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COAL RESOURCES OF NEW MEXICO

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Geological Survey

Introduction

Coal is the largest assured source of energy in New Mexico. Even though there are, at present, trends toward the use of petroleum, natural gas, and water power, coal should occupy an increasingly important position in the fuel economy of the State. This view is strongly supported by many technological developments, such as the synthetic production of liquid fuels from coal; the underground gasification of coal; and the use of powdered coal to power steam and gas turbines. All of these point to a day when coal will provide a large proportion of our heat and industrial power requirements.

The Geological Survey has, for many years, been keenly aware of the need for a comprehensive appraisal of coal reserves, even in times when other sources of energy have become increasingly popular. In an effort to supply basic data that will permit the preparation of estimates, both for the nation and for smaller areas like states and mining districts, numerous field surveys have been undertaken. A number of surveys have been made in New Mexico, and it was decided, some two years ago, to prepare from existing data new estimates of the coal reserves of the entire State. The project was begun in October 1948 and completed in December 1949.

Geographic Distribution of Coal Reserves

Reserves of coal are widely distributed in New Mexico. The index map, figure 1, shows the locations of the more important areas of coal occurrence.

The Raton field is on the margin of the Great Plains adjacent to the southern Rocky Mountains and has for many years been a substantial producer of bituminous coal including coking coal. The field is rather accessible and is only a moderate distance from Rocky Mountain industrial centers where there is a demand for fuel.

A second area is the vast San Juan River region in northwestern New Mexico. The group of fields in this region is situated in the Colorado Plateau province and contains major reserves of sub-bituminous as well as bituminous coal. Much of this region is relatively inaccessible. Development has, in consequence, been rather local.

The Datil Mountain field, which is a southward extension or lobe of the San Juan River region, likewise contains potentially valuable deposits of sub-bituminous coal. It is difficult of access and, accordingly, has seen only minor development.

A number of small fields occur in the intermontane basins of the Basin and Range Province of central and southeastern New Mexico. The Cerrillos, Carthage, and Sierra Blanca fields, in particular, have produced considerable quantities of bituminous coal. In addition, the Cerrillos field has yielded anthracite from several mines.

From this brief discussion of the geographic distribution of New Mexico's coal reserves it is apparent that extensive deposits of minable coal are known to occur in all except the southwestern quarter of the State. Some of the resources are well situated with respect to transportation facilities and sites of moderate industrial development. Others are less well located. If the coal reserves are to be used to full advantage in the future it is clearly desirable to appraise them and to consider the data thus assembled in connection with current and future planning.

Geologic Occurrence of Coal Reserves

The coal-bearing formations of New Mexico range from Carboniferous to Tertiary in age. Deposits of major economic importance are restricted, however, to strata of late Cretaceous and Tertiary (Paleocene) age. Coals in these rocks range from sub-bituminous to anthracite, although the greater portion of the reserves are of sub-bituminous and bituminous ranks.

The stratigraphic successions and thicknesses of coal-bearing rocks in some of the coal-bearing areas of New Mexico are shown in figure 2. The Mesaverde formation, or group, is the oldest coal-bearing unit that contains large reserves. This sequence of strata, of late Cretaceous age, is extensive in the San Juan River region and it occurs also in the Cerrillos, Una del Gato, Tijeras, Datil Mountain, Carthage, Jornada del Muerto, and Sierra Blanca fields. Data that will be presented indicate that the coal beds in this formation constitute a very large percentage of the State's reserves.

Coal beds of the Fruitland formation of late Cretaceous age are an important reserve in the northern and central portions of the San Juan River region. Generally equivalent strata in the Raton field of northeastern New Mexico are termed the Vermejo formation and also contain valuable deposits of coal.

