal and the base of the Cherokee Group. Some of the estimated reserves may be assignable to the Hastie bed but most are in an uncorrelated bed or beds below the Hastie bed horizon. Because the stratigraphic relations are unknown these beds are grouped in the reserve estimate.

In the northeastern part of the county, south of Madrid, a large amount of reserves is estimated for an uncorrelated bed, which is also present in Boone County on the north, that is known to be in the Lower Cherokee, probably near or at the horizon of the Hastie bed. This bed, called here the lowest bed mined at Madrid, is overlain at an average distance of 43 feet by another bed that is tentatively correlated with a bed called the Lower bed at Boone, in Boone County to the north, and is thus also tentatively correlated with the Hastie Plus coal bed.

Near the common corner of Dallas, Boone, and Green Counties, near the towns of Dawson and Angus, three coal beds are known to be present in an isolated area. The beds, which in this report are called the Upper, Middle, and Lower beds at Dawson-Angus, are uncorrelated but are probably correlatives of some of the beds present in the Lower Cherokee in the southern and eastern parts of the county.

Near the town of Van Meter in the southern part of Dallas County three coal beds are present within a stratigraphic interval of 22 to 28 feet (Leonard, 1898, p. 94). The available information does not allow stratigraphic assignment of these beds but they are all probably in the Lower Cherokee.

About 149 million tons of coal is estimated to have been originally present in an area of about 26,760 acres in Dallas County. An additional area of about 14,720 acres may contain coal beds 14 inches or more thick.

Polk County

Polk County was a major center of Iowa coal production for many years (Bain, 1897b). Exposures of the coal-bearing rocks along the Des Moines and Raccoon Rivers early attracted attention to the coal possibilities of the county, and the combination of thick fairly accessible coal beds and the fuel demands of a nearby major population and industrial center served to establish a coal industry that flourished for many years. Polk County ranks second among the counties of Iowa in total estimated original reserves; the estimated measured and indicated reserves are three times the inferred reserves. Although much information is available about the coal resources and mining industry of the county, the stratigraphic relations of the coal-bearing rocks in parts of the county are still imperfectly known. However, all of the estimated reserves of Polk County are in seven named and widely correlated coal beds.

The stratigraphically highest coal bed for which reserves were estimated is tentatively correlated with the Wheeler coal bed. Its reserves are small and are confined to the southwestern part of the county.

Coal reserves were estimated for the Munterville coal bed in the southwestern and southeastern parts of the county. The bed is identifiable at other places in the southern part of the county, but is commonly less than 14 inches thick.

The Ford coal bed, which is named for a town in northeastern Warren County, is identifiable through most of southern and central Polk County and a considerable quantity of reserves was estimated for the bed. The Ford is correlated with the bed that in Lucas County is called the Lower coal. A small amount of reserves is present in a bed that occurs about 20 feet above the

Ford in the southwestern part of the county. In the western part of the county a considerable quantity of coal was estimated for a bed whose correlation is doubtful but which seems to be about 30 feet below the top of the Lower Cherokee. This bed may be at the same horizon as the aforementioned bed that is 20 feet above the Ford coal bed. These beds are possible correlatives of the No. 5 coal of Lucas County.

The next persistent bed below the Ford, herein named the Manbeck coal bed for an old mine south of Des Moines, is present over most of the central and southern parts of the county and has been extensively mined.

A bed herein named the Hastie Plus bed, to signify that it is near but above the Hastie coal bed horizon, is identifiable and is more than 14 inches thick in many scattered areas in Polk and adjacent counties. Though correlation between some of these areas is rather tenuous, the bed seems to be a persistent horizon in central and eastern Iowa.

The most important coal bed of Polk and some of the adjacent counties is the Hastie bed. Over 40 percent of the estimated reserves of Polk County are assigned to this bed, which has been extensively prospected and mined. The bed can be correlated, in places very tentatively, over much of northern and some of eastern Iowa, and beds are known to be present at about the same stratigraphic horizon at isolated places in central and southern Iowa.

In the northwestern corner of the county reserves were estimated, largely as extensions of information, for two coal beds that are better known in Boone and Dallas Counties. These beds, called herein the Lower bed at Boone and the lowest bed mined at Madrid, are correlated with the Hastie Plus and Hastie beds.

Reserves were estimated for three beds in the northern part of the county that are only tentatively correlated. One appears to be a short distance above the Hastie bed, and is probably near or at the Hastie Plus bed horizon. Below this bed are the two other beds, which are about 40-45 feet apart; one is near the horizon of the Hastie coal and the other is below the Hastie.

In the north-central part of the county two small areas that may contain coal 14 inches or more thick, but in which no reserves were estimated, represent two beds of limited areal ex-

tent. One bed is about 30 feet below the Hastie and the other may be near the horizon of the Munterville coal bed.

Though much of the coal in Polk County has been mined or is unrecoverable, large amounts of coal are still present. Original reserves of almost 750 million tons of coal are estimated in the county in an area of about 92,960 acres. Another 14,760 acres may contain coal beds 14 inches or more thick.

Jasper County

Jasper County lies between the more fully prospected and developed coal mining counties along the Des Moines River to the west and the wedge edge of the Pennsylvanian rocks to the east. Pennsylvanian rocks underlie most of the county, but in some areas they are thin or absent. Nevertheless, a small amount of coal has been produced (Williams, 1905), and considerable quantities are estimated to be present in the county.

Most of the estimated reserves of Jasper County are in a coal bed that underlies much of the central and western parts of the county; it seems to be at the horizon of the Lower coal-Ford coal. In addition, reserves were estimated in the southwestern and central parts of the county for four other beds of uncertain correlation. The uppermost of these, which is about 40 to 50 feet above the Ford, may be near the horizon of the Munterville coal. A bed that is about 20 to 30 feet above the Ford coal horizon in the southwestern part of the county may be equivalent to a bed that is about 35 feet above the Ford coal horizon in the southern part of the county. These beds may be equivalents of the No. 5 bed of Lucas County. A bed 40 to 50 feet below the Ford coal horizon is 14 inches or more thick in several small areas of the southwestern part of the county. This bed may be at the stratigraphic horizon of the Manbeck coal bed.

East of the town of Monroe, near the southern boundary of the county, reserves were estimated for two uncorrelated beds that are about 10 to 20 feet apart. The beds are probably in the upper part of the Lower Cherokee.

Along the valley of the North Skunk River near Lynnville, reserves were estimated for three uncorrelated beds in a stratigraphic interval of about 65 feet in the Lower Cherokee.

Original reserves of about 194 million tons of coal are estimated in an area of about 30,820 acres. An additional area of about 15,970 acres may contain coal beds 14 inches or more thick.

COAL RESOURCES OF SOUTHEASTERN IOWA

The coal-bearing rocks of Pennsylvanian age in southeastern Iowa were originally deposited on a very irregular surface developed by pre-Pennsylvanian erosion of the underlying Mississippian rocks, were partially or completely removed by erosion prior to deposition of the overlying glacial material of Pleistocene age, and have subsequently been exposed and partially or completely removed along most of the major and many of the minor present-day streams. The resulting distribution is best described as patchy. Original reserves of almost 905 million tons of coal are estimated in the area (table 8), of which almost 427 million tons can be classed as recoverable (table 9).

Poweshiek County

The coal-bearing Cherokee Group is present in the southern and southwestern parts of Poweshiek County, but it is thin and its distribution is erratic and imperfectly known. A few mines have operated in the southern part of the county adjacent to the better known coal-producing areas of Mahaska County (Stookey, 1910, p. 263-264).

All reserves estimated in Poweshiek County are assigned to a bed tentatively correlated with the upper of the two main coal beds of central Mahaska County—the Lower coal-Ford coal.

Original reserves of about 0.72 million tons of coal are estimated in Poweshiek County in an area of about 280 acres. An additional 2,550 acres may be favorable for the presence of coal beds 14 inches or more thick.

Keokuk County

Rocks of Pennsylvanian age are absent over much of Keokuk County, but coal is known to be in most of the scattered and poorly defined areas underlain by the Cherokee Group (Bain, 1895b). In some areas the distribution of the coal-bearing rocks is so uncertain that no reserves could be estimated, and in areas where reserves were estimated the stratigraphic relations of the beds are imperfectly known.

All reserves in the county are grouped in the Laddsdale coal bed in table 3, but some of them may be assignable to the Cliffland coal bed.

Table 8. Original coal reserves (millions of short tons) of southeastern Iowa, by county

County	Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
Poweshiek	0.25	....	....	0.25	0.47	....	....	0.47	0.72	....	....	0.72
Keokuk	....	0.98	76.56	77.54	0.55	4.87	57.66	63.08	0.55	5.85	134.22	140.62
Wapello	16.06	44.52	104.43	165.01	30.24	67.54	101.56	199.34	46.30	112.06	205.99	364.35
Jefferson	3.61	28.68	20.19	52.48	12.91	37.01	24.57	74.49	16.52	65.69	44.76	126.97
Henry	0.25	0.52	0.71	1.48	0.46	1.42	0.27	2.15	0.71	1.94	0.98	3.63
Davis	3.35	14.08	23.53	40.96	10.39	26.22	36.14	72.75	13.74	40.30	59.67	113.71
Van Buren	4.41	26.88	21.85	53.14	11.70	52.62	10.41	74.73	16.11	79.50	32.26	127.87
Lee	2.17	2.00	0.71	4.88	5.05	4.71	1.62	11.38	7.22	6.71	2.33	16.26
Muscatine	0.96	0.07	....	1.03	2.95	....	....	2.95	3.91	0.07	....	3.98
Scott	0.64	1.68	0.57	2.89	2.91	0.99	....	3.90	3.55	2.67	0.57	6.79
Total	31.70	119.41	248.55	399.66	77.63	195.38	232.23	505.24	109.33	314.79	480.78	904.90

Table 9. Remaining and recoverable coal reserves (millions of short tons) of southeastern Iowa, January 1, 1964

County	Estimated original reserves	Production (Table 16 rounded to 0.01 million tons)	Remaining reserves	Recoverable reserves
Poweshiek	0.72	.....	0.72	0.4
Keokuk	140.62	8.45	123.72	61.9
Wapello	364.35	14.68	334.99	167.5
Jefferson	126.97	.26	126.45	63.2
Henry	3.63	[1]	3.63	1.8
Davis	113.71	.80	112.11	56.1
Van Buren	127.87	1.46	124.95	62.5
Lee	16.26	[1]	16.26	8.1
Muscatine	3.98	[1]	3.98	2.0
Scott	6.79	.21	6.37	3.2
Total	904.90	25.86	853.18	426.7

[1] Recorded production less than 0.005 million tons.

Original reserves of about 140 million tons of coal are estimated in Keokuk County in an area of about 16,220 acres. The available information indicates that an additional 6,800 acres may contain coal 14 inches or more thick.

Wapello County

Historically, Wapello County has been one of the most important coal-producing areas in Iowa (Leonard, 1902). Thick accessible coal beds near main transportation routes gave its mining industry an early and continuing impetus. In 1961, Wapello ranked third in coal production among the counties of Iowa.

The youngest coal bed for which reserves were estimated in Wapello County is the Whitebreast bed, which is present in the southwestern part of the county and is more than 2 feet thick in a small area near the southern boundary.

The most important coal bed in the county is about 50 feet below the Munterville Limestone in the Ottumwa area. This bed is tentatively correlated with the No. 5 bed of Lucas County, which is present at about this horizon in other counties to the west and northwest.

From a few inches to as much as 40 feet below the above-mentioned bed is the horizon of the next most important and widespread coal bed in Wapello County. This bed, which is about 60 feet below the Munterville Limestone at Ottumwa, is tentatively correlated with the upper of the two main coal beds of central Mahaska County—the Lower coal-Ford coal.

Another important bed, widely distributed in eastern and southeastern Iowa, is the Laddsdale coal. The Laddsdale horizon is about 80 feet below the Munterville Limestone in the Ottumwa area, though the bed contains little coal in that immediate area. Most of the reserves estimated for the bed are in the southeastern part of the county where the bed is thick and fairly persistent.

About 25 feet below the Laddsdale horizon in the Ottumwa area is the horizon of another coal bed that appears to be of widespread distribution in southeastern Iowa. This bed, herein named the Cliffland coal bed, is the lowest persistent coal bed horizon in the Cherokee Group of southeastern Iowa. Unfortu-

nately, stratigraphic control in many areas is not sufficiently precise to differentiate the Laddsdale from the Cliffland and reserves assignable to either or both of these beds must often be grouped, as in Keokuk County.

Some reserves were estimated for a bed that is present in an isolated area straddling the Wapello-Jefferson County line. The bed cannot be correlated on the basis of available stratigraphic information, but it is in the Lower Cherokee.

Original reserves of about 364 million tons of coal are estimated in an area of about 59,460 acres. An additional area of about 27,860 acres is favorable for the presence of coal beds 14 inches or more thick.

Jefferson County

The coal-bearing Cherokee Group is present over most of Jefferson County (Udden, 1902) and contains considerable quantities of coal. The Laddsdale is the major coal bed of the county and most of the reserves estimated for the county are assigned to this bed. The Laddsdale is present, and crops out, in most parts of the southern and eastern parts of the county.

The Cliffland coal bed is of spotty distribution in the county and only a small amount of reserves was estimated for it. A bed tentatively correlated with the bed that is about 60 feet below the Munterville Limestone at Ottumwa (the Lower coal-Ford coal) is 14 inches or more thick in two small areas in the southern and eastern parts of the county, but is absent or very thin over most of the county. Two areas containing a bed or beds in the Lower Cherokee that are uncorrelated are present near the western county line and a small amount of reserves is estimated in one of these areas as an extension of information from Wapello County.

Original reserves of almost 127 million tons of coal are estimated in an area of about 22,630 acres. The available information indicates that an additional area of about 29,880 acres may be favorable for the presence of coal beds 14 inches or more thick.

Henry County

The coal-bearing rocks of Pennsylvanian age are absent over most of Henry County (Savage, 1902), but a few thin patchy areas of the Lower Cherokee are present and contain coal.

Reserves estimated for Henry County are along the western boundary and are largely extensions of coal-bearing areas in Jefferson and Van Buren Counties. Most of the estimated reserves are assigned to the Laddsdale coal bed; a small amount of reserves is estimated for a bed that may be correlative with the Cliffland coal bed of Wapello and Jefferson counties.

Original reserves of about 3.63 million tons of coal are estimated in an area of about 620 acres. An additional area of about 340 acres may contain coal 14 inches or more thick.

Davis County

The Cherokee Group is well represented in Davis County, but most stratigraphic and coal resource data are confined to a few relatively small parts of the county (Arey, 1910a). The total coal reserve estimate for the county is not as large as it is for some other counties which have less obvious coal resource potential but which have more and better distributed information.

The Mystic coal bed of the Marmaton Group may be present in the southwestern part of the county; the bed has been mined in Missouri a few miles south of Davis County. A large, ill-defined channel filled with glacial material is present in eastern Appanoose County and probably extends into Davis County. The Mystic coal has been removed in the area of this channel in Appanoose County, but the geologic information is so sparse in southwestern Davis County that the coal resource potential of the Marmaton and Upper Cherokee coals cannot be evaluated in that area.

A small amount of reserves was estimated for two beds known to be present near the southern boundary of Davis County. These beds are probably in the Lower Cherokee, but correlation is not attempted with the available information.

The youngest coal bed for which reserves were estimated is the Whitebreast, which is 14 inches or more thick in a small area adjacent to the northern county boundary and contiguous with a similar area in Wapello County.

In the northeastern part of the county the Laddsdale coal bed is as much as 5 feet thick and has been extensively mined and prospected (Hinds, 1909, p. 304-306 and 322). Most of the estimated reserves of the county are assigned to this bed. In the

same area, the Cliffland bed is as much as 3½ feet thick and a considerable amount of reserves was estimated for this bed. Two other beds, which are probably correlative with the beds that are 50 and 60 feet below the Munterville Limestone in central Wapello County, are present in northeastern Davis County, but they are thin and nonpersistent in most places. No reserves were estimated for these two beds.

Drill holes in the southeastern and northwestern parts of the county indicate the presence of coal beds of uncertain thickness and stratigraphic position. No reserves were estimated but areas that may be underlain by coal 14 inches or more thick were delineated.

Original reserves of almost 114 million tons of coal are estimated in an area of about 13,430 acres. An additional area of about 11,000 acres may contain coal 14 inches or more thick.

Van Buren County

The Lower Cherokee is present over much of Van Buren County and crops out extensively along streams (Gordon, 1895).

The youngest coal bed for which reserves were estimated is a bed correlated with a bed in Wapello County that is about 50 feet below the Munterville Limestone near Ottumwa and is therefore tentatively correlated with the No. 5 coal of Lucas County. Reserves were estimated in two small areas in the central and northwestern parts of the county. This bed has probably been removed from much of the eastern part of the county.

In the northwestern and central parts of the county a small amount of reserves was estimate for a coal bed that is probably correlative with a bed that is about 60 feet below the Munterville Limestone in the Ottumwa area and is a possible correlative of the Lower coal-Ford coal.

The Laddsdale coal bed, which is over 14 inches thick in much of the central and northwestern parts of the county, contains most of the estimated reserves of the county. The bed crops out extensively along the Des Moines River and its tributaries.

Reserves were estimated for two coal beds in the eastern and southeastern parts of the county that are possibly near, or at, the horizons of the Laddsdale and Cliffland coal beds. The stratigraphic relations are obscure, however, and the beds are con-

sidered uncorrelated. In the area where two beds are present, reserves for the upper bed, which may be the Laddsdale, are listed separately in table 3; reserves for the lower bed are grouped with those estimated in adjacent, but noncontiguous, areas where only one uncorrelated bed is present.

Original reserves of almost 128 million tons of coal are estimated in an area of about 22,610 acres. An additional area of about 16,610 acres may contain coal beds 14 inches or more thick.

Lee County

The Lower Cherokee is present in Lee County as thin isolated patches (Keyes, 1895). However, coal is present and reserves were estimated for beds whose stratigraphic relations to other areas are, at best, obscure.

Reserves were estimated for an uncorrelated bed that is only a short distance above the base of the Pennsylvanian rocks in the southeastern part of the county. This bed is very tentatively correlated with the lower of two beds in southeastern Van Buren County, but the reserves are assigned to the uncorrelated bed category in table 3.

In central-northern Lee County are two uncorrelated coal beds that are herein called the first and second beds above the contact of the Pennsylvanian and Mississippian rocks. However, this contact is very irregular because of erosion of the Mississippian rocks prior to deposition of the Pennsylvanian rocks, and in some areas the first bed apparently never was deposited and the bed called the second bed above the Mississippian rocks is the lowest coal bed of the Cherokee Group. As could be expected under such depositional conditions, these beds are very discontinuous and their thicknesses change abruptly.

Original reserves of about 16 million tons of coal are estimated in an area of about 4,490 acres. An additional area of about 1,770 acres may contain coal beds 14 inches or more thick.

Muscatine County

The Pennsylvanian rocks in eastern Muscatine and western Scott Counties are generally considered to be an extension of the coal-bearing Pennsylvanian rocks of Illinois (Hinds, 1909, p. 345), and the discontinuous coal of Muscatine and Scott Counties

is usually correlated with the Rock Island No. 1 coal bed of adjacent parts of Illinois and with the Laddsdale coal of the Des Moines River area.

The coal is present at many places in Muscatine County, but is of very limited areal extent in any one area (Udden, 1899). About 4 million tons of original coal reserves are estimated for the county in an area of about 1,680 acres. An additional area of about 420 acres may contain coal 14 inches or more thick.

Scott County

Scott County has less area underlain by Pennsylvanian rocks than does Muscatine (Norton, 1899) but the areal extent of the coal in Scott County is better known and the estimated reserves in the Rock Island No. 1 (Laddsdale?) coal bed in the county are larger. In addition to the area in the southwestern part of the county where reserves were estimated, the available information indicates that coal is present in some of the small isolated outliers in the eastern and central parts of the county. However, no reserves were estimated in these outliers because of lack of information about the areal extent and exact thickness of the coal.

About 7 million tons of original coal reserves is estimated for an area of about 1,700 acres in Scott County. An additional area of about 1,270 acres may contain coal 14 inches or more thick.

COAL RESOURCES OF WESTERN IOWA

Rocks of Pennsylvanian age underlie a large part of western Iowa. The coal resource potential of most of the area is unknown, however, because of a lack of information. In addition to a thick blanket of glacial material, a sequence of rocks of Cretaceous age overlies the Pennsylvanian rock in parts of the area. Outcrops of Pennsylvanian rocks are rare, and they are not penetrated by most wells in the area (MacBride, 1906; Shimek, 1910; Lees, 1927a, 1927b; and Hinds, 1909). Consequently no reserves were estimated for Ida, Sac, Monona, Crawford, Harrison, Shelby, or Audubon Counties, and their coal resource potential cannot be evaluated. In the easternmost counties of western Iowa—Calhoun, Carroll, Green and Guthrie—available information allows estimation of some reserves and delineation of a few areas with coal resource potential. A total of almost 121 million tons of coal is estimated to have originally been present in the area (table 10), of which about 58 million tons can be classed as recoverable (table 11).

Calhoun County

All the information regarding coal in Calhoun County comes from well records. Of the 13 available records of wells that penetrated part or all of the Pennsylvanian rocks in the county, 5 reportedly encountered coal beds ranging from 1 to about 6 feet in thickness, at depths between 200 and 300 feet. No reserves were estimated because of the sparseness of the data but areas were delineated that may contain coal beds of potential value. About 16,300 acres are included in this potentially favorable area.

Carroll County

Carroll County, like Calhoun County, is underlain by Pennsylvanian rocks whose coal potential cannot be evaluated because of the scarcity of information (Bain, 1899). The records available for 13 wells that penetrated part or all of the Pennsylvanian rocks underlying the county indicate that 6 of these wells encountered coal beds, reported to be as much as 10 feet thick, at depths ranging from 245 to 700 feet. The data are too sparse

Table 10. Original coal reserves (millions of short tons) of western Iowa, by county

County	Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
Calhoun	....	....	....	....	....	....	....	....	....	....	....	....
Carroll	....	....	....	....	....	....	....	....	....	....	....	....
Greene	3.47	5.79	7.55	16.81	12.47	12.79	4.43	29.69	15.94	18.58	11.98	46.50
Guthrie	28.67	1.48	3.22	33.37	27.51	3.80	9.69	41.00	56.18	5.28	12.91	74.37
Total	32.14	7.27	10.77	50.18	39.98	16.59	14.12	70.69	72.12	23.86	24.89	120.87

Table 11. Remaining and recoverable coal reserves (millions of short tons) of western Iowa, January 1, 1964

County	Estimated original reserves	Production (Table 16 rounded to 0.01 million tons)	Remaining reserves	Recoverable reserves
Calhoun	.....	.....	.....	.....
Carroll	.....	.....	.....	.....
Greene	46.50	1.70	43.10	21.6
Guthrie	74.37	.49	73.39	36.7
Total	120.87	2.19	116.49	58.3

and unreliable to evaluate quantitatively, but an area of about 12,430 acres that may have coal resource potential was delineated.

Greene County

Most of Greene County must be considered unevaluated because of a lack of information, but coal was formerly mined in two areas in the southeastern part of the county (Hinds, 1909, p. 356-361).

Almost all the reserves are in three uncorrelated beds that were formerly mined adjacent to the towns of Dawson and Angus near the common corner of Greene, Boone, and Dallas Counties. These coal beds, which occur within a stratigraphic interval of about 100 feet, are almost certainly in the Lower Cherokee, and are designated the Upper, Middle, and Lower beds in the Dawson-Angus area. The Middle bed is the most persistent and most of the reserves of the area are assigned to it. Another bed, which is thin and very nonpersistent, is locally present about 15 feet above the Upper bed. No reserves were estimated for this thin bed.

North of the Dawson-Angus area, near Grand Junction, a coal bed of uncertain stratigraphic position was formerly mined. With the available data, the bed cannot be correlated, though it probably is one of the three Dawson-Angus beds.

Original reserves of about 46 million tons are estimated in an area of about 9,270 acres. An additional area of about 10,870 acres may contain coal beds 14 inches or more thick.

Guthrie County

The coal-bearing rocks of the Marmaton Group and the Upper Cherokee are exposed or are present at shallow depths along the major drainages of Guthrie County (Bain, 1897a). Reserves were estimated for seven named coal beds and one uncorrelated bed.

The Lonsdale coal in the upper part of the Marmaton Group is present in the southeastern part of the county, as it is in the adjoining part of Dallas County on the east. The Lower Mystic (Marshall of some reports) bed is 14 inches or more thick in two small areas, but the Upper Mystic though identifiable at a few places, is very thin in the county.

The Bevier, Whitebreast, Wiley, and Munterville coal beds of the Upper Cherokee are widespread in the central and southeastern parts of the county. Correlation of the Bevier is tentative and part or all of the reserves assigned to the Bevier may actually be in the Wheeler bed. More reserves were estimated for the Whitebreast coal than for any other coal bed in the county. The Whitebreast is present over a large area in the northwestern, central, and southeastern parts of the county. The Wiley coal bed is present over a limited area in central Guthrie County, but it is thin or unidentifiable in most of the county. The Munterville coal bed, second to the Whitebreast in estimated reserves, is identifiable over a large part of central and southeastern Guthrie County.

Reserves were estimated for only one named bed in the Lower Cherokee; a bed that is probably the Lower coal-Ford coal of the counties east of Guthrie was penetrated by drill holes in the southeastern part of the county. Some reserves were estimated for an uncorrelated bed that extends into the northeastern corner of the county from the Dawson-Angus area of Dallas, Boone, and Greene Counties; this bed is the Middle bed of the Dawson-Angus area.

In the southwestern corner of the county an area that may contain coal beds 14 inches or more thick extends a short distance into Guthrie County from Adair County. The coal bed or beds are in the Upper Cherokee.

