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Strippable Reserves of Bituminous Coal and Lignite in the United States



UNITED STATES DEPARTMENT OF THE INTERIOR

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By Staff, Bureau of Mines



UNITED STATES DEPARTMENT OF THE INTERIOR
Rogers C. B. Morton, Secretary

BUREAU OF MINES
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CONTENTS

	<u>Page</u>
Abstract.....	1
Introduction.....	1
Acknowledgments.....	2
Historical background.....	2
Constraints on the industry.....	3
Definitions.....	4
Coalfields of the United States.....	5
The Eastern province.....	5
The Interior province.....	8
The Gulf province.....	9
The Northern Great Plains province.....	10
The Rocky Mountain province.....	10
The Pacific Coast province.....	10
Alaska.....	10
Methodology.....	1
Resources and reserves.....	14
Strippable reserves by rank of coal.....	17
Strippable reserves by coal provinces.....	18
Strippable reserves by sulfur content.....	18
Low-sulfur coal.....	21
Medium-sulfur coal.....	21
High-sulfur coal.....	22
Strippable coal reserves by State.....	22
Low-sulfur bituminous coal.....	24
West Virginia.....	24
Eastern Kentucky.....	25
Virginia.....	26
Other States.....	27
Review of States.....	28
Alabama.....	28
Alaska.....	29
Arizona.....	31
Arkansas.....	31
Colorado.....	32
Illinois.....	34
Indiana.....	35
Iowa.....	37
Kansas.....	37
Kentucky.....	38
Maryland.....	39
Michigan.....	40
Missouri.....	41
Montana.....	42
New Mexico.....	43
North Dakota.....	44
Ohio.....	44
Oklahoma.....	45
Pennsylvania.....	47

CONTENTS--Continued

	<u>Page</u>
Tennessee.....	48
Texas.....	49
Utah.....	50
Virginia.....	50
Washington.....	52
West Virginia.....	52
Wyoming.....	53
Other States.....	54
Bibliography.....	56
Appendix A.--Strippable resources and reserves, in the United States, by States.....	70
Appendix B.--Summary of strip-mining laws in the United States, by States	122

ILLUSTRATIONS

1. Bituminous and subbituminous coal and lignite fields of the conterminous United States.....	6
2. Coalfields of Alaska.....	7
3. Total remaining resources and strippable reserves of coal and lignite in the United States, by rank, as of January 1, 1968....	17
4. Remaining strippable resources and reserves of coal and lignite in the United States by coal province as of January 1, 1968.....	18
5. Strippable reserve, of the conterminous United States, by region..	19
6. Strippable reserves of coal and lignite in the United States by sulfur category as of January 1, 1968.....	20

TABLES

1. Summary of certain criteria used in estimating strippable reserves of coal and lignite.....	12
2. Estimated remaining strippable resources and strippable reserves of coal and lignite in the United States, January 1, 1968, by rank of coal, sulfur category, and coal province.....	14
3. Estimated strippable reserves of coal and lignite in the United States, January 1, 1968, by States.....	23

Strippable reserves by seam

A-1. Alabama.....	70
A-6. Arizona (by formation).....	74
A-9. Arkansas.....	75
A-12. California.....	76
A-15. Colorado (by deposit and seam).....	77
A-20. Indiana.....	81
A-23. Iowa.....	82
A-26. Kansas.....	83
A-29. Kentucky--east.....	85
A-32. Kentucky--west.....	88
A-35. Maryland.....	89

TABLES--Continued

	<u>Page</u>
<u>Strippable reserves by seam--Continued</u>	
A-38. Michigan.....	90
A-41. Missouri.....	91
A-44. Montana (by deposit and seam).....	93
A-47. New Mexico (by deposit and formation).....	97
A-50. North Dakota (by deposit and seam).....	98
A-53. Ohio.....	100
A-56. Oklahoma.....	102
A-59. Oregon.....	103
A-62. Pennsylvania.....	104
A-65. South Dakota.....	106
A-68. Tennessee.....	107
A-71. Texas (by formation).....	109
A-74. Utah (by deposit and formation).....	111
A-77. Virginia.....	113
A-80. Washington (by deposit and seam).....	116
A-83. West Virginia.....	117
A-86. Wyoming (by deposit and seam).....	120

Strippable reserves by county

A-2. Alabama.....	71
A-4. Alaska (by coalfield).....	73
A-7. Arizona.....	74
A-11. Arkansas.....	75
A-12. California.....	76
A-16. Colorado.....	78
A-18. Illinois.....	79
A-21. Indiana.....	81
A-24. Iowa.....	82
A-27. Kansas.....	84
A-30. Kentucky--east.....	86
A-33. Kentucky--west.....	88
A-36. Maryland.....	90
A-39. Michigan.....	91
A-42. Missouri.....	92
A-45. Montana.....	95
A-48. New Mexico.....	97
A-51. North Dakota.....	99
A-54. Ohio.....	101
A-57. Oklahoma.....	102
A-60. Oregon.....	103
A-63. Pennsylvania.....	105
A-66. South Dakota.....	106
A-69. Tennessee.....	108
A-72. Texas.....	110
A-75. Utah.....	112
A-78. Virginia.....	114

TABLES--Continued

	<u>Page</u>
<u>Strippable reserves by county--Continued</u>	
A-81. Washington.....	116
A-84. West Virginia.....	118
A-87. Wyoming.....	121
<u>Strippable reserves by seam and sulfur category</u>	
A-3. Alabama.....	72
A-5. Alaska (by coalfield and sulfur category).....	73
A-8. Arizona (by formation and sulfur category).....	74
A-11. Arkansas.....	76
A-14. California.....	77
A-17. Colorado.....	78
A-19. Illinois.....	80
A-22. Indiana.....	82
A-25. Iowa.....	83
A-26. Kansas.....	84
A-31. Kentucky--east.....	87
A-34. Kentucky--west.....	89
A-37. Maryland.....	90
A-40. Michigan.....	91
A-43. Missouri.....	92
A-46. Montana.....	96
A-49. New Mexico (by formation and sulfur category).....	97
A-52. North Dakota.....	100
A-55. Ohio.....	101
A-58. Oklahoma.....	103
A-61. Oregon.....	104
A-64. Pennsylvania.....	105
A-67. South Dakota.....	106
A-70. Tennessee.....	109
A-73. Texas (by formation and sulfur category).....	111
A-76. Utah (by formation and sulfur category).....	112
A-79. Virginia.....	115
A-82. Washington.....	116
A-85. West Virginia.....	119
A-88. Wyoming.....	121
B-1. A summary of the regulations governing surface mining on lands under the jurisdiction of the U.S. Government.....	122
B-2. Summary of the laws regulating strip mining in the United States, by States.....	125

STRIPPABLE RESERVES OF BITUMINOUS COAL AND LIGNITE IN THE UNITED STATES

by

Staff, Bureau of Mines

ABSTRACT

The strippable reserves of bituminous coal and lignite in the United States were calculated in accordance with the prevailing conditions of seam thickness and depth of overburden in each of the several coal-producing areas of the Nation. Within defined limits of seam thickness and depth of overburden, it is estimated that there was a remaining strippable resource of 118 billion tons of raw bituminous coal and lignite as of January 1, 1968. Because of topography, natural and manmade features, and other limitations, only 45 billion tons of the resource are strippable reserves. Of this, 32 billion tons is considered low-sulfur (less than 1 percent), 4 billion tons is medium-sulfur (1 to 2 percent), and 9 billion tons is high-sulfur (over 2 percent) coal. Owing to a cleaning loss affecting that portion of strip coal that is mechanically cleaned, the 45 billion tons of strippable reserves are reduced to 39.6 billion tons of marketable coal.

A brief discussion is given for each coal-producing State, summarizing past and present production, historical background, and outlook. Appendix A contains reserve data by State, county, seam, and sulfur content. Appendix B contains the general information and requirements necessary to comply with the current strip mining laws covering 20 States.

INTRODUCTION

During 1969, 35 percent of the bituminous coal and lignite produced in the United States was from strip mining operations. By 1980, the demand for coal is expected to be 53 percent greater than it was in 1967, and by the year 2000 the projected demand will be 78 percent greater, probably resulting in more and larger strip mines. Of particular significance is the increasing demand for coal of low sulfur content to comply with present or proposed air quality standards.

This study, a joint undertaking of several Bureau of Mines offices, was undertaken to establish the location and extent of coal of varying sulfur content available for strip mining. In each of these offices, coal reserves were estimated in accordance with the locally prevailing criteria and mining techniques.

For each State except Alaska the strippable reserves were identified by county and by seam. Reserves have been compiled by State and coal province as well as by rank--bituminous, subbituminous, and lignite. Additionally, the reserves were compiled by seam, by sulfur content, and by the coal presently in place within specified limits of overburden thickness.

The U.S. Geological Survey has published reports on strippable coal resources of the United States and, additionally, for selected areas of Montana, North Dakota, and Pennsylvania. A joint study was made of the strippable coal in Indiana by the U.S. Geological Survey and the Indiana Geological Survey. The strippable resources of Kansas were estimated by the Kansas Geological Survey. The Illinois Survey has calculated the resources in several counties in that State.

This report differs from previous reports in that it is primarily concerned with strippable reserves, that portion of the resource which is recoverable with present prices, technology, and other conditions. It is also concerned with the amount and location of coal reserves by sulfur content. United States, when used in this report, refers to the conterminous United States and Alaska.

ACKNOWLEDGMENTS

The manuscript was compiled with the assistance and cooperation of many people concerned with coal resources and coal mining by stripping methods. The authors gratefully acknowledge advice and criticism on all aspects of strip mining from representatives of the coal and utility companies. Special appreciation is extended to the many agencies and individuals that contributed coal data, including many State Geological Surveys, State Mining Departments, and authors of U.S. Geological Survey and Bureau of Mines publications. Thanks are extended to those Bureau of Mines engineers whose review and criticism contributed to the accuracy of this report.

HISTORICAL BACKGROUND

Strip mining is thought to have started in 1877 in the area of Pittsburg, Kans. (154).¹ The fully revolving steam shovel made its appearance at Pittsburg in 1910; the capacity of the bucket was 1-1/2 cubic yards. The early shovels were mounted on rails and moved in the coal pits on portable track. They were used primarily to remove overburden. The uncovered coal was drilled and blasted and hand-loaded into wooden mine cars.

In the Appalachian area, contour stripping on hillsides began about 1917. Because of the steep slopes, the work was difficult and progress was slow until the advent of crawler-track equipment.

During World War II when road construction was reduced, much earthmoving equipment was diverted to strip mining. Many road contractors continued to

¹Underlined numbers in parentheses refer to items in the bibliography of this report.

strip-mine coal after the war, and never returned to highway construction. Over the ensuing years, the number of mines increased, and equipment became larger and more efficient.

During the 30 years preceding 1969, coal production in the United States from underground mines declined about 3 percent, from 357 million tons to 347 million tons per year. Meanwhile strip mining increased 413 percent, from 38 million tons to 195 million tons. Auger mining, which was virtually unknown in 1939, produced 16 million tons of coal in 1969. During 1969, 30 percent of the coal mines were strip operations, accounting for 35 percent of total production. There were 87 strip mines with annual production of more than one-half million tons each.

CONSTRAINTS ON THE INDUSTRY

The Nation is experiencing an increasing demand for energy. Compared with the 53.8 quadrillion Btu of energy consumed in 1966, it is estimated that 159 quadrillion Btu will be required annually by the year 2000 (114). Coal in general, as well as the portion of production that is strip mined, is expected to share in this increased market. The extent of expansion by strip mining will depend on various constraints; these include safety legislation, regulations on strip-mine reclamation, competition from other fuels, and pollution controls.

The Air Quality Act of 1967 enables the Federal Government to establish controls for industries that contribute to air pollution. While no such regulation has been established nationally, various local regulations have been applied which limit the sulfur content of fuel or stack gas emission of sulfur oxides. Since as yet no acceptable system has been developed to remove sulfur from either coal or stack gas, there has been a trend towards the consumption of low-sulfur fuels. In some areas this has resulted in a switch by electric utilities, the major consumer of coal, to low-sulfur residual fuel oil and natural gas; it has also given some impetus to the development of nuclear power.

The first law requiring reclamation of strip-mined land was enacted in West Virginia in 1939. Since then, 20 more States have enacted similar regulations. Certain provisions that are common to these laws include the following: Need for a permit, posting of bonds, land descriptions and progress reports, restoration standards, time limits, water pollution controls, and penalties for violations. While the impact of current regulations has been considered in this report, more stringent regulations are being considered. The effect of future regulations along with recently implemented safety legislation has not been fully assessed.

In most cases, these regulations will result in additional costs to the consumer. These additional costs will affect the competitive position of strip-mined coal as well as the amount of strip coal available.

DEFINITIONS

The words "resource" and "reserve" have occasionally been used interchangeably in other publications. To eliminate possible confusion, these and other terms used in this report are defined as follows.

Area stripping.--Mining of large areas of flat-lying beds under relatively shallow overburden. Overburden is removed in many successive cuts.

Cleaned coal.--Coal recovered after processing by cleaning and sizing. A loss averaging more than 20 percent of the raw coal entering the preparation plant results from cleaning.

Contour stripping.--Mining of coal on hillsides in hilly or mountainous areas. Overburden is removed in one or several cuts by equipment following the coal outcrop along the natural contour of the surface of the ground.

Cut.--Width of coal uncovered in one position of the stripping equipment.

Depletion.--The tonnage mined plus the coal lost as a result of the mining operation.

High-sulfur coal.--Coal containing over 2 percent sulfur, by weight.

Highwall.--The final face of the overburden at the last cut.

Low-sulfur coal.--Coal containing less than 1 percent sulfur, by weight.

Marketable coal.--Coal in a condition ready for sale to consumers; includes both raw and cleaned coal.

Medium-sulfur coal.--Coal containing 1 to 2 percent sulfur, by weight.

Mineable coal.--A coalbed equal to or greater than a specified minimum thickness. Grade or quality of the coal is not considered.

Overburden.--Soil and rock material overlying the coalbed.

Raw coal.--Coal shipped to the consumer as mined, without prior preparation other than crushing to a desired maximum size, but which causes no appreciable additional loss.

Recoverable strippable resource.--The remaining strippable resource multiplied by a mining recovery factor.

Recovery factor.--The proportion of the resource that is technically capable of being produced, usually expressed as a percent.

Reserves.--The measured portion of the resource that is recoverable (mineable coal) with the technology and equipment presently available or that may be made available in the foreseeable future.

Remaining strippable resource.--The total original coal resource under a specified maximum depth of overburden and reduced by depletion computed from past strip and sugar mining production.

Resource.--The estimated total quantity of all coal in place, having a specified minimum coalbed thickness and under a specified maximum depth of overburden.

Strippable reserves.--The recoverable strippable resource adjusted to conform to the stripping ratio, which varies by area. Coal that cannot be mined because of the proximity of natural or manmade features is also excluded. These reserves are the actual raw tons of coal that can be removed from the ground. They are also assumed to be all "available" tonnages and are not divided into "measured," "indicated," and "inferred" reserves.

Stripping ratio.--The ratio of overburden to coal is generally expressed in the following two ways:

1. As cubic yards of overburden per ton of coal either mined or marketable (cubic yards to ton),
2. as average feet of overburden thickness per foot of coalbed thickness (feet to feet).

In this report the feet to feet ratio is used.

The maximum economic stripping ratio is determined by the producer's accepted difference between the total cost of production and the selling price per ton.

COALFIELDS OF THE UNITED STATES

The bituminous coal and lignite fields of the United States (fig. 1) are subdivided geographically by the U.S. Geological Survey, as follows: (1) The Eastern province, (2) the Interior province, (3) the Gulf province, (4) the Northern Great Plains province, (5) the Rocky Mountain province, (6) the Pacific Coast province, and (7) Alaska (fig. 2). Within these provinces the bituminous coal and lignite deposits are further subdivided into regions, basins, and fields.

The Eastern Province

In the Eastern province, bituminous coal occurs throughout the Appalachian region, an area of about 70,000 square miles. This region encompasses parts of Pennsylvania, Ohio, Maryland, West Virginia, Virginia, eastern Kentucky, Tennessee, Alabama, and Georgia. The coal occurs in formations of Pennsylvanian and Permian ages. There has been some structural deformation of the coal-bearing formations into broad, open folds. Attitudes of the seams vary from flat to gently dipping, with local steepening in some fields.