The Raton formation of late Cretaceous and Paleocene age likewise contains large coal reserves

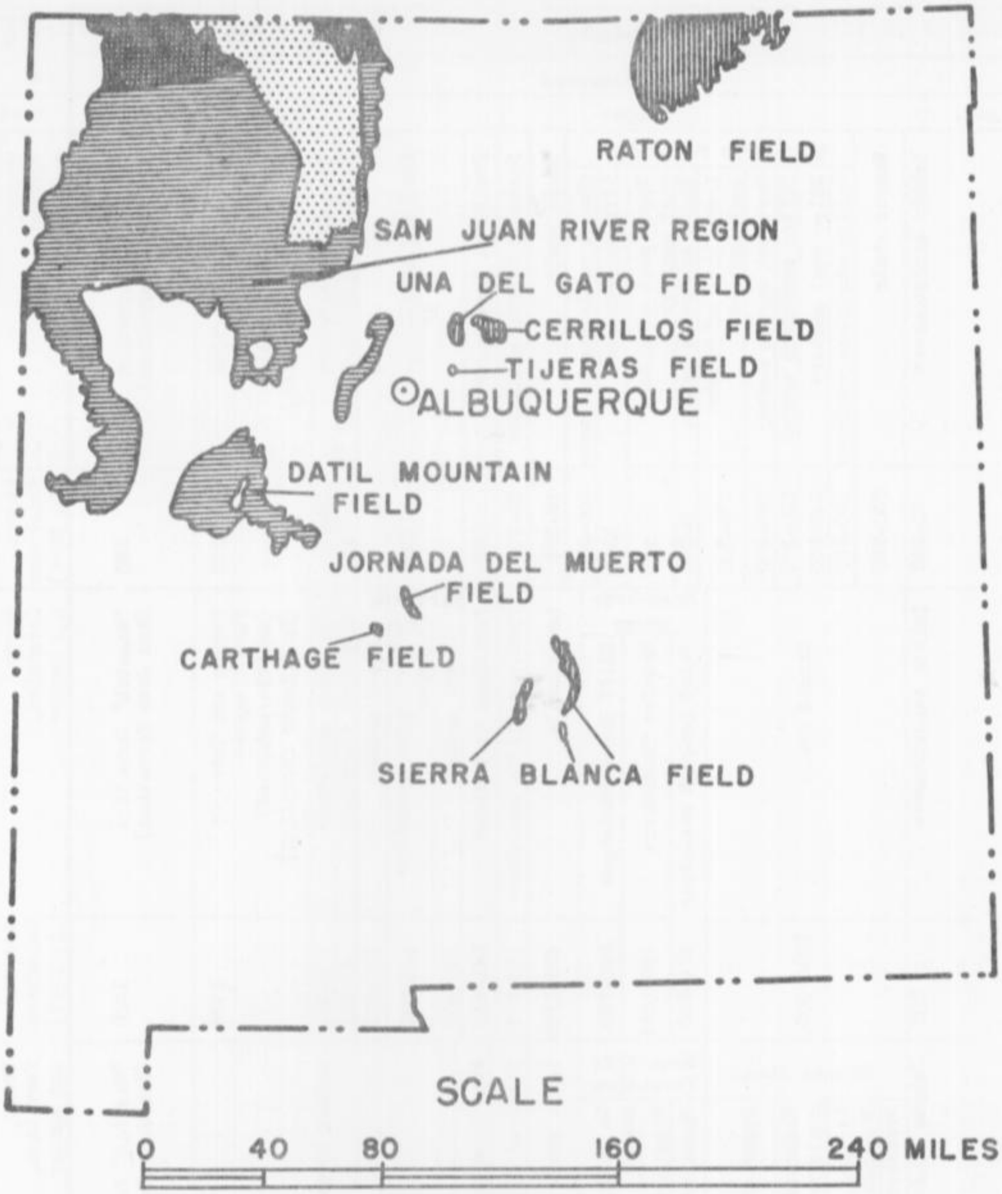

FIGURE 1. MAP OF NEW MEXICO SHOWING LOCATIONS OF COAL FIELDS

- Area containing sub-bituminous coal reserves
- Area containing bituminous coal reserves
- Area containing sub-bituminous or bituminous coal reserves
- Area containing anthracite coal reserves
- Area underlain by coal at depths greater than 3000 feet

Figure 2.--Generalized stratigraphic sections in the major coal-bearing areas in New Mexico