Original reserves of about 74 million tons of coal reserves are estimated in an area of about 20,300 acres in Guthrie County. An additional area of about 28,470 acres is potentially underlain by coal beds 14 inches or more thick.

COAL RESOURCES OF SOUTHWESTERN IOWA

The coal resources of the previously described parts of Iowa are all confined to the Marmaton and Cherokee Groups of the Des Moines Series. In southwestern Iowa, the Des Moines Series is overlain by younger beds of the Missouri and Virgil Series. The uppermost group of the Virgil Series, the Wabaunsee, is the only one of the younger Pennsylvanian rock units that contains coal beds of economic interest. Figure 6 shows the areal distribution of the Wabaunsee Group in southwestern Iowa. A total of about 335 million tons of coal is estimated to have originally been present in the area (table 12), of which about 166 million tons can be classed as recoverable (table 13).

Pottawattamie County

The only information available about coal resources in the county is derived from the records of isolated deep wells. The coal-bearing Wabaunsee Group is not present in the county (Hershey and others, 1960, p. 91), but the well records indicate coal beds in the Marmaton and Cherokee Groups. No coal reserves were estimated but some areas are delineated that may contain coal beds 14 inches or more thick. The total area involved is about 10,880 acres. However, the available information is so sparse that the coal resource potential of Pottawattamie County remains largely unknown.

Cass County

The Wabaunsee Group underlies a small part of Cass County along the southern boundary (Hershey and others, 1960, fig. 2). All the reserves estimated for the county are in the Nodaway coal bed near the base of the Wabaunsee and are based on extension of information from Montgomery and Adams Counties. A few deep wells in Cass and northeastern Montgomery Counties indicate the presence of coal beds in the Marmaton and Cherokee Groups. No reserves were estimated at these isolated points.

About 3 million tons of original coal reserves are estimated in the Nodaway bed in an area of about 10,800 acres. An additional area of about 7,480 acres is potentially underlain by coal beds 14 inches or more thick.

Table 12. Original coal reserves (millions of short tons) of southwestern Iowa, by county

County	Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
Pottawattamie	....	....	....	....	....	....	....	....	....	....	....	....
Cass	0.37	....	....	0.37	2.79	....	....	2.79	3.16	....	....	3.16
Adair	2.11	....	....	2.11	7.12	....	....	7.12	9.23	....	....	9.23
Mills	....	....	....	....	....	....	....	....	....	....	....	....
Montgomery	0.78	....	....	0.78	20.21	....	....	20.21	20.99	....	....	20.99
Adams	34.81	....	....	34.81	86.50	....	....	86.50	121.31	....	....	121.31
Fremont	1.33	....	....	1.33	10.00	....	....	10.00	11.33	....	....	11.33
Page	25.98	....	....	25.98	91.14	....	....	91.14	117.12	....	....	117.12
Taylor	10.63	....	....	10.63	41.64	....	....	41.64	52.27	....	....	52.27
Total	76.01	....	....	76.01	259.40	....	....	259.40	335.41	....	....	335.41

Table 13. Remaining and recoverable coal reserves (millions of short tons) of southwestern Iowa, January 1, 1964

County	Estimated original reserves	Production (Table 16 rounded to 0.01 million tons)	Remaining reserves	Recoverable reserves
Pottawattamie	.....	.....	.....	.....
Cass	3.16	[1]	3.16	1.6
Adair	9.23	[1]	9.23	4.6
Mills	.....	.....	.....	.....
Montgomery	20.99	[1]	20.99	10.5
Adams	121.31	.69	119.93	60.0
Fremont	11.33	.....	11.33	5.7
Page	117.12	.66	115.80	57.9
Taylor	52.27	.51	51.25	25.6
Total	335.41	1.86	331.69	165.9

[1] Recorded production less than 0.005 million tons.

Adair County

Adair County has considerable coal resource potential but the available information is so sparse that reserves were estimated in only two areas, and one of these is based on extension of information from an adjoining county.

A small amount of reserves in the Whitebreast coal bed is estimated to be present in northeastern Adair County adjacent to Guthrie County.

One mine reportedly was operated in the western part of Adair County (Keyes, 1894, p. 442). The mine produced coal from a bed about 260 feet deep; two more beds, at about 305 and 315 feet, were reportedly present. Other prospect holes and deep water wells indicate that coal beds at about the same stratigraphic positions are present in western, central, and northern Adair County. The information is so sparse, however, that reserves were estimated only in a limited area near the old mine, and the other data points only serve to indicate areas potentially underlain by coal beds of minable thickness. Stratigraphic assignment of the coal beds is not attempted with the present information, but the beds appear to be in the Marmaton Group and in the Upper Cherokee. The estimated reserves are probably in the Marmaton Group.

About 9 million tons of original reserves are estimated in an area of about 2,350 acres. An additional area of about 14,390 acres is favorable for the presence of coal beds 14 inches or more thick.

Mills County

Little is known about the coal resource potential of Mills County. Available records of six deep wells in the county indicate the presence of coal beds in the Marmaton Group and in the Upper Cherokee in three of the wells. A total area of about 6,250 acres is believed to be favorable for the presence of coal beds 14 inches or more thick at depths ranging from about 600 to 900 feet.

Montgomery County

The Wabaunsee Group, which contains the Nodaway coal near its base, underlies most of Montgomery County (Hershey and

others, 1960, fig. 2). Scattered information points indicate that the Nodaway may be 14 inches or more thick in much of its area of occurrence in the county. A few deep wells indicate that the Marmaton and Cherokee Groups contain coal beds that may be 14 inches or more thick in the west-central and northeastern parts of the county.

Original reserves of almost 21 million tons of coal, all in the Nodaway bed, were estimated in an area of about 9,620 acres, and an additional area of about 162,100 acres is considered to be favorable for the presence of coal beds 14 inches or more thick.

Adams County

The Nodaway coal bed underlies almost a third of Adams County and it may be more than 14 inches thick throughout its area of occurrence. The bed has been very extensively mined and prospected in the central-western part of the county, information is abundant (Hinds, 1909; and Reports of the State Mine Inspector), and reserves were estimated in over 60 percent of the area of Adams County that is underlain by the stratigraphic horizon of the Nodaway coal.

Adams County has very few wells that are deep enough to penetrate the Des Moines Series; therefore, the coal potential of the older Pennsylvanian rocks is unknown.

Original reserves of about 121 million tons of coal, all in the Nodaway bed, are estimated in an area of about 53,780 acres of Adams County. An additional area of about 32,020 acres may contain coal 14 inches or more thick.

Fremont County

More than two-thirds of Fremont County is underlain by the Wabaunsee Group with the Nodaway coal near the base (Hershey and others, 1960, fig. 2). The Nodaway is identifiable over much of the area underlain by the Wabaunsee but is generally less than 14 inches thick except in the southwestern part of the county where some reserves were estimated. Information is sparse and the reported thicknesses may be unreliable so the reserve estimation areas are small compared to the area in which the Nodaway bed may reach a thickness of 14 inches or more.

The coal resource potential of the Des Moines Series, which underlies the county at considerable depths, cannot be evaluated with presently available information.

Original reserves of about 11 million tons of coal are estimated in the Nodaway coal bed in an area of about 4,650 acres of Fremont County. An additional area of about 41,070 acres is potentially favorable for the presence of the Nodaway bed in thicknesses of 14 inches or more.

Page County

The Nodaway coal bed was mined extensively for many years near the town of Clarinda in eastern Page County (Calvin, 1901; Hinds, 1909). The bed generally is less than 18 inches thick and has been mined in some places where it is only a foot thick. The Wabaunsee Group with the Nodaway near the base underlies all of the county except where it has been removed along the valley of the Nodaway River and its branches (Hershey and others, 1960, fig. 2). The sparse available information indicates that the Nodaway is generally less than 14 inches thick along the western edge of the county. A deep well in Taylor County adjacent to the eastern boundary of Page County indicates the possible presence of coal beds 14 inches or more thick in the Marmaton Group and in the Upper Cherokee; otherwise the coal potential of the Des Moines Series in Page County is unknown at this time.

Original reserves of about 117 million tons of coal in the Nodaway bed are estimated in an area of about 49,220 acres in Page County. An additional area of about 286,650 acres may be underlain by coal beds 14 inches or more thick.

Taylor County

The eastern edge of the Wabaunsee Group parallels the western boundary of Taylor County and extends less than 6 miles into the county at any point. However, the Nodaway bed has been extensively mined and prospected (Arey, 1916b), especially near the town of New Market, and reserves were estimated in more than 25 percent of the area in which the Nodaway may be present. All of the area within the county that is underlain by the Wabaunsee Group is considered potentially favorable for the presence of the Nodaway bed in thicknesses of 14 inches or more.

In the central, northeastern, and western parts of the county deep well records indicate the presence of coal beds in the Marmaton Group and the Upper Cherokee. No reserves were estimated, but the areas that may contain coal beds 14 inches or more thick in the Des Moines Series were delineated.

Original reserves of about 52 million tons of coal, all in the Nodaway coal bed, are estimated in an area of about 19,360 acres in Taylor County. An additional area of about 55,850 acres may contain coal beds 14 inches or more thick in the Wabaunsee, Marmaton, and Cherokee Groups.

PRODUCTION OF COAL IN IOWA

Recorded production of coal in Iowa dates from 1840, though some coal may have been utilized prior to that date (Lees, 1909a, and Beyer, 1909). The increase of heat energy requirements of an expanding population and the decrease of readily available firewood created a demand for coal, and the total annual production exceeded a million tons a year by 1875. Table 14 lists coal production by years from 1840 through 1879, because available records are fragmentary and in most years before 1880 only total production is known. Table 15 (in pocket) lists coal production from 1880 through 1963 by county and year. Table 16 summarizes that part of the total recorded production that is assignable to individual counties. A history of early coal mining in the State is given by Lees (1909a).

Mining Methods

The earliest coal mines in the State were very small strippings and drifts along outcrops. Underground mining by both shaft and slope entries soon became the predominant mining method. In the last two decades strip mining has become increasingly important, and in 1963 19 strip mines produced over 87 percent of total Iowa production. Thirteen underground mines were in operation at that time. Young and Anderson (1964, p. 87) stated: "Strip mines have two substantial advantages over underground mines: (1) the output per man per day in strip mines is more than double that in underground mines, and (2) the average value of strip coal, f.o.b. mines, is about one-third less than the average value of coal from underground mines." In Iowa mines, in 1963, the average production per man per day in strip mines was 20.31 tons, at a cost of $3.39 per ton; in underground mines it was 5.59 tons, at a cost of $4.22 per ton.

Removal of coal by augers, a common adjunct to strip mining in some States, was not being done in Iowa in 1963. However, in the United States, in 1963, the average production per man per day by use of augers was 38.87 tons, compared to 28.69 tons by strip mining.

Treatment Methods

None of the coal currently produced in Iowa is mechanically cleaned; that is, cleaned with mechanical devices that separate out impurities, usually by differences in specific gravity (Young

and Anderson, 1964, p. 115). A coal-washing plant operated in Mahaska County for about 5 years (1912-17) (Olin and others, 1930, p. 34-35), but none is presently in operation. It appears economically advantageous to clean coal from some areas; for instance Illinois, where in 1963 more than 88 percent of the coal produced was mechanically cleaned despite a loss of more than 18 percent of the raw coal during the process; and in 1963 over 63 percent of the national production was mechanically cleaned (Young and Anderson, 1964, tables 47 and 46).

Almost 80 percent of the Iowa coal production in 1963 was mechanically crushed but less than 1 percent was treated for allaying dust (Young and Anderson, 1964, tables 54 and 56).

Table 14. Coal produced in Iowa 1840-1879
[From Beyer (1909)]

Year	Short tons	Year	Short tons
1840	400	1860	41,920
1841	500	1861	50,000
1842	750	1862	53,000
1843	1,000	1863	57,000
1844	2,500	1864	63,000
1845	5,000	1865	69,574
1846	6,500	1866	99,320
1847	8,000	1867	150,000
1848	10,000	1868	241,453
1849	12,500	1869	295,105
1850	15,000	1870	263,487
1851	18,000	1871	300,000
1852	20,000	1872	336,000
1853	23,000	1873	392,000
1854	25,000	1874	799,936
1855	28,000	1875	1,231,547
1856	30,000	1876	1,250,000
1857	33,000	1877	1,300,000
1858	37,500	1878	1,350,000
1859	42,000	1879	1,400,000
		Total 1840-1879.....	10,061,992

Table 16. Coal produced in Iowa to January 1, 1964 (in short tons); county summary[1]

County	Production	County	Production	County	Production
Adair	4,340	Henry	480	Polk	50,967,285
Adams	694,243	Jasper	10,204,725	Scott	207,014
Appanoose	46,100,511	Jefferson	250,223	Story	30,270
Boone	18,882,647	Keokuk	8,447,711	Taylor	507,869
Cass	120	Lee	815	Van Buren	1,456,634
Dallas	14,044,026	Lucas	13,390,631	Wapello	14,684,881
Davis	796,181	Mahaska	39,107,336	Warren	2,465,253
Greene	1,690,934	Marion	37,044,691	Wayne	2,672,803
Guthrie	485,300	Monroe	63,376,880	Webster	4,929,085
Hamilton	10,523	Muscatine	1,785	Other counties [2] and small mines	13,018,468
Hardin	9,002	Page	659,028		

[1] From Table 15, and Keyes (1894).

[2] Includes, at various times, Adams, Dallas, Davis, Greene, Guthrie, Hamilton, Hardin, Jasper, Jefferson, Keokuk, Lucas, Page, Polk, Scott, Story, Taylor, Van Buren, Warren, Wayne and Webster Counties.

SELECTED BIBLIOGRAPHY

American Society for Testing Materials, 1964, Proposed revised tentative specifications for classification of coals by rank (ASTM Designation: D388-T.)

Aresco, S. J., and Haller, C. P., 1953a, Analyses of tipple and delivered samples of coal (collected during the fiscal year 1951): U. S. Bur. Mines Rept. Inv. 4934, 93 p.

———1953b, Analyses of tipple and delivered samples of coal (collected during the fiscal year 1952): U. S. Bur. Mines Rept. Inv. 4972, 84 p.

Aresco, S. J., Haller, C. P., and Abernethy, R. F., 1955, Analyses of tipple and delivered samples of coal (collected during the fiscal year 1953): U. S. Bur. Mines Rept. Inv. 5085, 82 p.

———1956a, Analyses of tipple and delivered samples of coal (collected during the fiscal year 1954): U. S. Bur. Mines Rept. Inv. 5221, 77 p.

———1956b, Analyses of tipple and delivered samples of coal (collected during the fiscal year 1955): U. S. Bur. Mines Rept. Inv. 5270, 66 p.

———1957, Analyses of tipple and delivered samples of coal (collected during the fiscal year 1956): U. S. Bur. Mines Rept. Inv. 5332, 67 p.

———1958, Analyses of tipple and delivered samples of coal (collected during the fiscal year 1957): U. S. Bur. Mines Rept. Inv. 5401, 59 p.

———1959, Analyses of tipple and delivered samples of coal (collected during the fiscal year 1958): U. S. Bur. Mines Rept. Inv. 5489, 54 p.

———1960, Analyses of tipple and delivered samples of coal (collected during the fiscal year 1959): U. S. Bur. Mines Rept. Inv. 5615, 59 p.

———1961, Analyses of tipple and delivered samples of coal (collected during the fiscal year 1960): U. S. Bur. Mines Rept. Inv. 5792, 44 p.

———1963, Analyses of tipple and delivered samples of coal (collected during the fiscal year 1961): U. S. Bur. Mines Rept. Inv. 6086, 41 p.

Arey, M. F., 1910a, Geology of Davis County, *in* Calvin, Samuel, Annual Report, 1909: Iowa Geol. Survey, v. 20, p. 487-524.

———1910b, Geology of Wayne County, *in* Calvin, Samuel, Annual Report, 1909: Iowa Geol. Survey, v. 20, p. 199-236.

———1916a, Geology of Ringgold County, *in* Kay, G. F., Annual Report, 1916: Iowa Geol. Survey, v. 27, p. 33-68.

———1916b, Geology of Taylor County, *in* Kay, G. F., Annual Report, 1916: Iowa Geol. Survey, v. 27, p. 69-104.

Averitt, Paul, 1961, Coal reserves of the United States—A progress report, Jan. 1, 1960: U. S. Geol. Survey Bull. 1136, 116 p.

Bain, H. F., 1894, Structure of the Mystic Coal Basin: Iowa Acad. Sci., pt. 4, v. 1, p. 33-36.

———1895a, Geology of Mahaska County, *in* Calvin, Samuel, Third Annual Report, 1894: Iowa Geol. Survey, v. 4, p. 313-380.

———1895b, Geology of Keokuk County, *in* Calvin, Samuel, Third Annual Report, 1894: Iowa Geol. Survey, v. 4, p. 255-311.

———1896, Geology of Appanoose County, *in* Calvin, Samuel, Annual Report, 1895: Iowa Geol. Survey, v. 5, p. 363-438.

———1897a, Geology of Guthrie County, *in* Calvin, Samuel, Annual Report, 1896: Iowa Geol. Survey, v. 7, p. 413-487.

———1897b, Geology of Polk County, *in* Calvin, Samuel, Annual Report, 1896: Iowa Geol. Survey, v. 7, p. 263-412.

———1898, Geology of Decatur County, *in* Calvin, Samuel, Annual Report, 1897: Iowa Geol. Survey, v. 8, p. 255-309.

———1899, Geology of Carroll County, *in* Calvin, Samuel, Annual Report, 1898: Iowa Geol. Survey, v. 9, p. 49-107.

Beyer, S. W., 1896, Geology of Boone County, *in* Calvin, Samuel, Annual Report, 1895: Iowa Geol. Survey, v. 5, p. 175-232.

———1897, Geology of Marshall County, *in* Calvin, Samuel, Annual Report, 1896: Iowa Geol. Survey, v. 7, p. 197-262.

———1899, Geology of Story County, *in* Calvin, Samuel, Annual Report, 1898: Iowa Geol. Survey, v. 9, p. 155-237.

———1900, Geology of Hardin County, *in* Calvin, Samuel, Annual Report, 1899: Iowa Geol. Survey, v. 10, p. 241-306.

———1909, Coal statistics, *in* Calvin, Samuel, Annual Report, 1908: Iowa Geol. Survey, v. 19, p. 590-597.

Beyer, S. W., and Young, L. E., 1903, Geology of Monroe County, *in* Calvin, Samuel, Annual Report, 1902: Iowa Geol. Survey v. 13, p. 353-422.

Calvin, Samuel, 1901, Geology of Page County, *in* Calvin, Samuel, Administrative Reports: Iowa Geol. Survey, v. 11, p. 397-460.

Campbell, M. R., 1917, Coal fields of the United States, General introduction: U. S. Geol. Survey Prof. Paper 100-A, p. 1-33. [Revised and reprinted 1922; reprinted 1929.]

Campbell, M. R., and Parker, E. W., 1909, Coal fields of the United States: U. S. Geol. Survey Bull. 394, p. 7-26.

Cline, L. M., 1941, Traverse of upper Des Moines and lower Missouri series from Jackson County, Missouri, to Appanoose County, Iowa: Am. Assoc. Petroleum Geologists Bull., v. 25, no. 1, p. 23-72.

Cline, L. M., and Greene, F. C., 1950, A stratigraphic study of the upper Marmaton and lowermost Pleasanton groups, Pennsylvanian, of Missouri: Missouri Geol. Survey and Water Res. Rept. Inv. 12, 74 p.

Cole, W. A., Grosh, W. A., and Stehlik, C. J., 1957, Iowa coals as a source of sulfur: U. S. Bur. Mines, Rept. Inv. 5362, 23 p.

Condra, G. E., 1933, The Missouri Valley traverse in Iowa, north of the Jones Point deformation: Nebraska Geol. Survey Paper No. 2, 24 p.

Condra, G. E., and Upp, J. E., 1933a, The Middle River traverse of Iowa: Nebraska Geol. Survey Paper No. 4, 31 p.

———1933b, The Red Oak-Stennett-Lewis traverse of Iowa: Nebraska Geol. Survey Paper No. 3, 23 p.

Condra, G. E., and Reed, E. C., 1938, The Redfield anticline of Nebraska and Iowa: Nebraska Geol. Survey Paper No. 12, 19 p.

Fieldner, A. C., Selvig, W. A., and Frederic, W. H., 1939, Classification of typical coals of the United States, showing B.T.U.

per pound on the moist, mineral-matter-free basis, plotted against fixed carbon on the dry, mineral-matter-free basis: U. S. Bur. Mines Rept. Inv. 3296 and 3296A, 22 p.

Fieldner, A. C., Rice, W. E., and Moran, H. E., 1942, Typical analyses of coals of the United States: U. S. Bur. Mines Bull. 446, 45 p.

Fleming, B. P., 1927, Possible researches in Iowa coal, *in* Kay, G. F., Annual Reports, 1925 and 1926: Iowa Geol. Survey, v. 32, p. 91-100.

Flynn, G. J., Jr., 1949, Average heating values of American coals by rank and by states: U. S. Bur. Mines Inf. Circ. 7538, 11 p.

Gordon, C. H., 1895, Geology of Van Buren County, *in* Calvin, Samuel, Third Annual Report, 1894: Iowa Geol. Survey, v. 4, p. 197-254.

Gow, J. E., and Tilton, J. L., 1916, Geology of Adair County, *in* Kay, G. F., Annual Report, 1916: Iowa Geol. Survey, v. 27, p. 277-344.

Hale, W. E., 1955, Geology and ground-water resources of Webster County, Iowa: Iowa Geol. Survey, Water-Supply Bull. No. 4, 257 p.

Hall, James, and Whitney, J. D., 1858, Report on the geological survey of the State of Iowa, embracing the results of investigations made during 1855, 56, and 57: v. 1, pt. 1, Geology, p. 1-472, Albany, N. Y.

Hershey, H. G., 1941b, A summary of mineral production in Iowa 1895-1938, *in* Trowbridge, A. C., Annual Reports, 1934-1939: Iowa Geol. Survey, v. 37, p. 447-474.

——— and others, 1947, Mineral resources of Iowa: Iowa Geol. Survey Map.

Hershey, H. G., Brown, C. N., Van Eck, Orville, and Northup, R. C., 1960, Highway construction materials from the consolidated rocks of southwestern Iowa: Iowa State Highway Comm., Iowa Highway Research Board Bull. 15, 151 p.

Hinds, Henry, 1909, Coal deposits of Iowa, *in* Calvin, Samuel, Annual Report, 1908: Iowa Geol. Survey, v. 19, p. 21-396.

——— [1912?], The coal deposits of Missouri: Missouri Bur. Geol. and Mines, v. 11, 2d ser., 503 p.

Hixson, A. W., 1914, Analyses of Iowa coals, *in* Kay, G. F., Annual Report, 1913: Iowa Geol. Survey, v. 24, p. 687-763.

Jerger, E. W., and May, J. R., 1951, The analysis of Iowa coals: Iowa Engineering Experiment Station Engineering Report No. 5, 20 p., Iowa State College, Ames.

Kay, G. F., 1915, The first coal-washing plant in Iowa: Iowa Acad. Sci., v. 22, p. 225-227.

Keyes, C. R., 1894, Coal deposits of Iowa: Iowa Geol. Survey, v. 2, 536 p.

———1895, Geology of Lee County, *in* Calvin, Samuel, Second Annual Report, 1893: Iowa Geol. Survey, v. 3, p. 305-407.

———1897, Stages of the Des Moines, or chief coal-bearing series of Kansas and southwest Missouri and their equivalents in Iowa: Iowa Acad. Sci., v. 4, p. 22-25.

———1901, Names of coals west of the Mississippi River: Iowa Acad. Sci., v. 8, p. 128-137.

———1913, Annotated bibliography of Iowa geology and mining: Iowa Geol. Survey, v. 22, 908 p.

Kosanke, R. M., Simon, J. A., Wanless, H. R., Willman, H. B., 1960, Classification of the Pennsylvanian strata of Illinois: Illinois State Geol. Survey Rept. Inv. 214, 84 p.

Lees, J. H., 1909a, History of coal mining in Iowa, *in* Calvin, Samuel, Annual Report, 1908: Iowa Geol. Survey, v. 19, p. 521-590.

———1909b, General section of the Des Moines stage of Iowa, *in* Calvin, Samuel, Annual Report, 1908: Iowa Geol. Survey, v. 19, p. 598-604.

———1909c, Bibliography of Iowa coals, *in* Calvin, Samuel, Annual Report, 1908: Iowa Geol. Survey, v. 19, p. 659-687.

———1927a, Iowa coal areas and characteristics of Iowa coal, *in* Kay, G. F., Annual Reports, 1925 and 1926: Iowa Geol. Survey, v. 32, p. 65-81.

———1927b, Geology of Crawford County, *in* Kay, G. F., Annual Reports, 1925 and 1926: Iowa Geol. Survey, v. 32, p. 239-362.

———1935, Additional deep wells, *in* Kay, G. F., Annual Reports, 1930, 1931, 1932, and 1933: Iowa Geol. Survey, v. 36, p. 365-420.

Lees, J. H., and Hixson, A. W., 1909, Analyses of Iowa coals, *in* Calvin, Samuel, Annual Report, 1908: Iowa Geol. Survey, v. 19, p. 476-519.

Leonard, A. G., 1898, Geology of Dallas County, *in* Calvin, Samuel, Annual Report, 1897: Iowa Geol. Survey, v. 8, p. 51-118.

———1902, Geology of Wapello County, *in* Calvin, Samuel, Annual Report, 1901: Iowa Geol. Survey, v. 12, p. 439-499.