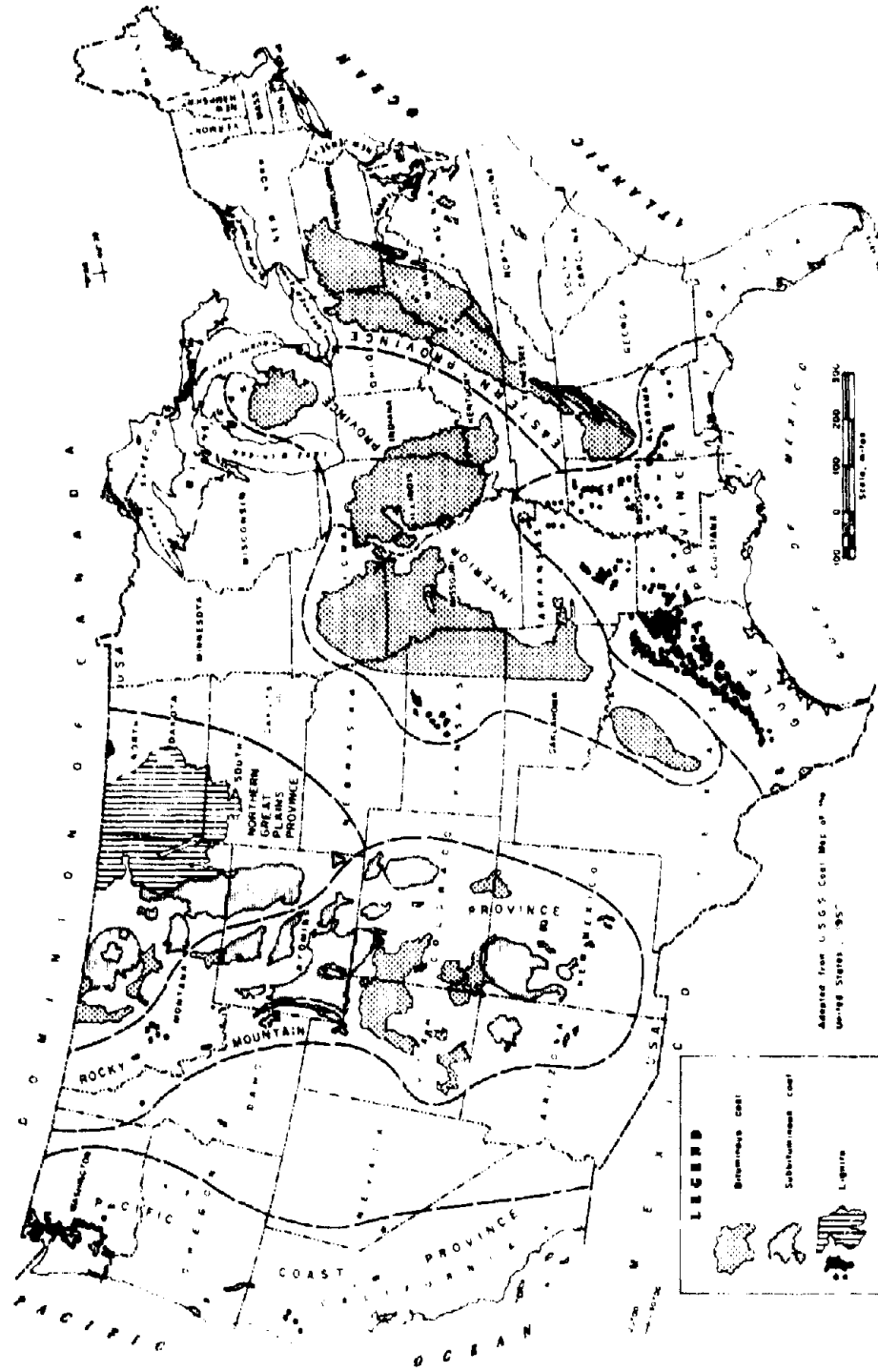
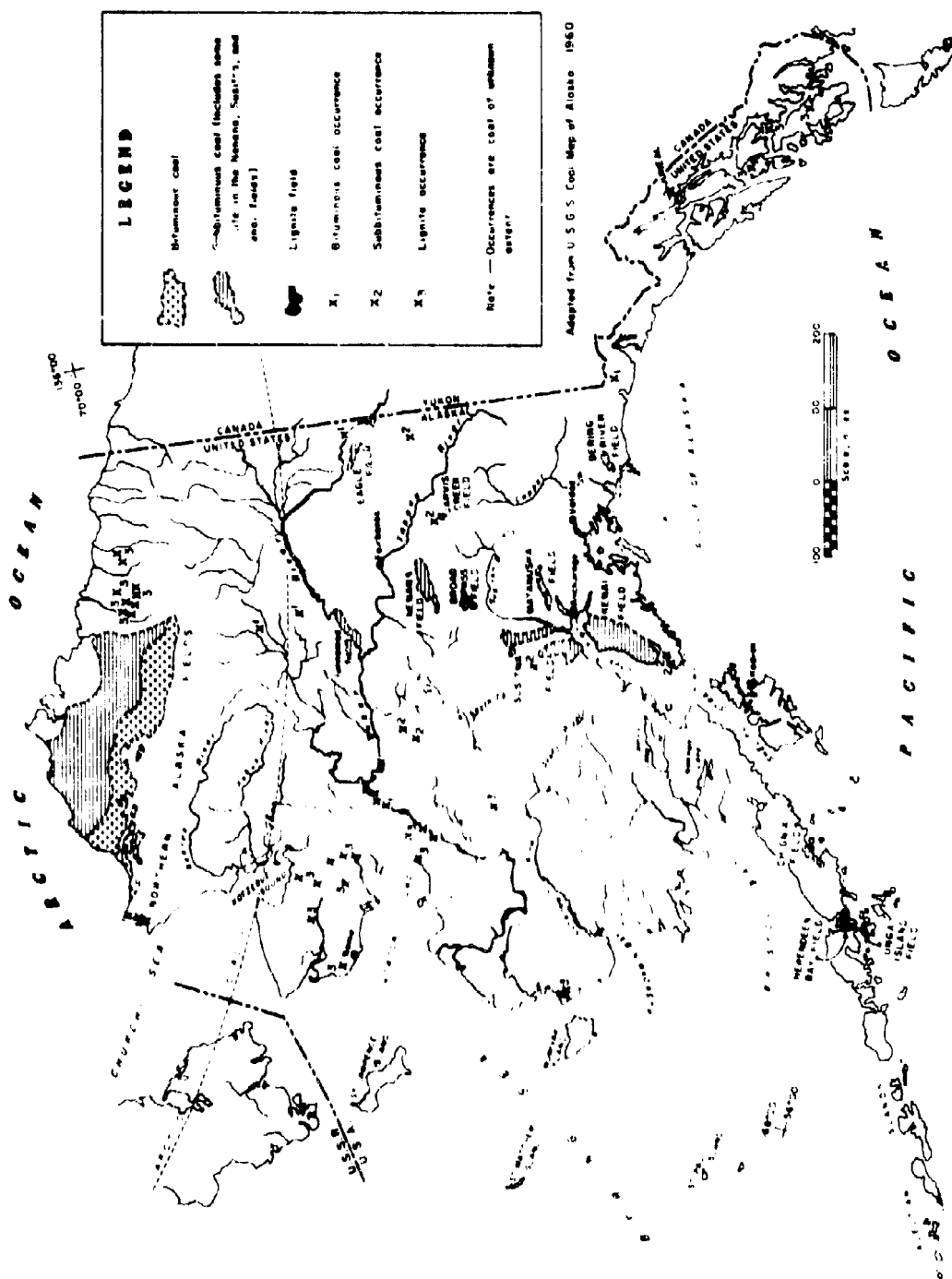


FIGURE 1. - Bituminous and Subbituminous Coal and Lignite Fields of the Conterminous United States.



There are approximately 90 minable bituminous coal seams throughout the Appalachian region. Sixty of the seams can be strip-mined to varying extents, depending on location and depth of overburden. West Virginia has the largest number of strippable seams in the Appalachian States. The minimum thickness of coal that can be mined by stripping depends on many factors and varies from locality to locality. In the Appalachian region, the minimum thickness used for estimating strip reserves was 28 inches, except for Alabama where the minimum was 14 inches.

Coals of the Appalachian region are bituminous in rank and range from low-volatile to high-volatile C coals. Sulfur content of the different seams and even within seams ranges from about 1/2 percent to over 6 percent.

The major seams are continuous over large areas. The seams pinch and swell and are sometimes faulted out or interrupted by erosion.

Major markets for coal produced from this province include electric utilities, coke production, other industrial uses, and exports. The coal is moved to destinations by truck, railway, and waterways.

The Interior Province

The Interior province contains approximately 159,000 square miles of land underlain by bituminous coal-bearing formations in four separate regions. The regions are the Eastern Interior region, with 47,800 square miles of coal-bearing land; the Western Interior region, with 83,500 square miles; the Northern Interior region, with 11,600 square miles; and the Southwestern Interior region, with 16,100 square miles.

The Eastern Interior region covers parts of Illinois, Indiana, and western Kentucky. The coal occurs in an oval basin with mining restricted essentially to the margins. Minimum coalbed thicknesses used to estimate strip reserves range from 14 to 24 inches. The beds are horizontal to gently dipping. The coal is Pennsylvanian in age and low-volatile to high-volatile C bituminous. It is high-ash, high-sulfur coal generally unsuitable for coking, but is an excellent steam, industrial, and space-heating coal.

The Western Interior region covers parts of Iowa, Nebraska, Missouri, Kansas, Oklahoma, and Arkansas. The coal seams occur in formations of Pennsylvanian age. The coal formations are essentially flat to gently dipping except in eastern Oklahoma and western Arkansas. The coals are bituminous, ranging from low-volatile to high-volatile C except in the strongly folded area of Arkansas where they grade into semianthracite. The bituminous coals are generally medium to high sulfur and low to high ash.

There is little correlation of the coal seams from field to field. Seams are discontinuous and irregular in thickness, thinning and swelling in comparatively short distances. Strippable reserves have been estimated for seams having minimum thicknesses ranging from 12 to 28 inches.

The Northern Interior region is a small, shallow basin covering an area of 11,600 square miles in the central part of the Southern Peninsula of Michigan. The coal is Pennsylvanian in age, and is high-volatile B and C rank bituminous coal with high sulfur and ash content.

The exploited coals are on the east side of the basin. They occur in discontinuous beds that vary in thickness and pinch out in relatively short distances. The seams all occur within the Saginaw Formation, which ranges from 200 to 650 feet in thickness. Strippable reserves were estimated for a minimum coalbed thickness of 28 inches.

The Southwestern Interior region is a northeast-southwest trending belt covering 13 counties in north-central Texas. Coals occur in formations of Pennsylvanian and Permian ages. The formations have a low regional dip to the west. Six Pennsylvanian and three Permian coal seams are of importance. The seams range from about 12 to about 36 inches in thickness. The coal ranges in rank from high-volatile B and C bituminous in the Pennsylvanian formations to subbituminous A coals in the Permian formations. Sulfur content ranges from about 1.4 to 3.0 percent. The coal seams are discontinuous, and only three have been mined extensively. There has been no production since 1943.

Major markets in the Interior province are electric utilities and other industrial uses. While coal is still used to some extent for space heating, oil and gas have become more important fuels. Transport to market is by truck, rail, and inland waterway.

The Gulf Province

The Gulf province covers parts of Alabama, Arkansas, Louisiana, Mississippi, Tennessee, and Texas. It includes small, scattered bituminous coal and lignite fields of Cretaceous and Tertiary ages. There are only three small bituminous fields, all in Texas. One of these, the Santo Tomas deposit, is cannel coal and is probably the largest body of cannel coal in the United States. Owing to an eastward-dipping outcrop along the Rio Grande and excessive depths of overburden, none of the cannel coal can be strip mined. Strippable reserves of the other deposits have not been ascertained, but part could probably be strip mined. No coal has been mined since 1943, and with no foreseeable market, there appears to be little likelihood that the resource will be exploited for many years to come.

The lignite fields, which usually contain less than 1 percent sulfur, are mostly thin beds varying from less than 3 to over 20 feet in thickness. As of January 1, 1968, strippable reserves have been determined in only two of the States--Arkansas with 25 million tons, based on a minimum lignite thickness of 30 inches; and Texas with about 1.3 billion tons, based on a minimum lignite thickness of 60 inches. Texas is the only State in the Gulf province with recent production of lignite.

The Northern Great Plains Province

The Northern Great Plains province covers parts of Montana, North Dakota, South Dakota, and Wyoming. The coal deposits include both bituminous and sub-bituminous coal and lignite in formations of Tertiary and Cretaceous ages. Strippable reserves are estimated for only subbituminous coal and lignite. The subbituminous coal seams range up to 220 feet, and the lignite seams range up to 40 feet in thickness. Reserves were estimated for a minimum coalbed thickness of 5 feet. Present production is almost exclusively for electric power generation.

The Rocky Mountain Province

The Rocky Mountain province covers parts of Arizona, Colorado, Idaho, Montana, New Mexico, Utah, and Wyoming. Coal seams occur in formations of Cretaceous and Tertiary ages. The beds are generally flat to gently dipping, but local steepening is present in some districts. There is great variation in thickness and continuity. Seams range from 4 feet to 90 feet in thickness. For estimating reserves, only those of 5 feet or more were considered.

The strippable reserves include subbituminous and bituminous coal. The major market is electric utilities, with some coal going to coke production and very little to industrial or domestic use. Present transportation is by rail. Some utility plants are built at the deposit site.

The Pacific Coast Province

The Pacific Coast province covers parts of California, Oregon, and Washington. Minor deposits occur in California and Oregon and the largest strippable reserves of importance occur in Washington. All the coals of this province are in Tertiary formations. There is only one major strippable subbituminous coal deposit, which is located in the Tono Basin of the Centralia region of Washington. Strippable coal occurs in two seams, the Big seam and the Smith seam. The Centralia region contains many other coal seams for which no strippable reserves have been estimated. The coal seams range from 5 to 50 feet in thickness. Over 90 percent of the estimated reserve is in the Big seam. The coal is subbituminous in rank and is mined to supply an electric generating plant. Washington is the only State in the province with a sizable deposit of coking coal, none of which is considered strippable.

Alaska

Alaska has six coalfields for which strippable reserves of bituminous and subbituminous coal and lignite have been estimated. Figure 2 shows the known coalfields of Alaska. The coals are of Cretaceous and Tertiary ages, and rank from lignite to anthracite. The seams range from nearly flat to steeply dipping, and from relatively continuous to lenticular. Seam thicknesses range up to 50 feet; strippable reserves are estimated for a minimum thickness of 14 inches. The coal is low in sulfur, with generally less than 1 percent; much of it contains less than 0.5 percent sulfur.

Nearly all the coal currently produced is consumed within 150 miles of the mine. Transportation is by rail or truck. Although the markets are electric utilities and space heating, natural gas is becoming more competitive for heating purposes.

METHODOLOGY

The procedure in ascertaining strippable coal resources was dependent upon the type, quantity, and quality of information that was available. The criteria for evaluating these resources were based on economic consideration for each area under study.

The original in-place resource was obtained mainly as follows:

1. Where outcrop maps were available, the length of each minable coalbed outcrop was measured by map meter or the area was measured by planimeter. An average coalbed thickness was determined for each seam, and an average bench width from outcrop to maximum overburden thickness was estimated. From these data acres of strippable coal were calculated, and when multiplied by a tonnage factor, gave total original in-place resource. It was generally assumed that 1 acre-foot of coal in the ground was equivalent to 1,800 tons of bituminous coal. A lesser figure of 1,760 tons per acre-foot was used for subbituminous coal and lignite.

2. In other areas, original resource was based on latest estimates of the U.S. Geological Survey, State Geological Surveys, coal mining companies, and railroad companies.

In areas where coal demand was great and the supply rather limited, the minable seam thickness was generally less and the maximum overburden greater than for the country as a whole. For example, in the Appalachian area, only that coal greater than 28 inches in thickness under a 15-to-1 ratio of overburden thickness (at the final highwall) to seam thickness was considered strippable. In parts of the Rocky Mountain area, only coal in seams 5 feet or more in thickness are considered minable by stripping. Meanwhile, in Alaska, very large tonnages of coal, particularly on the North Slope, are considered more as a resource than a reserve because of the high cost of mining created by severe weather conditions and the lack of an export market. All coal that was considered uneconomic or unminable was excluded from the available reserve estimates. Table 1 summarizes the minimum coalbed thickness, maximum overburden thickness, and economic stripping ratio used to estimate the strippable reserves in the various States.

Sulfur content was generally derived from coal analyses published by either the Bureau of Mines or State agencies. Over 11,000 analyses were recorded and used. In the absence of sufficient information on sulfur analyses of coal from strip mines, published analyses of sulfur content from underground mines were applied to the stripping portion of the same coalbed.

TABLE 1. - Summary of certain criteria used in estimating
strippable reserves of coal and lignite

Province and State	Minimum coal-bed thickness, inches	Maximum overburden thickness for computing reserves, feet	Economic stripping ratio (feet to feet) ¹
Eastern province--Appalachian region:			
Alabama.....	14	120	24:1
Kentucky--east.....	28	120	14:1
Maryland.....	28	120	15:1
Ohio.....	28	120	15:1
Pennsylvania.....	28	120	15:1
Tennessee.....	28	120	19:1
Virginia.....	28	120	15:1
West Virginia.....	28	120	15:1
Interior and Gulf province:			
Arkansas (bituminous)....	14	60	30:1
Arkansas (lignite).....	30	100	30:1
Illinois.....	18	150	18:1
Indiana.....	14	90	20:1
Iowa.....	28	120	18:1
Kansas.....	12	120	15:1
Kentucky--west.....	24	150	18:1
Michigan.....	28	100	20:1
Missouri.....	12	120	15:1
Oklahoma.....	12	120	15:1
Texas.....	60	90	15:1
Rocky Mountain and Northern Great Plains provinces:			
Arizona.....	60	130	8:1
Colorado.....	60	^a 50 to 120	4:1 to 10:1
Montana.....	60	^a 60 to 125	2:1 to 18:1
New Mexico.....	60	^a 60 and 90	8:1 to 12:1
North Dakota.....	50	^a 50 to 75	3:1 to 12:1
South Dakota.....	60	100	12:1
Utah.....	60	^a 39 to 150	3:1 to 8:1
Wyoming.....	60	^a 60 to 200	1.5:1 to 10:1
Pacific Coast province:			
California.....	60	100	10:1
Oregon.....	48	40	4.75:1
Washington.....	60	100 and 250	10:1
Alaska.....	14	120	-

¹ Based on maximum feet of overburden thickness at the highwall per foot of coalbed thickness.

^a Maximum overburden thickness varies for different coalbeds.

Procedures used to evaluate the strippable coal resources are as follow:

1. Original in-place resource was either estimated or obtained from other sources.
2. Past production from earliest dates available to January 1, 1968, was tabulated by seams and by strip and auger, and the depletion was computed.
3. Remaining strippable resource was computed by subtracting depletion from original resource.
4. Recoverable strippable resource was computed by multiplying remaining strippable resource by a recovery factor. Recovery factors employed were 80 percent for strip and 50 percent for auger mining. The exception was western Kentucky where a 90-percent factor was used for strip.
5. Strippable reserves (raw mined coal) were computed by deleting the following from the recoverable strippable resource:
 - a. Coal with overburden greater than the economic stripping ratios listed in table 1,
 - b. coal under towns, rivers, highways, railroads, utilities, cemeteries, and gas and oil wells,
 - c. coal cropping out close to a stream channel,
 - d. coal known to be bony, dirty, faulted, or unusually high in sulfur,
 - e. coal known to be inaccessible, dipping steeply at the outcrop or burned at the outcrop,
 - f. coal mined out in previous years by underground methods and minable coalbeds lost to stripping because they lie too close to a coalbed that has been strip mined,
 - g. coal that may never be sold or leased for strip mining,
 - h. any other unminable coal.
6. An average sulfur content was determined, generally on a county and seam basis, and used to categorize strippable reserves into high-, medium-, and low-sulfur coal.