Era and System		Series	San Juan River Region						Raton Mesa Region	
			Southwestern part		Northwestern part		Northeastern part			
			Group, formation, and member	Approx. thickness (in feet)	Group, formation, and member	Approx. thickness (in feet)	Group, formation, and member	Approx. thickness (in feet	Group, formation, and member	Approx. thickness (in feet)
Cenozoic	Tertiary	Eocene	"Wasatch" formation (San Jose formation)	250	"Wasatch" formation (San Jose formation)	1000	"Wasatch" formation (San Jose formation)	2000		
Cenozoic	Tertiary	Paleocene	Puerco and Torrejon formations*** (undifferentiated) (Nacimiento formation)	630-1140	Puerco and Torrejon formations*** (undifferentiated) (Nacimiento formation)	1450			Poison Canyon formation	300
Mesozoic	Cretaceous	Upper	Ojo Alamo sandstone	30-130	Ojo Alamo sandstone	0-400	Animas formation***	1500-3000	Raton formation*	1000-1700
			McDermott formation	50	McDermott formation	40-245				
			Kirtland shale	700	Kirtland shale: Upper member	110-475				
					Kirtland shale: Farmington sandstone member	350-500				
					Kirtland shale: Lower member	240-400			Vermejo formation*	0-425
			Fruitland formation*	230	Fruitland formation*	241-530	Fruitland formation*	160	Trinidad sandstone	100
			Pictured Cliffs sandstone	50-90	Pictured Cliffs sandstone	160-275	Pictured Cliffs sandstone	100		
			Lewis shale	76-270	Lewis shale	475-1710	Lewis shale	2000		
			Mesaverde formation: Chacra sandstone member**	300-360						
			Mesaverde formation: Allison member**	1500	Mesaverde group: Cliff House sandstone	390-750	Mesaverde formation: La Ventana sandstone member	30-80		
			Mesaverde formation: Upper part of Gibson coal member*	300	Mesaverde group: Menefee formation*	356-1076	Mesaverde formation: Gibson coal member*	80-130	Pierre shale	1500-1700
			Mesaverde formation: Hosta sandstone member	0-200	Mesaverde group: Point Lookout sandstone	274-300	Mesaverde formation: Hosta sandstone member	75-160		
			Mesaverde formation: Lower part of Gibson coal member*	275-300	Mancos shale	1880-2000	Mancos shale: Upper shale member	650		
			Mesaverde formation: Bartlett barren member	330-400						
			Mesaverde formation: Dalton sandstone member	100-180						
			Mesaverde formation: Dilco coal member*	240-300			Mancos shale: Niobrara calcareous shale member	800	Niobrara formation	800-1000
			Mesaverde formation: Gallup sandstone member**	180-250			Mancos shale: Carlile shale member	440		
			Mancos shale	700-950			Mancos shale: Greenhorn limestone member	70	Benton shale	350-450
							Mancos shale: Graneros shale member	100		
		?	Dakota sandstone***	50-250	Dakota sandstone***	200	Dakota sandstone***	175-200	Dakota sandstone***	200
		Lower								

* Formation or member contains important coal resources.
** Formation or member contains locally important coal reserves.
*** Formation or member contains coal beds that are not believed to be important resources.

in the Raton area. Higher strata that are assigned to the Tertiary in New Mexico are not known to contain reserves although carbonaceous or impure lignitic strata occur.

The geologic structure in the San Juan River region and the Raton field is generally synclinal and does not, except locally, complicate economic development of the coal beds. In the Datil Mountain field, as well as in the fields of the intermontane basins, the geologic structure is complex at many points and, in consequence, appears to have affected mining adversely.

The details of coal-bearing sequences and geologic structure in the fields are covered by numerous published and unpublished geologic reports. It is, therefore, impracticable to go further into the matter at this time.

Procedures Used in Preparing Estimates

The estimates that are presented in this account are drawn from published and unpublished information from numerous sources. The analysis of these reports has been difficult and time-consuming. One matter was apparent at the outset of the work: A number of assumptions regarding the coal beds should be made and procedures thereafter should be standardized. Only if the investigation were so disciplined could data of comparative value be developed.

Before going into the results of the U. S. Geological Survey's appraisal it seems appropriate to summarize these assumptions and standardized procedures, for reserve figures have little meaning unless these are known.