Lonsdale, E. H., 1895, Geology of Montgomery County, *in* Calvin, Samuel, Third Annual Report, 1894: Iowa Geol. Survey, v. 4, p. 381-451.

Lord, N. W., Holmes, J. A., Stanton, F. M., Fieldner, A. C., and Sanford, Samuel, 1913, Analyses of coals in the United States with descriptions of mine and field samples collected between July 1, 1904, and June 30, 1910: U. S. Bur. Mines Bull. 22, part I, Analyses, p. 1-321; Part II, Description of samples, p. 323-1200.

Lugn, A. L., 1927, Geology of Lucas County, *in* Kay, G. F., Annual Reports, 1925 and 1926: Iowa Geol. Survey, v. 32, p. 101-237.

MacBride, T. H., 1899, Geology of Humboldt County, *in* Calvin, Samuel, Annual Report, 1898: Iowa Geol. Survey, v. 9, p. 109-154.

———1905, Geology of Emmet, Palo Alto, and Pocahontas Counties, *in* Wilder, F. A., Annual Report, 1904: Iowa Geol. Survey, v. 15, p. 227-259.

———1906, Geology of Sac and Ida Counties, *in* Wilder, F. A., Annual Report, 1905; Iowa Geol. Survey, v. 16, p. 509-562.

———1910, Geology of Hamilton and Wright Counties, *in* Calvin, Samuel, Annual Report, 1909: Iowa Geol. Survey, v. 20, p. 97-149.

Marsh, T. A., 1927, The use of Iowa coal for steam production, *in* Kay, G. F., Annual Reports, 1925 and 1926: Iowa Geol. Survey, v. 32, p. 82-90.

Miller, B. L., 1901, Geology of Marion County, *in* Calvin, Samuel, Administrative Reports: Iowa Geol. Survey, v. 11, p. 127-197.

Norton, W. H., 1899, Geology of Scott County, *in* Calvin, Samuel, Annual Report, 1898: Iowa Geol. Survey, v. 9, p. 389-519.

———1928, Deep wells of Iowa [a supplementary report], *in* Kay, G. F., Annual Report, 1927: Iowa Geol. Survey, v. 33, p. 9-374.

———1935, Deep wells drilled in Iowa, 1928-32, *in* Kay, G. F., Annual Reports, 1930, 1931, 1932, and 1933: Iowa Geol. Survey, v. 36, p. 311-364.

Norton, W. H., Hendrixson, W. S., Simpson, H. E., Meinzer, O. E., and others, 1912, Underground water resources of Iowa: U. S. Geol. Survey, Water-Supply Paper 293, 994 p.

Olin, H. L., and Troeltzsch, J. R., 1924, The distribution of ash and sulfur in Iowa coals as affected by washing and flotation, *in* Kay, G. F., Annual Reports, 1923 and 1924: Iowa Geol. Survey, v. 31, p. 153-166.

Olin, H. L., Kinne, R. C., Scott, C. E., Waddell, J. D., Ambrose, J. N., Barrett, Clark, Allen, H. D., Johnson, F. V., Jr., and Lees, J. H., 1930, Studies of Iowa coals: Iowa Geol. Survey Tech. Paper No. 2, 63 p.

Olin, H. L., 1936, Iowa Coal Studies: Iowa Geol. Survey Tech. Paper No. 3, 80 p.

Rice, G. S., Fieldner, A. C., and Osgood, F. D., 1921, Analyses of Iowa coals: U. S. Bur. Mines Tech. Paper 269, 26 p.

St. John, O. H., 1870, Carboniferous System, Middle coal-measures, *in* White, C. A., 1870, Report on the geological survey of the State of Iowa, v. 1, p. 264-284.

Savage, T. E., 1902, Geology of Henry County, *in* Calvin, Samuel, Annual Report, 1901: Iowa Geol. Survey, v. 12, p. 237-302.

———1905, Report on the tests of Iowa coals made at the Government coal-testing plant at the Louisiana Purchase Exposition, St. Louis, Mo., 1904: Iowa Geol. Survey Bull. 2, p. 22-38.

Shimek, Bohumil, 1910, Geology of Harrison and Monona Counties, *in* Calvin, Samuel, Annual Report, 1909: Iowa Geol. Survey, v. 20, p. 271-485.

Smith, G. L., 1909, The Carboniferous section of southwestern Iowa, *in* Calvin, Samuel, Annual Report, 1908: Iowa Geol. Survey, v. 19, p. 605-657.

Snyder, N. H., and Aresco, S. J., 1953, Analyses of tipple and delivered samples of coal (collected during the fiscal years 1948 to 1950, inclusive): U. S. Bur. Mines Bull. 516, 133 p.

Stookey, S. W., 1910, Geology of Poweshiek County, *in* Calvin, Samuel, Annual Report, 1909: Iowa Geol. Survey, v. 20, p. 237-269.

Tilton, J. L., 1895, Geological section along Middle River in central Iowa, *in* Calvin, Samuel, Second Annual Report, 1893: Iowa Geol. Survey, v. 3, p. 137-146.

———1896, Geology of Warren County, *in* Calvin, Samuel, Annual Report, 1895: Iowa Geol. Survey, v. 5, p. 301-359.

———1916a, Geology of Cass County, *in* Kay, G. F., Annual Report, 1916: Iowa Geol. Survey, v. 27, p. 171-276.

———1916b, Geology of Clarke County, *in* Kay, G. F., Annual Report, 1916: Iowa Geol. Survey, v. 27, p. 105-170.

Tilton, J. L., and Bain, H. F., 1897, Geology of Madison County, *in* Calvin, Samuel, Annual Report, 1896: Iowa Geol. Survey, v. 7, p. 489-539.

Thompson, M. L., 1934, The fusulinids of the Des Moines series of Iowa: Iowa Univ. Studies in Nat. History, v. 16, no. 4, p. 277-332, State Univ. of Iowa, Iowa City.

Udden, J. A., 1899, Geology of Muscatine County, *in* Calvin, Samuel, Annual Report, 1898: Iowa Geol. Survey, v. 9, p. 247-380.

———1901, Geology of Pottawattamie County, *in* Calvin, Samuel, Administrative Reports: Iowa Geol. Survey, v. 11, p. 199-277.

———1902, Geology of Jefferson County, *in* Calvin, Samuel, Annual Report, 1901: Iowa Geol. Survey, v. 12, p. 355-437.

———1903, Geology of Mills and Fremont Counties, *in* Calvin, Samuel, Annual Report, 1902: Iowa Geol. Survey, v. 13, p. 123-183.

U. S. Bureau of Mines, 1949, Analyses of Iowa coals: Tech. Paper 706, 65 p.

———, 1924-1931, Mineral resources of the United States (annual volumes).

———, 1932-1963, Minerals yearbooks (annual volumes).

U. S. Geological Survey, 1900-1923, Mineral resources of the United States, (annual volumes).

Weller, J. M., Wanless, H. R., Cline, L. M., and Stookey, D. G., 1942, Interbasin Pennsylvanian correlations, Illinois and Iowa: Am. Assoc. Petroleum Geologists Bull., v. 26, no. 10, p. 1585-1593.

White, C. A., 1870, Report on the geological survey of the State of Iowa: 2 vols., v. 1, 391 p., v. 2, 443 p., Des Moines.

Wilder, F. A., 1902, Geology of Webster County, *in* Calvin, Samuel, Annual Report, 1901: Iowa Geol. Survey, v. 12, p. 63-191.

———1909, Fuel values of Iowa coals, *in* Calvin, Samuel, Annual Report, 1908: Iowa Geol. Survey, v. 19, p. 397-475.

Williams, I. A., 1905, Geology of Jasper County, *in* Wilder, F. A., Annual Report, 1904: Iowa Geol. Survey, v. 15, p. 277-367.

Wilson, L. R., and Brokaw, A. L., 1937, Plant microfossils of an Iowa coal deposit: Iowa Acad. Sci. Proc., v. 44, p. 127-130.

Wood, L. W., 1935, The road and concrete materials of southern Iowa, *in* Kay, G. F., Annual Reports, 1930, 1931, 1932, and 1933: Iowa Geol. Survey, v. 36, p. 8-310.

Young, W. H., and Anderson, R. L., 1952, Thickness of bituminous coal and lignite seams at all mines and thickness of overburden at strip mines in the United States in 1950: U. S. Bur. Mines Inf. Circ. 7642, 18 p.

———1962, Thickness of bituminous coal and lignite seams mined in 1960: U. S. Bur. Mines Inf. Circ. 8118, 19 p.

———1964, Coal—bituminous and lignite: U. S. Bur. Mines Minerals Yearbook 1963, v. 2, p. 49-174.

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
ADAIR COUNTY													
Uncorrelated Marmaton Age Coal													
77N	33W	0.76	....	....	0.76	3.24	....	....	3.24	4.00	....	....	4.00
76N	33W	1.26	....	....	1.26	3.35	....	....	3.35	4.61	....	....	4.61
Total.....		2.02	....	....	2.02	6.59	....	....	6.59	8.61	....	....	8.61
Whitebreast Coal													
77N	30W	0.09	....	....	0.09	0.53	....	....	0.53	0.62	....	....	0.62
Total.....		0.09	....	....	0.09	0.53	....	....	0.53	0.62	....	....	0.62
Total County Reserves													
77N	30W	0.09	....	....	0.09	0.53	....	....	0.53	0.62	....	....	0.62
77N	33W	.76	....	....	.76	3.24	....	....	3.24	4.00	....	....	4.00
76N	33W	1.26	....	....	1.26	3.35	....	....	3.35	4.61	....	....	4.61
Total.....		2.11	....	....	2.11	7.12	....	....	7.12	9.23	....	....	9.23
ADAMS COUNTY													
Nodaway Coal													
73N	35W	6.07	....	....	6.07	25.01	....	....	25.01	31.08	....	....	31.08
72N	35W	21.78	....	....	21.78	29.54	....	....	29.54	51.32	....	....	51.32
71N	35W	1.38	....	....	1.38	18.05	....	....	18.05	19.43	....	....	19.43
73N	34W	2.98	....	....	2.98	9.28	....	....	9.28	12.26	....	....	12.26
72N	34W	2.60	....	....	2.60	4.62	....	....	4.62	7.22	....	....	7.22
Total.....		34.81	....	....	34.81	86.50	....	....	86.50	121.31	....	....	121.31

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
APPANOOSE COUNTY													
Mystic Coal													
67N	16W	....	3.86	....	3.86	....	4.41	....	4.41	....	8.27	....	8.27
70N	17W	1.08	1.17	....	2.25	2.51	4.96	....	7.47	3.59	6.13	....	9.72
69N	17W	2.43	18.62	....	21.05	1.47	23.11	....	24.58	3.90	41.73	....	45.63
68N	17W	....	27.97	....	27.97	....	38.81	....	38.81	....	66.78	....	66.78
67N	17W	....	6.85	....	6.85	....	31.35	....	31.35	....	38.20	....	38.20
70N	18W	....	11.62	....	11.62	.26	26.49	....	26.75	.26	38.11	....	38.37
69N	18W	17.12	16.79	....	33.91	7.65	19.61	....	27.26	24.77	36.40	....	61.17
68N	18W	.23	39.88	....	40.11	.32	71.99	....	72.31	.55	111.87	....	112.42
67N	18W	....	6.20	....	6.20	....	43.64	....	43.64	....	49.84	....	49.84
70N	19W	6.93	....	....	6.93	53.66	6.51	....	60.17	60.59	6.51	....	67.10
69N	19W	9.40	18.33	....	27.73	25.57	31.74	....	57.31	34.97	50.07	....	85.04
68N	19W	2.26	3.84	....	6.10	22.26	40.57	....	62.83	24.52	44.41	....	68.93
67N	19W	....	2.30	....	2.30	....	26.44	....	26.44	....	28.74	....	28.74
Total.....		39.45	157.43	....	196.88	113.70	369.63	....	483.33	153.15	527.06	....	680.21
BOONE COUNTY													
Highest Bed in Area North of Madrid (Munterville Coal?)													
82N	26W	2.77	0.03	....	2.80	2.49	....	....	2.49	5.26	0.03	....	5.29
Total.....		2.77	0.03	....	2.80	2.49	....	....	2.49	5.26	0.03	....	5.29
Upper Bed at Boone (Manbeck Coal?)													
85N	25W	....	....	....	....	....	....	0.33	0.33	....	....	0.33	0.33
84N	25W	0.87	2.15	4.23	7.25	0.49	1.01	7.22	8.72	1.36	3.16	11.45	15.97
84N	26W	3.70	4.73	3.75	12.18	2.50	.23	....	2.73	6.20	4.96	3.75	14.91
83N	26W	1.25	2.86	....	4.11	3.48	2.68	....	6.16	4.73	5.54	....	10.27
82N	26W	1.18	1.81	....	2.99	1.18	1.50	....	2.68	2.36	3.31	....	5.67

85N 27W	2.66	4.55	4.17	11.38	3.85	1.56	....	5.41	6.51	6.11	4.17	16.79
84N 27W	4.23	23.84	2.02	30.09	7.38	12.65	....	20.03	11.61	36.49	2.02	50.12
83N 27W	4.91	4.50	....	9.41	6.70	.46	....	7.16	11.61	4.96	....	16.57
Total.....	18.80	44.44	14.17	77.41	25.58	20.09	7.55	53.22	44.38	64.53	21.72	130.63
Lower Bed at Boone (Hastie Plus Coal?)												
84N 25W	1.26	0.46	1.58	3.30	1.96	2.30	0.28	4.54	3.22	2.76	1.86	7.84
82N 25W	1.04	.26	.17	1.47	....	....	....	....	1.04	.26	.17	1.47
84N 26W	.11	....	....	.11	.09	....	....	.09	.20	....	....	.20
82N 26W	3.62	6.81	1.36	11.79	1.10	.90	....	2.00	4.72	7.71	1.36	13.79
85N 27W	.47	.89	.25	1.31	.42	....	....	.42	.89	.59	.25	1.73
84N 27W	2.73	4.87	9.65	17.25	5.56	5.41	.91	11.88	8.29	10.28	10.56	29.13
Total.....	9.23	12.99	13.01	35.23	9.13	8.61	1.19	18.93	18.36	21.60	14.20	54.16
Lowest Bed Mined at Madrid (Hastie Coal?)												
82N 25W	2.16	7.70	0.89	10.75	0.83	1.80	....	2.63	2.99	9.50	0.89	13.38
82N 26W	3.82	8.61	10.72	23.15	2.32	2.79	0.12	5.23	6.14	11.40	10.84	28.38
Total.....	5.98	16.31	11.61	33.90	3.15	4.59	0.12	7.86	9.13	20.90	11.73	41.76
Upper Bed in Dawson-Angus Area (Uncorrelated-Lower Cherokee)												
82N 28W	....	....	0.88	0.88	....	....	0.96	0.96	....	....	1.84	1.84
Total.....	....	....	0.88	0.88	....	....	0.96	0.96	....	....	1.84	1.84
Middle Bed in Dawson-Angus Area (Uncorrelated-Lower Cherokee)												
82N 28W	....	....	3.13	3.13	....	0.15	1.37	1.52	....	0.15	4.50	4.65
Total.....	....	....	3.13	3.13	....	0.15	1.37	1.52	....	0.15	4.50	4.65
(Lower Bed in Dawson-Angus Area (Uncorrelated-Lower Cherokee)												
82N 28W	1.39	2.97	1.10	5.46	....	....	....	....	1.39	2.97	1.10	5.46
Total.....	1.39	2.97	1.10	5.46	....	....	....	....	1.39	2.97	1.10	5.46

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
BOONE COUNTY—Continued													
Total County Reserves													
85N	25W	....	....	....	....	....	....	0.33	0.33	....	....	0.33	0.33
84N	25W	2.13	2.61	5.81	10.55	2.45	3.31	7.50	13.26	4.58	5.92	13.31	23.81
82N	25W	3.20	7.96	1.06	12.22	.83	1.80	....	2.63	4.03	9.76	1.06	14.85
84N	26W	3.81	4.73	3.75	12.29	2.59	.23	....	2.82	6.40	4.96	3.75	15.11
83N	26W	1.25	2.86	....	4.11	3.48	2.68	....	6.16	4.73	5.54	....	10.27
82N	26W	11.39	17.26	12.08	40.73	7.09	5.19	.12	12.40	18.48	22.45	12.20	53.13
85N	27W	3.13	5.14	4.42	12.69	4.27	1.56	....	5.83	7.40	6.70	4.42	18.52
84N	27W	6.96	28.71	11.67	47.34	12.94	18.06	.91	31.91	19.90	46.77	12.58	79.25
83N	27W	4.91	4.50	....	9.41	6.70	.46	....	7.16	11.61	4.96	....	16.57
82N	28W	1.39	2.97	5.11	9.47	....	.15	2.33	2.48	1.39	3.12	7.44	11.95
Total.....		38.17	76.74	43.90	158.81	40.35	33.44	11.19	84.98	78.52	110.18	55.09	243.79
CASS COUNTY													
Nodaway Coal													
74N	34W	....	....	....	....	0.80	....	....	0.80	0.80	....	....	0.80
74N	35W	0.37	....	....	0.37	1.29	....	....	1.29	1.66	....	....	1.66
74N	36W	....	....	....	....	.70	....	....	.70	.70	....	....	.70
Total.....		0.37	....	....	0.37	2.79	....	....	2.79	3.16	....	....	3.16
CLARKE COUNTY													
Lower Coal—Ford Coal													
72N	24W	....	....	....	....	....	0.42	....	0.42	....	0.42	....	0.42
Total.....		....	....	....	....	....	0.42	....	0.42	....	0.42	....	0.42

DALLAS COUNTY

Lonsdale Coal

79N	29W	0.72	....	....	0.72	1.09	....	....	1.09	1.81	....	....	1.81
Total.....		0.72	....	....	0.72	1.09	....	....	1.09	1.81	....	....	1.81

Upper Mystic Coal

80N	27W	....	....	....	....	....	0.14	....	0.14	....	0.14	....	0.14
79N	27W	....	....	....	....	....	.55	....	.55	....	.55	....	.55
79N	28W	0.24	....	0.92	1.16	0.04	....	2.76	2.80	0.28	....	3.68	3.96
79N	29W	.11	....	....	.11	....	....	....	....	.11	....	....	.11
Total.....		0.35	....	0.92	1.27	0.04	0.69	2.76	3.49	0.39	0.69	3.68	4.76

Lower Mystic Coal

79N	26W	0.05	0.56	....	0.61	0.60	1.06	....	1.66	0.65	1.62	....	2.27
80N	27W	.07	....	....	.07	.30	....	....	.30	.37	....	....	.37
79N	27W	.37	.69	....	1.06	1.79	....	....	1.79	2.16	.69	....	2.85
79N	28W	....	.50	....	.50	.94	....	....	.94	.94	.50	....	1.44
79N	29W	.46	....	....	.46	1.38	....	....	1.38	1.84	....	....	1.84
Total.....		0.95	1.75	....	2.70	5.01	1.06	....	6.07	5.96	2.81	....	8.77

Uncorrelated Marmaton Age Coal

80N	28W	....	0.46	....	0.46	....	1.36	....	1.36	....	1.82	....	1.82
Total.....		....	0.46	....	0.46	....	1.36	....	1.36	....	1.82	....	1.82

Bevier-Wheeler Coal

78N	28W	....	....	....	....	0.34	....	....	0.34	0.34	....	....	0.34
79N	27W	0.34	....	....	0.34	.41	....	....	.41	.75	....	....	.75
78N	27W	.22	....	....	.22	.19	....	....	.19	.41	....	....	.41
Total.....		0.56	....	....	0.56	0.94	....	....	0.94	1.50	....	....	1.50

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
DALLAS COUNTY—Continued													
Whitebreast Coal													
79N	26W	....	0.42	....	0.42	....	1.07	....	1.07	....	1.49	....	1.49
78N	26W	....	.28	....	.28	....	1.00	....	1.00	....	1.28	....	1.28
78N	27W	0.46	....	....	.46	1.38	....	....	1.38	1.84	....	....	1.84
78N	28W	.14	....	....	.14	0.47	....	....	.47	.61	....	....	.61
79N	29W	.11	....	....	.11	0.19	....	....	.19	.30	....	....	.30
78N	29W	.93	....	....	.93	.74	....	....	.74	1.67	....	....	1.67
Total.....		1.64	0.70	....	2.34	2.78	2.07	....	4.85	4.42	2.77	....	7.19
Munterville Coal													
79N	26W	0.25	....	....	0.25	0.71	....	....	0.71	0.96	....	....	0.96
78N	26W	.21	....	....	.21	.67	....	0.92	1.59	.88	....	0.92	1.80
79N	27W	.46	....	....	.46	1.27	....	....	1.27	1.73	....	....	1.73
78N	27W	.45	....	....	.46	1.38	....	....	1.38	1.84	....	....	1.84
79N	29W	.39	0.24	1.38	2.01	1.29	1.53	.81	3.63	1.68	1.77	2.19	5.64
Total.....		1.77	0.24	1.38	3.39	5.32	1.53	1.73	8.58	7.09	1.77	3.11	11.97
Bed approximately 20 feet above Ford Coal (No. 5 Coal of Lucas County?)													
78N	26W	....	....	....	....	....	....	0.55	0.55	....	....	0.55	0.55
78N	28W	0.28	....	....	0.28	....	....	....	....	0.28	....	....	.28
Total.....		0.28	....	....	0.28	....	....	0.55	0.55	0.28	....	0.55	0.83
Lower Coal—Ford Coal													
78N	26W	....	....	....	....	....	....	1.10	1.10	....	....	1.10	1.10
80N	27W	....	....	0.05	0.05	....	0.19	.47	.66	....	0.19	.52	.71
79N	27W	....	....	1.03	1.03	....	.34	.92	1.26	....	.34	1.95	2.29

80N	28W	....	....	....	....	....	.08	.08	.16	....	.08	.08	.16
79N	28W	....	....	....	....	....	.19	.33	.52	....	.19	.33	.52
78N	28W	0.15	....	....	.15	....	....	....	....	0.15	....	....	.15
79N	29W	.66	0.55	....	1.21	1.84	....	....	1.84	2.50	.55	....	3.05
78N	29W	.25	2.98	....	3.23	1.07	.17	....	1.24	1.32	3.15	....	4.47
Total.....		1.06	3.53	1.08	5.67	2.91	0.97	2.90	6.78	3.97	4.50	3.98	12.45

Lower Bed at Boone (Hastie Plus Coal?)

81N	26W	2.78	2.86	0.55	6.19	....	....	....	....	2.78	2.86	0.55	6.19
Total.....		2.78	2.86	0.55	6.19	....	....	....	....	2.78	2.86	0.55	6.19

Lowest Bed Mined at Madrid (Hastie Coal?)