RESOURCES AND RESERVES²

Data on coal resources for the Nation (table 2) were assembled and evaluated to determine the quantity, location, and sulfur content of coal available by strip mining. Data on remaining strippable resource has no significance as to the amount of coal that can be mined economically, and is given in the tables mainly as a basis of comparison to other reports on strip coal resource. Within defined limits of seam thickness and depth of overburden, there is an estimated 118 billion tons of remaining resource of bituminous and subbituminous coal and lignite in the United States. Of this, 45 billion tons, or 38 percent, is appropriately termed a strippable reserve, available with existing technology.

TABLE 2. - Estimated remaining strippable resources and strippable reserves of coal and lignite in the United States, January 1, 1968, by rank of coal, sulfur category, and coal province

(Millions of short tons)

Rank	Remaining strippable resource	Strippable reserves	Strippable reserves		
			Low sulfur	Medium sulfur	High sulfur
BITUMINOUS COAL					
Eastern province--Appalachian region:					
Alabama.....	667	134	33	74	27
Kentucky--east.....	4,609	781	532	189	60
Maryland.....	150	21	0	8	13
Ohio.....	5,566	1,033	0	126	907
Pennsylvania.....	2,272	752	0	225	527
Tennessee.....	483	74	5	43	26
Virginia.....	1,556	258	154	99	5
West Virginia.....	11,230	2,118	1,138	569	311
Subtotal.....	26,533	5,171	1,862	1,433	1,876

²Resource and reserve data were compiled by the following personnel: Robert S. Warfield, mining engineer, Juneau, Alaska; Clinton C. Knox, Joseph B. Smith, Benjamin C. Pollard, mining engineers, Denver, Colo.; John S. Conway, petroleum engineer, Frank E. Federspiel, geologist, Arel B. McMahan, mineral specialist, and Raymond B. Stroud, physical science administrator, Bartlesville, Okla.; Melvin E. Hinkle, mining engineer, and Avery H. Reed, physical science administrator, Pittsburgh, Pa.; William R. Barton, supervisory physical scientist, F. Vernon Tompkins, mining engineer, and Doss H. White, mining engineer, Knoxville, Tenn.; William G. Park, physical scientist, Dallas, Tex. Robert G. Hobbs, mining engineer, formerly at Knoxville, Tenn., and Charles C. Yeloushan, mining engineer, formerly at Pittsburgh, Pa., contributed to the initial effort. Coordinator was Harold F. York, supervisory physical scientist, Pittsburgh, Pa.

TABLE 2. - Estimated remaining strippable resources and strippable reserves of coal and lignite in the United States, January 1, 1968, by rank of coal, sulfur category, and coal province--Continued

Rank	Remaining strippable resource	Strippable reserves	Strippable reserves		
			Low sulfur	Medium sulfur	High sulfur
BITUMINOUS COAL--Continued					
Interior and Gulf provinces: ¹					
Arkansas.....	200	149	3	118	28
Illinois.....	18,845	3,247	0	80	3,167
Indiana.....	2,741	1,096	0	293	803
Iowa.....	1,000	180	0	0	180
Kansas.....	1,388	375	0	0	375
Kentucky--west.....	4,746	977	0	0	977
Michigan.....	6	1	0	0	^a 1
Missouri.....	3,425	1,160	0	0	1,160
Oklahoma.....	434	111	10	44	57
Subtotal.....	32,785	7,296	13	535	6,748
Rocky Mountain and Northern Great Plains provinces: ²					
Colorado.....	870	500	476	24	0
Utah.....	252	150	6	136	8
Subtotal.....	1,122	650	482	160	8
Alaska.....	1,201	480	⁴ 480	0	0
Total bituminous.....	62,826	13,597	2,837	2,128	8,632
SUBBITUMINOUS COAL					
Rocky Mountain and Northern Great Plains provinces: ⁵					
Arizona.....	400	387	387	0	0
Montana.....	7,813	3,400	3,176	224	0
New Mexico.....	3,307	2,474	2,474	0	0
Wyoming.....	22,028	13,971	13,377	65	529
Subtotal.....	33,548	20,232	19,414	289	529
Pacific Coast province: ⁶					
California.....	100	25	0	0	25
Oregon.....	0	0	0	0	0
Washington.....	500	135	135	0	0
Subtotal.....	600	160	135	0	25
Alaska.....	6,190	⁴ 3,926	⁴ 3,926	0	0
Total subbituminous.....	40,338	24,318	23,475	289	554
LIGNITE					
Interior and Gulf provinces: ⁸					
Arkansas.....	32	25	25	0	0
Texas.....	3,272	1,309	625	684	0
Subtotal.....	3,304	1,334	650	684	0
See footnotes at end of table.					

See footnotes at end of table.

TABLE 2. - Estimated remaining strippable resources and strippable reserves of coal and lignite in the United States, January 1, 1968, by rank of coal, sulfur category, and coal province--Continued

Rank	Remaining strippable resource	Strippable reserves	Strippable reserves		
			Low sulfur	Medium sulfur	High sulfur
LIGNITE--Continued					
Rocky Mountain and Northern Great Plains provinces:					
Montana.....	7,058	3,497	2,957	540	0
North Dakota.....	5,239	2,075	1,678	397	0
South Dakota.....	399	160	160	0	0
Subtotal.....	12,696	5,732	4,795	937	0
Alaska.....	8	5	5	0	0
Total lignite.....	16,006	7,071	5,450	1,621	0
Grand total United States	117,987	44,986	31,762	4,038	9,186

¹ Bituminous coal resource and reserve not estimated for Texas and Nebraska.

² There may be isolated areas of some seams which might be classed in the medium-sulfur category.

³ Bituminous coal resource and reserve not estimated for Montana, New Mexico, Idaho, and Wyoming.

⁴ 478 million tons of bituminous and 3,387 million tons of subbituminous coal reserves in the northern Alaska fields (North Slope) are included in the estimates even though an economic export market, which is essential for exploitation, does not currently exist.

⁵ Subbituminous coal resource and reserve not estimated for Colorado.

⁶ Bituminous coal resource and reserve not estimated for Washington; the subbituminous coal resource and reserve estimated for Oregon is less than 1 million tons.

⁷ Includes 179 million tons of undifferentiated subbituminous coal and lignite.

⁸ Lignite resource and reserve not estimated for Kansas, Mississippi, Louisiana, and Alabama.

According to Bureau of Mines statistics for 1967 through 1969, an average of 80 percent of the total U.S. coal production (underground, strip, and auger) was mechanically cleaned. The loss in cleaning (refuse) averaged 22 percent of the raw coal entering preparation plants. For the same years, the statistics do not indicate the quantity of strip-mined coal that was sent to cleaning plants, but records do show that an average of 46 percent of total strip-mine production was clean coal, that is, coal leaving preparation plants. By applying this information to future strip production of bituminous and subbituminous coal, the 45 billion tons of raw strippable reserves are reduced to 39.6 billion tons of marketable coal.

Strippable Reserves by Rank of Coal

The 45 billion tons of strippable reserves consists of 13.6 billion tons of bituminous coal, 24.3 billion tons of subbituminous coal, and 7.1 billion tons of lignite (table 2). These reserves and the remaining strippable resources are shown graphically in figure 3. Figure 4 compares the reserves and remaining resource by coal province.

Major reserves of bituminous coal are located in the Appalachian region and the Interior province. In the Appalachian region, only one-fifth of the strippable resource is minable. Much of the rest is unavailable because mining would be in conflict with other land uses. Only a slightly larger proportion is recoverable in the Interior province.

Extensive deposits of subbituminous coal and lignite are located in the Rocky Mountain and Northern Great Plains provinces. Almost 60 percent of the remaining strippable resource is considered strippable reserves in these areas.

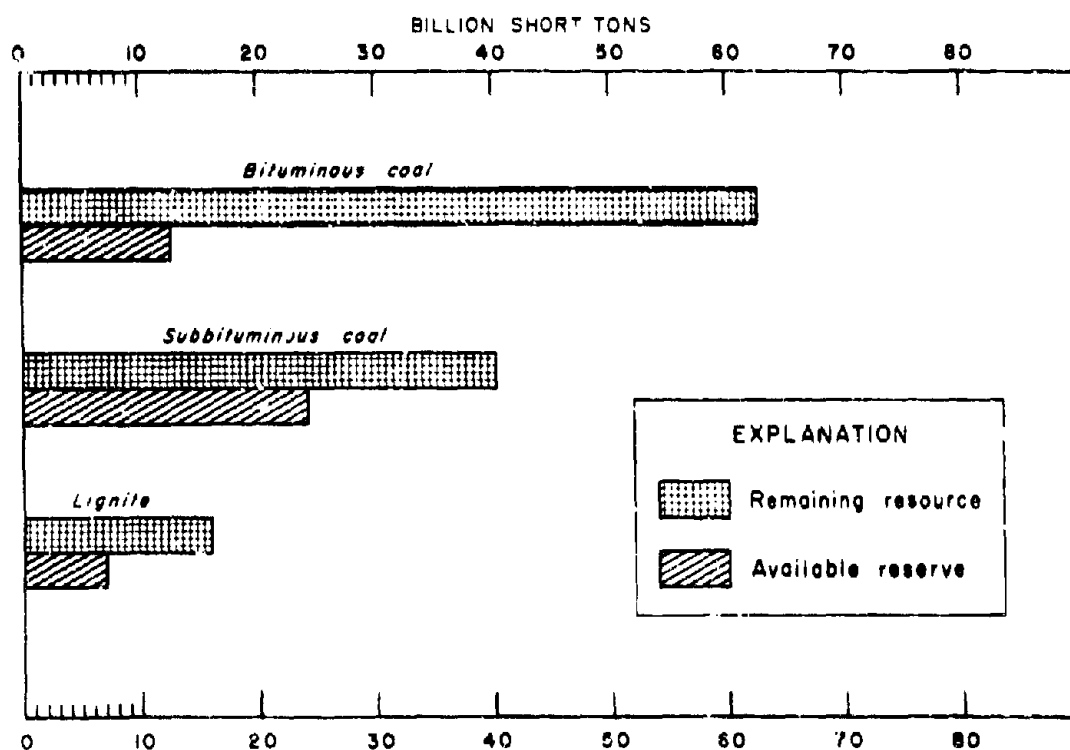


FIGURE 3. - Total Remaining Resources and Strippable Reserves of Coal and Lignite in the United States, by Rank, as of January 1, 1963.

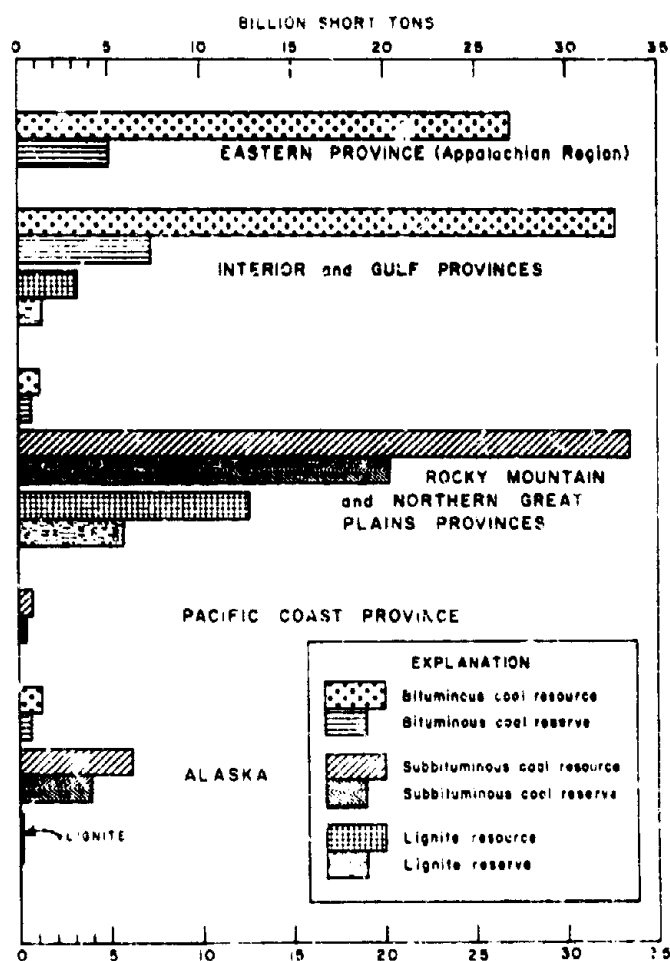


FIGURE 4. - Remaining Strippable Resources and Reserves of Coal and Lignite in the United States by Coal Province as of January 1, 1968.

icated in table 2. Of the total 45 billion tons of strippable reserves, 71 percent is low-sulfur, 9 percent is medium-sulfur, and 20 percent is high-sulfur coal.

Figure 6 graphically shows total tons of coal by sulfur category and by geographical area. The names of coal seams and their sulfur category by States are given in appendix A.

Large strippable reserves of subbituminous coal are present in Alaska, while considerable reserves of lignite occur in the Gulf province. The Pacific Coast province has few reserves of coal, regardless of rank.

Strippable Reserves by Coal Provinces

Reserve data for the Nation are summarized by coal province and rank of coal in table 2 and figure 5. The largest concentration, 59 percent of the Nation's 45 billion tons of strippable reserves, is in the Rocky Mountain and Northern Great Plains provinces. The second largest concentration, 19 percent of the reserves, is in the Interior and Gulf provinces. Twelve percent of the reserves is in the Appalachian region, and 10 percent is located in Alaska. The Pacific Coast province has only 0.4 percent of the total strippable reserves.

Strippable Reserves by Sulfur Content

Strippable reserves of low-, medium-, and high-sulfur coal by rank and geographical area are indicated in table 2.

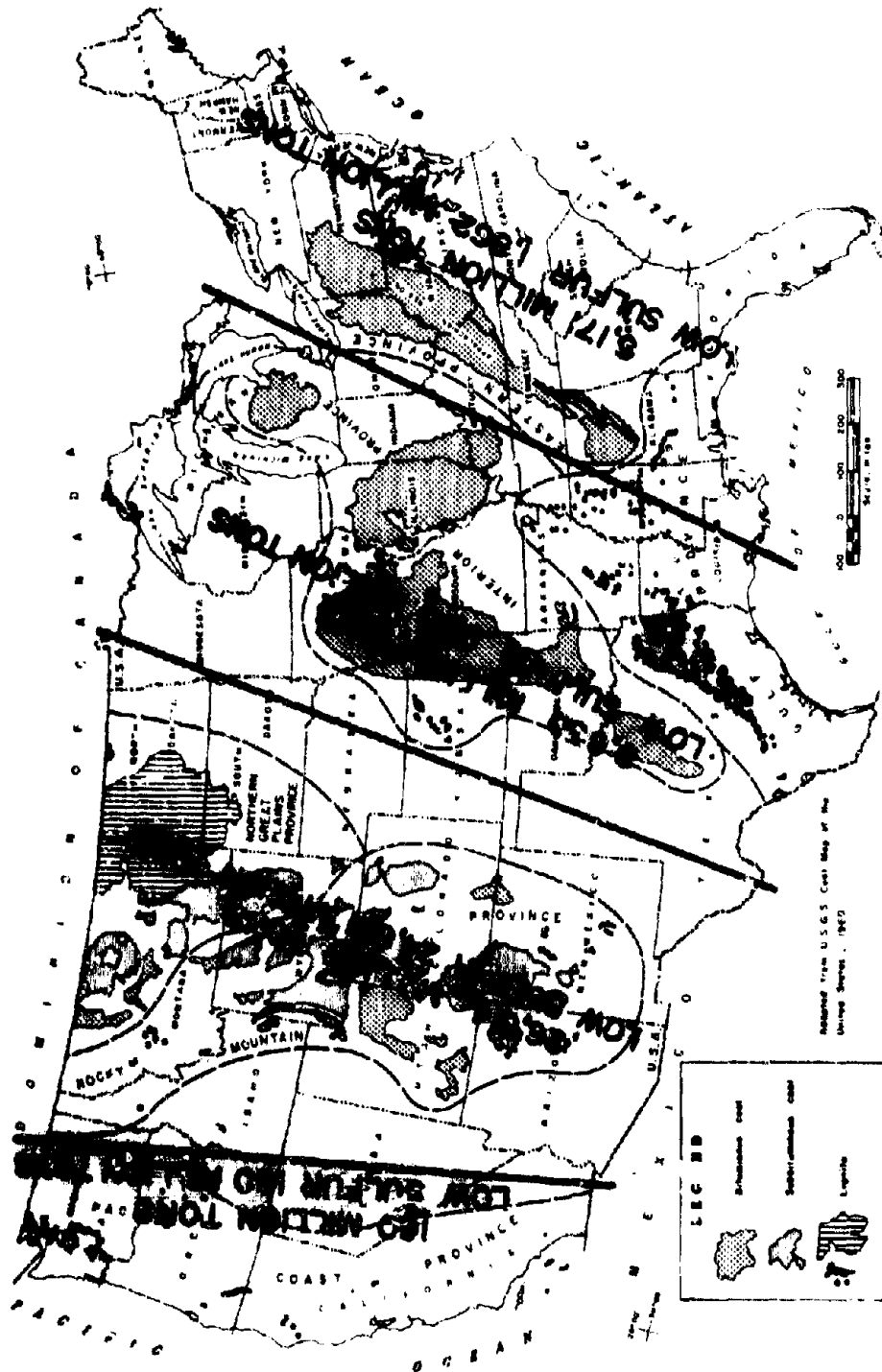


FIGURE 5. - Strippable Reserves of the Conterminous United States, by Region.