In preparing the present estimate of New Mexico coal reserves, calculations were made for reserves in each bed, and in each township wherever possible. Separate calculations were made also for reserves in each rank of coal; in three categories of thickness; in three categories according to the overburden on the beds; and three categories according to the reliability of the information on which the estimates were based.

Ranks of Coals

Ranks of New Mexico coals have been determined from chemical analyses that are, in some cases, supplemented by physical data. The ranks assigned accord with standards of classification that have been established by the American Society for Testing Materials and are summarized in Table 1.

Thickness categories

The thickness categories for the purpose of calculating reserves were established by the Geological Survey after consultation with numerous organizations. These are presented in table 2.

Lines of equal thickness based on the categories indicated in this table have been drawn on each coal bed wherever possible. In districts where drilling has been done during or prior to development, the positions of these lines can be determined fairly accurately. In undeveloped areas the data usually are restricted to outcrop measurements and the positions of the thickness lines back of the outcrops can not be well determined. In such circumstances interpolation of thickness points has been necessary. In general, the lengths of outcrops within the thickness classes are considered to establish the diameters of semicircular areas underlain by coal of such ranges of thicknesses.

Overburden Categories

Overburden, the thickness of rock overlying a coal bed, has been recognized as important in considering the utilization of the mineral fuel and the feasibility of various mining operations. Three overburden thickness categories have been established: 0-1000 feet, 1000-2000 feet, and 2000-3000 feet. Coal beds at depths greater than 3000 feet are not, at present, considered reserves.

Reliability Categories

Three categories of reserves based on the relative abundance of reliable information have been adopted and used in preparing the table of estimates. These are termed measured, indicated, and inferred.

Measured coal is coal for which tonnage estimates are based on data that permit calculations that are believed to be accurate to within 20 percent of the tonnage that will be proved by mining.

Indicated coal is coal for which tonnage estimates are computed partly from direct measurement and partly from projection of such data a reasonable distance on geologic evidence. In general, points of observation should be no greater than one mile apart.

Inferred coal is coal for which tonnage estimates are based largely on geologic information concerning character and continuity of the beds but for which there are only widely spaced measurements.

Weight of coal

The Geological Survey has recognized that there is wide range in weights of coals of apparently

Table 1

CLASSIFICATION OF COALS BY RANK[a]

Legend: F.C. = Fixed Carbon V.M. = Volatile Matter Btu. = British thermal units

Class	Group	Limits of Fixed Carbon or Btu. Mineral-Matter-Free Basis	Requisite Physical Properties
I. Anthracitic	1. Meta-anthracite	Dry F.C., 98 percent or more (Dry V.M., 2 percent or less)	
	2. Anthracite	Dry F.C., 92 percent or more and less than 98 percent (Dry V.M., 8 percent or less and more than 2 percent)	
	3. Semianthracite.	Dry F.C., 86 percent or more and less than 92 percent (Dry V.M., 14 percent or less and more than 8 percent)	Nonagglomerating[b]
II. Bituminous[d]	1. Low-volatile bituminous coal	Dry F.C., 78 percent or more and less than 86 percent (Dry V.M., 22 percent or less and more than 14 percent)	
	2. Medium volatile bituminous coal	Dry F.C., 69 percent or more and less than 78 percent (Dry V.M., 31 percent or less and more than 22 percent)	
	3. High volatile A bituminous coal	Dry F.C., less than 69 percent (Dry V.M., more than 31 percent); and moist[c] Btu., 14,000[e] or more	
	4. High volatile B bituminous coal	Moist[c] Btu., 13,000 or more and less than 14,000[e]	
	5. High volatile C bituminous coal	Moist Btu., 11,000 or more and less than 13,000[e]	Either agglomerating or nonweathering[f]

Table 1. CLASSIFICATION OF COALS BY RANK (cont'd)

Class	Group	Limits of Fixed Carbon or Btu. Mineral-Matter-Free Basis	Requisite Physical Properties
III. Sub-bituminous	1. Sub-bituminous A coal	Moist Btu., 11,000 or more and less than 13,000[e]	Both weathering and nonagglomerating
	2. Sub-bituminous B coal	Moist Btu., 9,500 or more and less than 11,000[e]	
	3. Sub-bituminous C coal	Moist Btu., 8,300 or more and less than 9,500[e]	
IV. Lignitic	1. Lignite	Moist Btu., less than 8,300	Consolidated
	2. Brown coal	Moist Btu., less than 8,300	Unconsolidated

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

b. If agglomerating, classify in low-volatile group of the bituminous class.