81N	26W	6.67	11.12	8.99	26.78	5.35	2.32	1.62	9.29	12.02	13.44	10.61	36.07
Total.....		6.67	11.12	8.99	26.78	5.35	2.32	1.62	9.29	12.02	13.44	10.61	36.07

Hastie Coal

79N	28W	0.48	3.73	2.54	6.75	2.67	5.93	....	8.60	3.15	9.66	2.54	15.35
78N	28W	.19	....	....	.19	.86	....	....	0.86	1.05	....	....	1.05
78N	28W	.29	0.19	....	.48	.06	....	....	.06	.35	.19	....	.54
Total.....		0.96	3.92	2.54	7.42	3.59	5.93	....	9.52	4.55	9.85	2.54	16.94

Uncorrelated Beds Below Hastie

80N	28W	....	0.69	0.92	1.61	2.74	....	....	2.74	2.74	0.69	0.92	4.35
79N	28W	0.46	....	....	.46	1.38	....	....	1.38	1.84	....	....	1.84
Total.....		0.46	0.69	0.92	2.07	4.12	....	....	4.12	4.58	0.69	0.92	6.19

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
DALLAS COUNTY—Continued													
Beds at Van Meter (Uncorrelated—Lower Cherokee)													
78N	27W												
Upper		0.58	....	....	0.58	1.23	....	....	1.23	1.81	....	....	1.81
Middle		....	1.24	....	1.24	....	2.62	....	2.62	....	3.86	....	3.86
Lower		....	1.24	....	1.24	....	2.66	....	2.66	....	3.90	....	3.90
Total		0.58	2.48	....	3.06	1.23	5.28	....	6.51	1.81	7.76	....	9.57
Beds in Dawson-Angus Area (Uncorrelated—Lower Cherokee)													
81N	29W												
Upper		0.68	....	....	0.68	0.47	....	....	0.47	1.15	....	....	1.15
Middle		.60	4.89	....	5.49	2.24	10.33	....	12.57	2.84	15.22	....	18.06
Lower		....	....	1.41	1.41	....	....	2.90	2.90	....	....	4.31	4.31
Total		1.28	4.89	1.41	7.58	2.71	10.33	2.90	15.94	3.99	15.22	4.31	23.52
Total County Reserves													
81N	26W	9.45	13.98	9.54	32.97	5.35	2.32	1.62	9.29	14.80	16.30	11.16	42.26
79N	26W	.78	4.71	2.54	8.03	3.98	8.06	....	12.04	4.76	12.77	2.54	20.07
78N	26W	.40	.28	....	.68	1.87	1.00	2.57	5 44	2.27	1.28	2.57	6.12
80N	27W	.07	....	.05	.12	.30	.33	.47	' 10	.37	.33	.52	1.22
79N	27W	1.17	.69	1.03	2.89	3.47	.89	.92	5.28	4.64	1.58	1.95	8.17
78N	27W	1.72	2.48	....	4.20	4.18	5.28	....	9.46	5.90	7.76	....	13.66
80N	28W	....	1.15	.92	2.07	2.74	1.44	.08	4.26	2.74	2.59	1.00	6.33
79N	28W	.70	.50	.92	2.12	2.36	.19	3.09	5.64	3.06	.69	4.01	7.76
78N	28W	.88	.19	....	1.05	.53	....	....	0.53	1.39	.19	....	1.58
81N	29W	1.28	4.89	1.41	7.58	2.71	10.33	2.90	15.94	3.99	15.22	4.31	23.52
79N	29W	2.45	.79	1.38	4.62	5.79	1.53	.81	8.13	8.24	2.32	2.19	12.75
78N	29W	1.18	2.98	....	4.16	1.81	.17	....	1.98	2.99	3.15	....	6.14
Total		20.06	32.64	17.79	70.49	35.09	31.54	12.46	79.09	55.15	64.18	30.25	149.58

DAVIS COUNTY

Whitebreast Coal

70N 14W	....	0.66	....	0.66	0.87	....	....	0.87	0.87	0.66	....	1.53
Total.....	....	0.66	....	0.66	0.87	....	....	0.87	0.87	0.66	....	1.53

Laddsdale Coal

70N 12W	0.90	1.56	6.68	9.14	2 47	0.91	3.41	6.79	3.37	2.47	10.09	15.93
70N 13W	....	4.67	8.83	13.50	....	10.50	17.54	28.04	....	15.17	26.37	41.54
70N 14W	....	2.53	4.55	7.08	....	4.42	4.47	8.89	....	6.95	9.02	15.97
Total.....	0.90	8.76	20.06	29.72	2.47	15.83	25.42	43.72	3.37	24.59	45.48	73.44

Cliffland Coal

70N 12W	1.40	0.03	....	1.43	3.90	....	....	3.90	5.30	0.03	....	5.33
70N 13W	....	2.73	3.47	6.20	.13	3.38	10.72	14.23	.13	6.11	14.19	20.43
70N 14W	....	.07	....	.07	....	2.70	....	2.70	....	2.77	....	2.77
Total.....	1.40	2.83	3.47	7.70	4.03	6.08	10.72	20.83	5.43	8.91	14.19	28.53

Upper Uncorrelated Lower Cherokee Coal

67N 14W	1.05	....	....	1.05	3.02	....	....	3.02	4.07	....	....	4.07
Total.....	1.05	....	....	1.05	3.02	....	....	3.02	4.07	....	....	4.07

Lower Uncorrelated Lower Cherokee Coal

67N 14W	....	1.83	....	1.83	....	4.31	....	4.31	....	6.14	....	6.14
Total.....	....	1.83	....	1.83	....	4.31	....	4.31	....	6.14	....	6.14

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
DAVIS COUNTY—Continued													
Total County Reserves													
70N	12W	2.30	1.59	6.68	10.57	6.37	0.91	3.41	10.69	8.67	2.50	10.09	21.26
70N	13W	....	7.40	12.30	19.70	.13	13.88	28.26	42.27	.13	21.28	40.56	61.97
70N	14W	....	3.26	4.55	7.81	.87	7.12	4.47	12.46	.87	10.38	9.02	20.27
67N	14W	1.05	1.83	....	2.88	3.02	4.31	....	7.33	4.07	6.14	....	10.21
Total.....		3.35	14.08	23.53	40.96	10.39	26.22	36.14	72.75	13.74	40.30	59.67	113.71
DECATUR COUNTY													
Bevier Coal													
69N	25W	2.98	2.17	1.61	6.76	10.62	4.08	5.34	20.04	13.60	6.25	6.85	26.80
68N	25W	.35	....	....	.35	8.06	....	....	8.06	8.41	....	....	8.41
69N	26W	....	....	....	....	....	....	.62	.62	....	....	.62	.62
68N	26W	....	....	11.58	11.58	.01	....	26.85	26.86	.01	....	38.43	38.44
67N	26W	....	....	1.78	1.78	....	....	31.56	31.56	....	....	33.34	33.34
Total.....		3.33	2.17	14.97	20.47	18.69	4.08	64.37	87.14	22.02	6.25	79.34	107.61
Whitebreast Coal													
69N	25W	2.19	....	....	2.19	8.50	4.78	....	13.28	10.69	4.78	....	15.47
68N	25W	.31	....	....	.31	9.50	2.82	....	12.32	9.81	2.82	....	12.63
69N	26W	....	....	....	....	....	1.30	....	1.30	....	1.30	....	1.30
68N	26W	....	2.06	6.69	8.75	....	3.53	16.90	20.43	....	5.59	23.59	29.18
67N	26W	....	....	1.42	1.42	....	1.51	22.78	24.29	....	1.51	24.20	25.71
Total.....		2.50	2.06	8.11	12.67	18.00	13.94	39.68	71.62	20.50	16.00	47.79	84.29

Bed 40 feet Below Whitebreast Coal (Uncorrelated—Upper Cherokee?)

69N 25W	0.57	1.35	4.09	6.01	0.59	1.07	8.02	9.68	1.16	2.42	12.11	15.69
68N 25W	....	....	.73	.73	.07	.24	3.73	4.04	.07	.24	4.46	4.77
Total.....	0.57	1.35	4.82	6.74	0.66	1.31	11.75	13.72	1.23	2.66	16.57	20.46

Total County Reserves

69N 25W	5.74	3.52	5.70	14.96	19.71	9.93	13.36	43.00	25.45	13.45	19.06	57.96
68N 25W	.66	....	.73	1.39	17.63	3.06	3.73	24.42	18.29	3.06	4.46	25.81
69N 26W	....	....	....	....	....	1.30	.62	1.92	....	1.30	.62	1.92
68N 26W	....	2.06	18.27	20.33	.01	3.53	43.75	47.29	.01	5.59	62.02	67.62
67N 26W	....	....	3.20	3.20	....	1.51	54.34	55.85	....	1.51	57.54	59.05
Total.....	6.40	5.58	27.90	39.88	37.35	19.33	115.80	172.48	43.75	24.91	143.70	212.36

FREMONT COUNTY

Nodaway Coal

68N 41W	....	....	....	....	0.34	....	....	0.34	0.34	....	....	0.34
67N 41W	1.20	....	....	1.20	7.03	....	....	7.03	8.23	....	....	8.23
67N 42W	.13	....	....	.13	2.63	....	....	2.63	2.76	....	....	2.76
Total.....	1.33	....	....	1.33	10.00	....	....	10.00	11.33	....	....	11.33

GREENE COUNTY

Upper Bed in Dawson-Angus Area (Uncorrelated—Lower Cherokee)

82N 29W	....	....	0.27	0.27	....	....	1.06	1.06	....	....	1.33	1.33
Total.....	....	....	0.27	0.27	....	....	1.06	1.06	....	....	1.33	1.33

Middle Bed in Dawson-Angus Area (Uncorrelated—Lower Cherokee)

82N 29W	1.11	4.54	6.83	12.48	6.77	10.68	2.99	20.44	7.88	15.22	9.82	32.92
82N 30W	.23	.12	....	.35	.81	.49	....	1.30	1.04	.61	....	1.65
Total.....	1.34	4.66	6.83	12.83	7.58	11.17	2.99	21.74	8.92	15.83	9.82	34.57

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
GREENE COUNTY—Continued													
Lower Bed in Dawson-Angus Area (Uncorrelated—Lower Cherokee)													
82N	29W	0.30	1.13	0.45	1.88	0.53	1.62	0.38	2.53	0.83	2.75	0.83	4.41
Total.....		0.30	1.13	0.45	1.88	0.53	1.62	0.38	2.53	0.83	2.75	0.83	4.41
Bed at Grand Junction (Uncorrelated—Lower Cherokee)													
84N	29W	1.02	....	....	1.02	2.23	....	....	2.23	3.25	....	....	3.25
83N	29W	.81	....	....	.81	2.13	....	....	2.13	2.94	....	....	2.94
Total.....		1.83	....	....	1.83	4.36	....	....	4.36	6.19	....	....	6.19
Total County Reserves													
84N	29W	1.02	....	....	1.02	2.23	....	....	2.23	3.25	....	....	3.25
83N	29W	.81	....	....	.81	2.13	....	....	2.13	2.94	....	....	2.94
82N	29W	1.41	5.67	7.55	14.63	7.30	12.30	4.43	24.03	8.71	17.97	11.98	38.66
82N	30W	.23	.12	....	.35	.81	.49	....	1.30	1.04	.61	....	1.65
Total.....		3.47	5.79	7.55	16.81	12.47	12.79	4.43	29.69	15.94	18.58	11.98	46.50
GUTHRIE COUNTY													
Lonsdale Coal													
8N	30W	4.78	....	....	4.78	4.79	....	....	4.79	9.57	....	....	9.57
8N	31W	.76	....	....	.76	1.85	....	....	1.85	2.61	....	....	2.61
Total.....		5.54	....	....	5.54	6.64	....	....	6.64	12.18	....	....	12.18

Marshall (Lower Mystic) Coal

78N 30W	1.74	....	....	1.74	0.98	....	....	0.98	2.72	....	....	2.72
78N 31W	.15	....	....	.15	.79	....	....	.79	.94	....	....	.94
Total.....	1.89	....	....	1.89	1.77	....	....	1.77	3.66	....	....	3.66

Bevier Coal

79N 30W	0.33	....	....	0.33	0.48	....	....	0.48	0.81	....	....	0.81
Total.....	0.33	....	....	0.33	0.48	....	....	0.48	0.81	....	.....	0.81

Whitebreast Coal

80N 30W	1.88	....	....	1.88	0.30	....	....	0.30	2.18	....	....	2.18
78N 30W	.37	....	....	.37	.85	....	....	.85	1.22	....	....	1.22
80N 31W	2.00	....	....	2.00	1.12	....	....	1.12	3.12	....	....	3.12
79N 31W	.81	....	....	.81	2.42	....	....	2.42	3.23	....	....	3.23
78N 31W	....	0.58	....	.58	....	1.73	....	1.73	....	2.31	....	2.31
81N 32W	2.17	....	....	2.17	2.70	....	....	2.70	4.87	....	....	4.87
80N 32W	1.19	....	....	1.19	1.99	....	....	1.99	3.18	....	....	3.18
79N 32W	....	....	....	....	1.08	....	....	1.08	1.08	....	....	1.08
81N 33W	1.81	....	....	1.81	1.36	....	....	1.36	3.17	....	....	3.17
Total.....	10.23	0.58	....	10.81	11.82	1.73	....	13.55	22.05	2.31	....	24.36

Wiley Coal

81N 31W	0.28	....	....	0.28	0.83	....	....	0.83	1.11	....	....	1.11
80N 31W	.07	0.69	....	.76	.21	2.07	....	2.28	.28	2.76	....	3.04
Total.....	0.35	0.69	....	1.04	1.04	2.07	....	3.11	1.39	2.76	....	4.15

Munterville Coal

78N 30W	0.30	....	....	0.30	0.90	....	....	0.90	1.20	....	....	1.20
81N 31W	2.30	....	....	2.30	.14	....	....	.14	2.44	....	....	2.44
80N 31W	6.08	....	....	6.08	2.55	....	....	2.55	8.63	....	....	8.63
79N 31W	.46	....	....	.46	1.38	....	....	1.38	1.84	....	....	1.84
78N 31W	....	....	0.92	.92	....	....	2.77	2.77	....	....	3.69	3.69
Total.....	9.14	....	0.92	10.06	4.97	....	2.77	7.74	14.11	....	3.69	17.80

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
GUTHRIE COUNTY—Continued													
Lower Coal—Ford Coal													
78N	30W	....	....	1.15	1.15	....	....	3.46	3.46	....	....	4.61	4.61
79N	31W	....	....	1.15	1.15	....	....	3.46	3.46	....	....	4.61	4.61
Total.....		....	....	2.30	2.30	....	....	6.92	6.92	....	....	9.22	9.22
Middle Bed in Dawson-Angus Area (Uncorrelated—Lower Cherokee)													
81N	30W	1.19	0.21	....	1.40	0.79	....	....	0.79	1.98	0.21	....	2.19
Total.....		1.19	0.21	....	1.40	0.79	....	....	0.79	1.98	0.21	....	2.19
Total County Reserves													
81N	30W	1.19	0.21	....	1.40	0.79	....	....	0.79	1.98	0.21	....	2.19
80N	30W	1.88	....	....	1.88	.30	....	....	.30	2.18	....	....	2.18
79N	30W	.33	....	....	.33	.48	....	....	.48	.81	....	....	.81
78N	30W	7.19	....	1.15	8.34	7.52	....	3.46	10.98	14.71	....	4.61	19.32
81N	31W	2.58	....	....	2.58	.97	....	....	.97	3.55	....	....	3.55
80N	31W	8.15	.69	....	8.84	3.88	2.07	....	5.95	12.03	2.76	....	14.79
79N	31W	1.27	....	1.15	2.42	3.80	....	3.46	7.26	5.07	....	4.61	9.68
78N	31W	.91	.58	.92	2.41	2.04	1.73	2.77	7.14	3.55	2.31	3.69	9.55
81N	32W	2.17	....	....	2.17	2.70	....	....	2.70	4.87	....	....	4.87
80N	32W	1.19	....	....	1.19	1.99	....	....	1.99	3.18	....	....	3.18
79N	32W	....	....	....	....	1.08	....	....	1.08	1.08	....	....	1.08
81N	33W	1.81	....	....	1.81	1.36	....	....	1.36	3.17	....	....	3.17
Total.....		28.67	1.48	3.22	33.37	27.51	3.80	9.69	41.00	56.18	5.28	12.91	74.37

HAMILTON COUNTY

Uncorrelated Lower Cherokee Bed (Tyson Bed of Webster County?)

88N	25W	0.77	0.52	....	1.29	1.82	0.14	....	1.96	2.59	0.66	....	3.25
87N	25W	....	.06	....	.06	.32	1.62	....	1.94	.32	1.68	....	2.00
88N	26W	.83	1.11	....	1.94	.96	....	....	.96	1.79	1.11	....	2.90
87N	26W	.78	3.38	3.44	7.60	3.06	8.36	4.50	15.92	3.84	11.74	7.94	23.52
Total.....		2.38	5.07	3.44	10.89	6.16	10.12	4.50	20.78	8.54	15.19	7.94	31.67

Uncorrelated Lower Cherokee Bed (Pretty Bed of Webster County?)

88N	25W	0.05	....	....	0.05	0.51	....	....	0.51	0.56	....	....	0.56
88N	26W	1.29	....	....	1.29	1.20	....	....	1.20	2.49	....	....	2.49
87N	26W	....	....	....	....	.30	....	....	.30	.30	....	....	.30
Total.....		1.34	....	....	1.34	2.01	....	....	2.01	3.35	....	....	3.35

Uncorrelated Lower Cherokee Bed (Colburn Bed of Webster County?)

88N	25W	0.19	....	....	0.19	0.60	....	....	0.60	0.79	....	....	0.79
88N	26W	.88	....	....	.88	1.16	....	....	1.16	2.04	....	....	2.04
87N	26W	....	....	....	....	.17	....	....	.17	.17	....	....	.17
Total.....		1.07	....	....	1.07	1.93	....	....	1.93	3.00	....	....	3.00

Total County Reserves

88N	25W	1.01	0.52	....	1.53	2.93	0.14	....	3.07	3.94	0.66	....	4.60
87N	25W	....	.06	....	.06	.32	1.62	....	1.94	.32	1.68	....	2.00
88N	26W	3.00	1.11	....	4.11	3.32	....	....	3.32	6.32	1.11	....	7.43
87N	26W	.78	3.38	3.44	7.60	3.53	8.36	4.50	16.39	4.31	11.74	7.94	23.99
Total.....		4.79	5.07	3.44	13.30	10.10	10.12	4.50	24.72	14.89	15.19	7.94	38.02

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
HARDIN COUNTY													
Upper Bed at Eldora City (Uncorrelated—Lower Cherokee)													
88N	19W	0.30	....	....	0.30	0.04	....	....	0.04	0.34	....	....	0.34
87N	19W	.10	....	....	.10	....	....	....	....	.10	....	....	.10
Total.....		0.40	....	....	0.40	0.04	....	....	0.04	0.44	....	....	0.44
Lower Bed at Eldora City (Uncorrelated—Lower Cherokee)													
88N	19W	....	1.38	0.09	1.47	....	3.12	0.33	3.45	....	4.50	0.42	4.92
87N	19W	....	....	3.13	3.13	....	1.56	1.70	3.26	....	1.56	4.83	6.39
Total.....		....	1.38	3.22	4.60	....	4.68	2.03	6.71	....	6.06	5.25	11.31
Total County Reserves													
88N	19W	0.30	1.38	0.09	1.77	0.04	3.12	0.33	3.49	0.34	4.50	0.42	5.26
87N	19W	.10	....	3.13	3.23	....	1.56	1.70	3.26	.10	1.56	4.83	6.49
Total.....		0.40	1.38	3.22	5.00	0.04	4.68	2.03	6.75	0.44	6.06	5.25	11.75
HENRY COUNTY													
Laddsdale Coal													
72N	7W	0.25	....	....	0.25	0.46	....	....	0.46	0.71	....	....	0.71
71N	7W	....	0.52	....	.52	....	0.66	....	.66	....	1.18	....	1.18
70N	7W	....	....	0.48	.48	....	.76	....	.76	....	.76	0.48	1.24
Total.....		0.25	0.52	0.48	1.25	0.46	1.42	....	1.88	0.71	1.94	0.48	3.13

Cliffland Coal

72N	7W	....	....	0.23	0.23	....	....	0.27	0.27	....	....	0.50	0.50
Total.....		....	....	0.23	0.23	....	....	0.27	0.27	....	....	0.50	0.50

Total County Reserves

72N	7W	0.25	....	0.23	0.48	0.46	....	0.27	0.73	0.71	....	0.50	1.21
71N	7W	....	0.52	....	.52	....	0.66	....	.66	....	1.18	....	1.18
70N	7W	....	....	.48	.48	....	.76	....	.76	....	.76	.48	1.24
Total.....		0.25	0.52	0.71	1.48	0.46	1.42	0.27	2.15	0.71	1.94	0.98	3.63

JASPER COUNTY

Bed 40 to 50 feet above Lower Coal—Ford Coal (Munterville Coal (?)

80N	19W	0.17	....	....	0.17	0.48	....	....	0.48	0.65	....	....	0.65
79N	19W	1.25	1.40	1.52	4.17	.19	....	....	.19	1.44	1.40	1.52	4.36
79N	20W	.08	1.90	1.22	3.20	3.48	1.11	....	4.59	3.56	3.01	1.22	7.79
78N	21W	1.52	.28	1.15	2.95	....	1.31	....	1.31	1.52	1.59	1.15	4.26
Total.....		3.02	3.58	3.89	10.49	4.15	2.42	....	6.57	7.17	6.00	3.89	17.06

Bed 20-35 feet above Lower Coal—Ford Coal (No. 5 Coal of Lucas County?)

79N	20W	....	....	....	....	....	0.04	0.12	0.16	....	0.04	0.12	0.16
78N	20W	0.13	0.23	1.77	2.13	0.62	1.88	2.52	5.02	0.75	2.11	4.29	7.15
78N	21W	1.16	0.70	2.48	4.34	1.32	0.90	....	2.22	2.48	1.60	2.48	6.56
Total.....		1.29	0.93	4.25	6.47	1.94	2.82	2.64	7.40	3.23	3.75	6.89	13.87

Lower Coal—Ford Coal

79N	18W	0.14	....	....	0.14	0.24	....	....	0.24	0.38	....	....	0.38
79N	19W	2.90	8.15	7.60	18.65	7.90	5.68	0.79	14.37	10.80	13.83	8.39	33.02
80N	20W	.13	.54	.96	1.63	.10	....	....	.10	.23	.54	.96	1.73
79N	20W	1.44	6.05	8.04	15.53	8.46	6.61	6.69	21.76	9.90	12.66	14.73	37.29
80N	21W	.84	2.36	1.52	4.72	4.13	.12	....	4.25	4.97	2.48	1.52	8.97
79N	21W	2.41	5.99	4.90	13.30	8.01	6.57	5.10	19.68	10.42	12.56	10.00	32.98
Total.....		7.86	23.09	23.02	53.97	28.84	18.98	12.58	60.40	36.70	42.07	35.60	114.37

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
JASPER COUNTY—Continued													
Bed 40 to 50 feet below Lower Coal—Ford Coal (Manbeck Coal?)													
78N	20W	0.51	1.34	....	1.85	1.87	1.74	....	3.61	2.38	3.80	....	5.46
79N	21W	.46	....	....	.46	1.38	....	....	1.38	1.84	....	....	1.84
78N	21W	.19	.84	0.21	1.24	1.52	.86	0.08	2.46	1.71	1.70	0.29	3.70
Total.....		1.16	2.18	0.21	3.55	4.77	2.60	0.08	7.45	5.93	4.78	0.29	11.00
Upper Bed at Lynnville (Uncorrelated—Lower Cherokee)													
79N	17W	....	1.01	....	1.01	0.90	....	....	0.90	0.90	1.01	....	1.91
78N	17W	....	.31	....	.31	.64	....	....	.64	.64	.31	....	.95
Total.....		....	1.32	....	1.32	1.54	....	....	1.54	1.54	1.32	....	2.86
Middle Bed at Lynnville (Uncorrelated—Lower Cherokee)													
79N	17W	0.60	....	....	0.60	0.54	....	....	0.54	1.14	....	....	1.14
78N	17W	.33	....	....	.33	.37	....	....	.37	.70	....	....	.70
Total.....		0.93	....	....	0.93	0.91	....	....	0.91	1.84	....	....	1.84
Lower Bed at Lynnville (Uncorrelated—Lower Cherokee)													
79N	17W	0.20	....	....	0.20	0.01	....	....	0.01	0.21	....	....	0.21
78N	17W	.28	....	....	.28	.31	....	....	.31	.59	....	....	.59
Total.....		0.48	....	....	0.48	0.32	....	....	0.32	0.80	....	....	0.80

Upper of Two Beds East of Monroe (Uncorrelated—Lower Cherokee)

78N	18W	0.16	....	....	0.16	0.40	....	....	0.40	0.56	....	....	0.56
78N	19W	1.25	4.08	8.84	14.17	2.37	0.51	0.36	3.24	3.62	4.59	9.20	17.41
Total.....		1.41	4.08	8.84	14.33	2.77	0.51	0.36	3.64	4.18	4.59	9.20	17.97

Lower of Two Beds East of Monroe (Uncorrelated—Lower Cherokee)

78N	19W	1.04	2.43	7.50	10.97	1.51	1.39	0.68	3.58	2.55	3.82	8.18	14.55
Total.....		1.04	2.43	7.50	10.97	1.51	1.39	0.68	3.58	2.55	3.82	8.18	14.55

Total County Reserves

79N	17W	0.80	1.01	....	1.81	1.45	....	....	1.45	2.25	1.01	....	3.26
78N	17W	.61	.31	....	.92	1.32	....	....	1.32	1.93	.31	....	2.24
79N	18W	.14	....	....	.14	.24	....	....	.24	.38	....	....	.38
78N	18W	.16	....	....	.16	.40	....	....	.40	.56	....	....	.56
80N	19W	.17	....	....	.17	.48	....	....	.48	.65	....	....	.65
79N	19W	4.15	9.55	9.12	22.82	8.09	5.68	0.79	14.56	12.24	15.23	9.91	37.38
78N	19W	2.29	6.51	16.34	25.14	3.88	1.90	1.04	6.82	6.17	8.41	17.38	31.96
80N	20W	.13	.54	.96	1.63	.10	....	....	.10	.23	.54	.96	1.73
79N	20W	1.52	7.95	9.26	18.73	11.94	7.76	6.81	26.51	13.46	15.71	16.07	45.24
78N	20W	.64	1.57	1.77	3.98	2.49	3.62	2.52	8.63	3.13	5.19	4.29	12.61
80N	21W	.84	2.36	1.52	4.72	4.13	.12	....	4.25	4.97	2.48	1.52	8.97
79N	21W	2.87	5.99	4.90	13.76	9.39	6.57	5.10	21.06	12.26	12.56	10.00	34.82
78N	21W	2.87	1.82	3.84	8.53	2.84	3.07	.08	5.99	5.71	4.89	3.92	14.52
Total.....		17.19	37.61	47.71	102.51	46.75	28.72	16.34	91.81	63.94	66.33	64.05	194.32

JEFFERSON COUNTY

Bed approximately 60 feet below Munterville Limestone at Ottumwa (Lower Coal—Ford Coal?)