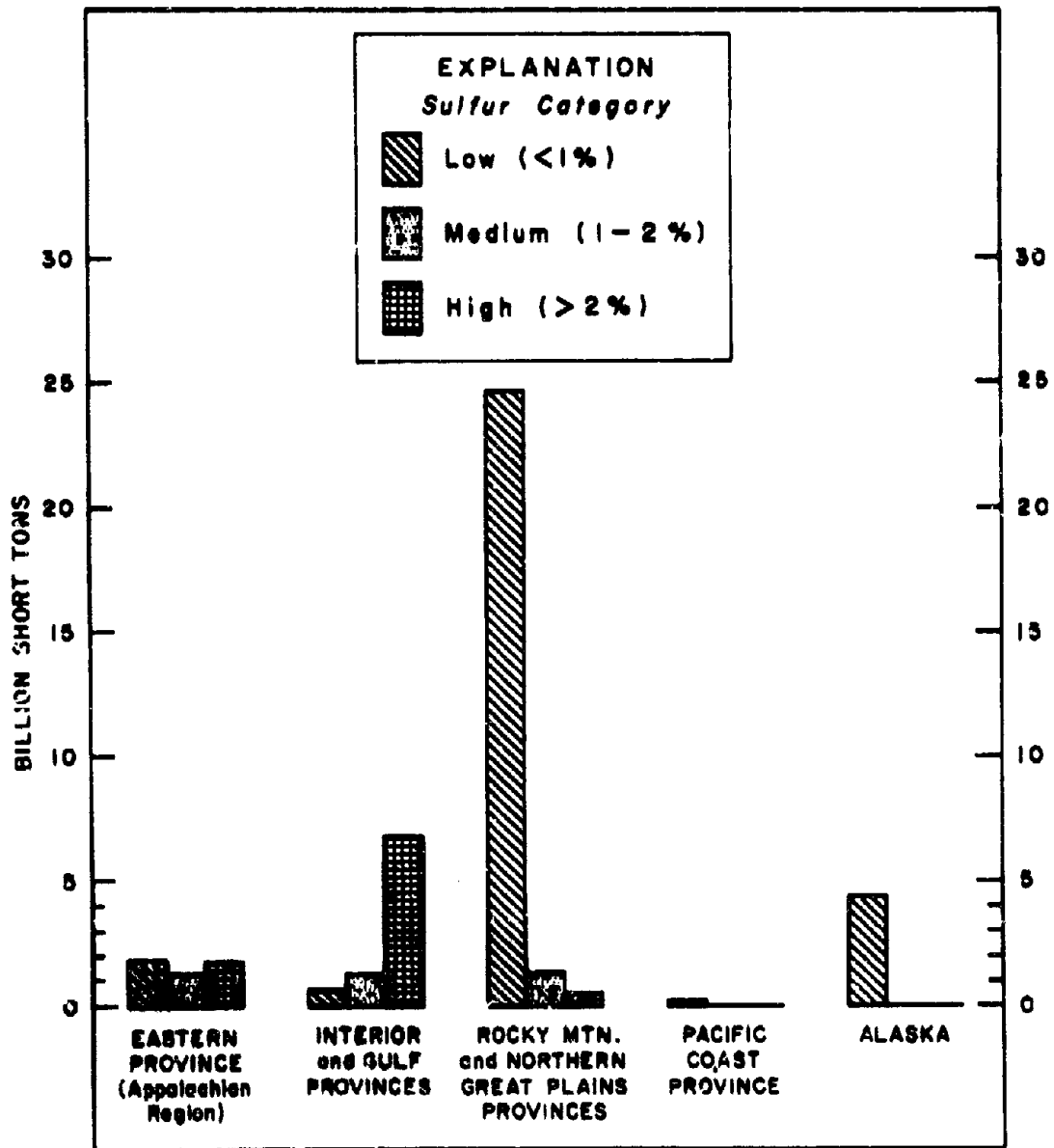


FIGURE 6. - Strippable Reserves of Coal and Lignite in the United States by Sulfur Category as of January 1, 1968.

Low-Sulfur Coal

Almost three-fourths of the 31.8 billion tons of low-sulfur reserve is subbituminous in rank, 17 percent is lignite, and 9 percent is bituminous coal.

Over 80 percent of the total of 23.5 billion tons of low-sulfur subbituminous coal is in the Rocky Mountain and Northern Great Plains provinces, with almost 70 percent (13.4 billion tons) in Wyoming. Most of the remainder is in Montana, New Mexico, Arizona, and Alaska. Because of weather conditions, strip mining much of the Alaska reserve would be extremely difficult except for a relatively brief period each year.

Although there are extensive deposits of lignite in Texas, 85 percent of the Nation's low-sulfur lignite reserve of 5.5 billion tons is in Montana and North Dakota. Lesser amounts are in Arkansas, South Dakota, and Alaska.

Of the total low-sulfur bituminous coal reserves of 2.8 billion tons, 66 percent is in the Appalachian region, 17 percent in the Rocky Mountain and Northern Great Plains provinces, and 17 percent in Alaska. The Interior province has less than 1 percent of the Nation's low-sulfur stripable reserves.

The low-sulfur bituminous coal in the Appalachian region, totaling 1.9 billion tons, is found in five States--Alabama, eastern Kentucky, Tennessee, Virginia, and West Virginia. West Virginia has an estimated 1.1 billion tons, or about 61 percent of that region's and 4 percent of the Nation's low-sulfur reserve. Eastern Kentucky has the next largest reserve, estimated at 532 million tons. The remaining 192 million tons are located in Alabama, Tennessee, and Virginia.

The Rocky Mountain province States of Colorado and Utah have an estimated 482 million tons of low-sulfur bituminous coal. An additional estimated 480 million tons are in Alaska. The reserve of 13 million tons in the Interior province is not considered large enough nor sufficiently concentrated to support a large-capacity mine.

Medium-Sulfur Coal

Sixty-seven percent of the 2.1 billion tons of medium-sulfur bituminous coal reserve is concentrated in the Appalachian region. Almost one-half of the Appalachian reserve is in West Virginia. Other States with significant stripable reserves of medium-sulfur bituminous coal include Pennsylvania and Kentucky with 223 million and 189 million tons, respectively.

The Interior province contains the second largest concentration of medium-sulfur bituminous coal reserves, 535 million tons. Indiana has over half of this reserve.

Most of the 289 million tons of medium-sulfur subbituminous coal reserve is in Montana, 224 million tons; the remaining 65 million tons is in Wyoming.

Almost one-half of the 1.6 billion tons of medium-sulfur lignite is located in Texas, 684 million tons; Montana and North Dakota have 540 million tons and 397 million tons, respectively.

High-Sulfur Coal

Nationally, there is a total strippable reserve of 9.2 billion tons of high-sulfur coal. Bituminous coal accounts for 94 percent, 8.6 billion tons, of the total; subbituminous reserves consist of 529 million tons; and there are no reserves classified as high-sulfur lignite. Illinois has the largest concentration of strippable high-sulfur bituminous coal reserves, nearly 3.2 billion tons. Over a billion tons are to be found in Missouri, and almost a billion tons in both western Kentucky and Indiana. Only Utah in the Rocky Mountain area has any significant tonnage of high-sulfur bituminous coal, 8 million tons.

The strippable reserve of high-sulfur subbituminous coal is 529 million tons, all of which is located in Wyoming.

Strippable Coal Reserves by State

Four States account for 57 percent of the strippable reserves of bituminous coal in the conterminous United States and Alaska; 24 percent is located in Illinois, 16 percent in West Virginia, 9 percent in Missouri, and 8 percent in Indiana (table 3).

Of the 24.3 billion tons of subbituminous coal reserve, 57 percent is located in Wyoming, 14 percent in Montana, and 10 percent in New Mexico. Sixteen percent, or nearly 4 billion tons, is in Alaska.

Practically all of the strippable lignite is in Montana, North Dakota, and Texas.

The tables in appendix A give by States the average coalbed thickness and resources and reserves by seam and by county.

Many factors within a State influence the availability of strip coal, causing a considerable reduction from the remaining strippable resource to the strippable reserve. Included is the urbanization of the land, particularly in the eastern and midcontinent regions. Associated with urbanization is the influx of highways, railroads, airports, and other features which tend to reduce the amount of coal-bearing lands available for mining.

Valuable agricultural land is another factor that severely affects the economics of coal production by strip-mining methods, particularly in the Interior province. Restrictive mining laws preclude strip mining under certain surface conditions and affect production economics in others. Some of the most stringent of surface-mining laws apply to areas devoted mainly to grazing or forest land. Current strip-mining laws are summarized in appendix B.

TABLE 3. - Estimated strippable reserves of coal and lignite in the United States, January 1, 1968, by States

(Millions of short tons)

State	Bituminous coal ¹	Subbituminous coal ²	Lignite ³	Total
Alabama.....	134	0	(³)	134
Alaska.....	⁴ 480	⁴ 3,926	5	4,411
Arizona.....	0	387	0	387
Arkansas.....	149	0	25	174
California.....	0	25	0	25
Colorado.....	500	(²)	0	500
Illinois.....	3,247	0	0	3,247
Indiana.....	1,096	0	0	1,096
Iowa.....	180	0	0	180
Kansas.....	375	0	(²)	375
Kentucky--east.....	781	0	0	781
Kentucky--west.....	977	0	0	977
Maryland.....	21	0	0	21
Michigan.....	1	0	0	1
Missouri.....	1,160	0	0	1,160
Montana.....	(¹)	3,400	3,497	6,897
New Mexico.....	(¹)	2,474	0	2,474
North Dakota.....	0	0	2,075	2,075
Ohio.....	1,033	0	0	1,033
Oklahoma.....	111	0	0	111
Pennsylvania.....	752	0	0	752
South Dakota.....	0	0	160	160
Tennessee.....	74	0	0	74
Texas.....	(¹)	0	1,309	1,309
Utah.....	150	0	0	150
Virginia.....	258	0	0	258
Washington.....	(¹)	135	0	135
West Virginia.....	2,118	0	0	2,118
Wyoming.....	(¹)	13,971	0	13,971
Total.....	13,597	24,318	7,071	44,986

¹ Bituminous coal reserves not estimated for Idaho, Montana, Nebraska, New Mexico, Texas, Washington, and Wyoming.

² Subbituminous coal reserves not estimated for Colorado and Oregon.

³ Lignite reserves not estimated for Alabama, Kansas, Louisiana, and Mississippi.

⁴ 478 million tons of bituminous and 3,387 million tons of subbituminous coal reserves in the northern Alaska fields (North Slope) are included in the estimates even though an economic export market, which is essential for exploitation, does not currently exist.

⁵ Includes 179 million tons of undifferentiated subbituminous coal and lignite.

An undetermined portion of the total strippable reserves are "captive" owned and are not available for sale in the open market. According to 1967 statistics of production by the 50 biggest bituminous underground and strip

mines in the United States, "captive" coal produced at these mines amounted to only 2.8 percent of the national total production of bituminous coal and lignite (115).

LOW-SULFUR BITUMINOUS COAL

The Nation's strippable low-sulfur coal reserves are estimated to total 31.8 billion tons. Of this, only about 9 percent, 2.8 billion tons, consists of bituminous coal. Subbituminous coal and lignite account for the other 29 billion tons. Practically all subbituminous coal and lignite strippable reserves, over 92 percent, are low sulfur. Only 21 percent of the 13.6 billion tons of total strippable bituminous coal reserves are low sulfur, the rest being medium and high sulfur.

The largest part of the 2.8 billion tons of total strippable low-sulfur bituminous coal reserves, over 65 percent, is in the Appalachian region. Almost all of the remaining strippable low-sulfur bituminous coal reserves are evenly divided between the Rocky Mountain province (Colorado and Utah) and Alaska.

The 1.9 billion tons of low-sulfur bituminous coal in the Appalachian region is located in five States--Alabama, eastern Kentucky, Tennessee, Virginia, and West Virginia. About 61 percent of these reserves are in West Virginia, followed by eastern Kentucky with almost 30 percent.

In the discussion that follows, the major coalbeds and counties in each State having low-sulfur bituminous coal reserves are identified. The major counties having the largest reserves are then followed by the low-sulfur coalbeds that are strippable in each county.

West Virginia

West Virginia's 1,138 million tons of strippable low-sulfur bituminous coal occurs in 28 minable coalbeds spread through 20 central and southern counties of which almost 94 percent is included in 13 southern counties. Sixteen of the coalbeds contain only low-sulfur coal. The other 12 coalbeds may present a selective mining problem as they also contain medium- and high-sulfur coal.

The 16 coalbeds having only low-sulfur coal contain 53 percent of the West Virginia total low-sulfur bituminous coal reserves. Four coalbeds--the Lower Kittanning (203 million tons), the Stockton (115 million tons), the Coalburg (216 million tons), and the Winifrede (128 million tons)--contain 58 percent of the low-sulfur reserve, in addition to medium- and high-sulfur reserves. These four coalbeds crop out and are available for strip mining in 13 central and southern counties of the State. In the southern counties, Boone County has the largest reserves of low-sulfur coal estimated at 275 million tons, followed by Mingo and Logan Counties at 146 and 124 million tons, respectively. Raleigh and Kanawha Counties have 109 and 103 million tons, respectively. These five counties have over 66 percent of the State's low-sulfur reserves. Coalbeds containing low-sulfur coal reserves in each of the five above-named counties are as follows:

<u>Coalbed</u>	<u>Reserves</u> <u>(million tons)</u>	<u>Coalbed</u>	<u>Reserves</u> <u>(million tons)</u>
Boone County:		Raleigh County:	
Lower Kittanning.....	78	Lower Kittanning.....	14
Stockton.....	65	Winifrede.....	23
Coalburg.....	46	Alma.....	8
Winifrede.....	56	Campbell Creek.....	8
Chilton.....	12	Powellton.....	6
Campbell Creek.....	15	Eagle.....	13
Powellton.....	2	Little Eagle.....	6
Eagle.....	<u>1</u>	Sewall.....	4
Total.....	<u>275</u>	Beckley.....	16
Mingo County:		Fire Creek.....	6
Lower Kittanning.....	19	Pocahontas No. 6.....	1
Stockton.....	20	Pocahontas No. 3.....	<u>4</u>
Coalburg.....	47	Total.....	<u>109</u>
Buffalo Creek.....	18	Kanawha County:	
Winifrede.....	3	Coalburg.....	55
Chilton.....	12	Winifrede.....	44
Lower Cedar Grove....	11	Chilton.....	1
Alma.....	6	Powellton.....	1
Campbell Creek.....	<u>10</u>	Eagle.....	<u>2</u>
Total.....	<u>146</u>	Total.....	103
Logan County:			
Lower Kittanning.....	27		
Stockton.....	25		
Coalburg.....	34		
Chilton.....	27		
Lower Cedar Grove....	5		
Campbell Creek.....	<u>6</u>		
Total.....	<u>124</u>		

The Pocahontas group of coalbeds, No. 2 to No. 9, are all low-sulfur beds. They contain an estimated 81 million tons of available strippable coal and are located in seven southern counties of West Virginia--Fayette, Greenbrier, McDowell, Mercer, Raleigh, Summers, and Wyoming.

Eastern Kentucky

Eastern Kentucky has an estimated 532 million tons of strippable low-sulfur bituminous coal reserves located in 16 minable coalbeds in 31 counties. More than 73 percent of the total low-sulfur reserves is concentrated in five coalbeds--Princess No. 3 (42 million tons), Princess No. 4 (64 million tons), Princess No. 3 (137 million tons), Hazard No. 7 (79 million tons), and the Fire Clay (68 million tons). These five coalbeds are located in 23 eastern Kentucky counties. The following five counties have 57 percent of the low-sulfur reserves:

<u>Coalbed</u>	<u>Reserves</u> <u>(thousand tons)</u>	<u>Coalbed</u>	<u>Reserves</u> <u>(thousand tons)</u>
Martin County:		Breathitt County:	
Princess No. 5.....	10,371	Princess No. 5.....	4,244
Princess No. 4.....	24,348	Princess No. 4.....	14,188
Princess No. 3.....	33,680	Hazard No. 7.....	21,785
Haddix.....	9,312	Princess No. 3.....	8,169
Fire Clay.....	2,970	Haddix.....	6,266
Total.....	<u>80,681</u>	Copland.....	93
Pike County:		Total.....	<u>56,745</u>
Princess No. 5.....	70	Harlan County:	
Princess No. 4.....	2,219	Princess No. 4.....	807
Princess No. 3.....	8,008	Hazard No. 7.....	2,653
Haddix.....	1,323	Princess No. 3.....	9,147
Fire Clay.....	8,139	Haddix.....	689
Upper Elkhorn No. 2.	20,683	Upper Hamlin.....	2,013
Upper Elkhorn No. 1.	6,033	Fire Clay.....	2,163
Lower Elkhorn.....	22,059	Upper Elkhorn No. 2.	9,375
Bingham.....	2,666	Upper Elkhorn No. 1.	8,630
Auxier.....	124	Lower Split of	
Total.....	<u>71,324</u>	Harlan.....	1,341
Perry County:		Lower Elkhorn.....	6,769
Princess No. 4.....	6,837	Total.....	<u>43,587</u>
Hazard No. 7.....	26,816	Grand total.....	
Princess No. 3.....	22,597	310,347	
Haddix.....	1,463		
Fire Clay.....	2,297		
Total.....	<u>60,010</u>		

Other counties having appreciable reserves of low-sulfur coal are Bell, Floyd, Knott, Leslie, and Letcher.

Virginia

Virginia has an estimated 154 million tons of strippable low-sulfur bituminous coal reserves in 27 minable coalbeds. About 55 percent of the reserves is in four coalbeds--Campbell Creek's (Imboden) (12 million tons), Splash Dam (19 million tons), Upper Banner (21 million tons), and Lower Banner (32 million tons). Low-sulfur coal occurs in all six coal-bearing counties of Virginia. The three following counties have 78 percent of the low-sulfur coal reserves:

<u>Coalbed</u>	<u>Reserves</u> <u>(thousand tons)</u>	<u>Coalbed</u>	<u>Reserves</u> <u>(thousand tons)</u>
Suchanan County:		Wise County:	
Cedar Grove.....	1,100	High Splint.....	2,600
Lower Cedar Grove...	1,000	Morris.....	2,200
Splash Dam.....	18,200	Pardee (Parsons)....	4,900
Upper Banner.....	300	Phillips.....	700
Lower Banner.....	18,600	Low Splint.....	2,000
Raven.....	4,600	Taggart.....	2,800
Tiller.....	<u>1,200</u>	Taggart-Marker.....	1,100
Total.....	<u>45,000</u>	Standiford (Lower)..	200
Dickenson County:		Kelly.....	6,100
Clintwood.....	4,900	Imboden (Campbell	
Blair.....	200	Creek).....	10,300
Splash Dam.....	1,100	Blair.....	5,000
Upper Banner.....	13,700	Upper Banner.....	3,000
Lower Banner.....	6,000	Lower Banner.....	2,000
Tiller.....	<u>900</u>	Kennedy.....	1,500
Total.....	<u>26,800</u>	Jawbone.....	1,700
		Tiller.....	<u>1,800</u>
		Total.....	<u>47,900</u>
		Grand total.....	119,700

The other three counties in Virginia that have low-sulfur bituminous coal reserves are Lee, Russell, and Taxawall.