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

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

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

f. There are three varieties of coal in the high-volatile C bituminous coal group, namely, Variety 1, agglomerating and nonweathering; Variety 2, agglomerating and weathering; Variety 3, nonagglomerating and nonweathering.

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similar rank. In the absence of precise local information the weights that are given in table 3 have been used in calculating reserves.

Calculation of reserves

Classification of coal beds by rank, thickness, overburden, and certainty of existence has been possible through the preparation of numerous special maps of individual beds throughout the coal fields. Average thicknesses within unit areas of these beds have then been calculated, the areas measured, and tonnages computed through the use of the weight factors. Summary tables of original tonnages of coal in New Mexico have thus resulted.

Coal mined and lost in mining has been calculated from production figures, assuming that losses in mining are equal to production. This has been subtracted from the original reserves to give the remaining reserves.

Table 4.--Estimated original coal reserves in New Mexico under less than 3,000 feet overburden
(In millions of short tons)

Region or Field and County	Sub-bituminous coal (Beds more than 30 inches thick)											Bituminous coal (Beds more than 14 inches thick)					Anthracite (Beds more than 14 inches thick)			Total, all ranks				
	Fruitland formation					Mesaverde formation						Mesaverde, Raton, and Vermejo formations					Mesaverde formation							
	Calculated on coal bed basis					Calculated on coal bed basis						Calculated on coal bed basis					Calculated on coal bed basis			Calculated on coal bed basis				
	Measured	Indicated	Inferred	Additional inferred on coal zone basis	Total Fruitland formation	Measured	Indicated	Inferred	Additional inferred on coal zone basis	Total Mesaverde formation	Total Sub-bituminous coal	Measured	Indicated	Inferred	Additional inferred on coal zone basis	Total Bituminous coal	Measured	Indicated	Total Anthracite	Measured	Indicated	Inferred	Additional inferred on coal zone basis	Total
San Juan River Region																								
McKinley County	4.3	59.2	84.6	18.1	166.2	229.5	180.2	21.4	12,597.4	13,028.5	13,194.7	—	—	—	—	—	—	—	—	233.8	239.4	106.0	12,615.5	13,194.7
San Juan County	514.1	1,171.2	4,747.0	9,319.8	15,752.1	1.3	4.2	—	12,657.2	12,662.7	28,414.8	49.1	66.8	12.4	3,957.4	4,085.7	—	—	—	564.5	1,242.2	4,759.4	25,934.4	32,500.5
Sandoval County	0.2	0.5	—	1,609.6	1,610.3	67.3	320.9	547.9	2,399.1	3,335.2	4,945.5	—	—	—	—	—	—	—	—	67.5	321.4	547.9	4,008.7	4,945.5
Rio Arriba County	0.9	0.8	—	2,135.7	2,137.4	5.0	30.6	—	470.7	506.3	2,643.7	7.0	6.6	—	390.3	408.9	—	—	—	12.9	38.0	—	2,996.7	3,047.6
Bernalillo County	—	—	—	—	—	1.0	—	—	—	1.0	1.0	—	—	—	—	—	—	—	—	1.0	—	—	—	1.0
Valencia County	—	—	—	—	—	2.9	—	—	278.4	281.3	281.3	—	—	—	—	—	—	—	—	2.9	—	—	278.4	281.3
Raton Field																								
Colfax County	—	—	—	—	—	—	—	—	—	—	—	567.9	1,296.6	2,844.5	—	4,709.0	—	—	—	567.9	1,296.6	2,844.5	—	4,709.0
Miscellaneous Small Fields																								
Tijeras Field																								
Bernalillo County	—	—	—	—	—	—	—	—	—	—	—	0.4	1.2	—	—	1.6	—	—	—	0.4	1.2	—	—	1.6
Cerrillos Field																								
Santa Fe County	—	—	—	—	—	—	—	—	—	—	—	6.6	14.6	26.3	—	47.5	2.8	2.9	5.7	9.4	17.5	26.3	—	53.2
Una del Gato Field																								
Sandoval County	—	—	—	—	—	—	—	—	—	—	—	0.6	15.9	0.8	—	17.3	—	—	—	0.6	15.9	0.8	—	17.3
Sierra Blanca Field																								
Lincoln County	—	—	—	—	—	—	—	—	—	—	—	3.3	8.0	—	1,405.3	1,416.6	—	—	—	3.3	8.0	—	1,405.3	1,416.6
Otero County	—	—	—	—	—	—	—	—	—	—	—	—	—	—	227.4	227.4	—	—	—	—	—	—	227.4	227.4
Carthage and Jornada del Muerto Fields																								
Socorro County	—	—	—	—	—	—	—	—	—	—	—	19.7	14.3	4.7	—	38.7	—	—	—	19.7	14.3	4.7	—	38.7
Datil Mountain Field																								
Valencia County	—	—	—	—	—	—	—	—	942.9	942.9	942.9	—	—	—	—	—	—	—	—	—	—	—	942.9	942.9
Catron County	—	—	—	—	—	—	—	—	267.4	267.4	267.4	—	—	—	—	—	—	—	—	—	—	—	267.4	267.4
Socorro County	—	—	—	—	—	—	—	—	109.9	109.9	109.9	—	—	—	—	—	—	—	—	—	—	—	109.9	109.9
Total estimated original reserves	519.5	1,231.7	4,831.6	13,083.2	19,666.0	307.0	535.9	569.3	29,723.0	31,135.2	50,801.2	654.6	1,424.0	2,888.7	5,980.4	10,947.7	2.8	2.9	5.7	1,483.9	3,194.5	8,289.6	48,786.6	61,754.6