72N	8W	0.59	....	....	0.59	1.67	....	....	1.67	2.26	....	....	2.26
71N	10W	.44	....	....	.44	.48	....	....	.48	.92	....	....	.92
Total.....		1.03	....	....	1.03	2.15	....	....	2.15	3.18	....	....	3.18

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
JEFFERSON COUNTY—Continued													
Laddsdale Coal													
72N	8W	....	....	5.55	5.55	0.28	....	10.53	10.81	0.28	....	16.08	16.36
73N	9W	....	10.09	1.45	11.54	....	14.20	....	14.20	....	24.29	1.45	25.74
72N	9W	....	....	....	....	....	2.59	....	2.59	....	2.59	....	2.59
71N	9W	0.48	....	1.06	1.54	1.16	....	2.35	3.51	1.64	....	3.41	5.05
72N	10W	.05	6.32	.76	7.13	1.97	4.23	2.61	8.81	2.02	10.55	3.37	15.94
71N	10W	.83	8.39	3.85	13.07	2.91	10.42	4.31	17.64	3.74	18.81	8.16	30.71
71N	11W	1.22	3.27	7.52	12.01	4.44	4.35	4.13	12.92	5.66	7.62	11.65	24.93
Total.....		2.58	28.07	20.19	50.84	10.76	35.79	23.93	70.48	13.34	63.86	44.12	121.32
Cliffland Coal													
72N	8W	....	0.61	....	0.61	....	1.22	....	1.22	....	1.83	....	1.83
Total.....		....	0.61	....	0.61	....	1.22	....	1.22	....	1.83	....	1.83
Uncorrelated Lower Cherokee Beds													
72N	11W	....	....	....	....	....	....	0.64	0.64	....	....	0.64	0.64
Total.....		....	....	....	....	....	....	0.64	0.64	....	....	0.64	0.64

Total County Reserves

72N	8W	0.59	0.61	5.55	6.75	1.95	1.22	10.53	13.70	2.54	1.83	16.08	20.45
73N	9W	....	10.09	1.45	11.54	....	14.20	....	14.20	....	24.29	1.45	25.74
72N	9W	....	....	....	....	....	2.59	....	2.59	....	2.59	....	2.59
71N	9W	.48	....	1.06	1.54	1.16	....	2.35	3.51	1.64	....	3.41	5.05
72N	10W	.05	6.32	.76	7.13	1.97	4.23	2.61	8.81	2.02	10.55	3.37	15.94
71N	10W	1.27	8.39	3.85	13.51	3.39	10.42	4.31	18.12	4.66	18.81	8.16	31.63
72N	11W	....	....	....	....	....	....	.64	.64	....	....	.64	.64
71N	11W	1.22	3.27	7.52	12.01	4.44	4.35	4.13	12.92	5.66	7.62	11.65	24.93
Total.....		3.61	28.68	20.19	52.48	12.91	37.01	24.57	74.49	16.52	65.69	44.76	126.97

KEOKUK COUNTY

Laddsdale or Cliffland Coal

74N	10W	....	....	2.32	2.32	....	2.59	....	2.59	....	2.59	2.32	4.91
77N	13W	....	....	26.45	26.45	....	....	34.51	34.51	....	....	60.96	60.96
76N	13W	....	0.87	46.32	47.19	0.55	2.11	21.77	24.43	0.55	2.98	68.09	71.62
75N	13W	....	.11	1.47	1.58	....	.17	1.38	1.55	....	.28	2.85	3.13
Total.....		....	0.98	76.56	77.54	0.55	4.87	57.66	63.08	0.55	5.85	134.22	140.62

LEE COUNTY

Lower of Two Beds in Southeast Van Buren County (Uncorrelated—Lower Cherokee)

65N	5W	0.40	....	....	0.40	0.95	....	....	0.95	1.35	....	....	1.35
67N	7W	....	....	....	....	....	0.49	....	.49	....	0.49	....	.49
Total.....		0.40	....	....	0.40	0.95	0.49	....	1.44	1.35	0.49	....	1.84

Second Bed above base of Cherokee Group? (Uncorrelated—Lower Cherokee)

69N	5W	0.62	....	....	0.62	1.98	....	....	1.98	2.60	....	....	2.60
69N	6W	.57	0.83	....	1.40	1.19	1.87	....	3.06	1.76	2.70	....	4.46
68N	6W	.58	1.17	....	1.75	.93	2.35	....	3.28	1.51	3.52	....	5.03
Total.....		1.77	2.00	....	3.77	4.10	4.22	....	8.32	5.87	6.22	....	12.09

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
LEE COUNTY—Continued													
First Bed above Base of Cherokee Group? (Uncorrelated—Lower Cherokee)													
68N	5W	....	....	0.71	0.71	....	....	1.41	1.41	....	....	2.12	2.12
68N	6W	....	....	....	....	....	....	.21	.21	....	....	.21	.21
Total.....		....	....	0.71	0.71	....	....	1.62	1.62	....	....	2.33	2.33
Total County Reserves													
69N	5W	0.62	....	....	0.62	1.98	....	....	1.98	2.60	....	....	2.60
68N	5W	....	....	0.71	.71	....	....	1.41	1.41	....	....	2.12	2.12
65N	5W	.40	....	....	.40	.95	....	....	.95	1.35	....	....	1.35
69N	6W	.57	0.83	....	1.40	1.19	1.87	....	3.06	1.76	2.70	....	4.46
68N	6W	.58	1.17	....	1.75	.93	2.35	.21	3.49	1.51	3.52	.21	5.24
67N	7W	....	....	....	....	....	.49	....	.49	....	.49	....	.49
Total.....		2.17	2.00	0.71	4.88	5.05	4.71	1.62	11.38	7.22	6.71	2.33	16.26
LUCAS COUNTY													
Mystic Coal													
71N	20W	....	....	....	....	1.11	....	....	1.11	1.11	....	....	1.11
Total.....		....	....	....	....	1.11	....	....	1.11	1.11	....	....	1.11
Mulky Coal													
72N	22W	0.66	....	....	0.66	0.55	....	....	0.55	1.21	....	....	1.21
72N	23W	4.06	....	....	4.06	3.20	....	....	3.20	7.26	....	....	7.26
Total.....		4.72	....	....	4.72	3.75	....	....	3.75	8.47	....	....	8.47

Bevier Coal

73N	21W	0.33	....	....	0.33	1.95	....	....	1.95	2.28	....	....	2.28
72N	21W	.17	....	....	.17	.29	....	....	.29	.46	....	....	.46
73N	22W	.21	....	....	.21	1.70	....	....	1.70	1.91	....	....	1.91
72N	22W	4.32	....	....	4.32	8.93	....	....	8.93	13.25	....	....	13.25
72N	23W	.35	....	....	.35	1.04	....	....	1.04	1.39	....	....	1.39
Total.....		5.38	....	....	5.38	13.91	....	....	13.91	19.29	....	....	19.29

Wheeler Coal

73N	21W	0.49	....	....	0.49	1.69	....	....	1.69	2.18	....	....	2.18
72N	21W	5.19	....	....	5.19	6.16	....	....	6.16	11.35	....	....	11.35
73N	22W	1.75	....	....	1.75	3.90	....	....	3.90	5.65	....	....	5.65
72N	22W	.02	2.30	....	2.32	4.38	5.30	....	0.68	4.40	7.60	....	12.00
73N	23W	1.07	....	....	1.07	1.77	....	....	1.77	2.84	....	....	2.84
72N	23W	3.92	....	....	3.92	5.16	....	....	5.16	9.08	....	....	9.08
Total.....		12.44	2.30	....	14.74	23.06	5.30	....	28.36	35.50	7.60	....	43.10

Whitebreast Coal

73N	20W	0.47	....	....	0.47	4.20	....	....	4.20	4.67	....	....	4.67
72N	20W	.89	....	....	.89	.21	....	....	.21	1.10	....	....	1.10
73N	21W	3.10	2.08	....	5.18	12.02	....	....	12.02	15.12	2.08	....	17.20
72N	21W	3.25	.78	....	4.03	16.17	....	....	16.17	19.42	.78	....	20.20
73N	22W	1.64	....	....	1.64	12.53	....	....	12.53	14.17	....	....	14.17
72N	22W	1.38	....	....	1.38	5.68	....	....	5.68	7.06	....	....	7.06
71N	22W	.05	....	....	.05	.98	....	....	.98	1.03	....	....	1.03
Total.....		10.78	2.86	....	13.64	51.79	....	....	51.79	62.57	2.86	....	65.43

Wiley Coal

73N	20W	3.49	0.06	....	3.55	4.52	....	....	4.52	8.01	0.06	....	8.07
73N	21W	1.24	....	....	1.24	7.13	....	....	7.13	8.37	....	....	8.37
72N	21W	3.28	....	....	3.28	2.66	....	....	2.66	5.94	....	....	5.94
73N	22W	....	1.81	....	1.81	2.04	....	....	2.04	2.04	1.81	....	3.85
72N	22W	.29	....	....	.29	2.68	....	....	2.68	2.97	....	....	2.97
Total.....		8.30	1.87	....	10.17	19.03	....	....	19.03	27.33	1.87	....	29.20

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
LUCAS COUNTY—Continued													
No. 7 Coal													
73N	20W	1.10	....	....	1.10	1.18	....	....	1.18	2.28	....	....	2.28
73N	21W	.91	....	....	.91	.40	....	....	.40	1.31	....	....	1.31
72N	21W	.29	....	....	.29	.74	....	....	.74	1.03	....	....	1.03
73N	22W	.48	....	....	.48	.53	....	....	.53	1.01	....	....	1.01
Total.....		2.78	....	....	2.78	2.85	....	....	2.85	5.63	....	....	5.63
No. 5 Coal													
73N	20W	0.32	10.57	....	10.89	4.71	4.87	....	9.58	5.03	15.44	....	20.47
72N	20W	2.16	1.04	....	3.20	1.68	....	....	1.68	3.84	1.04	....	4.88
73N	21W	....	....	....	....	.14	....	....	.14	.14	....	....	.14
72N	21W	.43	.12	....	.55	1.00	....	....	1.00	1.43	.12	....	1.55
72N	22W	.23	....	....	.23	.16	....	....	.16	.39	....	....	.39
Total.....		3.14	11.73	....	14.87	7.69	4.87	....	12.56	10.83	16.60	....	27.43
Lower Coal—Ford Coal													
73N	20W	1.61	7.94	23.70	33.25	10.02	12.29	22.01	44.32	11.63	20.23	45.71	77.57
72N	20W	.26	....	....	.26	.46	.14	....	.60	.72	.14	....	.86
73N	21W	1.19	1.64	20.31	23.14	2.36	3.26	18.78	24.40	3.55	4.90	39.09	47.54
72N	21W	.96	3.93	19.95	24.84	4.33	6.94	5.64	16.91	5.29	10.87	25.59	41.75
72N	22W	.37	1.09	11.54	13.00	.81	2.50	26.11	29.42	1.18	3.59	37.65	42.42
71N	22W	....	....	....	....	.62	2.88	....	3.50	.62	2.88	....	3.50
73N	23W	....	....	4.61	4.61	....	....	5.76	5.76	....	....	10.37	10.37
72N	23W	....	....	20.91	20.91	5.69	....	32.46	38.15	5.69	....	53.37	59.06
Total.....		4.39	14.60	101.02	120.01	24.29	28.01	110.76	163.06	28.68	42.61	211.78	283.07

Total County Reserves

73N	20W	6.99	18.57	23.70	49.26	24.63	17.16	22.01	63.80	31.62	35.73	45.71	113.06
72N	20W	3.31	1.04	....	4.35	2.35	.14	....	2.49	5.66	1.18	....	6.84
71N	20W	....	....	....	....	1.11	....	....	1.11	1.11	....	....	1.11
73N	21W	7.26	3.72	20.31	31.29	25.69	3.26	18.78	47.73	32.95	6.98	39.09	79.02
72N	21W	13.57	4.83	19.95	38.35	31.35	6.94	5.64	43.93	44.92	11.77	25.59	82.28
73N	22W	4.08	1.81	....	5.89	20.70	....	....	20.70	24.78	1.81	....	26.59
72N	22W	7.27	3.39	11.54	22.20	23.19	7.80	26.11	57.10	30.46	11.19	37.65	79.30
71N	22W	.05	....	....	.05	1.60	2.88	....	4.48	1.65	2.88	....	4.53
73N	23W	1.07	....	4.61	5.68	1.77	....	5.76	7.53	2.84	....	10.37	13.21
72N	23W	8.33	....	20.91	29.24	15.09	....	32.46	47.55	23.42	....	53.37	76.79
Total.....		51.93	33.36	101.02	186.31	147.48	38.18	110.76	298.42	199.41	71.54	211.78	482.73

MAHASKA COUNTY

Lower Coal (Lower Coal—Ford Coal)

76N	14W	0.23	0.37	0.21	0.81	....	....	....	....	0.23	0.37	0.21	0.81
75N	14W	.25	3.63	3.36	7.24	1.55	5.91	2.66	10.12	1.80	9.54	6.02	17.36
77N	15W	....	2.60	8.05	10.65	....	7.78	.38	8.16	....	10.38	8.43	18.81
76N	15W	.21	.46	1.05	1.72	.41	1.15	1.40	2.96	.62	1.61	2.45	4.68
75N	15W	1.58	2.40	31.21	35.19	.77	3.07	8.43	12.27	2.35	5.47	39.64	47.46
74N	15W	.90	1.67	3.64	6.21	....	....	....	....	.90	1.67	3.64	6.21
77N	16W	.44	2.39	1.38	4.21	2.81	1.70	4.15	8.66	3.25	4.09	5.53	12.87
76N	16W	.60	1.87	....	2.47	2.59	3.14	.38	6.11	3.19	5.01	.38	8.58
75N	16W	1.69	2.75	74.95	79.39	....	.50	19.32	19.82	1.69	3.25	94.27	99.21
74N	16W	....	3.32	21.48	24.80	....	4.53	20.57	25.10	....	7.85	42.05	49.90
77N	17W	....	.32	....	.32	....	.72	....	.72	....	1.04	....	1.04
76N	17W	.85	.32	....	1.17	3.97	.12	....	4.09	4.82	.44	....	5.26
75N	17W	2.55	5.55	18.62	26.72	3.96	5.07	.45	9.48	6.51	10.62	19.07	36.20
74N	17W	.10	.47	73.18	73.75	.50	.37	53.19	54.06	.60	.84	126.37	127.81
Total.....		9.40	28.12	237.13	274.65	16.56	34.06	110.93	161.55	25.96	62.18	348.06	436.20

Bed approximately 60 feet below Munterville Limestone at Ottumwa (Lower Coal—Ford Coal?)

74N	15W	0.13	6.67	27.14	33.94	1.54	1.54	2.20	5.28	1.67	8.21	29.34	39.22
Total.....		0.13	6.67	27.14	33.94	1.54	1.54	2.20	5.28	1.67	8.21	29.34	39.22

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
MAHASKA COUNTY—Continued													
Lowest Coal—(Manbeck Coal?)													
75N	16W	0.08	3.98	4.93	8.99	1.36	5.25	0.55	7.16	1.44	9.23	5.48	16.15
74N	16W	....	....	.86	.86	....	.11	1.37	1.48	....	.11	2.23	2.34
75N	17W	.29	6.77	5.53	12.59	4.42	6.65	.08	11.15	4.71	13.42	5.61	23.74
Total.....		0.37	10.75	11.32	22.44	5.78	12.01	2.00	19.79	6.15	22.76	13.32	42.23
Laddsdale or Cliffland Coal													
76N	14W	....	....	4.21	4.21	....	....	2.12	2.12	....	....	6.33	6.33
Total.....		....	....	4.21	4.21	....	....	2.12	2.12	....	....	6.33	6.33
Total County Reserves													
76N	14W	0.23	0.37	4.42	5.02	....	....	2.12	2.12	0.23	0.37	6.54	7.14
75N	14W	.25	3.63	3.36	7.24	1.55	5.91	2.66	10.12	1.80	9.54	6.02	17.36
77N	15W	....	2.60	8.05	10.65	....	7.78	.38	8.16	....	10.38	8.43	18.81
76N	15W	.21	.46	1.05	1.72	.41	1.15	1.40	2.96	.62	1.61	2.45	4.68
75N	15W	1.58	2.40	31.21	35.19	.77	3.07	8.43	12.27	2.35	5.47	39.64	47.46
74N	15W	1.03	8.34	30.78	40.15	1.54	1.54	2.20	5.28	2.57	9.88	32.98	45.43
77N	16W	.44	2.39	1.38	4.21	2.81	1.70	4.15	8.66	3.25	4.09	5.53	12.87
76N	16W	.60	1.87	....	2.47	2.59	3.14	.38	6.11	3.19	5.01	.38	8.58
75N	16W	1.77	6.73	79.88	88.38	1.36	5.75	19.87	26.98	3.13	12.48	99.75	115.36
74N	16W	....	3.32	22.34	25.66	....	4.64	21.94	26.58	....	7.96	44.28	52.24
77N	17W	....	.32	....	.32	....	.72	....	.72	....	1.04	....	1.04
76N	17W	.85	.32	....	1.17	3.97	.12	....	4.09	4.82	.44	....	5.26
75N	17W	2.84	12.32	24.15	39.31	8.38	11.72	.53	20.63	11.22	24.04	24.68	59.94
74N	17W	.10	.47	73.18	73.75	.50	.37	53.19	54.06	.60	.84	126.37	127.81
Total.....		9.90	45.54	279.80	335.24	23.88	47.61	117.25	188.74	33.78	93.15	397.05	523.98

MARION COUNTY

Wiley Coal

74N 20W	0.52	....	....	0.52	0.86	....	....	0.86	1.38	....	....	1.38
74N 21W	....	....	....	....	.41	....	....	.41	.41	....	....	.41
Total.....	0.52	....	....	0.52	1.27	....	....	1.27	1.79	....	....	1.79

Bed 20 to 50 feet above the Lower Coal—Ford Coal (No. 5 Coal of Lucas County)

76N 18W	....	....	....	....	0.52	....	....	0.52	0.52	....	....	0.52
74N 18W	0.24	0.56	....	0.80	.18	1.07	....	1.25	.42	1.63	....	2.05
74N 19W	.30	.87	0.59	1.76	.23	.90	....	1.13	.53	1.77	0.59	2.89
74N 20W	.08	.68	.18	.94	.46	.87	0.14	1.47	.54	1.55	.32	2.41
74N 21W	.60	....	....	.60	.49	....	....	.49	1.09	....	....	1.09
Total.....	1.22	2.11	0.77	4.10	1.88	2.84	0.14	4.86	3.10	4.95	0.91	8.96

Lower Coal—Ford Coal

76N 18W	1.31	2.28	4.57	8.16	0.26	0.20	....	0.46	1.57	2.48	4.57	8.62
75N 18W	4.66	11.23	30.55	46.44	2.65	2.32	4.32	9.29	7.31	13.55	34.87	55.73
74N 18W	2.05	5.43	123.13	130.61	1.31	1.25	17.70	20.26	3.36	6.68	140.83	150.87
77N 19W	4.97	4.58	7.85	17.40	.73	.54	.31	1.58	5.70	5.12	8.16	18.98
76N 19W	2.53	8.41	23.42	34.36	1.98	2.45	5.03	9.46	4.51	10.86	28.45	43.82
75N 19W	9.04	21.49	41.91	72.44	3.26	2.07	.83	6.16	12.30	23.56	42.74	78.60
74N 19W	....	.53	18.05	18.58	9.40	21.07	11.23	41.70	9.40	21.60	29.28	60.28
77N 20W	....	....	1.84	1.84	....	1.70	.65	2.35	....	1.70	2.49	4.19
76N 20W	3.92	....	....	3.92	4.74	....	....	4.74	8.66	....	....	8.66
75N 20W	3.45	3.59	1.15	8.19	5.15	1.55	....	6.70	8.60	5.14	1.15	14.89
74N 20W	3.90	1.22	2.73	7.85	4.62	6.41	2.62	13.65	8.52	7.63	5.35	21.50
77N 21W	2.97	7.13	.71	10.81	5.96	4.36	....	10.32	8.93	11.49	.71	21.13
75N 21W	1.44	14.73	.50	16.67	6.88	8.47	....	15.35	8.32	23.20	.50	32.02
74N 21W	.90	22.65	2.49	26.04	2.03	30.99	.70	33.72	2.93	53.64	3.19	59.76
Total.....	41.14	103.27	258.90	403.31	48.97	83.38	43.39	175.74	90.11	186.65	302.29	579.05

Bed 16 to 25 feet below the Lower Coal—Ford Coal

76N 19W	0.22	0.51	....	0.73	0.85	0.15	....	1.00	1.07	0.66	....	1.73
77N 21W	....	6.70	....	6.70	.40	1.65	....	2.05	.40	8.35	....	8.75
Total.....	0.22	7.21	....	7.43	1.25	1.80	....	3.05	1.47	9.01	....	10.48

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
MARION COUNTY—Continued													
Bed 40 to 50 feet below the Lower Coal—Ford Coal (Manbeck Coal?)													
77N	20W	1.17	4.66	8.14	13.97	3.17	2.26	1.59	7.02	4.34	6.92	9.73	20.99
76N	20W	.37	.91	.07	1.35	.85	....	....	.85	1.22	.91	.07	2.20
77N	21W	....	.15	7.83	7.98	....	.74	3.98	4.72	....	.89	11.81	12.70
Total.....		1.54	5.72	16.04	23.30	4.02	3.00	5.57	12.59	5.56	8.72	21.61	35.89
Uncorrelated Lower Cherokee Beds													
77N	18W	0.08	0.45	1.42	1.95	0.27	0.42	0.88	1.57	0.35	0.87	2.30	3.52
76N	18W	....	.88	1.02	1.90	.48	.89	.08	1.45	.48	1.77	1.10	3.35
77N	19W	.25	.18	.37	.80	.21	.98	.13	1.32	.46	1.16	.50	2.12
Total.....		0.33	1.51	2.81	4.65	0.96	2.29	1.09	4.34	1.29	3.80	3.90	8.99
Total County Reserves													
77N	18W	0.08	0.45	1.42	1.95	0.27	0.42	0.88	1.57	0.35	0.87	2.30	3.52
76N	18W	1.31	3.16	5.59	10.06	1.26	1.09	.08	2.43	2.57	4.25	5.67	12.49
75N	18W	4.66	11.23	30.55	46.44	2.05	2.32	4.32	9.29	7.31	13.55	34.87	55.73
74N	18W	2.29	5.99	123.13	131.41	1.49	2.32	17.70	21.51	3.78	8.31	140.83	152.92
77N	19W	5.22	4.76	8.22	18.20	.94	1.52	.44	2.90	6.16	6.28	8.66	21.10
76N	19W	2.75	8.92	23.42	35.09	2.83	2.60	5.03	10.46	5.58	11.52	28.45	45.55
75N	19W	9.04	21.49	41.91	72.44	3.26	2.07	.83	6.16	12.30	23.56	42.74	78.60
74N	19W	.30	1.40	18.64	20.34	9.03	21.97	11.23	42.83	9.93	23.37	29.87	63.17
77N	20W	1.17	4.66	9.98	15.81	3.17	3.96	2.24	9.37	4.34	8.62	12.22	25.18
76N	20W	4.29	.91	.07	5.27	5.59	....	....	5.59	9.88	.91	.07	10.86
75N	20W	3.45	3.59	1.15	8.19	5.15	1.55	....	6.70	8.60	5.14	1.15	14.89
74N	20W	4.50	1.90	2.91	9.31	5.94	7.28	2.76	15.98	10.44	9.18	5.67	25.29
77N	21W	2.97	13.98	8.54	25.49	6.36	6.75	3.98	17.09	9.33	20.73	12.52	42.58
75N	21W	1.44	14.73	.50	16.67	6.88	8.47	....	15.35	8.32	23.20	.50	32.02
74N	21W	1.50	22.65	2.49	26.64	2.93	30.99	.70	34.62	4.43	53.64	3.19	61.26
Total.....		44.97	119.82	278.52	443.31	58.35	93.31	50.19	201.85	103.32	213.13	328.71	645.16

MARSHALL COUNTY

Hastie Coal (?)

84N 20W	.03	.16	....	0.19	.28	.24	....	.52	.31	.40	....	.71
83N 20W	.49	.67	0.34	1.50	1.39	.32	.17	1.88	1.88	.99	0.51	3.38
Total.....	0.52	0.83	0.34	1.69	1.67	0.56	0.17	2.40	2.19	1.39	0.51	4.09

Uncorrelated Bed 15 feet below the Hastie Coal (?)

83N 20W	....	.69	....	.69	....	2.07	....	2.07	....	2.76	....	2.76
Total.....	....	0.69	....	0.69	....	2.07	....	2.07	....	2.76	....	2.76

Uncorrelated Lower Cherokee Beds

85N 17W	....	....	....	....	....	....	5.53	5.53	....	....	5.53	5.53
85N 19W	0.46	1.14	....	1.60	1.38	2.91	....	4.29	1.84	4.05	....	5.89
84N 19W	....	.17	....	.17	....	.62	....	.62	....	.79	....	.79
Total.....	0.46	1.31	....	1.77	1.38	3.53	5.53	10.44	1.84	4.84	5.53	12.21

Total County Reserves

85N 17W	....	....	....	....	....	....	5.53	5.53	....	....	5.53	5.53
85N 19W	0.46	1.14	....	1.60	1.38	2.91	....	4.29	1.84	4.05	....	5.89
84N 19W	....	.17	....	.17	....	.62	....	.62	....	.79	....	.79
84N 20W	.03	.16	....	.19	.28	.24	....	.52	.31	.40	....	.71
83N 20W	.49	1.36	0.34	2.19	1.39	2.39	.17	3.95	1.88	3.75	.51	6.14
Total.....	0.98	2.83	0.34	4.15	3.05	6.16	5.70	14.91	4.03	8.99	6.04	19.06

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
MONROE COUNTY													
Mystic Coal													
71N	17W	0.09	....	....	0.09	0.86	....	....	0.86	0.95	....	....	0.95
71N	19W	....	....	....	....	.25	....	....	.25	.25	....	....	.25
Total.....		0.09	....	....	0.09	1.11	....	....	1.11	1.20	....	....	1.20
Bevier—Wheeler Beds													
71N	16W	0.43	....	....	0.43	0.98	....	....	0.98	1.41	....	....	1.41
72N	17W	1.19	....	....	1.19	4.25	....	....	4.25	5.44	....	....	5.44
71N	17W	.95	....	....	.95	1.71	....	....	1.71	2.66	....	....	2.66
73N	19W	.09	....	....	.09	.14	....	....	.14	.23	....	....	.23
Total.....		2.66	....	....	2.66	7.08	....	....	7.08	9.74	....	....	9.74
Whitebreast Coal													
71N	16W	1.92	....	....	1.92	3.44	....	....	3.44	5.36	....	....	5.36
72N	17W	3.52	....	....	3.52	4.56	....	....	4.56	8.08	....	....	8.08
71N	17W	5.36	0.69	....	6.05	9.95	....	....	9.95	15.31	0.69	....	16.00
72N	18W	.04	....	....	.04	1.02	....	....	1.02	1.06	....	....	1.06
71N	18W	.21	....	....	.21	1.20	....	....	1.20	1.41	....	....	1.41
Total.....		11.05	0.69	....	11.74	20.17	....	....	20.17	31.22	0.69	....	31.91
No. 5 Coal of Lucas County													
73N	19W	0.15	4.58	....	4.73	0.62	3.44	....	4.06	0.77	8.02	....	8.79
Total.....		0.15	4.58	....	4.73	0.62	3.44	....	4.06	0.77	8.02	....	8.79

Lower Coal—Ford Coal

73N	16W	....	13.20	52.24	65.44	....	9.32	17.14	26.46	....	22.52	69.38	91.90
72N	16W	....	29.70	26.19	55.89	4.53	26.46	.78	31.77	4.53	56.16	26.97	87.66
71N	16W	....	....	....	....	....	.31	3.05	3.36	....	.31	3.05	3.36
73N	17W	1.10	16.39	73.63	91.12	2.93	11.88	33.54	48.35	4.03	28.27	107.17	139.47
72N	17W	4.64	22.59	24.55	51.78	9.46	19.88	7.07	36.41	14.10	42.47	31.62	88.19
71N	17W	.66	6.44	56.44	63.54	.20	9.22	17.97	27.39	.86	15.66	74.41	90.93
73N	18W	1.31	3.91	63.54	68.76	3.20	18.74	50.94	72.88	4.51	22.65	114.48	141.64
72N	18W	.18	8.88	61.60	70.66	4.69	8.89	7.98	21.56	4.87	17.77	69.58	92.22
73N	19W	....	....	11.33	11.33	....	....	22.31	22.31	....	....	33.64	33.64
72N	19W	....	.24	38.80	39.04	....	2.56	14.56	17.12	....	2.80	53.36	56.16
Total.....		7.89	101.35	408.32	517.56	25.01	107.26	175.34	307.61	32.90	208.61	583.66	825.17

Lowest Outcropping Coal (Manbeck?)