Other States

Alabama has an estimated 33 million tons of strippable low-sulfur bituminous coal reserves located in 12 minable coalbeds. The Mary Lee coalbed contains over 20 million tons, or more than 60 percent of the State total. The Mary Lee crops out in the counties of Jefferson, Tuscaloosa, and Walker. Other coalbeds having over 1 million tons of coal reserves are the Johnson, Clements, Helena, Upper Thompson, and Gwin. Low-sulfur reserves occur in six counties. Seventy percent of the reserve is located in Jefferson (7 million tons), Tuscaloosa (3 million tons), and Walker (14 million tons) Counties. Movable low-sulfur coalbeds in the three counties include the Helena, Gwin, and Mary Lee beds in Jefferson County, the Johnson, Clements, and Mary Lee beds in Tuscaloosa County, and the Mary Lee bed in Walker County.

Tennessee has an estimated 5 million tons of strippable low-sulfur bituminous coal reserves occurring in three minable coalbeds. They are the Pewee seam cropping out in Anderson, Campbell, Claiborne, Morgan, and Scott Counties; the Rex seam in Campbell, Claiborne, and Morgan Counties; and the White Oak seam occurring mostly in Fentress County. Campbell and Morgan Counties have about 65 percent of total low-sulfur coal reserves in the State.

Colorado has an estimated 476 million tons of strippable low-sulfur bituminous coal reserves in five minable coalbeds. Over 97 percent is in the Mesa Verde Formation (six seams, 330 million tons) in Routt County, and in the

Mesa Verde Formation (eight seams, 134 million tons) in Moffat County. Other low-sulfur coal occurs in Jackson and Montrose Counties.

Oklahoma has a stripable reserve of 10 million tons of low-sulfur bituminous coal in the Upper and Lower Hartshorne seams.

All of Utah's estimated 6 million tons of low-sulfur bituminous coal reserves occur in the Ferron Formation in the Emery-Sevier Counties area.

Arkansas has an estimated strippable reserve of 3 million tons of low-sulfur bituminous coal in the Upper Hartshorne.

All but 2 million tons of Alaska's estimated 480 million tons of low-sulfur bituminous coal reserves are in the northern Alaska fields (North Slope). Two million tons of reserves are in the Matanuska Field (south-central Alaska).

Because of the noncorrelation and different naming of coalbeds between States, an exact count of the total number of low-sulfur bituminous coalbeds in the United States cannot be determined. However, in the Appalachian region, it is estimated that there are 28 coalbeds averaging 30 inches thick in West Virginia, 27 coalbeds averaging 46 inches thick in Virginia, 16 coalbeds averaging 45 inches thick in eastern Kentucky, 11 coalbeds averaging 32 inches thick in Alabama, and three coalbeds averaging 37 inches thick in Tennessee. In the Interior province, there are two coalbeds averaging 40 inches thick in Oklahoma and one coalbed 18 inches thick in Arkansas. In the Rocky Mountain province, Colorado has five low-sulfur coalbeds averaging 10 feet thick, and Utah has a 5-foot low-sulfur coalbed in one coal-bearing formation.

The average thickness of all low-sulfur coalbeds in the Appalachian region is 48 inches. In the Interior province, the average thickness is 35 inches, and in the Rocky Mountain province, it is 10 feet. These low-sulfur coalbeds range in thickness from 18 inches in Arkansas to 30 feet in Colorado, and nationwide, average 61 inches.

REVIEW OF STATES

Alabama

Production in Alabama reached a peak in 1926 with a total of 21 million tons of coal, followed by a decline during the depression years. After World War II, production was adversely affected by the loss of railroad and domestic fuel markets, but a countering influence grew out of the expanding market for coal by electric utilities. In 1968, Alabama coal production was 16.4 million tons, of which 7.2 million tons, or 44 percent, was produced from 60 strip and two auger mines. However, coal from auger mines was less than 0.5 percent of total production.

Electric utilities provided the major market for coal mined in the State in 1968. Most of the production was used in Alabama, but a small quantity was shipped to Mississippi. During the next decade, utilization of Alabama coal

should conform to present patterns. Electricity derived from atomic fuel is not expected to affect the market of coal for a decade or more.

All coalfields in the State are served by railroads and highways. In addition, the Warrior River flows through the Warrior coalfield, making possible the transport of coal to the electric utility plants along the Warrior-Tombigbee River by barge. In 1968, transportation of strip coal was 73 percent by railroad or barge, and 27 percent by truck. The largest quantity was delivered by railroad.

All coal-bearing strata are of early Pennsylvanian age. Together they cover more than 3,300 square miles. The State's four coalfields are located in the southwestern part of the Appalachian coal region. Fields are located in structural basins, and each is partly bordered on the southeastern edge by a thrust fault. Generally, dip of the strata is steep near the faults but flattens in the basins. This structure limits the amount of coal available for surface mining.

Alabama coalbeds are generally thin, and where thick, frequently carry thick rock partings. Large reserves are committed through "captive" ownership or contract to iron and steel companies and electric utilities. The strip-pable reserves of bituminous coal under less than 120 feet of overburden are estimated at 134 million tons. Tables A-1, A-2, and A-3 show the reserves by seams, counties, and sulfur categories. The prevailing laws that apply to strip mining are summarized in appendix B.

Alaska

Strip-pable reserve estimates totaling 4.4 billion tons under less than 120 feet of overburden were made for the six following Alaskan coalfields: the Northern, Nenana, Broad Pass, Susitna, Matanuska, and Kenai Fields. The Northern Field, where coal is believed to underlie continuously about 30,000 square miles, contains 92 percent of Alaska's estimated total original resource of 130 billion tons. These coals are Cretaceous in geologic age, whereas coals of the other fields are Tertiary. The Nenana and Matanuska Fields, located near Fairbanks and Anchorage, respectively, and served by rail, are the only fields from which sustained production has been made. Total recorded Alaskan production through 1969 is about 20.6 million tons. Production, except for a single one- or two-man stripping operation, ceased during 1967 in the Matanuska Field. Strip production from the Nenana Field continues at the rate of about 670,000 tons per year. Analyses of Alaskan coals indicate that they nearly all fall into the low-sulfur category.

The first coal mine in Alaska was opened in 1855 by the Russians at Port Graham, but the mine was abandoned after only about 10 years of operation. Sustained coal production did not come about until completion of the Alaska Railroad to the Matanuska coalfield in 1916 and to the Nenana Field in 1918.

All Alaskan coal production is by strip mining. The Nenana Field coals are all subbituminous in rank. The greater proportion of Nenana Field coal is burned for power generation in and near Fairbanks, but a considerable amount

is still used directly for space heating and for space heat steam raising in central plants.

The small amount of coal still being produced from the Matanuska Field is hauled to market by truck and is consumed in entirety for space heating purposes. Electric utilities in the Anchorage area that formerly burned Matanuska Field coal have been converted to natural gas.

An export market for metallurgical-quality coking coals, and possibly some steam coal, exists in Japan and possibly elsewhere, but no such exports have taken place, basically owing to the apparent inability to make Alaskan coals economically competitive f.o.b. an Alaskan all-weather port. A factor which may enhance export possibilities is the apparent low-sulfur content of most Alaskan coals.

Some of the bituminous coking coals of Arctic northwestern Alaska (North Slope), where exposed, exhibit simple geologic structure that should be amenable to modern large-scale mechanized mining, either surface or underground; their permanently frozen condition can perhaps be used advantageously in the mining system. The greatest problem of exploitation is transport of the coal to an ice-free harbor for export. The Arctic Ocean near the coal deposits has only about 90 ice-free days per year.

All Alaskan coals that are or have been mined in quantity are Tertiary in geologic age. The Tertiary coals range in rank from lignite to anthracite, the Cretaceous coals from subbituminous to bituminous. Strip mining usually, but with the possible exception of some lignite beds and some northern field subbituminous beds, is confronted with dipping beds and some faulting.

The Tertiary coalfields are much less in areal extent than the northern Cretaceous field, and individual Tertiary beds are characteristically lenticular. Coalbeds of the northern field are believed to be less lenticular, but this premise is based on the observable persistence of more resistant beds rather than on actual knowledge of coalbed continuity.

Coalbed thicknesses vary from a few inches to 50 feet. Nenana Field subbituminous beds currently being strip-mined are 25 feet and 50 feet thick and dip about 55°. A group of eight formerly mined Matanuska Field bituminous beds range in individual thickness from 3 feet to 16 feet, comprising a total coal thickness of about 50 feet within a total strata thickness of about 200 feet dipping approximately 40°. Coal burning ceased during the 1960's when Barrow was granted permission by Congress to use natural gas from a field just outside Barrow in Naval Petroleum Reserve No. 4.

Alaska has not enacted strip mining laws. Probably, when large-scale strip mining becomes imminent, regulations will be issued to control surface damage and to enforce reasonable reclamation practices.

A summary of the strippable coal resources and reserves is shown in tables A-4 and A-5.

There are no privately owned coal lands in Alaska; they all are either Federal Government or State held lands to which the leasing laws apply. State leasing laws are similar to the Federal laws. The Federal law is summarized in appendix B.

Arizona

Prior to 1970 there was no commercial strip coal mining in Arizona. However, the expanding southwestern market for electric power and the competitive position of coal for this energy market has led to the development of strip mining in the Black Mesa coalfield in the northeast corner of the State. Production is expected in 1970 from a new 3-million-ton-per-year strip mine. Based on delivery contracts made, or under negotiation, production for the next 40 years is expected to range from 5 to 10 million tons per year.

A shortage of cooling water in or near the Black Mesa coalfield restricts its development for local power generation. Black Mesa coal will therefore be shipped to powerplants located along the Colorado River. One plant under construction near Bullhead City, Nev., will be supplied through a 273-mile coal-slurry pipeline; a proposed plant at Page, Ariz., would receive its coal by unit train via a proposed 80-mile railway from Black Mesa.

Competition in the market for Arizona coal is provided by extensive coal deposits in New Mexico and Utah. However, Black Mesa coal has the advantages of closer proximity to the southern California energy market, higher Btu value than New Mexico coal, and presumably lower mining cost than southern Utah coal, which is expected to be mined almost exclusively by underground methods. Coal in the Black Mesa Field is believed unsuitable for coking purposes and probably will be used exclusively for electric power generation.

Commercial seams lie in the Dakota and Mesa Verde Formations of Cretaceous age. Seam thicknesses average between 4 and 22 feet, and for the most part coal seams dip approximately 2°. Owing to the extreme lenticularity of individual seams, difficulty is encountered in seam correlation and estimation of the volume of resource. Strippable reserves of subbituminous coal, under less than 130 feet of overburden, have been estimated at 387 million tons. (See tables A-6-A-8.)

The general requirements of the State's strip mining law are shown in appendix B.

Arkansas

The bituminous coalfield in Arkansas is located in the west-central part of the State. The coalfield is approximately 33 miles wide by 60 miles long and occupies parts of seven counties. All the coalbeds are in the lower part of the Pennsylvanian System. Economically significant low-volatile bituminous coal, low in ash, is found in the McAlester and Savanna Formations.

Four coal seams over 14 inches thick and covered by less than 60 feet of overburden originally contained a total of 231.3 million tons of coal (68).

These seams, Lower and Upper Hartshorne, Charleston, and Paris, are the only ones considered to be of economic significance, even though over 19 coalbeds are known in the Arkansas coalfields.

Principal uses of Arkansas coal have been for domestic heating, fuel for smelters, steam generation, and coke. Coke currently is the major use. Because of the relatively low ash content and high heat value, Arkansas coals are adaptable for use as a blend in making metallurgical coke.

Transportation from mine to consumer is almost entirely by rail. Recent completion of the Arkansas River Navigation Project may cause increased coal production in both Arkansas and Oklahoma because of lower transportation costs.

Arkansas contains significant deposits of lignite located in the southern and northeastern parts of the State within the Gulf province. Beds of lignite have not been named individually; however, most are found in the Wilcox, Claiborne, and Jackson Groups of the Tertiary System. Many individual beds are present in each group, and many of these are thin and lenticular, with little or no commercial value. Strippable reserves in the Wilcox Group are 21.6 million tons, which constitute over 85 percent of the State's reserves.

Sulfur content usually is less than 1 percent by weight. Heat values range from 2,770 to 7,560 Btu per pound.

Lignites in Arkansas have been used to make montan wax, dye, distilled oil, and locally, for heating. Currently no lignite is being mined except locally as a heating fuel.

Estimated strippable reserves of bituminous coal and lignite in Arkansas total 174 million tons. Of this, 149 million tons of bituminous coal is under less than 60 feet of overburden; and 25 million tons of lignite is under less than 100 feet of overburden.

Tables A-9-A-11 show the reserves by seam, county, and sulfur category.

No strip mining laws are currently in effect.

Colorado

Strip-coal mine output in Colorado increased from insignificance through World War II up to the 1968 total of 1.8 million tons. Most of this tonnage was by three relatively large strip-mine operators in Routt County, ranking it first among Colorado's 14 coal-producing counties. The only other significant strip-coal producers in Colorado are one each in Mesa and Montrose Counties.

Electric utilities in the population centers of eastern Colorado use most of the coal output. Only a relatively small share of the Plateau strip coal production of western Colorado is burned locally by electric utilities.

The most significant strip-coal production in the Rocky Mountain province of Colorado was in the Jackson County intermountain basin of North Park. Intermittent coal production, from 1909 until the latest of the abandonments in 1963, totaled about 2 million tons from the strip and underground mines in the Coalmont coalfield (67) in the southwestern part of the park, and from the underground mines about 20 miles eastward in the McCallum anticline coalfield (21).

Much of the North Park coal was used locally or by the railroads. With no such demand remaining, any future production would be handicapped by the severe winters and the lack of any feasible transportation route, except by rebuilding the 200-mile spur railroad to Laramie, Wyo. Additionally, there is the competition for coal markets being filled by recently developed, low-cost, strip mining in Wyoming.

Six counties of eastern Colorado (Adams, Arapahoe, Boulder, Elbert, El Paso, and Weld) in the Denver basin have production records back to 1887. Desultory small-scale mining took place some years ago in underground and strip-mined areas where the coal is near the surface. The coal seams are lenticular and lignitic in some places about 15 miles east of Denver. These seams extend on a southward trend through Adams, Arapahoe, and Elbert Counties. The most significant underground and strip mine production (until the latest closedown in 1963) was in the subbituminous coal near the terminus of that southward trend at Franceville. Here the coalbed flanks upward against the Rocky Mountain uplift in the Colorado Springs coalfield of El Paso County.

No commercial strip-coal reserves were computed for any of the Denver Basin coalfields in eastern Colorado. The large reserves in the Boulder-Weld County coalfield are too deep. The large resources in Stratford, Lost Creek, and Ramah-Fondis coalfields of Adams, Arapahoe, and Elbert Counties are unavailable. The U.S. Air Force Academy has taken over the coal-bearing lands north of Colorado Springs, leaving only modest reserves in the Franceville coalfield.

The largest commercial stripping coal reserves in Colorado are tentatively computed for Routt, Moffat, and Montrose Counties in the western Plateau coal province, and in North Park, Jackson County, in the Rocky Mountain province.

Owing to the hard sandstone that envelopes some Colorado coalbeds, particularly in the western Plateau province, cutoffs used were a maximum of 50 feet of overburden or a 10-to-1 stripping ratio, a minimum coalbed thickness of 5 feet, a minimum of 12,000 Btu per pound of coal, and a low sulfur content.

The bituminous strip-coal reserves are estimated at 500 million tons. The details are shown in tables A-15-A-17. Strip mining laws are summarized in appendix B.

Illinois

The coalfields of Illinois are the State's most valuable mineral resource (130). Covering almost 43,000 square miles, this is the largest coal-producing area in the United States, and the largest coal area of the eastern Interior province (fig. 1). Exclusive of the anthracite production in Pennsylvania and the coal-producing operations in Virginia, this is probably the oldest coal production in the country. From the earliest reported production of 6,000 tons in 1833, production increased steadily to 36 million tons in 1904, and to 65 million tons in 1967, of which 57 percent came from strip mines.

Although few seams of coal in Illinois are thick enough for mining, the State is underlain by seams that are extensive and remarkably continuous. Illinois ranks fourth in coal production, behind West Virginia, Kentucky, and Pennsylvania. However, two of the three largest mines in the United States are located there. In 1967, Illinois led the Nation in strip-coal production.

Over 58 percent of Illinois coal production is consumed within the State. Nearly 70 percent of the output is consumed by electric utilities. Manufacturing and processing industries account for 24 percent, and retail dealers and coke plants each account for 3 percent.

Table 2 shows that Illinois has a remaining strippable bituminous resource of 18.8 billion tons with a maximum overburden depth of 150 feet, but only 3.2 billion tons is currently available for strip mining. At the 1967 rate of strip production, this represents an 88-year supply. Virtually all of this is high-sulfur coal. From the environmental standpoint, a national policy that would restrict the amount of sulfur oxide emissions as stack gas could also severely affect the production of coal in Illinois unless technology affords an efficient method of removing the sulfur through either precombustion cleaning or removal from the stack gas.

Within the foreseeable future, it seems probable that the principal use for Illinois-produced coal will be for electric utilities, with lesser amounts to be shipped to coke and gas plants, retail dealers, and manufacturers.

The coal-bearing formations in Illinois are Pennsylvanian in age and, from the bottom up, are the Pottsville, Carbondale, and McLeansboro (21). They correspond respectively to the Pottsville, Allegheny, and Conemaugh Formations of the Appalachian region. The Pottsville Formation contains the No. 1 coal and all seams below the No. 2 coal. The Carbondale contains all seams from the base of the No. 2 to the top of the No. 6 coal. The McLeansboro Formation contains all coal above the No. 6, of which only the No. 7 coal is important.

Thickness of the Pottsville Formation may range up to 100 feet in northern Illinois and 300 to 1,000 feet in southern Illinois. The Carbondale Formation ranges from about 120 feet in thickness in Fulton County to 400 feet in Saline and Gallatin Counties in the south. The McLeansboro Formation is the uppermost of the Pennsylvanian System and may be as much as 900 feet thick in parts of the State.