Depletion through mining and loss in mining, 1882-1947, assuming past losses equal production	239.8
Estimated reserves remaining in ground on January 1, 1948	61,514.8
Recoverable reserves as of January 1, 1948, assuming 65 percent recovery	39,984.6
Recoverable reserves as of January 1, 1948, assuming 50 percent recovery	30,757.4

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Recoverable reserves have been calculated on the basis of both 65 percent and 50 percent recoverability to show on these two assumptions the usable coal reserve that New Mexico has within its boundaries.

Reserve Estimates

A summary of the U. S. Geological Survey's estimates of New Mexico's coal reserves is given in table 4. This shows that the State had original reserves of slightly more than 61.75 billion tons of coal ranging in rank from sub-bituminous to anthracite. Mining through nearly seven decades has removed a considerable tonnage of coal, but the reserves in the ground are still greater than 61.5 billion tons.

Sub-bituminous coal constitutes the greater part of this reserve and is estimated to be in excess of 50 billion tons. Bituminous reserves are calculated at 11 billion tons, and anthracite reserves at about 5 million tons.

Although substantial reserves are present in most of the fields, it is apparent that the great sub-bituminous coal reserve of the State is concentrated in the San Juan River region. Bituminous reserves of major consequence occur in the Raton and Sierra Blanca fields.

As has been stated earlier, this appraisal is both preliminary and provisional. It seems quite possible that future exploration and development may modify local estimates. Advances in technology may change views of cut-off thicknesses and depths at which mining is practical. It is believed, however, that the present estimates are close approximations of what New Mexico can consider as energy sources for future use.

Table 2. CLASSIFICATION OF COAL BEDS IN THICKNESS CATEGORIES

Coal rank	Thickness categories a	b	c
Anthracite	greater than 42 inches	42-28 inches	28-14 inches
Semi-anthracite	greater than 42 inches	42-28 inches	28-14 inches
Bituminous	greater than 42 inches	42-28 inches	28-14 inches
Sub-bituminous	greater than 120 inches	120-60 inches	60-30 inches
Lignite	greater than 120 inches	120-60 inches	60-30 inches

Table 3. WEIGHTS OF COALS OF VARIOUS RANKS

Rank	Weight per acre-foot*
Anthracite	2000 short tons
Semi-anthracite	2000 short tons
Bituminous	1800 short tons
Sub-bituminous	1770 short tons
Lignite	1750 short tons

* Acre-foot: A volume of coal equivalent to one acre one foot thick.