73N	16W	....	3.73	....	3.73	....	4.29	....	4.29	....	8.02	....	8.02
Total.....		....	3.73	....	3.73	....	4.29	....	4.29	....	8.02	....	8.02

Total County Reserves

73N	16W	....	16.93	52.24	69.17	....	13.61	17.14	30.75	....	30.54	69.38	99.92
72N	16W	....	29.70	26.19	55.89	4.53	26.46	.78	31.77	4.53	56.16	26.97	87.66
71N	16W	2.35	....	....	2.35	4.42	.31	3.05	7.78	6.77	.31	3.05	10.13
73N	17W	1.10	16.39	73.63	91.12	2.93	11.88	33.54	48.35	4.03	28.27	107.17	139.47
72N	17W	9.35	22.59	24.55	56.49	18.27	19.88	7.07	45.22	27.62	42.47	31.62	101.71
71N	17W	7.06	7.13	56.44	70.63	12.72	9.22	17.97	39.91	19.78	16.35	74.41	110.54
73N	18W	1.31	3.91	63.54	68.76	3.20	18.74	50.94	72.88	4.51	22.65	114.48	141.64
72N	18W	.22	8.88	61.60	70.70	5.71	8.89	7.98	22.58	5.93	17.77	69.58	93.28
71N	18W	.21	....	....	.21	1.20	....	....	1.20	1.41	....	....	1.41
73N	19W	.24	4.58	11.33	16.15	.76	3.44	22.31	26.51	1.00	8.02	33.64	42.66
72N	19W	....	.24	38.80	39.04	....	2.56	14.56	17.12	....	2.80	53.36	56.16
71N	19W	....	....	....	....	.25	....	....	.25	.25	....	....	.25
Total.....		21.84	110.35	408.32	540.51	53.99	114.99	175.34	344.32	75.83	225.34	583.66	884.83

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
MONTGOMERY COUNTY													
Nodaway Coal													
73N	36W	0.78	....	....	0.78	3.40	....	....	3.40	4.18	....	....	4.18
72N	36W	....	....	....	....	1.27	....	....	1.27	1.27	....	....	1.27
71N	36W	....	....	....	....	13.38	....	....	13.38	13.38	....	....	13.38
71N	38W	....	....	....	....	2.16	....	....	2.16	2.16	....	....	2.16
Total.....		0.78	....	....	0.78	20.21	....	....	20.21	20.99	....	....	20.99
MUSCATINE COUNTY													
Rock Island No. 1 Coal (Laddsdale?)													
77N	1E	0.15	....	....	0.15	1.71	....	....	1.71	1.86	....	....	1.86
77N	1W	.41	0.07	....	.48	.67	....	....	.67	1.08	0.07	....	1.15
77N	2W	.40	....	....	.40	.57	....	....	.57	.97	....	....	.97
Total.....		0.96	0.07	....	1.03	2.95	....	....	2.95	3.91	0.07	....	3.98
PAGE COUNTY													
Nodaway Coal													
70N	36W	....	....	....	....	9.15	....	....	9.15	9.15	....	....	9.15
69N	36W	2.76	....	....	2.76	8.50	....	....	8.50	11.26	....	....	11.26
68N	36W	3.11	....	....	3.11	9.99	....	....	9.99	13.10	....	....	13.10
67N	36W	....	....	....	....	.76	....	....	.76	.76	....	....	.76
70N	37W	....	....	....	....	.79	....	....	.79	.79	....	....	.79
69N	37W	6.63	....	....	6.63	14.34	....	....	14.34	20.97	....	....	20.97
68N	37W	7.20	....	....	7.20	19.55	....	....	19.55	26.75	....	....	26.75
67N	37W	1.90	....	....	1.90	16.87	....	....	16.87	18.77	....	....	18.77
70N	38W	....	....	....	....	.79	....	....	.79	.79	....	....	.79
69N	38W	3.34	....	....	3.34	3.68	....	....	3.68	7.02	....	....	7.02
68N	38W	....	....	....	....	4.85	....	....	4.85	4.85	....	....	4.85
67N	38W	1.04	....	....	1.04	1.87	....	....	1.87	2.91	....	....	2.91
Total.....		25.98	....	....	25.98	91.14	....	....	91.14	117.12	....	....	117.12

POLK COUNTY

Wheeler(?) Coal

78N 25W	0.46	....	....	0.46	0.94	....	....	0.94	1.40	....	....	1.40
Total.....	0.46	....	....	0.46	0.94	....	....	0.94	1.40	....	....	1.40

Munterville(?) Coal

79N 22W	....	1.14	4.01	5.15	1.51	1.40	....	2.91	1.51	2.54	4.01	8.06
78N 22W	0.76	1.92	1.83	4.51	1.27	2.10	2.17	5.54	2.03	4.02	4.00	10.05
78N 25W	....	....	1.15	1.15	....	....	2.36	2.36	....	....	3.51	3.51
Total.....	0.76	3.06	6.99	10.81	2.78	3.50	4.53	10.81	3.54	6.56	11.52	21.62

Bed approximately 20 feet above Ford Coal (No. 5 of Lucas County?)

78N 25W	....	1.38	0.92	2.30	....	4.60	1.89	6.49	....	5.98	2.81	8.79
Total.....	....	1.38	0.92	2.30	....	4.60	1.89	6.49	....	5.98	2.81	8.79

Bed approximately 30 feet below the top of the Lower Cherokee (No. 5 Coal of Lucas County?)

80N 24W	0.59	2.65	13.19	16.43	1.80	2.55	3.19	7.54	2.39	5.20	16.38	23.97
80N 25W	.10	.21	....	.31	.48	.20	....	.68	.58	.41	....	.99
Total.....	0.69	2.86	13.19	16.74	2.28	2.75	3.19	8.22	2.97	5.61	16.38	24.96

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
POLK COUNTY—Continued													
Lower Coal—Ford Coal													
80N	22W	....	....	....	....	0.38	....	....	0.38	0.38	....	....	0.38
79N	22W	0.16	0.79	0.20	1.15	1.94	0.48	....	2.42	2.10	1.27	0.20	3.57
78N	22W	.13	5.05	5.88	11.06	6.98	.56	0.21	7.75	7.11	5.01	0.09	18.81
80N	23W	....	.27	.60	.87	.75	.70	....	1.45	.75	.97	.60	2.32
79N	23W	.31	.87	.81	1.99	.93	1.27	1.07	3.27	1.24	2.14	1.88	5.26
78N	23W	.02	3.75	10.70	14.47	.76	3.28	2.39	6.43	.78	7.03	13.09	20.90
80N	24W	....	....	.58	.58	....	....	.58	.58	....	....	1.16	1.16
79N	24W	1.78	1.09	.25	3.12	1.31	.20	....	1.51	3.09	1.29	.25	4.63
78N	24W	3.01	2.42	1.50	6.93	2.89	1.90	.08	4.87	5.90	4.32	1.58	11.80
80N	25W	....	.60	....	.60	....	1.80	....	1.80	....	2.40	....	2.40
79N	25W	.28	.73	.98	1.99	1.54	2.30	....	3.84	1.82	3.03	.98	5.83
78N	25W	1.17	1.37	1.44	3.98	1.47	4.40	2.36	8.23	2.64	5.77	3.80	12.21
Total.....		6.86	16.94	22.94	46.74	18.95	16.89	6.69	42.53	25.81	33.83	29.63	89.27
Manbeck Coal													
80N	22W	0.09	....	....	0.09	0.19	....	....	0.19	0.28	....	....	0.28
80N	23W	1.88	4.96	15.67	22.51	2.57	4.84	8.49	15.90	4.45	9.80	24.16	38.41
79N	23W	.10	.04	.81	.95	.42	....	1.19	1.61	.52	.04	2.00	2.56
78N	23W	.38	2.17	8.24	10.79	.74	1.87	5.96	8.57	1.12	4.04	14.20	19.36
80N	24W	.40	.52	1.38	2.30	1.02	1.20	1.25	3.47	1.42	1.72	2.63	5.77
79N	24W	.59	1.28	1.03	2.90	2.59	.43	1.02	4.04	3.18	1.71	2.05	6.94
78N	24W	3.70	3.00	3.72	10.42	1.87	1.01	.34	3.22	5.57	4.01	4.06	13.64
80N	25W	.36	.04	.04	.44	.58	.26	.04	.88	.94	.30	.08	1.32
79N	25W	.81	.94	.25	2.00	.66	.03	....	.69	1.47	.97	.25	2.69
78N	25W	3.44	4.08	2.23	9.75	2.14	1.23	....	3.37	5.58	5.31	2.23	13.12
Total.....		11.75	17.03	33.37	62.15	12.78	10.87	18.29	41.94	24.53	27.90	51.66	104.09

Hastie Plus Coal

81N	23W	....	....	1.61	1.61	....	....	4.84	4.84	....	....	6.45	6.45
80N	23W	0.63	0.21	....	.84	0.28	....	....	.28	0.91	0.21	....	1.12
79N	23W	4.03	7.17	8.40	19.60	3.92	2.99	.16	7.07	7.95	10.16	8.56	26.67
78N	23W	.71	1.08	.37	2.16	.89	.14	....	1.03	1.60	1.22	.37	3.19
80N	24W	.15	....	....	.15	.10	....	....	.10	.25	....	....	.25
79N	24W	2.67	4.24	10.03	16.94	3.83	2.22	.08	6.13	6.50	6.46	10.11	23.07
78N	24W	2.48	7.31	10.92	20.71	1.42	1.27	1.19	3.88	3.90	8.58	12.11	24.59
79N	25W	.33	2.98	3.26	6.57	1.72	1.73	3.26	6.71	2.05	4.71	6.52	13.28
78N	25W	2.03	4.26	7.30	13.59	1.53	2.13	1.86	5.52	3.56	6.39	9.16	19.11
Total.....		13.03	27.25	41.89	82.17	13.69	10.48	11.39	35.56	26.72	37.73	53.28	117.73

Lower Bed at Boone (Hastie Plus Coal?)

81N	25W	2.88	2.45	0.42	5.75	....	....	....	....	2.88	2.45	0.42	5.75
Total.....		2.88	2.45	0.42	5.75	....	....	....	....	2.88	2.45	0.42	5.75

Bed above the Hastie Coal (Hastie Plus Coal?)

81N	24W	3.26	4.26	5.65	13.17	0.47	1.31	0.47	2.25	3.73	5.57	6.12	15.42
81N	25W	1.47	5.36	.09	6.92	1.64	.84	....	2.48	3.11	6.20	.09	9.40
80N	25W	.31	2.37	....	2.68	.50	.33	....	.83	.81	2.70	....	3.51
Total.....		5.04	11.99	5.74	22.77	2.61	2.48	0.47	5.56	7.65	14.47	6.21	28.33

Hastie Coal

79N	22W	1.10	2.60	3.77	7.47	0.85	0.68	....	1.53	1.95	3.28	3.77	9.00
78N	22W	.60	1.20	1.16	2.96	....	....	....	....	.60	1.20	1.16	2.96
80N	23W	1.26	3.11	4.70	9.07	.33	.45	....	.78	1.59	3.56	4.70	9.85
79N	23W	4.86	19.87	35.69	60.42	2.44	3.59	2.10	8.13	7.30	23.46	37.79	68.55
78N	23W	4.79	8.91	30.53	44.23	.19	.64	.12	.95	4.98	9.55	30.65	45.18
80N	24W	1.54	7.22	12.07	20.83	1.04	.99	....	2.03	2.58	8.21	12.07	22.86
79N	24W	9.38	22.02	38.01	69.41	.97	....	....	.97	10.35	22.02	38.01	70.38
78N	24W	4.10	7.71	30.41	42.22	2.56	2.10	.36	5.02	6.66	9.81	30.77	47.24
80N	25W	.04	.21	.42	.67	.35	.49	....	.84	.39	.70	.42	1.51
79N	25W	4.13	8.93	6.86	19.92	.33	.35	....	.68	4.46	9.28	6.86	20.60
78N	25W	3.16	7.13	19.45	29.74	1.54	.27	....	1.81	4.70	7.40	19.45	31.55
Total.....		34.96	88.91	183.07	306.94	10.60	9.56	2.58	22.74	45.56	98.47	185.65	329.68

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
POLK COUNTY—Continued													
Lowest Bed Mined at Madrid (Hastie Coal?)													
81N	25W	4.00	5.24	4.37	13.61	0.17	....	....	0.17	4.17	5.24	4.37	13.78
Total.....		4.00	5.24	4.37	13.61	0.17	....	....	0.17	4.17	5.24	4.37	13.78
Bed Near Hastie Coal (Hastie Coal?)													
81N	24W	....	0.15	0.77	0.92	0.67	0.51	0.97	2.15	0.67	0.66	1.74	3.07
Total.....		....	0.15	0.77	0.92	0.67	0.51	0.97	2.15	0.67	0.66	1.74	3.07
Bed Below Hastie Coal													
81N	24W	0.73	....	....	0.73	0.17	....	....	0.17	0.90	....	....	0.90
81N	25W	.09	....	....	.09	.40	....	....	.40	.49	....	....	.49
Total.....		0.82	....	....	0.82	0.57	....	....	0.57	1.39	....	....	1.39
Total County Reserves													
80N	22W	0.09	....	....	0.09	0.57	....	....	0.57	0.66	....	....	0.66
79N	22W	1.26	4.53	7.98	13.77	4.30	2.56	....	6.86	5.56	7.09	7.98	20.63
78N	22W	1.49	8.17	8.87	18.53	8.25	2.66	2.38	13.29	9.74	10.83	11.25	31.82
81N	23W	....	....	1.61	1.61	....	....	4.84	4.84	....	....	6.45	6.45
80N	23W	3.77	8.55	20.97	33.29	3.93	5.09	8.49	18.41	7.70	14.54	29.46	51.70
79N	23W	9.30	27.95	45.71	82.96	7.71	7.85	4.52	20.08	17.01	35.80	50.23	103.04
78N	23W	5.90	15.91	49.84	71.65	2.58	5.93	8.47	16.98	8.48	21.84	58.31	88.63
81N	24W	3.99	4.41	6.42	14.82	1.31	1.82	1.44	4.57	5.30	6.23	7.86	19.39
80N	24W	2.68	10.39	27.22	40.29	3.96	4.74	5.02	13.72	6.64	15.13	32.24	54.01
79N	24W	14.42	28.63	49.32	92.37	8.70	2.85	1.10	12.65	23.12	31.48	50.42	105.02

78N	24W	13.29	20.44	46.55	80.28	8.74	6.28	1.97	16.99	22.03	26.72	48.52	97.27
81N	25W	8.44	13.05	4.88	26.37	2.21	.84	....	3.05	10.65	13.89	4.88	29.42
80N	25W	.81	3.43	.46	4.70	1.91	3.08	.04	5.03	2.72	6.51	.50	9.73
79N	25W	5.55	13.58	11.35	30.48	4.25	4.41	3.26	11.92	9.80	17.99	14.61	42.40
78N	25W	10.26	18.22	32.49	60.97	7.62	12.63	8.47	28.72	17.88	30.85	40.96	89.69
Total.....		81.25	177.26	313.67	572.18	66.04	61.04	50.00	177.08	147.29	238.90	363.67	749.86

POWESHIEK COUNTY

Lower Coal—Ford Coal

78N	15W	0.21	....	....	0.21	0.23	....	....	0.23	0.44	....	....	0.44
76N	16W	.04	....	....	.04	.24	....	....	.24	.28	....	....	.28
Total.....		0.25	....	....	0.25	0.47	....	....	0.47	0.72	....	....	0.72

SCOTT COUNTY

Rock Island No. 1 Coal (Laddsdale?)

77N	2E	0.64	1.68	0.57	2.89	2.91	0.99	....	3.90	3.55	2.67	0.57	6.79
Total.....		0.64	1.68	0.57	2.89	2.91	0.99	....	3.90	3.55	2.67	0.57	6.79

STORY COUNTY

Munterville Coal

83N	22W	....	....	0.50	0.50	0.02	0.52	0.81	1.35	0.02	0.52	1.31	1.85
84N	23W	....	....	1.15	1.15	....	....	3.46	3.46	....	....	4.61	4.61
83N	23W	....	0.04	1.29	1.33	.41	.97	1.88	3.26	.41	1.01	3.17	4.59
Total.....		....	0.04	2.94	2.98	0.43	1.49	6.15	8.07	0.43	1.53	9.09	11.05

Upper Bed at Boone (Manbeck Coal?)

85N	24W	....	....	4.22	4.22	....	....	11.06	11.06	....	....	15.28	15.28
84N	24W	....	0.24	.09	.33	0.46	0.55	.42	1.43	0.46	0.79	.51	1.76
Total.....		....	0.24	4.31	4.55	0.46	0.55	11.48	12.49	0.46	0.79	15.79	17.04

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
STORY COUNTY—Continued													
Lower Bed at Boone (Hastie Plus Coal?)													
84N	24W	0.32	....	....	0.32	0.62	0.66	....	1.28	0.94	0.66	....	1.60
Total.....		0.32	....	....	0.32	0.62	0.66	....	1.28	0.94	0.66	....	1.60
Hastie Plus Coal (?)													
82N	22W	0.24	....	....	0.24	0.38	....	....	0.38	0.62	....	....	0.62
82N	23W	....	....	1.15	1.15	....	....	3.46	3.46	....	....	4.61	4.61
83N	24W	.02	0.18	....	.20	.42	0.03	....	.45	.44	0.21	....	.65
Total.....		0.26	0.18	1.15	1.59	0.80	0.03	3.46	4.29	1.06	0.21	4.61	5.88
Hastie Coal (?)													
84N	23W	0.46	....	....	0.46	1.11	....	....	1.11	1.57	....	....	1.57
83N	23W	.23	1.14	3.32	4.69	.46	1.99	6.41	8.86	.69	3.13	9.73	13.55
82N	23W	....	.44	1.48	1.92	.69	.22	3.75	4.66	.69	.66	5.23	6.58
83N	24W	.02	.14	1.27	1.43	.22	1.22	.30	1.74	.24	1.36	1.57	3.17
Total.....		0.71	1.72	6.07	8.50	2.48	3.43	10.46	16.37	3.19	5.15	16.53	24.87
Uncorrelated Beds (Lower Cherokee)													
84N	21W	....	0.03	2.14	2.17	....	1.05	3.72	4.77	....	1.08	5.86	6.94
83N	21W	0.97	.24	.39	1.60	2.35	1.31	1.50	5.16	3.32	1.55	1.89	6.76
82N	21W	....	1.63	2.77	4.40	.14	5.15	4.69	9.98	.14	6.78	7.46	14.38
84N	22W	....	....	1.32	1.32	....	....	4.35	4.35	....	....	5.67	5.67
83N	22W	.54	.55	4.67	5.76	1.59	1.75	3.23	6.57	2.13	2.30	7.90	12.33
82N	22W	.69	1.12	.60	2.41	1.40	2.93	.48	4.81	2.09	4.05	1.08	7.22
84N	23W	....	....	....	....	....	.07	.17	.24	....	.07	.17	.24
83N	23W	.37	.07	1.79	2.23	.80	1.93	1.57	4.30	1.17	2.00	3.36	6.53
Total.....		2.57	3.04	13.68	19.89	6.28	14.19	19.71	40.18	8.85	17.83	33.39	60.07

Total County Reserves

84N	21W	....	0.03	2.14	2.17	....	1.05	3.72	4.77	....	1.08	5.86	6.94
83N	21W	0.97	.24	.39	1.60	2.35	1.31	1.50	5.16	3.32	1.55	1.89	6.76
82N	21W	....	1.63	2.77	4.40	.14	5.15	4.69	9.98	.14	6.78	7.46	14.38
84N	22W	....	....	1.32	1.32	....	....	4.35	4.35	....	....	5.67	5.67
83N	22W	.54	.55	5.17	6.26	1.61	2.27	4.04	7.92	2.15	2.82	9.21	14.18
82N	22W	.93	1.12	.60	2.65	1.78	2.93	.48	5.19	2.71	4.05	1.08	7.84
84N	23W	.46	....	1.15	1.61	1.11	.07	3.63	4.81	1.57	.07	4.78	6.42
83N	23W	.60	1.25	6.40	8.25	1.67	4.89	9.86	16.42	2.27	0.14	16.26	24.67
82N	23W	....	.44	2.63	3.07	.69	.22	7.21	8.12	.69	.66	9.84	11.19
85N	24W	....	....	4.22	4.22	....	....	11.06	11.06	....	....	15.28	15.28
84N	24W	.32	.24	.09	.65	1.08	1.21	.42	2.71	1.40	1.45	.51	3.36
83N	24W	.04	.32	1.27	1.63	.64	1.25	.30	2.19	.68	1.57	1.57	3.82
Total.....		3.86	5.82	28.15	37.83	11.07	20.35	51.26	82.68	14.93	26.17	79.41	120.51

TAYLOR COUNTY

Nodaway Coal

70N	35W	3.67	....	....	3.67	12.43	....	....	12.43	16.10	....	....	16.10
69N	35W	5.47	....	....	5.47	22.26	....	....	22.26	27.73	....	....	27.73
68N	35W	1.49	....	....	1.49	6.95	....	....	6.95	8.44	....	....	8.44
Total.....		10.63	....	....	10.63	41.64	....	....	41.64	52.27	....	....	52.27

VAN BUREN COUNTY

Bed approximately 50 feet below Munterville Limestone at Ottumwa (No. 5 of Lucas County?)

69N	10W	0.18	....	....	0.18	0.27	....	....	0.27	0.45	....	....	0.45
70N	11W	....	0.42	....	.42	....	1.11	....	1.11	....	1.53	....	1.53
Total.....		0.18	0.42	....	0.60	0.27	1.11	....	1.38	0.45	1.53	....	1.98

Bed approximately 60 feet below Munterville Limestone at Ottumwa (Lower Coal—Ford Coal?)

69N	9W	0.24	....	....	0.24	0.52	....	....	0.52	0.76	....	....	0.76
70N	11W	.20	0.81	0.64	1.65	.20	0.36	0.78	1.34	.40	1.17	1.42	2.99
Total.....		0.44	0.81	0.64	1.89	0.72	0.36	0.78	1.86	1.16	1.17	1.42	3.75

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
VAN BUREN COUNTY—Continued													
Laddsdale Coal													
70N	9W	0.62	0.30	....	0.92	....	1.83	....	1.83	0.62	2.13	....	2.75
69N	9W	....	1.59	....	1.59	1.45	....	....	1.45	1.45	1.59	....	3.04
68N	9W	.44	.86	....	1.30	1.57	2.42	....	3.99	2.01	3.28	....	5.29
70N	10W	.06	8.33	....	8.39	.02	19.41	....	19.43	.08	27.74	....	27.82
70N	11W	1.19	7.64	15.17	24.00	1.44	8.47	5.11	15.02	2.63	16.11	20.28	39.02
69N	11W	....	.52	....	.52	.14	2.07	....	2.21	.14	2.59	....	2.73
Total.....		2.31	19.24	15.17	36.72	4.62	34.20	5.11	43.93	6.93	53.44	20.28	80.65
Upper of Two Beds in SE Van Buren County (Laddsdale?)													
69N	8W	0.44	0.49	....	0.93	2.23	....	....	2.23	2.67	0.49	....	3.16
68N	8W	.30	.21	....	.51	1.67	0.31	....	1.98	1.97	.52	....	2.49
Total.....		0.74	0.70	....	1.44	3.90	0.31	....	4.21	4.64	1.01	....	5.65
Uncorrelated Beds—Lower Cherokee													
70N	8W	....	3.94	2.25	6.19	....	13.11	....	13.11	....	17.05	2.25	19.30
69N	8W	0.23	1.04	.82	2.09	1.48	2.17	0.60	4.25	1.71	3.21	1.42	6.34
68N	8W	.21	.48	1.86	2.55	.55	1.36	1.20	3.11	.76	1.84	3.06	5.66
67N	8W	.30	.25	1.11	1.66	.16	....	2.72	2.88	.46	.25	3.83	4.54
Total.....		0.74	5.71	6.04	12.49	2.19	16.64	4.52	23.35	2.93	22.35	10.56	35.84

Total County Reserves

70N	8W	....	3.94	2.25	6.19	....	13.11	....	13.11	....	17.05	2.25	19.30
69N	8W	0.67	1.53	.82	3.02	3.71	2.17	0.60	6.48	4.38	3.70	1.42	9.50
68N	8W	.51	.69	1.86	3.06	2.22	1.07	1.20	5.09	2.73	2.36	3.06	8.15
67N	8W	.30	.25	1.11	1.66	.16	....	2.72	2.88	.46	.25	3.83	4.54
70N	9W	.62	.30	....	.92	....	1.83	....	1.83	.62	2.13	....	2.75
69N	9W	.24	1.59	....	1.83	1.97	....	....	1.97	2.21	1.59	....	3.80
68N	9W	.44	.86	....	1.30	1.57	2.42	....	3.99	2.01	3.28	....	5.29
70N	10W	.06	8.33	....	8.39	.02	19.41	....	19.43	.08	27.74	....	27.82
69N	10W	.18	....	....	.18	.27	....	....	.27	.45	....	....	.45
70N	11W	1.39	8.87	15.81	26.07	1.64	9.94	5.89	17.47	3.03	18.81	21.70	43.54
69N	11W	....	.52	....	.52	.14	2.07	....	2.21	.14	2.59	....	2.73
Total.....		4.41	26.88	21.85	53.14	11.70	52.02	10.41	74.73	16.11	79.50	32.26	127.87

WAPELLO COUNTY

Whitebreast Coal

71N	14W	0.26	....	....	0.26	1.98	....	....	1.98	2.24	....	....	2.24
Total.....		0.26	....	....	0.26	1.98	....	....	1.98	2.24	....	....	2.24

Beds approximately 50 feet below Munterville Limestone at Ottumwa (No. 5 of Lucas County?)