Sixteen seams have been identified in the State, but only five, Nos. 1, 2, 5, 6, and 7, are important. Variations in seam thickness and the conditions of the roof are important considerations. Local lenses of clay, sand, or "bone" also contribute to the cost of mining.

In southern Illinois, a hilly section known as the Illinois Ozarks contains some higher rank coals with improved heating values. According to Bement (21) these coals have not been mined because they are too distant from market.

Most Illinois coals range from 10,500 to 11,500 Btu per pound on an as-received basis. In southern Illinois, in Jefferson, Franklin, Jackson, and Williamson Counties, the Btu content ranges from 11,500 to 12,000, and in Saline County and small portions of adjacent counties, the heating value ranges from 12,000 to 13,000 Btu per pound. Sulfur content is generally high, but ranges from less than 1.0 percent to as much as 10.9 percent (32). Most Illinois coals are ranked as high-volatile C. Rank generally increases toward the disturbed belt in southern Illinois where some high-volatile B coals are present. High-volatile A coals are available in Eagle Valley of Gallatin County. Tables A-18 and A-19 show the strippable reserves for Illinois.

Salient features of the Illinois strip mining laws are shown in appendix B.

Indiana

The presence of coal in Indiana was noted as early as 1763 (7). Reportedly, Robert Fulton removed a small amount of Indiana coal for his steamboat Orleans in 1812. By 1832, coal was being mined in several places within the State, and by 1840 it was being transported on the White, Wabash, and Ohio Rivers. Almost 500,000 tons were mined in 1870. Annual production exceeded 30 million tons in 1918 but declined to 18.8 million tons by 1967.

During 1967, 37 of the 48 mines in the State were strip mines with most of the production coming from five counties of which Warrick County was the leader. Eleven cleaning plants processed about 80 percent of the coal. Nearly 65 percent of the coal produced in Indiana is consumed by electric utilities. Forty million tons of coal were used in Indiana during 1967--about 47 percent of which was produced in the State. Coal is imported from several States, but mainly from the Appalachian region.

Table 2 shows the estimated strippable reserves of bituminous coal under less than 120 feet of overburden to be 1.1 billion tons. At the 1967 rate of production this represents a 64-year supply. About 73 percent of this reserve is high-sulfur coal; the remainder is medium sulfur.

Looking to the future, it is anticipated that most of the coal produced in Indiana will be destined for electric utility plants. Most of the imported coal will be converted to coke for use in blast furnaces.

The coalfields of Indiana are on the east side of the Interior province and are generally in the southwestern part of the State, covering about 6,500 square miles. The coal of commercial value is Pennsylvanian in age. In many places the coal-bearing strata are overlain by glacial deposits, particularly in the northern part of the coal-producing area (165). Most of the coal is produced from the Brazil Formation (Upper Pottsville), and from the Staunton, Linton, Petersburg, and Dugger Formations, equivalent to the Allegheny Formation of the Appalachian area.

Four coal seams are present in the Brazil Formation--the Lower Block, Upper Block, Minshall, and Coal II (Upper Minshall). Each averages about 3 feet in thickness. Coal III, or the Seelyville, is the only commercial coal in the Staunton Formation. The Linton Formation contains Coal IIIa which may be thin, and Coal IV, about 4 feet thick. The Petersburg Formation contains Coal IVa, 12 to 18 inches in thickness, and Coal V, 3 to 5 feet thick. The Dugger Formation contains four coal seams: Coals Va and Vb which are both thin, Coal VI which is locally absent, but may reach 6 feet in thickness, and Coal VII, ranging from 2-1/2 to 4 feet thick. Some thin coal seams occur in the overlying Shelburn Formation.

The coal-bearing formations in Indiana lie on the west flank of the Cincinnati Arch. The dip averages 20 to 50 feet per mile toward the southwest. According to Spencer (165) at least 25 coal seams in Indiana may locally attain a minable thickness of 2 feet or more. Seven of these are fairly persistent and have been mined in several places. The largest total reserves are in Coal V, Coal III, and Coal IV.

Coal V contains both the largest total reserves and the largest strip reserves. It averages 5 feet in thickness but may reach 11 feet in local areas. Coal V is ranked as high-volatile C bituminous; Btu content ranges between 11,000 and 13,000. It is a high-sulfur coal, for the most part.

Coal III is considered second in total reserves but ranks third in strip reserves. Also referred to as the Seelyville, it averages 6 feet in thickness and locally contains some cannel coal. Also ranked as high-volatile C bituminous, Coal III is usually high in sulfur, but a significant amount may be considered medium-sulfur coal.

Coal IV (Survant coal) averages 4 feet in thickness but attains a maximum of 7 feet. Ranked as high-volatile C bituminous, Coal IV is relatively low in sulfur content compared with other Indiana coals. It is generally classified as medium- to high-sulfur coal.

Coal VII ranks second in strippable reserves. It ranges from 30 to 72 inches thick. It is medium to high sulfur, and is low in ash.

Production of coal by strip mining was first recorded in 1917, and by 1924-25, Indiana led the Nation in tonnage of strip-mined coal. In 1967, 91 percent of the production was recovered by stripping. The details of the strippable reserves, by seam, are shown in table A-20. Table A-21 gives the details by county. Sulfur content, by seam, is shown in table A-22. The strip mining laws of Indiana are summarized in appendix B.

Iowa

The mining of coal in Iowa dates back to 1840 when early settlers utilized coal from outcropping beds for domestic fuel. By 1890, coal mining was a major industry in the State, with production reaching a peak of 9 million tons in 1917 (20). It has steadily declined, amounting to less than 1 million tons in 1967.

Over three-fourths of the Iowa coal production is used in electric powerplants. Of the total State production from five underground mines and 12 strip mines, 70 percent is shipped by rail and the remainder by truck.

In Iowa, the coal-bearing rocks are Pennsylvanian in age, covering about 20,000 square miles. Much of the surface material covering the State is glacial debris. The presence of these glacial deposits, and their water-bearing nature, has adversely affected coal mining.

Coal is present throughout most of the Pennsylvanian, but seams of economic importance occur only in the Wabunsee Group of the Virgil Series, and the Marmaton and Upper and Lower Cherokee Groups of the Des Moines Series. Three coals are recognized in the Wabunsee Group, but only one is of commercial importance.

The Des Moines Series make up the lower part of the Pennsylvanian System in Iowa. The Marmaton Group of this series contains four named coal seams. The Cherokee Group contains a series of relatively thick coal seams although they are not continuous over large areas. Six named coal seams occur in the Upper Cherokee, and eight in the Lower Cherokee.

Most Iowa coal is ranked as high-volatile C bituminous. Virtually all Iowa coal has in excess of 2 percent sulfur.

Tables A-2J-A-25 show unassigned strippable reserves of 180 million tons, all of which is considered high sulfur. A summary of the strip mining laws, as they pertain to Iowa, is shown in appendix B.

Kansas

The early history of bituminous coal mining in Kansas is not complete, but according to available information, one of the first coal mines to open was in Leavenworth County near Leavenworth, Kans., in 1854 (38). The first coal mines were shallow pits or short drifts constructed near the outcrop of a coalbed in the Lawrence Formation of the Pennsylvanian System. The first commercial mine of importance was opened near Fort Scott, Kans., in 1865. The mine was developed in the Mulky coal near the top of the Cherokee Shale. Much of the production was consumed by a railroad company. No records are available of coal produced prior to 1890.

During the 1900's large-scale stripping operations were extended westward from Missouri into Kansas. By 1960, strip-mining operations in Cherokee and Crawford Counties had increased. The Mineral, Fleming, and Bevier coals in

the counties are currently being strip-mined. In 1968, 1.3 million tons of coal were produced, all of which was mined at four strip operations.

Steam-electric generation plants constitute the main market for coal. Transportation of coal is mainly by railway. Demand is expected to increase with the completion in 1973 of a coal-fired mine-mouth powerplant near the town of La Cygne in eastern Kansas. This plant will be supplied from nearby surface mines in Linn County.

Bituminous coalfields in eastern Kansas are a part of the Interior province. The coals are located in strata of Pennsylvanian age.

The recoverable strippable resource is estimated to be 526 million tons, of which the strippable reserves are 375 million tons.

Lignite occurs in the Dakota Formation, Cretaceous age, in north-central Kansas. The Dakota Formation is exposed across the central part of the State in a north-south belt about 175 miles wide. Lignite is known in 19 counties in seams ranging from 2 inches to 12 feet in thickness. The seams outcrop at the surface and in some areas extend to a depth of 160 feet.

Production of lignite has been variously recorded from 12 counties between 1875 and 1940. The last production was reported from Cloud County in 1940 by underground and surface methods. The strip-mined seams ranged from 12 to 40 inches in thickness.

The lignite was used for domestic heating purposes and fuel for railroad locomotives. The quality of Kansas lignite is not well known, but available analyses indicate that it ranges from low to high in sulfur content; air dried samples contained from 0.48 to 6.28 percent sulfur. The calorific value ranges up to 7,290 Btu per pound.

The Kansas Geological Survey estimates the original reserves of lignite in 12 counties to be 198 million tons. A comprehensive evaluation of the strippable lignite in Kansas cannot be made on the basis of available data. However, limited data suggest that the lignite is a potential future source of fuel for energy requirements.

Tables A-26-A-28 show the bituminous coal reserves by seam, county, and sulfur content. Those laws pertaining to strip mining are summarized in appendix B.

Kentucky

Coal occurs in two separate areas, the eastern coalfield of the Appalachian region and the western coalfield of the Interior province. The contrasting topography of mountains in eastern Kentucky and flat-to-undulating country in western Kentucky has resulted in a difference in mining and transportation of coal from these fields. Currently, the greatest difference is the economics of area strip mining in the west and contour strip mining in the east.

Annual production of coal first reached 1 million tons in 1880, 10 million tons in 1907, and 100 million tons in 1967. Production in 1968 was 101 million tons of which 40.5 million tons was strip mined; western Kentucky produced 71 percent of the State's surface-mined coal. Kentucky was second in the Nation in 1967 in strip-coal production.

The major market for coal from Kentucky surface mines is electric utilities; minor markets include industrial use and space heating. In 1968, 83 percent of the strip coal was hauled by railroad or barge, while the balance was moved by truck. Part of the coal moved by truck was hauled a relatively short distance from the mine and used by the Tennessee Valley Authority for electric power generation.

Construction of additional nuclear-fueled powerplants may eventually reduce the new markets of coal for electric utilities. However, an increase in demand is expected for the next decade or more, based on requirements of present and scheduled coal-fired electric-generating plants. Future coal production rate may also depend on metallurgical demand and on a potential demand for products derived from coal; the rate of surface mine production may also be affected by an increasing concern for conservation and environmental pollution.

Coalbeds in both eastern and western Kentucky occur in strata of Pennsylvanian age. Beds in eastern Kentucky dip gently in an easterly or southeasterly direction, while the attitude of the beds in western Kentucky is generally flat to gently dipping. The two coalfields are separated by the Cincinnati Arch. Strip-coal reserves under less than 120 feet of overburden are estimated at 781 million tons in eastern Kentucky and 977 million tons in western Kentucky.

Strippable resources and reserves for eastern Kentucky are shown in tables A-29-A-31. Similar data for western Kentucky are shown in tables A-32-A-34. Kentucky's strip-mining laws are summarized in appendix B.

Maryland

Coal was first discovered near Frostburg at least as early as 1782, but the first shipments were not made until 1820 when small amounts were barged down the Potomac River. The output of Maryland coal increased with the completion of the Baltimore and Ohio Railroad in 1842, and of the Chesapeake and Ohio Canal in 1850.

During 1967, 53 mines, including 19 underground, 31 strip, and three auger, produced 1.3 million tons of bituminous coal. Since the earliest recorded production, over 276 million tons of coal have been produced. The year of greatest production was 1907, when 5.5 million tons were produced. Slightly more than one-half of Maryland production is moved by rail and the remainder by truck.

Most of the coal production from the Georges Creek Field in Allegany and Garrett Counties has been from the Pittsburgh (Big Vein) and Sewickley (Tyson)

coalbeds. Depletion of these seams will contribute to a declining output of coal in Maryland unless the deeper coal horizons are developed (189). The lower coals are low-volatile bituminous, suitable for blending in the manufacture of metallurgical coke and other industrial purposes. Sulfur content of Maryland coals is relatively high, ranging from 1.8 to 4.5 percent.

The coalbeds in the Georges Creek Basin are in a broad, flat, synclinal basin. The strata dip as much as 15° where the coal crops out on the flanks of the basin, but are flat, or nearly so, near the axis. Core drilling in the area by the Bureau of Mines established the presence of 13 coal seams in addition to the two previously mentioned. Three of the 13 seams are thin or irregular and therefore are not likely to be mined commercially; included are the Federal Hill coal, the Brush Creek coal, and the Mount Savage coals. As shown in tables A-35-A-37, 10 seams contain an economically strippable reserve under less than 120 feet of overburden, of 21 million tons, 60 percent of which is regarded as high-sulfur coal. The balance is medium sulfur. Btu content is variable, but on a dry basis ranges from 11,680 per pound for a sample taken from the Mount Savage seam to over 15,000 for a sample from the Lower Freeport (189).

Some Maryland coals are strongly coking. Coal from the Pittsburgh seam was coked in beehive ovens during the 19th century. Much of the Pittsburgh seam has since been depleted. The Barton seam is persistent but is high in ash content. The Harlem seam locally may be too thin. The Upper Bakerstown seam is generally high in ash and sulfur, but the Lower Bakerstown seam has excellent coking properties. The Upper Freeport seam likewise has fine coking properties, either singly or blended. The Upper and Lower Kittanning beds may be high in ash and sulfur, but both have been used to produce metallurgical coke.

Recorded production from strip mining activities in Maryland began in 1943. Production has ranged from 100,000 to a record high of 880,000 tons per year set in 1967. While recorded strip production is just over 10 million tons, it is estimated that total strip depletion may have been as much as 13 million tons as of January 1968.

The salient features of the Maryland strip mining laws are shown in appendix B.

Michigan

The first recorded production of coal in Michigan dates from 1860. Coal mining became important in 1897 with the opening of mines in Bay and Saginaw Counties. During 1907, the peak year of production, 2,036,000 tons were produced. Production has generally declined since.

The coalfields of Michigan are Pennsylvanian in age and are located on the east side of the Michigan Basin. The coal occurs sporadically in isolated beds of variable thickness that pinch out within relatively short distances.

The coal-bearing strata cover about 11,500 square miles in the central part of the Southern Peninsula. The beds are essentially flat lying, dipping toward the center of the basin at an average rate of 20 to 30 feet per mile, reaching a maximum depth of 960 feet below the surface (35). Overlying the Pennsylvanian rocks are patches of unconsolidated sediments overlain by thin to thick deposits of glacial drift. In the southeastern part of the Michigan coal basin the glacial drift is thin or absent where the coal is near the surface. This is the area of past strip-mining operations.

All of the coalbeds in Michigan are in the Saginaw Formation which is considered equivalent to the lower part of the Allegheny Formation in the Appalachian Basin. The coalbeds are of limited areal extent and generally too thin for mining. Only three seams are of significance, and these are relatively thin. According to Cohee (35) few of the coalbeds that have been mined in Michigan average over 3 feet in thickness.

Michigan coal is ranked as high-volatile B and C bituminous. Analysis shows the Btu content per pound to range from 10,500 to 12,300. Sulfur ranges from 1 to 3 percent. Michigan coal is generally suitable for domestic and industrial fuel only.

Tables A-38-A-40 show an estimated strippable coal reserve of 1 million tons under less than 100 feet of overburden in Michigan. This is an arbitrary estimate without the benefit of any measured data. There is no doubt that some coal reserves occur in Michigan, but the extent will probably remain unknown pending further exploration. Quite probably, 1 million tons is a conservative estimate.

Michigan at present has no surface mining laws that apply to the strip mining of coal.

Missouri

Production of coal from Missouri was first reported in 1840 with an output of 9,972 short tons. Production increased until 1917 when the annual output reached a peak of nearly 5.7 million tons. Production was from underground mines until 1915, when strip mining by use of steam shovels was introduced. Strip mining began on a small scale, but in 1967 over 99 percent of the State's production was from strip mines.

The minable coal seams in Missouri occur in 400 to 900 feet of strata of Pennsylvanian age. Twelve named coal seams have been strip-mined in the State along with an undetermined number of uncorrelated beds. Fifty-three counties are underlain by minable coal. Twenty-nine counties are underlain by coal that is available for strip mining. The 1968 production of coal was 3.2 million tons, all from strip mines.

The State's coal is used for steam-electric power generation and domestic heating. Some coal from mines in the northern counties is shipped to Iowa for the same uses. Nevertheless, the State imported nearly twice as much coal as it produced in 1968.

The coals of Missouri are ranked from high-volatile A bituminous to high-volatile C bituminous. The heat value of the coal ranges from 10,000 Btu to 14,500 Btu per pound. All the coal is high sulfur, ranging from 2.2 to 8.7 percent in sulfur content.

The total strippable resource is not shown because of insufficient data. Resource estimates are not shown for the coal in Clark County, and resource estimates were not made for the Wheeler coal which occurs in nine counties. Resource estimates for several coals in many counties are conservative because of insufficient data. For 72 occurrences of coals in the counties of Missouri, only 23 afforded analyses. In some cases, the analyses of a coal seam in one county were applied to the coal in several counties.

The strippable coal resource and reserve estimates for the State are shown in tables A-41-A-43. The strippable reserve estimate is 1.2 billion tons.

Missouri at present has no surface mining laws that apply to the strip mining of coal.

Montana

Annual coal-lignite production declined from the World War II high of 4,844,000 tons in 1944 to a 1958 low of 355,000 tons. Production, from eight underground and five strip mines in eastern Montana, has since increased to about 850,000 tons in 1969. Strip mines accounted for over 90 percent of the total 1969 production; over 60 percent of the production was lignite. Nearly all of the lignite and subbituminous coal production was accounted for in the Williston and Powder River Basins in the northern Great Plains coal province.

Strippable deposits of lignite and subbituminous coal in the eastern part of Montana lie in the Tongue River Member of the Tertiary Fort Union Formation. Most of the resources are in beds 20 to 30 feet in thickness; however, seam thicknesses range upward to 85 feet. Deposits range in size from 10 million tons to nearly 2 billion tons; four deposits each contain more than 1 billion tons.