73N	13W	0.20	0.81	....	1.01	0.62	1.36	....	1.98	0.82	2.17	....	2.99
72N	13W	2.35	1.77	0.25	4.37	3.43	2.20	1.48	7.20	5.78	4.06	1.73	11.57
73N	14W	.74	.86	27.68	29.28	.85	1.12	27.37	29.34	1.59	1.98	55.05	58.62
72N	14W	1.41	5.45	19.21	26.07	3.62	2.01	12.80	19.33	5.03	8.36	32.01	45.40
73N	15W	....	2.22	1.52	3.74	....	4.28	2.57	6.85	....	6.50	4.09	10.59
72N	15W	.48	12.73	12.30	25.51	4.51	27.81	12.38	44.70	4.99	40.54	24.68	70.21
71N	15W	....	....	....	....	....	1.82	....	1.82	....	1.82	....	1.82
Total.....		5.18	23.84	60.96	89.98	13.03	41.59	56.60	111.22	18.21	65.43	117.56	201.20

Beds approximately 60 feet below Munterville Limestone at Ottumwa (Lower Coal—Ford Coal?)

72N	13W	2.34	2.88	1.29	6.51	2.60	5.24	3.32	11.16	4.94	8.12	4.61	17.67
73N	14W	....	....	7.38	7.38	....	....	13.30	13.30	....	....	20.68	20.68
72N	14W	....	....	13.47	13.47	....	.38	10.31	10.69	....	.38	23.78	24.16
73N	15W	....	.63	5.38	6.01	.15	.48	2.53	3.16	.15	1.11	7.91	9.17
Total.....		2.34	3.51	27.52	33.37	2.75	6.10	29.46	38.31	5.09	9.61	56.98	71.68

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
WAPELLO COUNTY—Continued													
Laddsdale Coal													
71N	12W	2.78	6.61	3.78	13.17	3.48	5.63	1.11	10.22	6.26	12.24	4.89	23.39
72N	13W	.87	.84	....	1.71	1.73	.60	....	2.33	2.60	1.44	....	4.04
71N	13W	.44	1.12	.18	1.74	.94	3.30	.87	5.11	1.38	4.42	1.05	6.85
72N	14W	.66	.37	1.66	2.69	.09	.38	3.66	4.13	.75	.75	5.32	6.82
Total.....		4.75	8.94	5.62	19.31	6.24	9.91	5.64	21.79	10.99	18.85	11.26	41.10
Cliffland Coal													
71N	12W	1.27	5.14	....	6.41	3.05	6.36	....	9.41	4.32	11.50	....	15.82
72N	13W	.53	.89	0.66	2.08	.65	....	....	.65	1.18	.89	0.66	2.73
71N	13W	1.73	1.39	2.46	5.58	2.54	1.68	2.03	6.25	4.27	3.07	4.49	11.83
71N	14W	....	....	7.21	7.21	....	....	7.83	7.83	....	....	15.04	15.04
Total.....		3.53	7.42	10.33	21.28	6.24	8.04	9.86	24.14	9.77	15.46	20.19	45.42
Uncorrelated Bed—Lower Cherokee													
72N	12W	....	0.81	....	0.81	....	1.90	....	1.90	....	2.71	....	2.71
Total.....		....	0.81	....	0.81	....	1.90	....	1.90	....	2.71	....	2.71
Total County Reserves													
72N	12W	....	0.81	....	0.81	....	1.90	....	1.90	....	2.71	....	2.71
71N	12W	4.05	11.75	3.78	19.58	6.53	11.99	1.11	19.63	10.58	23.74	4.89	39.21
73N	13W	.20	.81	....	1.01	.62	1.36	....	1.98	.82	2.17	....	2.99
72N	13W	6.09	6.38	2.20	14.67	8.41	8.13	4.80	21.34	14.50	14.51	7.00	36.01
71N	13W	2.17	2.51	2.64	7.32	3.48	4.98	2.90	11.36	5.65	7.49	5.54	18.68
73N	14W	.74	.86	35.06	36.66	.85	1.12	40.67	42.64	1.59	1.98	75.73	79.30

72N	14W	2.07	5.82	34.34	42.23	3.71	3.67	26.77	34.15	5.78	9.49	61.11	76.38
71N	14W	.26	....	7.21	7.47	1.98	....	7.83	9.81	2.24	....	15.04	17.28
73N	15W	....	2.85	6.90	9.75	.15	4.76	5.10	10.01	.15	7.61	12.00	19.76
72N	15W	.48	12.73	12.30	25.51	4.51	27.81	12.38	44.70	4.99	40.54	24.68	70.21
71N	15W	....	....	....	....	....	1.82	....	1.82	....	1.82	....	1.82
Total.....		16.06	44.52	104.43	165.01	30.24	67.54	101.56	199.34	46.30	112.06	205.99	364.35

WARREN COUNTY

Mystic Coal

74N	23W	1.43	....	....	1.43	3.10	....	....	3.10	4.53	....	....	4.53
Total.....		1.43	....	....	1.43	3.10	....	....	3.10	4.53	....	....	4.53

Bevier Coal

76N	22W	0.78	....	....	0.78	2.26	....	....	2.26	3.04	....	....	3.04
75N	22W	2.49	....	....	2.49	3.72	....	....	3.72	6.21	....	....	6.21
77N	23W	1.19	....	....	1.19	1.30	....	....	1.30	2.49	....	....	2.49
76N	23W	1.21	....	....	1.21	2.08	....	....	2.08	3.29	....	....	3.29
75N	24W	1.78	....	....	1.78	1.71	....	....	1.71	3.49	....	....	3.49
Total.....		7.45	....	....	7.45	11.07	....	....	11.07	18.52	....	....	18.52

Wheeler Coal

76N	22W	3.03	....	....	3.03	7.08	....	....	7.08	10.11	....	....	10.11
75N	22W	1.16	....	....	1.16	2.38	....	....	2.38	3.54	....	....	3.54
74N	22W	.98	....	....	.98	3.60	....	....	3.60	4.58	....	....	4.58
75N	23W	2.09	....	....	2.09	3.77	....	....	3.77	5.86	....	....	5.86
74N	23W	.77	....	....	.77	1.49	....	....	1.49	2.26	....	....	2.26
77N	25W	.46	6.29	....	6.75	2.04	8.48	....	10.52	2.50	14.77	....	17.27
76N	25W	1.07	....	....	1.07	3.63	.55	....	4.18	4.70	.55	....	5.25
Total.....		9.56	6.29	....	15.85	23.99	9.03	....	33.02	33.55	15.32	....	48.87

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
WARREN COUNTY—Continued													
Whitebreast Coal													
77N	22W	....	....	....	....	0.41	....	....	0.41	0.41	....	....	0.41
76N	22W	4.57	....	....	4.57	10.49	....	....	10.49	15.06	....	....	15.06
75N	22W	2.11	....	....	2.11	2.14	....	....	2.14	4.25	....	....	4.25
75N	23W	4.32	....	....	4.32	6.58	....	....	6.58	10.90	....	....	10.90
74N	23W	2.56	....	....	2.56	5.96	....	....	5.96	8.52	....	....	8.52
Total.....		13.56	....	....	13.56	25.58	....	....	25.58	39.14	....	....	39.14
Wiley Coal													
75N	22W	2.79	0.98	....	3.77	6.80	....	....	6.80	9.59	0.98	....	10.57
74N	22W	3.20	....	....	3.20	4.71	....	....	4.71	7.91	....	....	7.91
Total.....		5.99	0.98	....	6.97	11.51	....	....	11.51	17.50	0.98	....	18.48
Munterville Coal													
77N	22W	1.70	....	....	1.70	2.21	0.35	....	2.56	3.91	0.35	....	4.26
76N	22W	.45	4.78	0.29	5.52	4.15	2.53	....	6.68	4.60	7.31	0.29	12.20
77N	23W	6.35	5.55	....	11.90	12.21	.26	....	12.47	18.56	5.81	....	24.37
76N	23W	....	....	....	....	.16	....	....	.16	.16	....	....	.16
77N	24W	.46	2.80	.38	3.64	3.09	3.66	....	6.75	3.55	6.46	.38	10.39
76N	24W	1.40	.87	....	2.27	4.68	.52	....	5.20	6.08	1.39	....	7.47
Total.....		10.36	14.00	0.67	25.03	26.50	7.32	....	33.82	36.86	21.32	0.67	58.85

Lower Coal—Ford Coal

77N	22W	2.37	17.49	....	19.86	3.51	38.18	....	41.69	5.88	55.67	....	61.55
76N	22W	.08	5.91	6.55	12.54	9.24	10.61	....	19.85	9.32	16.52	6.55	32.39
77N	23W	4.43	14.24	.83	19.50	36.42	12.93	....	49.35	40.85	27.17	.83	68.85
76N	23W	.81	.49	....	1.30	3.16	3.13	....	6.29	3.97	3.62	....	7.59
77N	24W	3.81	5.44	3.96	13.21	11.51	5.60	0.94	18.05	15.32	11.04	4.90	31.26
76N	24W	1.18	7.49	1.87	10.54	6.20	14.71	....	20.91	7.38	22.20	1.87	31.45
Total.....		12.68	51.06	13.21	76.95	70.04	85.16	0.94	156.14	82.72	136.22	14.15	233.09

Uncorrelated Beds Below the Lower Coal—Ford Coal

76N	22W	0.33	....	....	0.33	0.79	....	....	0.79	1.12	....	....	1.12
77N	24W	.32	0.17	1.15	1.64	.81	1.21	2.67	4.69	1.13	1.38	3.82	6.33
75N	24W	.76	....	....	.76	1.43	....	....	1.43	2.19	....	....	2.19
Total.....		1.41	0.17	1.15	2.73	3.03	1.21	2.67	6.91	4.44	1.38	3.82	9.64

Total County Reserves

77N	22W	4.07	17.49	....	21.56	6.13	38.53	....	44.66	10.20	56.02	....	66.22
76N	22W	9.24	10.69	6.84	26.77	34.01	13.14	....	47.15	43.25	23.83	6.84	73.92
75N	22W	8.55	.98	....	9.53	15.04	....	....	15.04	23.59	.98	....	24.57
74N	22W	4.18	....	....	4.18	8.31	....	....	8.31	12.49	....	....	12.49
77N	23W	11.97	19.79	.83	32.59	49.93	13.19	....	63.12	61.90	32.98	.83	95.71
76N	23W	2.02	.49	....	2.51	5.40	3.13	....	8.53	7.42	3.62	....	11.04
75N	23W	6.41	....	....	6.41	10.35	....	....	10.35	16.76	....	....	16.76
74N	23W	4.76	....	....	4.76	10.55	....	....	10.55	15.31	....	....	15.31
77N	24W	4.59	8.41	5.49	18.49	15.41	10.47	3.61	29.49	20.00	18.88	9.10	47.98
76N	24W	2.58	8.36	1.87	12.81	10.88	15.23	....	26.11	13.46	23.59	1.87	38.92
75N	24W	2.54	....	....	2.54	3.14	....	....	3.14	5.68	....	....	5.68
77N	25W	.46	6.29	....	6.75	2.04	8.48	....	10.52	2.50	14.77	....	17.27
76N	25W	1.07	....	....	1.07	3.63	.55	....	4.18	4.70	.55	....	5.25
Total.....		62.44	72.50	15.03	149.97	174.82	102.72	3.61	281.15	237.26	175.22	18.64	431.12

TABLE 17—ORIGINAL RESERVES (MILLIONS OF SHORT TONS) OF IOWA—Continued

Location		Measured and indicated				Inferred				Total by thickness categories			Total Original Reserves
Township	Range	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	Total	14-28 inches	28-42 inches	More than 42 inches	
WAYNE COUNTY													
Mystic Coal													
70N	20W	14.91	....	....	14.91	52.05	....	....	52.05	66.96	....	....	66.96
69N	20W	6.79	....	....	6.79	58.78	....	....	58.78	65.57	....	....	65.57
68N	20W	16.29	....	....	16.29	58.87	....	....	58.87	75.16	....	....	75.16
67N	20W	1.36	....	....	1.36	14.56	....	....	14.56	15.92	....	....	15.92
70N	21W	....	....	....	....	19.79	....	....	19.79	19.79	....	....	19.79
69N	21W	5.76	....	....	5.76	42.09	....	....	42.09	47.85	....	....	47.85
68N	21W	6.80	....	....	6.80	34.40	....	....	34.40	41.20	....	....	41.20
67N	21W	....	....	....	....	9.38	....	....	9.38	9.38	....	....	9.38
69N	22W	....	....	....	....	9.42	....	....	9.42	9.42	....	....	9.42
67N	22W	....	....	....	....	.32	....	....	.32	.32	....	....	.32
Total.....		51.91	....	....	51.91	299.66	....	....	299.66	351.57	....	....	351.57
WEBSTER COUNTY													
Tyson Coal (Uncorrelated—Lower Cherokee)													
87N	27W	0.92	....	....	0.92	1.74	....	....	1.74	2.66	....	....	2.66
86N	27W	.96	1.37	....	2.33	1.22	0.60	....	1.82	2.18	1.97	....	4.15
87N	28W	.34	....	....	.34	.72	....	....	.72	1.06	....	....	1.06
86N	28W	....	1.04	0.29	1.33	1.00	3.62	0.33	4.95	1.00	4.66	0.62	6.28
Total.....		2.22	2.41	0.29	4.92	4.68	4.22	0.33	9.23	6.90	6.63	0.62	14.15
Upper Bituminous Coal—Pretty Coal—Big Coal in SE Webster County (Uncorrelated—Lower Cherokee)													
87N	27W	1.47	0.76	....	2.23	3.14	....	....	3.14	4.61	0.76	....	5.37
86N	27W	1.96	2.39	0.54	4.89	1.62	3.76	1.87	7.25	3.58	6.15	2.41	12.14
89N	28W	....	....	....	....	.36	....	....	.36	.36	....	....	.36
88N	28W	4.35	6.64	9.03	20.02	7.93	4.97	2.29	15.19	12.28	11.61	11.32	35.21
87N	28W	2.25	2.70	.87	5.82	5.44	.47	.12	6.03	7.69	3.17	.99	11.85
86N	28W	....	.22	.64	.86	.11	1.25	.84	2.20	.11	1.47	1.48	3.06
Total.....		10.03	12.71	11.08	33.82	18.60	10.45	5.12	34.17	28.63	23.16	16.20	67.99

Colburn Coal—Cannel Coal—Big Coal (Uncorrelated—Lower Cherokee)

87N	27W	0.03	0.64	....	0.67	1.07	1.44	....	2.51	1.10	2.08	....	3.18
89N	28W	1.14	....	....	1.14	1.75	....	....	1.75	2.89	....	....	2.89
88N	28W	6.25	5.09	2.37	13.71	4.78	.70	....	5.48	11.03	5.79	2.37	19.19
87N	28W	.05	.42	....	.47	1.41	.21	....	1.62	1.46	.63	....	2.09
89N	29W	1.09	1.01	.08	2.18	1.90	....	....	1.90	2.99	1.01	.08	4.08
88N	29W	1.39	2.77	4.22	8.38	3.17	2.48	....	5.65	4.56	5.25	4.22	14.03
87N	29W	.41	.66	....	1.07	2.02	1.13	....	3.15	2.43	1.79	....	4.22
88N	30W	.03	.20	....	.23	.24	.12	....	.36	.27	.32	....	.59
Total.....		10.39	10.79	6.67	27.85	16.34	6.08	....	22.42	26.73	16.87	6.67	50.27

Uncorrelated Beds—Lower Cherokee

87N	29W	....	....	....	....	1.84	....	....	1.84	1.84	....	....	1.84
87N	30W	....	....	....	....	1.84	....	....	1.84	1.84	....	....	1.84
Total.....		....	....	....	....	3.68	....	....	3.68	3.68	....	....	3.68

Total County Reserves

87N	27W	2.42	1.40	....	3.82	5.95	1.44	....	7.39	8.37	2.84	....	11.21
86N	27W	2.92	3.76	0.54	7.22	2.84	4.36	1.87	9.07	5.76	8.12	2.41	16.29
89N	28W	1.14	....	....	1.14	2.11	....	....	2.11	3.25	....	....	3.25
88N	28W	10.60	11.73	11.40	33.73	12.71	5.67	2.29	20.67	23.31	17.40	13.69	54.40
87N	28W	2.64	3.12	.87	6.63	7.57	.68	.12	8.37	10.21	3.80	.99	15.00
86N	28W	....	1.26	.93	2.19	1.11	4.87	1.17	7.15	1.11	6.13	2.10	9.34
89N	29W	1.09	1.01	.08	2.18	1.90	....	....	1.90	2.99	1.01	.08	4.08
88N	29W	1.39	2.77	4.22	8.38	3.17	2.48	....	5.65	4.56	5.25	4.22	14.03
87N	29W	.41	.66	....	1.07	3.86	1.13	....	4.99	4.27	1.79	....	6.06
88N	30W	.03	.20	....	.23	.24	.12	....	.36	.27	.32	....	.59
87N	30W	....	....	....	....	1.84	....	....	1.84	1.84	....	....	1.84
Total.....		22.64	25.91	18.04	66.59	43.30	20.75	5.45	69.50	65.94	46.66	23.49	136.09

Grand Totals....	618.03	1,036.52	1,846.17	3,500.72	1,542.03	1,215.56	978.23	3,735.82	2,160.06	2,252.08	2,824.40	7,236.54

Table 3. Original coal reserves (millions of short tons) of Iowa, by coal beds and by county.

	Adair County	Adams County	Appanoose County	Boone County	Cass County	Clarke County	Dallas County	Davis County	Decatur County	Fremont County	Greene County	Guthrie County	Hamilton County	Hardin County	Henry County	Jasper County	Jefferson County	Keokuk County	Lee County	Lucas County	Mahaska County	Marion County	Marshall County	Monroe County	Montgomery County	Muscatine County	Page County	Polk County	Poweshiek County	Scott County	Story County	Taylor County	Van Buren County	Wapello County	Warren County	Wayne County	Webster County	Red Total
Wabaunsee Group																																					
Nodaway coal bed		121.31			3.16					11.33														20.99		117.12					52.27						326.18
Total		121.31			3.16					11.33														20.99		117.12					52.27						326.18
Marmaton Group																																					
Lonsdale coal bed							1.81					12.18																									13.99
Mystic			680.21																	1.11				1.20											4.53	351.57		1,038.62
Upper Mystic							4.76																														4.76
Lower Mystic (Marshall)							8.77					3.66																									12.43
Uncorrelated beds	8.61						1.82																														10.43
Total Marmaton Group	8.61		680.21				17.16					15.84								1.11				1.20											4.53	351.57		1,080.23
Cherokee Group																																					
Upper Cherokee																																					
Mulky coal bed																				8.47																	8.47
Bevier									107.61			0.81								19.29															18.52			146.23
Wheeler																				43.10							1.40							48.87			93.37
Bevier-Wheeler							1.50																	9.74													11.24
Whitebreast	0.62						7.19	1.53	84.29			24.36								65.43				31.91										2.24	39.14			256.71
Wiley												4.15								29.20		1.79													18.48			53.62
Munterville				5.29			11.97					17.80				17.06											21.62			11.04				58.85			143.64
Uncorrelated beds									20.46																												20.46
Total Upper Cherokee	0.62			5.29			20.66	1.53	212.36			47.12				17.06				165.49		1.79		41.65			23.02			11.05			2.24	183.86			733.74
Lower Cherokee																																					
No. 7 coal bed of Lucas County																				5.63																	5.63
No. 5 coal bed of Lucas County							0.83									13.87				27.43		8.96		8.79			33.75					1.98	201.20				296.81
Lower coal-Ford coal bed						0.42	12.45					9.22				114.37	3.18			283.07	475.42	579.05		825.17			99.27	0.72				3.75	71.68	233.09			2,700.86
Bed 16-25 feet below the Lower coal-Ford coal																						10.48															10.48
Manbeck coal bed				130.63												11.00					42.23	35.89		8.02			104.09			17.04							348.90
Hastie Plus				54.16			6.19																				151.81			7.48							219.64
Hastie				41.76			53.01																4.09				346.53			24.87							470.26
Beds below the Hastie							6.19																2.76				1.39										10.34
Laddsdale [1]								73.44							3.13		121.32	140.62			6.33				3.98				6.79			86.30	41.10				483.01
Cliffland								28.53							0.50		1.83	[2]			[2]												45.42				76.28
Uncorrelated beds				11.95			33.09	10.21			46.50	2.19	38.02	11.75		38.02	0.64		16.26			8.99	12.21							60.07			35.84	2.71	9.64		136.09	474.18
Total Lower Cherokee				238.50		0.42	111.76	112.18			46.50	11.41	38.02	11.75	3.63	177.26	126.97	140.62	16.26	316.13	523.98	643.37	19.06	841.98		3.98		726.84	0.72	6.79	109.46		127.87	362.11	242.73		136.09	5,096.39
County Total	9.23	121.31	680.21	243.79	3.16	0.42	149.58	113.71	212.36	11.33	46.50	74.37	38.02	11.75	3.63	194.32	126.97	140.62	16.26	482.73	523.98	645.16	19.06	884.83	20.99	3.98	117.12	749.86	0.72	6.79	120.51	52.27	127.87	364.35	431.12	351.57	136.09	7,236.54

[1] Includes some reserves that possibly are in the Cliffland bed.

[2] Reserves possibly in the Cliffland are included with the Laddsdale bed.