On the basis of pertinent literature and exploratory drilling data available from private sources and Government agencies, total available strip-coal and lignite reserves for 32 deposits were estimated at 6.9 billion tons. All strippable reserves are located in the northern Great Plains province of eastern Montana. No strip-coal reserves were computed for the scattered coal-fields in the central and western parts of the State; these fields are generally located in terrain unsuitable for strip mining. Tables A-44-A-46 show the breakdown of both the subbituminous coal and lignite reserves by seam, county, and sulfur category.

The major market for Montana coal is electric power generation. Plants placed in operation in recent years or under construction will place increased demands on Montana coal. In addition to facilities within the State, Montana coal is expected to fuel a steam-electric plant as far east as Cohasset, Minn.,

by 1973. Most coal is currently transported by unit train, and plans for future exports to Minnesota include unit train transportation.

The general requirements and reclamation requirements for strip-mined coal are summarized in appendix B.

New Mexico

Strip-coal mining in New Mexico has been limited to the west side of the San Juan Basin in the northwest corner of the State. The earliest (1932) strip mines were low-tonnage operations in the vicinity of Gallup; they furnished locomotive fuel to the Santa Fe Railroad. Recently, increased demand for coal by an expanding electric utility market has resulted in the opening of large strip-coal mines. One large mine-mouth powerplant has consumed over 2 million tons per year since 1963 from a nearby strip mine; this is the Four Corners plant, located near the San Juan River in the northern part of the San Juan Basin coalfield.

Strip mines in the southern end of the San Juan coalfield have the advantage of proximity to the east-west trunkline of the Santa Fe Railroad through Gallup to supply electric utilities in Arizona and elsewhere. Coal deposits in the central portion of the coalfield are inconvenient to either the railroad or the San Juan River. (The availability of water is essential to the location of a powerplant.) They are being considered for future coal-gasification and liquefaction mine-mouth plants.

The San Juan Basin continues to provide the entire New Mexico strip-coal production which is expected to increase to 10 million tons per year within the next decade. The far-western utility market for low-sulfur coal may be expected to draw more heavily upon the subbituminous strip-coal deposits in the southern part of the field. However, underground mines to the east in the Raton coalfield are expected to continue to supply virtually all the metallurgical coal and markets other than electric utilities. The Raton coalfield is not believed to hold any potential for strip mining.

Strippable coal in New Mexico occurs as lenticular deposits in the Menefee, Crevasse Canyon, and Fruitland Formations of Cretaceous age. The coal seams dip gently eastward except at the extreme northern and southwestern fringes of the basin where strata are folded into prominent regional monoclines. Of the coal-bearing formations, the Fruitland offers the best prospects for abundant strippable coal. The best coal in Crevasse Canyon Formation is near Gallup where seams thicken and unite. Coal also appears in the overlying Menefee Formation. Elsewhere coal seams in the Crevasse Canyon and Menefee Formations are presumed to be thin, but too little is known to say definitely where strippable potential does or does not exist.

The strip subbituminous coal reserves of New Mexico were estimated at 2.5 billion tons. The details are shown in tables A-47-A-49. General information regarding strip-mining regulation is shown in appendix B.

North Dakota

Production of lignite declined from a peak of 3.3 million tons in 1950 to 2.3 million tons in 1958; it has since risen to 4.5 million tons in 1968. The entire production for 1968 was mined by strip methods at 22 operations in 11 counties in the western part of the State.

Based on data from publications, private companies, and Government agencies, strippable lignite reserves were determined for deposits in 13 Williston Basin counties, all of which are in the northern Great Plains coal province. About two-thirds of the reserves are located in two large deposits on the southwestern flank of the basin with the remainder in smaller deposits on the eastern flank. Lignite beds lie principally in the Tongue River Member of the Fort Union Formation of Tertiary age. They are essentially flat-lying with dips of generally less than 1°. The beds range in thickness from a fraction of an inch up to 25 feet, and there are often two or more beds of minable thickness in a particular area.

The economic limits assumed for strippable reserves include 5 feet minimum thickness, 50 feet of overburden, a maximum stripping depth of 220 feet where multiple seams may be mined, and a minimum heating value of 6,000 Btu per pound. Reserves of uraniferous lignite deposits in southwestern North Dakota may be expected to continue in use only for recovery of uranium (and molybdenum); such deposits have been excluded as strip-lignite reserves. Strip-lignite reserves were estimated at 2.1 billion tons. Tables A-50-A-52 show the details of the lignite reserves of North Dakota. Summarized provisions of the State's strip-mining laws are shown in appendix B.

Ohio

From the time of the earliest settlements, the occurrence of Ohio coal was noted. Strip mining was underway near the village of Talmadge, in Summit County, as early as 1810. Drift mining began about 1820, with the coal being used for blacksmithing purposes. In 1818 coal was shipped to Cleveland to supply the lake steamboats with coal, but wood was so abundant and cheap that it found little sale.

The production of coal in Ohio during 1967 was a record 46 million tons, breaking the previous output of 1920. Sixty-three percent was from strip mines, 33 percent from underground mines, and the remainder from auger mines. Twenty-five counties reported coal production during 1967, led by Harrison and Belmont Counties. Harrison County also led in the production of strip-mined coal. During 1967, Ohio ranked third in the Nation in the output of strip coal. Thirty-two percent of the coal produced from strip mines was cleaned, compared with 67 percent of that produced from underground mines. Almost 30 million tons of Ohio-produced coal was shipped by rail or water, and about 14 million tons was hauled by truck. The rest was consumed locally.

Most of the coal is used for steam generation, but a considerable quantity is consumed in coke plants. The results of this study indicate that 1.03 billion tons of coal are recoverable by stripping. These reserves are in nine

named coalbeds in 25 counties. Of this reserve, 907 million tons are high sulfur and 126 million tons are medium sulfur. There are no stripable reserves of low-sulfur coal.

The greatest reserves are in Noble County followed by Perry, Jefferson, Tuscarawas, and Hocking Counties. By seam, 31 percent of the stripable reserve is in the Middle Kittanning; 21 percent is in the Pittsburgh; 14 percent is in the Sawickley; and 12 percent is in the Upper Freeport. The remainder, 22 percent, is in the Lower Kittanning, Lower Freeport, Clarion, Redstone, and Brookville seams.

Those counties on the northern and western edges of the coal area in Ohio have fewer coal seams than those counties to the south and east. About 10,000 square miles of eastern Ohio are underlain by coal. Most of the coals are of Pennsylvanian age, but there is some minable coal in the Washington Formation of Permian age. Generally the coal-bearing strata dip to the south and east at the rate of about 30 feet per mile.

From the base of the Pennsylvanian upward, the Fittsville Formation contains 12 named coalbeds; the Allegheny Formation has 15 named coalbeds, the Conemaugh Formation also has 13 named coalbeds, and the Monongahela has eight named coalbeds. The Washington and Greene Formations of Permian age contain four and five coalbeds, respectively, but none of the latter are minable. Likewise, many of the Pennsylvanian coal seams also are not minable.

Ohio coals are high-volatile bituminous. Almost without exception, the sulfur content is in excess of 2 percent and frequently exceeds 7 percent.

A summary of Ohio strip-mining laws is shown in appendix B. Tables A-53-A-55 contain the details of the stripable coal reserves of Ohio.

Oklahoma

The presence of coal in Oklahoma was first reported in 1821 by Thomas Nuttall in "A Journal of Travels into the Arkansas Territory." Today, the coal-bearing area of the State is known to extend under 14,550 square miles in 24 counties in the east-central and northeastern parts of the State. The coal occurs in the lower strata of the Pennsylvanian System. Coal-bearing formations consist chiefly of sandstone and shale with some limestone north of the Arkansas River. The formations contain at least 14 workable coalbeds in 16 counties. Thirteen coalbeds are workable by strip-mining methods in 15 counties.

Coal was first mined commercially in the State in the McAlester district in 1872, after the advent of the railroad (176). The coals of Oklahoma have been mined by underground and strip-mining methods, and from 1965 through 1967, by limited auger mining. Reported total production from 1880 through 1967 was 187 million tons.

Strip mining began in Oklahoma on a small scale in 1915, accounting for 0.8 percent of the State's production, and increased until 1967 when over

99 percent of the production was credited to strip mining. Estimated total strip production for the State is 85 million tons.

Oklahoma bituminous coal is used for steam-electric power generation, metallurgical coking, and domestic heating. Coal used for steam-electric generation is shipped to Kansas and Missouri. The coking coal is shipped out of the State.

Transportation of the State's coal is by rail, truck, and oceangoing vessels. Shipment to southern Missouri is made by truck. Coal exported to Japan is shipped to Port Arthur, Tex., by rail in unit train lots. Local markets are supplied by truck.

Table A-56 shows the estimated recoverable strip-coal resource and strip-pable coal reserves of Oklahoma, by county. The recoverable resource is estimated at 147.6 million tons; the strippable reserves are 110.7 million tons. Table A-57 shows the coal resource and the available strippable coal reserves, by seam. Table A-58 shows the available strippable reserves by sulfur category and average seam thickness.

Evaluation of the strippable coal resource of Oklahoma was hampered by insufficient data for use as a basis for estimates. With one exception (175), reports of detailed work on the coals of Oklahoma by county or mining district date from 1926 to 1948. Current mine maps of the strip-mined areas are not available, and much of the outcrop area is not covered by topographic mapping. In three northern counties, containing much of the State's strippable coal, maps are not available. Analyses are not available for some minable coal seams. Areas where data are not available may contain as much strippable coal as has been estimated in this report.

Lignite occurs in the upper strata of the Purgatoire Formation in Cimarron County. The Purgatoire Formation extends across the northwestern part of the county in a belt about 30 miles long and 15 miles wide. The lignite seams are exposed in two areas about 3 miles apart and are traceable for more than a quarter mile. The lignite seams are 18 inches in thickness and are covered by sandstone, shale, and clay.

The lignite has been mined in two places from shallow drifts and a strip pit and was used for domestic heating purposes. The quality of the lignite is not known. Sulfur content of the samples was 0.40 percent and 0.50 percent; heating value was 8,500 Btu and 7,550 Btu per pound (141).

Reserve estimates of strippable lignite were not calculated because of insufficient data.

Laws pertaining to strip-mining coal in Oklahoma were revised (effective January 1, 1968) to include provisions for reclamation of mined lands (128). A summary of the Oklahoma strip-mining law is included in appendix B.

Pennsylvania

Since 1760, Pennsylvania has produced 9 billion tons of bituminous coal. It led the Nation in production until 1927 when it was passed by West Virginia. Since 1960, Kentucky has also produced more coal annually than has Pennsylvania.

During 1967, Pennsylvania produced over 79 million tons of bituminous coal. Of this total, 22 million tons were produced from 517 strip mines. Sixty-two million tons were transported by rail or water, 15 million tons by truck, and the rest by conveyor or other means. Of that coal consumed in Pennsylvania, 45 percent was directed to coke and gas plants, 39 percent to electric utilities, and the rest to other industrial users and dealers.

In western Pennsylvania, the bituminous coalfields cover about 14,200 square miles. By rank, Pennsylvania coals range from high-volatile A bituminous to low-volatile semibituminous. Variations in volatile and fixed-carbon content are quite marked in the same seam but in different areas. Generally, volatile content decreases as the coal measures are traced eastward.

The coals of Pennsylvania are mainly Pennsylvanian in age, but some occur in the Permian as well. The coal assigned to the Mississippian is not significant. While over 30 seams may locally be minable, 20 seams have appreciable reserves of strippable coal. Seam thickness ranges from 34 to 68 inches and averages 43 inches. The coal-bearing strata are nearly horizontal but may be gently inclined up to 200 feet per mile in the western coalfields and up to 400 feet per mile in the fields to the east. Locally, the coals are displaced by faulting.

Table A-62 shows the strippable reserves of bituminous coal in Pennsylvania to be 752 million tons, 70 percent of which is classified as high-sulfur coal. The rest is medium sulfur (table A-64). At the 1967 rate of strip production, this strippable reserve represents less than a 34-year supply. During 1967, Washington County led in production, followed by Greene and Cambria Counties. Of the 517 operating strip mines, Clarion and Somerset Counties had 60 each, followed by Clearfield with 57, Armstrong with 45, and Jefferson with 41 mines.

One-fourth of Pennsylvania's strippable coal reserve is in the Upper Freeport, followed by the Lower Freeport and Lower Kittanning seams. The Pittsburgh seam, said to be the most valuable single mineral deposit in the world, has less than 38 million tons of economically strippable reserves. Butler County leads in strippable reserves, followed by Clearfield and Washington Counties (table A-63).

The Upper Freeport is minable over a wide area. Rank may be high-volatile A or B bituminous. The Lower Freeport is extensively mined in the central part of the State. Partings often tend to reduce the value of the coal. Rank ranges from high-volatile A through high-volatile C. The Lower Kittanning is uniform in thickness and quality and persists over a wide area.

Subsequent to the enactment of the Bituminous Coal Open Pit Mining Conservation Act in 1963, Pennsylvania has pioneered in the fields of restoring strip-mined land and in reducing stream pollution. Separate inspectors have been assigned to the inspection of strip mines, and a uniform inspection and enforcement policy has been established (appendix B).

Tennessee

The construction of railroads through the State's coalfields in the latter part of the 19th century created both a demand for coal and a means of transporting it. After World War II, the coal industry lost two of its major markets, space heating and locomotive fuel, but the demand increased for fuel by coal-fired electric generating facilities.

In 1968, the State's coal production was 8.1 million tons, of which 40 percent was produced at surface mines. The Tennessee Valley Authority (TVA) purchased approximately half of the total production for use in the generation of electricity in eastern Tennessee and northeastern Alabama; a significant quantity was shipped to out-of-State private utilities, and the balance was utilized by the chemical industry and for space heating.

The railroads and the navigable waterways created by the TVA dams have aided economical coal transportation. The reduction in shipping rates resulting from unit train transportation has expanded the market area. More than 1 million tons of coal is shipped annually by unit train from northern Tennessee to a private utility in central Georgia. Coal is barged from loading facilities on the Tennessee River to utilities in the southeastern part of the State and to northeastern Alabama. TVA coal-fired electric generating plants immediately east of the coalfields permit economical truck transportation from the mines to plants.

The future of the coal industry in Tennessee will depend on holding the present utility market and expanding into other markets. Competition from nuclear-fueled generating facilities may preclude the construction of new coal-fired generating plants. However, present demand for utility coal should remain strong until technological advances clearly swing the economic balance to favor the nuclear facilities. After cleaning, most of the coal is suitable for making high-grade chemical and metallurgical coke. An increased demand for coke and the resulting byproduct chemicals could provide an important secondary market.

Tennessee's coalfields are part of the Appalachian coal region. They are located in a belt about 47 miles wide, extending southwesterly across the eastern part of the State. Coal-bearing strata are of Pennsylvanian age. Estimated strip-coal reserves are 74 million tons of bituminous coal. Table A-68 shows these reserves to be in 29 seams averaging 38 inches in thickness. Table A-69 shows the 18 principal counties with strippable reserves. Most of the reserve (58 percent) is classified as medium sulfur, 36 percent is high sulfur, and the remaining 6 percent is low sulfur. Tennessee strip-mining laws are summarized in appendix B.

Texas

Annual Texas lignite production reached 1.4 million tons in 1914. After World War I, production began to decline and continued a downward trend through 1950 when less than 20,000 tons of lignite were mined. Although accurate data have not been available since 1950, production has increased substantially in recent years. Currently, lignite is strip-mined at two locations, in Milam and Henderson Counties, with the material used as fuel in the production of aluminum, and to produce carbon black and coal chemicals. Lignite will also fuel a steam-electric generating plant currently under construction. As demand for energy and chemicals increases, Texas lignites should find more use both as a direct fuel and as a source of chemical products.

Texas lignites are located within the Gulf province in a belt extending northeastward across the State. Deposits are in strata of Tertiary age. Individual seams vary in quality, thickness, and continuity. Seams range up to 20 feet in thickness, but only those seams over 5 feet are considered in reserve estimates. Most of the lignite reserves contain less than 2 percent sulfur, and a large part of the reserves contain less than 1 percent. Calorific values range from 7,000 to almost 9,000 Btu per pound on the as-received basis. Some of the lignite ranks with subbituminous coal, according to ASTM specifications. Available strip reserves of lignite are estimated at 1.3 billion tons.

Estimates have been previously made of the original bituminous coal resources in three areas of the State. Annual production from these areas reached 1.3 million tons in 1917, but subsequently declined; no production has been reported from these areas since 1943. Prior production came from Pennsylvanian and Permian age coals in north-central Texas, an area which contains about 88 percent of the State's bituminous coal resources. Coal in strata of Cretaceous and Tertiary age is found near the Rio Grande River in south-central Texas.

The Pennsylvanian-Permian age coals are lenticular, in dipping strata, and in areas of rough terrain. Thus, relatively small areas can be mined by surface methods, and no estimate has been made of these strippable bituminous coal reserves.

Bituminous coal of Cretaceous age is present in Maverick County in the southern part of the State. Although the principal seam averages 7 feet in thickness, it has numerous partings with only 4 feet of usable thickness. Calorific values range from 9,600 to 12,500 Btu per pound. Sulfur content has been reported at 0.56 to 2.14 percent. A large part of the original resource of 525 million tons in this area is sufficiently shallow to be mined by surface methods. However, currently no reliable estimate of the strippable reserves is available.

The largest cannel coal deposit of bituminous rank in the United States is located along the Rio Grande River in Webb County, Tex. Coal from this deposit is noted for a high yield of oil when distilled at low temperature.

The deposit consists of two seams which are of Tertiary age and individually average 2 to 3 feet in thickness. The seams are lenticular and crop out along the Rio Grande River. Yet, because of the dip of the strata and the topography of the area, none of the original 150 million tons of resource can be recovered by stripping.

Tables A-71-A-73 provide the details on the strippable reserves of lignite in Texas. No strip-mining laws are currently in effect in Texas.

Utah

No strip-coal production has been recorded in Utah in nearly 50 years; however, about 40,000 tons was extracted in a strip operation at Scofield, Carbon County, about 1920. Other small tonnages have since been mined from coal outcrops for local use, but nearly all production to date has been mined underground. Production reached a peak of 7.4 million tons in 1947.