Table 15. Coal produced in Iowa, by county, from 1880 to Jan. 1, 1964 (in short tons)

	Adair County	Adams County	Appanoose County	Boone County	Cass County	Dallas County	Davis County	Greene County	Guthrie County	Hamilton County	Hardin County	Henry County
1880	......	8,187	59,100	140,000	......	13,300	5,500	8,559	......	3,000	3,135	......
1881	......	3,708	107,348	337,724	36	47,884	489	81,530	......	1,787	1,317	67
1882	......	1,691	97,976	286,891	41	36,201	301	62,531	......	874	1,125	65
1883	......	3,891	128,896	466,981	43	38,208	527	88,851	......	1,998	1,203	65
1884	......	3,987	158,986	473,073	......	37,185	1,207	96,321	5,187	1,878	1,075	87
1885	......	3,796	245,896	458,691	......	32,986	13,655	89,587	4,596	986	885	196
1886	......	10,731	168,000	330,366	......	24,624	1,120	131,643	......	......	......	......
1887	......	22,233	179,593	187,116	......	45,270	2,016	118,601	......	......	......	......
1888	......	21,075	235,495	156,959	......	54,457	2,016	122,127	......	......	......	......
1889	......	13,457	285,194	174,392	......	67,055	3,825	51,438	......	......	......	......
1890	......	......	284,560	153,229	......	33,466	......	45,192	......	......	......	......
1891	......	......[3]	409,725	151,659	......	48,710	......[3]	53,215	......	......	......	......
1892	......	......[3]	411,984	139,820	......	26,550	......[3]	43,360	......	......	......	......
1893	1,840	20,085	650,775	267,310	......	33,800	2,620	25,200	19,080	......	......	......
1894	......	......[3]	667,271	241,522	......	10,201	......[3]	5,220	......	......	......	......
1895	......	......	588,438	268,422	......	6,061	......	7,197	......	......	......	......
1896	......	......	544,678	316,756	......	[7]9,624	......	......	......	......	......	......
1897	2,500	8,555	670,143	292,218	......	6,853	......	9,245	15,693	......	......	......
1898	......	9,822	608,165	331,543	......	7,907	391	12,920	1,510	......	......	......
1899	......	12,660	636,421	290,525	......	10,804	[8]412	17,568	......	......	......	......
1900	......	21,950	680,094	266,542	......	16,737	1,398	17,044	......	......	......	......
1901	......	18,091	721,997	254,054	......	16,987	1,986	18,810	......	......	......	......
1902	......	19,751	900,337	254,324	......	18,845	3,953	11,573	......[3]	......	......	......
1903	......	22,570	893,021	291,321	......	15,467	3,160	14,971	14,033	......	......	......
1904	......	12,970	872,920	285,157	......	13,086	......	27,704	11,949	......	......	......
1905	......	13,071	884,248	292,659	......	5,000	......	20,058	19,473	......	......	......
1906	......	11,724	1,101,595	233,110	......	5,522	......	19,816	12,063	......	......	......
1907	......	14,343	1,123,409	208,150	......	70,042	1 300	16,289	13,840	......	......	......
1908	......	17,492	1,144,405	237,498	......	174,585	3,700	15,431	12,684	......	......	......
1909	......	13,194	1,236,009	275,711	......	......[3]	......	9,700	6,730	......	......	......
1910	......	12,745	1,413,896	275,882	......	255,085	......	10,150	17,324	......	......	......
1911	......	7,472	1,104,723	214,440	......	385,588	......	11,800	10,390	......	......	......
1912	......	9,868	1,252,666	212,168	......	436,206	......	9,590	5,870	......	......	......
1913	......	6,971	1,207,387	256,212	......	574,186	......	......[3]	4,492	......	......	......
1914	......	6,660	1,272,276	181,952	......	466,697	......	......[3]	3,925	......	......	......
1915	......	8,340	1,225,100	156,260	......	470,881	......	......[3]	3,968	......	......	......
1916	......	11,703	1,227,127	170,582	......	473,971	......	......[3]	......[3]	......	......	......
1917	......	4,016	1,663,454	244,721	......	588,477	......	......[3]	......[3]	......	......	......
1918	......	5,418	1,559,253	277,619	......	527,478	......[3]	......[3]	......[3]	......	......	......
1919	......	7,418	988,225	242,009	......	279,644	......	......[3]	......[3]	......	......	......
1920	......	8,419	1,511,599	322,517	......	444,670	......	......[3]	......[3]	......	......	......
1921	......	......[3]	609,397	198,738	......	309,888	......	......[3]	......[3]	......	......	......
1922	......	2,140	822,303	223,792	......	312,771	......	......[3]	......[3]	......	......[3]	......
1923	......	......	931,667	264,434	......	545,861	......	......	......	......	......	......
1924	......	7,799	813,800	295,094	......	534,851	......[3]	3,156	5,148	......	......	......
1925	......	4,881	545,020	373,956	......	375,163	......[3]	......[3]	4,053	......	......	......
1926	......	6,088	480,497	427,382	......	359,411	......[3]	......[3]	5,591	......	......	......
1927	......	3,860	316,613	283,591	......	276,635	......[3]	......[3]	7,534	......	......	......
1928	......	......[3]	465,286	397,876	......	282,041	......[3]	......[3]	9,131	......	......	......
1929	......	13,132	569,314	483,590	......	419,396	......[3]	......[3]	10,609	......	......	......
1930	......	10,431	586,126	412,784	......	401,444	3,823	......[3]	6,878	......	......	......
1931	......	13,380	544,531	365,686	......	376,142	1,254	......[3]	9,256	......	......	......
1932	......	15,860	615,238	403,595	......	381,777	......[3]	30,278	12,435	......	......	......
1933	......	18,578	320,014	418,031	......	302,854	3,410	45,396	9,857	......[3]	......	......
1934	......	20,864	457,338	430,970	......	331,907	......	62,631	16,523	......[3]	......	......
1935	......	23,156	598,511	438,115	......	368,487	......[3]	54,456	23,232	......[3]	......	......
1936	......	30,337	659,936	444,949	......	398,917	......[3]	55,278	29,926	......	......	......
1937	......	28,270	602,846	343,930	......	393,047	......[3]	40,622	22,570	......	......	......
1938	......	21,546	393,503	375,518	......	366,134	......[3]	19,006	18,605	......	......	......
1939	......	17,561	344,055	248,608	......	389,637	......[3]	20,808	24,338	......	......	......
1940	......	19,260	427,002	308,844	......	349,359	......[3]	20,031	25,606	......	......	......
1941	......	22,862	386,958	237,870	......	......[3]	......[3]	16,961	22,137	......	......	......
1942	......	12,436	457,148	232,850	......	......[3]	......[3]	......[3]	......[3]	......	......	......
1943	......	1,206	455,359	142,647	......	......[3]	......	......[3]	12,523	......	......	......
1944	......	1,438	350,902	110,126	......	......[3]	......	9,917	......[3]	......	......	......
1945	......	......	275,911	86,744	......	304,313	6,192	10,681	4,899	......	......	......
1946	......	......	192,745	82,925	......	218,564	6,915	10,899	4,831	......	......	......
1947	......	......	165,028	60,582	......	......[3]	8,490	......[3]	3,220	......	......	......
1948	......	1,094	171,716	60,073	......	140,065	32,283	12,375	4,320	......	......	......
1949	......	......	163,169	45,336	......	75,062	49,944	6,740	3,856	......	......	......
1950	......	......	175,132	23,620	......	......	52,034	6,316	3,871	......	......	......
1951	......	......	142,954	20,247	......	......	87,193	1,142	1,255	......	......	......
1952	......	......	130,749	15,429	......	......	95,517	......	......	......	......	......
1953	......	......	122,104	6,000	......	......	149,994	......	......	......	......	......
1954	......	......	133,708	......	......	......	80,650	......	......	......	......	......
1955	......	......	105,543	......	......	......	78,549	......	......	......	......	......
1956	......	......	109,306	......	......	......	54,292	......	......	......	......	......
1957	......	......	88,687	......	......	......	35,488	......	......	......	......	......
1958	......	......	75,695	......	......	......	......	......	......	......	......	......
1959	......	......	79,348	......	......	......	......	......	......	......	......	......
1960	......	......	58,224	......	......	......	......	......	......	......	......	......
1961	......	......	47,080	......	......	......	......	......	......	......	......	......
1962	......	......	48,474	......	......	......	......	......	......	......	......	......
1963	......	......	36,751	......	......	......	......	......	......	......	......	......
Totals	4,340	694,243	46,198,073	18,882,017	120	14,044,026	795,604	1,699,934	485,011	10,523	8,740	480

	Jasper County	Jefferson County	Keokuk County	Lee County	Lucas County	Mahaska County	Marion County	Monroe County	Page County	Polk County	Scott County	Story County
1880	74,462	46,150	49,350	500	126,498	283,961	72,550	181,288	5,200	131,362	14,500	......
1881	42,435	39,124	463,010	......	458,274	917,495	93,997	98,143	685	473,893	3,804	......
1882	40,189	22,121	511,849	......	413,217	701,397	90,927	90,325	118	327,819	3,711	......
1883	45,883	38,887	500,040	......	487,821	927,387	90,985	93,435	748	558,821	3,714	......
1884	46,321	8,172	430,940	......	410,729	932,714	97,085	98,427	1,609	619,921	3,821	......
1885	90,425	1,116	372,816	......	439,956	762,785	100,011	101,517	1,819	462,895	5,937	......
1886	320,358	1,213	610,741	......	594,450	953,525	158,697	131,824	1,736	378,520	3,360	......
1887	159,083	11,645	670,888	......	529,758	1,148,614	238,218	205,525	1,993	341,705	9,670	......
1888	308,200	10,514	607,002	......	408,765	936,299	258,330	261,962	3,842	336,749	10,170	......
1889	199,152	8,123	455,162	......	339,229	1,056,477	145,180	258,401	2,768	434,047	9,446	......
1890	173,044	......[3]	349,318	......	......[3]	1,103,831	153,506	324,031	......	367,852	......	......
1891	267,202	......[3]	316,303	......	......[3]	1,231,405	165,867	393,227	......[3]	309,467	......[3]	......
1892	163,860	......[3]	361,233	......	......[3]	1,141,131	134,400	507,106	......[3]	388,590	......[3]	......
1893	293,400	7,140	270,350	......	12,330	1,093,530	329,168	648,300	1,800	693,103	16,500	......
1894	121,804	......[3]	142,750	......	......[3]	1,152,988	108,695	507,106	......[3]	395,647	......[3]	......
1895	155,707	......	266,394	......	......	1,016,623	193,768	559,982	......	485,360	......	......
1896	164,110	......	214,474	......	......	1,047,241	93,023	433,520	......	546,051	......	......
1897	175,316	1,014	289,478	......	7,265	1,420,510	129,502	497,831	3,800	489,136	3,462	12,097
1898	143,935	1,025	251,145	......	6,600	1,292,787	127,293	584,578	6,370	635,606	......	7,885
1899	191,928	......	314,900	......	32,419	1,273,473	231,668	689,004	4,000	749,708	7,348	6,788
1900	99,948	3,650	258,933	......	227,921	1,142,017	186,446	755,286	8,494	827,482	29,486	3,200
1901	184,670	3,875	308,193	......	221,058	929,110	145,981	1,038,332	6,740	1,025,014	17,097	300
1902	233,440	10,610	106,103	......	246,400	723,567	315,425	1,406,905	10,070	1,023,860	10,358	......[3]
1903	270,804	6,844	62,875	......	295,554	698,166	324,859	1,768,054	16 343	1,032,164	12,653	......
1904	258,098	9,810	41,512	......	189,895	675,113	314,908	1,987,450	18 302	1,130,668	9,930	......
1905	306,164	3,379	16,460	......	147,033	714,945	338,812	2,225,677	......[3]	1,210 320	6,222	......
1906	388,582	3,744	17,144	......	97,147	602,487	372,750	2,458,473	......[3]	1,369,506	24,778	......
1907	397,297	4,000	27,716	......	105,536	757,778	346,999	2,476,021	......[3]	1,460,203	1,047	......
1908	393,516	......[3]	18 301	......	......[3]	807,515	294,607	1,967,337	......[3]	1,616,895	......[3]	......
1909	323,092	......[3]	14,430	......	......[3]	925,438	329,353	2,025,559	16,134	1,788,129	......[3]	......
1910	349,063	......[3]	13,141	......	......[3]	848,199	215,281	2,184,030	......[3]	1,778,264	......[3]	......
1911	292,427	......[3]	12,512	......	......[3]	777,189	171,329	2,259,239	......[3]	1,532,010	......	......
1912	271,301	4,248	14,290	......	......[3]	578,843	182,068	2,393,412	......[3]	1,486,053	......[3]	......
1913	267,567	......[3]	......[3]	......	......[3]	355,737	298,552	2,571,277	......[3]	1,601,015	......	......
1914	241,991	......[3]	......[3]	......	......[3]	272,868	311,183	2,273,066	......[3]	1,706,779	......	......
1915	268,167	......[3]	......[3]	......	......[3]	245,786	360,155	2,157,349	......[3]	1,744 304	......	......
1916	232,825	......[3]	......[3]	......	......[3]	159,395	361,800	1,772,614	......[3]	1,719,844	......	......
1917	304,212	......[10]	......	......	......[3]	145,820	504,999	2,446,670	......[3]	1,845,839	......	......
1918	248,951	......	......	......	503,521	221,860	609,266	2,317,929	......[3]	1,434,433	......	......
1919	138,171	......[3]	......[3]	......	......[3]	73,409	508,767	1,734,633	......[3]	945,113	......	......
1920	......[3]	......[3]	......[3]	......	397,682	64,430	805,723	2,503,276	......[3]	1,183,822	......	......
1921	108,410	......[3]	......[3]	......	236,823	47,751	583,188	1,519,291	......[3]	750,351	......	......
1922	81,134	......[3]	......[3]	......	......[3]	29,288	533,907	1,036,298	......[3]	623,872	......	......
1923	103,391	......[3]	......[3]	......	[12]725,119	37,411	740,317	1,557,782	......[3]	667,831	......	......
1924	109,638	......[3]	10,235	......	......[3]	57,450	835,641	1,085,883	......[3]	893 082	......	......[3]
1925	41,334	......[3]	6,882	......	......[3]	43,943	947,949	814,367	......[3]	670,872	......	......[3]
1926	24,094	......[3]	......[3]	......	......[3]	55,133	926,088	874,972	......[3]	674,455	......	......[3]
1927	48,911	......[3]	......[3]	......	......[3]	44,117	475,228	444,973	......[3]	594,555	......	......[3]
1928	47,622	......[3]	......[3]	......	337,635	52,327	848,294	351,764	......[3]	575 354	......	......
1929	58,627	3,676	......[3]	......	440,037	48,755	780,667	513,019	......[3]	560,450	......	......
1930	58,137	......[3]	......[3]	......	558,293	53,651	537,757	382,533	23,108	584,093	......	......
1931	59,266	......[3]	......[3]	......	470,765	49,072	392,662	344,915	25,696	511,557	......	......
1932	64,206	......[3]	......[3]	......	......[3]	61,396	529,905	395,557	37,883	514,024	......	......
1933	52,475	......[3]	16,551	......	436,273	58,195	366,424	236,521	32,065	532,407	......[3]	......
1934	56,719	......[3]	19,842	......	506,484	90,157	268,494	278,590	38,859	468,766	......[3]	......
1935	45,974	......[3]	8,424	......	482,088	109,403	331,125	273,141	49,793	501,383	......[3]	......
1936	60,536	......[3]	8,269	......	560,727	152,474	366,713	245,957	46,139	531,069	......	......
1937	44,069	......[3]	10,206	......	431,918	230,297	470,955	189,352	39,588	435,557	......	......
1938	28,589	......[3]	......[3]	......	435,829	206,808	442,978	138,600	32,487	290,000	......	......
1939	27,792	......[3]	......	......	......[3]	270,781	529,686	103,612	35,611	308,920	......	......
1940	46,978	......[3]	......[3]	......	194,448	353,629	538,373	194,102	40,599	359,340	......	......
1941	52,627	......[3]	......[3]	......	130,752	315,281	594,713	183,850	39,233	318,730	......	......
1942	64,856	......	......[3]	......	104,875	330,809	514,038	235,064	29,520	307,813	......	......
1943	52,297	......	2,157	......	62,942	267,042	624,946	240,551	12,635	279,503	......	......
1944	24,238	......	......[3]	......	......[3]	190,310	503,893	175,030	6,530	176,378	......	......
1945	17,548	......	......	......	94,044	193,987	524,727	202,319	5,046	130,229	......	......
1946	17,086	......	......	......	74,627	250,657	530,455	175,286	6,900	48,551	......	......
1947	29,367	......	......	......	38,259	334,280	554,409	152,728	9,723	21,774	......	......
1948	50,389	......	......	......	33,792	249,950	608,287	158,856	7,492	......	......	......
1949	31,502	......	......	......	27,895	192,370	826,164	134,259	8,062	......	......	......
1950	29,926	......	......	......	27,461	210,821	932,472	168,992	8,971	......	......	......
1951	7,251	......	......	......	24,729	106,735	919,275	129,523	5,745	......	......	......
1952	7,800	......	......	......	17,906	100,748	718,322	146,093	2,412	......	......	......
1953	2,500	......	......	......	14,860	131,489	740,651	111,358	3,260	......	......	......
1954	......	......	......	......	......[3]	148,082	619,338	106,168	......[3]	......[3]	......	......
1955	......	......	......	......	......	114,491	708,747	100,088	......	9,889	......	......
1956	......	......	......	......	......[3]	145,144	780,488	122,649	......	9,886	......	......
1957	......	......	......	......	29,776	170,211	768,158	104,829	......	13,163	......	......
1958	......	......	......[3]	......	......[3]	160,067	727,192	92,462	......	12,085	......	......
1959	......	......	1,930	......	41,077	225,956	681,931	81,915	......	1,519	......	......
1960	......	......	2,987	......	41,690	254,806	592,544	52,807	......	......	......	......
1961	......	......	......	......	28,811	228,427	510,144	41,274	......	......	......	......
1962	......	......	......	......	39,826	285,029	644,448	36,250	......	......	......	......
1963	......	......	......	......	46,807	331,349	659,317	52,432	......	......	......	......
Totals	10,202,389	250,080	8,447,239	500	13,395,686	39,103,924	37,043,143	63,374,133	659,928	50,965,427	207,014	30,270

	Taylor County	Van Buren County	Wapello County	Warren County	Wayne County	Webster County	Other Counties	Small Mines	Total
1880	2,400	13,890	67,555	17,957	6,000	126,712	......	......	[1]1,461,116
1881	78	98	131,815	12,987	77	184,300	......	......	[2]3,502,105
1882	84	216	207,721	11,081	51	218,478	793,000	......[3]	[2]3,920,000
1883	94	1,678	237,821	12,828	1,892	248,560	......	......	[2]3,981,257
1884	127	1,778	240,720	13,727	4,947	214,014	......	......	[2]3,904,038
1885	617	1,193	187,911	12,825	25,812	145,296	......	......	[2]3,564,205
1886	9,615	9,003	265,564	26,132	38,080	120,710	......	......	[4]4,290,012
1887	13,642	29,491	304,722	27,772	31,454	163,768	......	......	[4]4,442,777
1888	8,962	29,075	426,042	19,155	27,208	178,881	......	......	[4]4,423,285
1889	9,736	39,258	359,199	14,515	17,480	137,739	......	......	[4]4,081,273
1890	......	47,464	341,932	8,470	25,415	118,829	491,600	......[3]	[4]4,021,739
1891	10,500	36,166	165,827	2,000	45,000	78,022	140,800	......[3]	[4]3,825,095
1892	15,204	28,946	231,472	3,600	62,078	115,154	141,000	......[3]	[4]3,915,488
1893	35,570	26,300	284,660	14,725	47,121	249,100	......	......	[5]5,043,807
1894	14,780	23,619	278,583	12,649	42,224	103,009	1,127	......[3]	[4]3,829,195
1895	14,062	9,896	261,510	6,116	46,315	123,882	146,341	......[3]	[6]4,156,074
1896	8,400	8,396	227,077	12,824	42,732	134,704	150,418	......[3]	[6]3,954,028
1897	10,726	5,760	229,470	6,610	56,996	168,899	98,786	......[3]	[6]4,611,865
1898	6,555	6,600	249,624	7,120	51,550	137,548	130,363	......[3]	[6]4,618,842
1899	10,965	9,385	325,029	34,815	62,818	124,841	......	140,000	[6]5,177,479
1900	17,159	12,108	276,360	24,724	65,140	123,660	136,800	......[3]	[6]5,202,579
1901	23,499	12,572	312,174	14,661	56,578	146,020	139,700	......[3]	[9]5,617,499
1902	14,207	14,816	340,762	20,127	65,374	149,615	4,344	......	[9]5,904,766
1903	16,933	13,561	382,398	12,760	105,170	138,296	......	7,834	[9]6,419,811
1904	16,273	8,005	379,560	11,290	98,879	134,538	......	11,916	[9]6,519,933
1905	22,345	6,192	303,360	9,876	112,549	113,393	27,313	......[3]	[9]6,798,609
1906	19,052	12,137	243,256	2,850	136,694	109,522	24,272	......[3]	[9]7,266,224
1907	19,692	15,374	258,651	5,054	146,901	80,275	24,405	......[3]	[9]7,574,322
1908	18,003	15,362	189,506	6,720	127,409	62,768	37,576	......[3]	[9]7,161,310
1909	13,536	15,955	261,520	16,201	128,004	66,584	292,483	......[3]	[9]7,757,762
1910	9,749	10,284	283,500	......[3]	135,439	49,973	66,115	......[3]	[9]7,928,120
1911	9,950	8,656	312,332	......[3]	116,382	46,026	59,183	......[3]	[9]7,331,648
1912	5,120	9,154	206,102	......[3]	99,168	48,074	65,328	......[3]	[9]7,289,529
1913	......[3]	14,381	153,705	......[3]	85,775	45,676	83,003	......[3]	[9]7,525,936
1914	......[3]	......[3]	237,176	......[3]	76,524	33,692	366,233	......[3]	[9]7,451,022
1915	......[3]	......[3]	313,993	......[3]	......[3]	18,905	613,111	27,824	[9]7,614,143
1916	......[3]	......[3]	316,332	......[3]	......[3]	......[3]	778,646	35,961	[9]7,260,800
1917	......[3]	6,431	346,509	......[3]	......[3]	......[3]	823,942	40,740	[9]8,965,830
1918	......[3]	13,195	245,166	......[3]	......[3]	......[3]	193,800	34,306	[9]8,192,195
1919	......[3]	6,667	169,500	......[3]	10,588	......	500,060	20,488	[9]5,624,692
1920	......[3]	8,845	143,793	......[3]	27,293	......	352,847	39,000	[9]7,813,916
1921	......[3]	......[3]	50,499	......[3]	21,553	......	95,503	......	[9]4,531,392
1922	......[3]	......[3]	25,202	......[3]	......[3]	......	605,554	......	[9]4,296,261
1923	......[3]	......[3]	33,067	51,880	......	......	43,225	......	[11]5,701,985
1924	......[3]	8,645	72,410	......[3]	27,219	......[3]	708,399	......	[9]5,468,450
1925	......[3]	......[3]	60,580	......[3]	29,201	......[3]	796,642	......	[9]4,714,843
1926	......[3]	6,643	52,508	......[3]	19,205	......[3]	713,420	......	[9]4,625,487
1927	17,312	11,023	55,825	127,007	21,010	......[3]	221,428	......	[9]2,949,622
1928	15,324	10,339	61,444	162,793	20,204	......[3]	46,201	......	[9]3,683,635
1929	8,828	9,797	77,414	202,682	15,270	......[3]	25,806	......	[11]4,241,069
1930	9,482	6,320	84,973	141,132	19,741	......[3]	11,865	......	[9]3,892,571
1931	8,642	9,071	80 071	84,666	19,240	......[3]	22,483	......	[9]3,388,355
1932	12,833	6,630	92,700	139,463	27,499	21,573	499,583	......	[9]3,862,435
1933	12,226	7,429	82,649	176,327	19,867	36,019	11,412	......	[9]3,194,983
1934	10,669	9,279	70,127	168,447	10,311	44,475	5,540	......	[9]3,366,992
1935	......[3]	13,797	82,783	161,959	10,041	48,321	25,974	......	[11]3,650,163
1936	15,635	14,020	102,596	135,927	29,643	50,090	21,562	......	[9]3,960,700
1937	......[3]	18,225	134,414	107,019	22,960	36,658	34,551	......	[9]3,637,054
1938	......[3]	18,935	148,917	81,594	18,736	27,682	37,720	......	[9]3,103,187
1939	......[3]	18,355	180,930	67,015	24,230	36,079	299,539	......	[9]2,947,557
1940	......[3]	23,926	177,092	78,299	24,394	22,878	27,017	......	[9]3,231,177
1941	......[3]	24,765	155,553	60,967	18,647	37,048	319,672	......	[9]2,938,626
1942	10,263	34,289	188,419	16,416	19,004	39,235	350,687	......	[9]2,947,722
1943	5,347	32,001	176,132	......[3]	11,181	31,931	360,210	......	[9]2,770,610
1944	3,673	31,332	129,835	......[3]	......[3]	18,571	408,763	......	[11]2,140,936
1945	......	34,412	126,145	7,088	6,678	14,637	......	......	[9]2,045,600
1946	......	28,465	124,201	6,302	4,299	4,425	......	......	[9]1,788,133
1947	......	40,608	79,758	8,969	2,348	......	174,512	......	[9]1,684,055
1948	......	44,778	84,504	10,182	......	......	......	......	[9]1,670,156
1949	......	65,778	79,783	13,359	1,205	......	......	......	[9]1,724,484
1950	......	89,188	149,081	13,526	......	......	......	......	[9]1,891,411
1951	......	52,942	120,584	10,723	......	......	......	......	[9]1,630,298
1952	......	46,442	92,014	7,301	......	......	......	......	[9]1,380,733
1953	......	31,008	66,928	7,854	......	......	......	......	[9]1,388,006
1954	......	......[3]	48,266	......[3]	......	......	60,486	......	[9]1,196,698
1955	......	26,594	109,091	5,365	......	......	......	......	[9]1,258.357
1956	......	25,971	102,298	......[3]	......	......	8,216	......	[9]1,358,250
1957	......	21,677	75,546	4,140	......	......	......	......	[9]1,311,675
1958	......	16,257	53,022	......[3]	......	......	41,833	......	[9]1,178,613
1959	......	17,094	46,733	2,397	......	......	......	......	[9]1,179,900
1960	......	15,869	49,097	......	......	......	......	......	[9]1,068,024
1961	......	11,584	59,836	......	......	......	......	......	[9]927,156
1962	......	18,433	57,104	......	......	......	......	......	[9]1,129,564
1963	......	18,554	67,779	......	......	......	......	......	[9]1,212,989
Totals	507,869	1,452,382	14,667,819	2,462,970	2,672,803	4,929,085	12,660,399	358,069	346,214,240

1 United States 10th Decennial Census, 1880.
2 Annual Report of Iowa State Mine Inspector, 1885.
3 Included in other counties.
4 Beyer (1909).
5 Keyes (1894).
6 U. S. Geological Survey (1900).
7 Includes Greene County.
8 Includes Lee County.
9 U. S. Geological Survey (1901-1923), U. S. Bureau of Mines (1924-1931), U. S. Bureau of Mines (1932 1963).
10 Included in Small Mines.
11 U. S. Bureau of Mines (1949).
12 Includes Guthrie and Wayne Counties.

IOWA GEOLOGICAL SURVEY

H. GARLAND HERSHEY
Director and State Geologist
Iowa City, Iowa

COAL RESOURCES OF IOWA

BY

E. R. LANDIS and J. O. MABERRY
United States Geological Survey

1964

Prepared cooperatively by the United States Geological Survey and the Iowa Geological Survey

EXPLANATION

All coal reserves shown on this map are of Pennsylvanian age

Area underlain by measured and indicated reserves

Area underlain by inferred reserves

Area underlain by potentially coal-bearing rocks of Pennsylvanian age. Favorable areas as indicated by available data shown in darker color

SCALE 1:500 000

10 0 10 20 30 40 50 MILES

10 0 10 20 30 40 50 KILOMETERS

Base modified from U. S. Geological Survey map of Iowa