Deposits near Alton in the Kanab Field in the southwestern part of the State appear favorable for large-scale strip mining. However, markets must be established before the deposits can be developed. Water supplies near these reserves appear inadequate for the development of mine-mouth electric generating facilities. Known strip-coal reserves are long distances from railroads. The Kanab Field is 45 miles southeast of the railroad terminal at Cedar City. Serviceable roads connect the deposits to Cedar City. However, slurry pipelines are considered a more probable means of transportation to proposed powerplants in southern California.

The Kanab coalfield contains the largest known reserves of strip coal in the State. These occur in one of two prominent coalbeds in the Cretaceous Tropic Formation. The upper coalbed is about 400 feet above the lower and is considered strippable where overburden is 10 to 60 feet. Average minable coal thickness of the upper seam is 11 feet. Smaller blocks of strippable coal are present in areas more remote from major markets than the Kanab Field. However, reserves in these areas are generally too small to support the construction of a railroad or slurry pipeline. Strippable reserves in Utah have been estimated at 150 million tons of bituminous coal. Table A-74 shows the reserve data by seam. County data are shown in table A-75, and sulfur data are in table A-76. A summary of the Utah strip-mining law appears in appendix B.

Virginia

Coal was discovered in the Colony of Virginia in 1700-01. Coal production apparently began in the so-called Richmond Field in Virginia as early as 1701, well before the first recorded production at Fort Pitt, Pa., in 1766.

The principal bituminous coal producing counties are Buchanan, Dickenson, Lee, Russell, Scott, Tazewell, and Wise. They are known as the Southwest Virginia Group, which is part of the Appalachian coal region. Almost 37 million tons were produced in 1967, the highest on record. Both high- and low-volatile bituminous coals are produced for use by electric utilities, in industrial heating, in coke, and in export. Ninety-seven percent of the

State's production is mined in Buchanan, Dickenson, Wise, and Russell Counties. Buchanan County accounts for 62 percent of the mines and 42 percent of the output. During 1967, 11 percent of the State's production was from strip mines, 6 percent from auger mines, and 83 percent from underground mines. Of the 918 mines, 70 were strip operations.

The coals range in rank from high-volatile to low-volatile bituminous. These coals are Pennsylvanian in age.

The southwest Virginia fields include the Pocahontas or Smokeless Field, the Virginia District Field, and the Buchanan Field. The Pocahontas Field derives most of its production from the Pocahontas No. 3 and No. 5 seams. These are low-volatile coals, known for their smokelessness and their recognized suitability for metallurgical, industrial, electric utility, and other purposes.

The Virginia District Field contains coals that are high volatile in rank. Most operations are in the Banner and Clintwood seams. These coals are suitable for industrial, electric utility, and domestic purposes. In Wise County, the minable seams, including the Banner, Blair, Clintwood, Dorchester, Imboden, Norton, and Taggart, are noted for their coking properties. In Lee County, the seams are numbered. There are seven that are mined commercially--Nos. 5, 6, 7, 9, 10, 11, and 12. These coals are suited to industrial purposes. Most coals from the Virginia District are high-volatile, high-quality coals, generally low in moisture, sulfur, and ash. The Buchanan County Field coals range from medium to high volatile and are suitable for general industrial uses. Most of the production is from the Lower Banner seam.

There are at least 39 minable bituminous coal seams in Virginia, although they are not all present in every area. Table A-77 shows 258 million tons of economically strippable coal. Of this, 153 million tons is considered low sulfur, 99 million tons is medium sulfur, and only 5 million tons is high sulfur (table A-79). The average seam thickness is 42 inches. Average sulfur content for Virginia coals is 0.8 percent. At the 1967 rate of strip production, Virginia has a 64-year supply of strippable coal.

Thirty-eight percent of the strippable reserve is in Buchanan County, 26 percent in Wise County, 18 percent in Dickenson County, and the remainder about equally distributed in Lee, Russell, and Tazewell Counties. Of the low-sulfur coal, the Lower Banner has the greatest strippable reserves, 21 percent of the total, followed by the Upper Banner, 14 percent, Splash Dam, 12 percent, and Imboden, 8 percent (tables A-75-A-76).

Production statistics for strip-produced coal in Virginia began in 1946. Since that time, recorded strip production has ranged from 700,000 tons per year to as high as 4 million tons per year. The average has been about 2 million tons. Total depletion of reserves due to strip mining is estimated to be 42 million tons as of January 1968.

The strip-mining laws of Virginia are summarized in appendix B.

Washington

Strip-mined coal in Washington has not been important until recently. In 1948, the peak year for strip mining, 21 percent of the State's total production of 1.2 million tons was recovered by stripping. By 1968, strip mine production declined to 128,000 tons of a total production of 178,000 tons.

Most of the coal deposits in Washington are located in the western third of the State. The coalfields in Kittitas County in the central part of the State are an important exception, and have produced coal by underground methods.

The single major deposit of strippable coal is northeast of Centralia in Lewis and Thurston Counties. The deposit is in the Big and Smith seams of the Skookumchuck Formation of Upper Eocene age. Over 90 percent of the strippable reserve is in the Big seam. Coalbed thicknesses range from 5 to 50 feet. This deposit is being developed to supply fuel for a newly built, steam-electric power plant. Washington Water Power Co. and Pacific Power and Light Co. expect to mine coal at a rate up to 5 million tons per year. Strippable reserves in the area are estimated at 135 million tons of subbituminous coal. Tables A-80-A-82 provide additional data. A summary of the Washington surface mining law is contained in appendix B.

West Virginia

In the Pennsylvanian System, West Virginia has 117 coalbeds, of which 61 are minable. The coal area of West Virginia covers 17,280 square miles. Forty-four of the 55 counties of the State contain minable coal, and during 1967, 35 counties produced coal for commercial purposes. Dating from 1863, the first year of recorded coal production, 7.7 billion tons of coal have been produced from West Virginia mines, second only to that of Pennsylvania. The year of greatest production was 1947.

Strip mining in West Virginia began in 1942 and has continued each year since. Production has ranged from 3 to 18 million tons per year, and has averaged about 10 million tons per year. Depletion due to strip mining is estimated at 324 million tons to January 1968.

During 1967, West Virginia continued to lead the Nation in coal production. Coal produced for sale on the open market totaled 134 million tons, while captive coal amounted to 20 million tons. There were 1,396 active mines--1,070 underground mines, 217 strip mines, and 109 auger mines. Seventy-nine percent of the coal produced was cleaned. Ninety-seven percent of the production is transported by rail or water, and the balance by truck.

Most coal produced from northern West Virginia is consumed by electric utilities (70 percent), coke and gas plants (13 percent), and industrial uses (15 percent). The rest goes to retail dealers, railroad fuel, sales to employees, etc. In southern West Virginia, particularly the southwestern part, most coal is consumed by electric utilities (40 percent), coke and gas plants (32 percent), and industrial uses (21 percent). The rest goes to retail dealers and others for miscellaneous purposes.

The results of this study indicate that a strippable reserve of 2.1 billion tons of coal remains in West Virginia. By counties, Boone leads with 15 percent, followed by Kanawha with 13 percent, Mingo with 8 percent, and Fayette and Logan Counties with 7 percent each. Actually, strippable reserves are present in 40 counties in the State (table A-84) and in 46 seams (table A-83).

From the standpoint of sulfur content, 53 percent of the strippable reserve is classified as low sulfur. Medium-sulfur coal accounts for 32 percent, and high-sulfur coal for 15 percent. Principal low-sulfur seams are the Sewell, 68 million tons; the Eagle, 53 million tons; Campbell Creek, 45 million tons; No. 3 Pocahontas, 37 million tons; and Beckley, 27 million tons.

Practically all West Virginia coals are bituminous or subbituminous. Considering only the five seams mentioned above, the Sewell seam ranges from 2 to 10 feet in thickness, averaging 14,600 Btu per pound and 0.9 percent sulfur. The Eagle is a medium- to high-volatile coking coal, low in sulfur, with Btu content ranging from 13,270 to 14,960. The Campbell Creek (No. 2 gas) is used for metallurgical coal, steam, industrial, and other purposes; thickness ranges from 3 to 7-1/2 feet; Btu content ranges from 13,110 to 15,100; sulfur content is generally low, ranging from 0.5 to 2.2 percent in those samples analyzed. The No. 3 Pocahontas is persistent; ranked as low-volatile bituminous, this seam ranges from 2-1/2 to 12 feet in thickness. Noted for its low ash, sulfur, and phosphorus content, the No. 3 is widely used for metallurgical blends; typical range of Btu content is 14,000 to 15,000, and sulfur content is generally less than 1 percent. The Beckley coal (Pocahontas No. 12) ranges from 2 to 5 feet in thickness. With superior coking characteristics, the Beckley is noted as a low-volatile steam, byproduct, and domestic coal. Sulfur content is usually less than 1 percent. Btu range is from 13,600 to 15,400.

West Virginia enacted the first laws governing surface mining in 1939. A summary of the West Virginia strip-mining law is presented in appendix B.

Wyoming

Coal production reached a peak of 9.8 million tons in 1945. A decline followed and led to a low of 1.6 million tons in 1958. Output has since increased to 3.8 million tons in 1968. Strip-mined coal amounted to 0.2 million tons, or 3 percent of production, in 1940; by 1968 the portion of production that was stripped had increased to 3.7 million tons, or 97 percent of the State's output. Stripping operations comprise nine pits in seven widely scattered counties.

The major market for Wyoming coal is electric power generation. Three generating plants have scheduled major expansion of facilities which will result in increased consumption of coal. One plant alone will require 2.5 million tons per year by 1971. The potential value of Wyoming coal has been recognized by various companies, including major oil companies, acquiring large coal reserves with the possibility of supplying future energy markets outside the State.

Coal-bearing strata are of Upper Cretaceous and Tertiary ages. The most significant strip-coal deposits are of Tertiary age in the northeastern part of the State; they include the 30- to 130-foot-thick Roland coalbed and the 10- to 40-foot-thick Felix coalbed. These two coalbeds crop out for more than 100 miles along the east flank of the Powder River Basin and contain a major part of the State's strippable reserves.

At Lake DeSmet, near Buffalo, on the west flank of the Powder River Basin, a coalbed averages more than 100 feet in thickness and locally may be as much as 220 feet thick; it underlies an area of several square miles and contains a strippable deposit of more than 1 billion tons. On the south flank of the basin in Converse County, the 35-foot-thick School and 20-foot-thick Badger coalbeds contain available strippable reserves exceeding 45 million tons. Strip-coal reserves for the State are estimated at 14 billion tons. Table A-86 shows the subbituminous reserves by seam. County data are shown in table A-87. As shown in table A-88, 96 percent of the State's strippable reserves are classified as low sulfur. There is a small amount of medium-sulfur coal, but most of the remaining 4 percent is classed as high sulfur. Wyoming's strip-mining laws are summarized in appendix B.

Other States

South Dakota lignite production reached a peak of 71,000 tons in 1941. However, production has declined to a few thousand tons in recent years. Lignite has been used locally for fuel, and production from some beds has been treated for the recovery of uranium.

Lignite resources of South Dakota, located in the northwestern part of the State, are an extension of the huge lignite deposits in North Dakota. South Dakota's total lignite resources have been estimated at 3 billion tons, occurring as beds 4 to 6 feet in thickness in the Lance and Fort Union Formations of Tertiary age. Average calorific content is 6,000 Btu per pound; average sulfur content is less than 1 percent. Recoverable strip lignite reserves are estimated at 160 million tons under less than 110 feet of overburden (tables A-65-A-67).

The coal resources of California, Georgia, Idaho, Nebraska, Nevada, and Oregon are small, and their potential for commercial strip-coal production is limited. A 25-million-ton estimate of subbituminous coal has been made for California. Data are shown in tables A-12-A-14.

The coal resources of Oregon have been variously estimated to be in the range of 100 million to 1 billion tons (127). The seams are relatively impure, and while they thin and thicken the average thickness is determined to be about 4 feet. The sulfur content ranges from less than 1 percent to over 5 percent, but most of the coal is considered to be low and medium sulfur. The resource and reserve estimates are shown in tables A-59-A-61.

No estimates have been made on the amount of reserves recoverable by strip mining in the other four States. The surface-mining laws for Georgia

and Idaho are summarized in appendix B. There are currently no strip-mining laws for the other States mentioned here.

Lignite deposits are present in northwestern Louisiana and the central part of Mississippi. The deposits are in the Gulf province. Principal seams are lenticular, rarely exceed 5 feet in thickness, and are of Tertiary age. These deposits have not been extensively mined or explored, and information is too scant to make reliable estimates of the resources or strippable reserves.

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APPENDIX A.--STRIPPABLE RESOURCES AND RESERVES IN THE UNITED STATES, BY STATES

TABLE A-1. - Strippable resources and reserves of bituminous coal in Alabama,
January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
Montevaillo.....	32	1,475	1,180	378
Brookwood.....	36	26,550	21,240	7,646
Milledale.....	28	6,888	5,510	1,543
Johnson.....	26	12,650	10,120	2,631
Clements.....	33	3,888	3,110	1,026
Yeshic.....	26	1,725	1,380	359
Uteley.....	28	13,100	10,480	2,934
Helena.....	41	5,713	4,570	1,874
Upper Thompson.....	63	4,788	3,830	2,413
Gwin.....	30	15,638	12,510	3,753
Cobb.....	16	28,638	22,910	3,666
Lower Thompson.....	37	1,363	1,090	403
Cholson.....	33	988	790	261
Clark.....	34	6,213	4,970	1,690
Pratt.....	18	91,663	73,330	13,199
Fire Clay.....	20	26,238	20,990	4,198
American.....	30	4,525	3,620	1,086
Hammond.....	35	225	180	63
Youngblood.....	31	4,300	3,440	1,066
Buck.....	32	175	140	45
Altoona.....	29	1,225	980	284
Coal City.....	36	475	380	137
Pump.....	23	1,263	1,010	232
Broken Arrow.....	33	488	390	129
Marion.....	21	63	50	11
Big Bone.....	60	2,425	1,940	1,164
Wadsworth.....	33	2,433	1,950	644
New Castle.....	18	5,413	4,330	779
Mary Lee.....	29	98,136	70,510	20,448
Blue Creek.....	21	7,262	5,810	1,220
Jagger.....	32	3,850	3,080	986
Martin.....	33	350	280	92
Cann.....	15	125	100	15
Fairview.....	30	838	670	201
Harkness.....	38	3,088	2,470	939
Jefferson.....	23	140,122	112,100	25,783
Black Creek.....	23	93,798	75,040	17,259
Upper Chapman.....	19	88	70	13
Nunally Zone.....	31	4,238	3,390	1,051
Gould.....	26	2,338	1,870	486
Rosa.....	24	917	730	175
Bear Creek.....	24	12,886	10,310	2,474
Underwood.....	31	38,673	30,940	9,591
Total.....	25	667,238	533,790	134,347

TABLE A-2. - Recoverable resources and reserves of bituminous coal
in Alabama, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Bibb.....	43	15,240	6,553
Blount.....	23	10,200	2,346
Cherokee.....	31	190	59
Cullman.....	23	14,160	3,257
Etowah.....	29	980	284
Fayette.....	17	23,670	4,024
Franklin.....	24	6,900	1,656
Jackson.....	31	30,750	9,533
Jefferson.....	25	117,750	28,970
Marion.....	23	12,250	2,818
Shelby.....	34	8,540	2,904
St. Clair.....	35	6,180	2,163
Tuscaloosa.....	32	41,950	13,424
Walker.....	23	228,710	52,603
Winston.....	23	16,320	3,753
Total.....	25	533,790	134,347

TABLE A-3. - Strippable bituminous coal reserves in Alabama,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Montevallo.....	32	378	-	-
Brookwood.....	36	-	7,646	-
Milldale.....	28	-	1,543	-
Johnson.....	26	2,631	-	-
Clements.....	33	1,026	-	-
Yeshic.....	26	359	-	-
Utley.....	28	-	-	2,934
Helena.....	41	1,874	-	-
Upper Thompson.....	63	2,413	-	-
Gwin.....	30	3,753	-	-
Cobb.....	16	-	-	3,666
Lower Thompson.....	37	-	403	-
Cholson.....	37	261	-	-
Clark.....	34	-	1,690	-
Pratt.....	18	-	-	13,199
Fire Clay.....	20	-	-	4,198
American.....	30	-	1,086	-
Hammond.....	35	-	63	-
Youngblood.....	31	-	1,066	-
Buck.....	32	-	45	-
Altoona.....	29	-	284	-
Coal City.....	36	137	-	-
Pump.....	23	232	-	-
Broken Arrow.....	33	129	-	-
Marion.....	21	-	-	11
Big Bone.....	60	-	-	1,164
Wadsworth.....	33	-	-	644
New Castle.....	18	-	-	779
Mary Lee.....	29	20,448	-	-
Blue Creek.....	21	-	1,220	-
Jagger.....	32	-	986	-
Martin.....	33	-	92	-
Cann.....	15	-	-	15
Fairview.....	30	-	-	201
Harkness.....	38	-	939	-
Jefferson.....	23	-	25,783	-
Black Creek.....	23	-	17,259	-
Upper Chapman.....	19	-	-	13
Nunally Zone.....	31	-	1,051	-
Gould.....	26	-	486	-
Rosa.....	24	-	175	-
Bear Creek.....	24	-	2,474	-
Underwood.....	31	-	9,591	-
Total.....	25	33,641	73,882	26,824

TABLE A-4. - Strippable resources and reserves of coal and lignite in Alaska, January 1, 1968, by coalfield

(Thousand short tons)

Coalfield	Average thickness ¹ (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
BITUMINOUS				
Northern.....	-	1,197,000	957,000	² 478,000
Matanuska.....	-	4,000	3,000	2,000
Total.....	-	1,201,000	960,000	480,000
SUBBITUMINOUS COAL AND LIGNITE				
Northern (S) ³	-	5,293,000	4,234,000	² 3,387,000
Nenana (S) ³	-	571,000	457,000	360,000
Broad Pass (L) ⁴	-	8,000	6,000	5,000
Susitna (S,L) ^{3 4}	-	288,000	230,000	163,000
Kenai (S,L) ^{3 4}	-	38,000	31,000	16,000
Total.....	-	6,198,000	4,958,000	3,931,000
Grand total...	-	7,399,000	5,918,000	4,411,000

¹No average coal thicknesses are given, but thicknesses range from a minimum of 14 inches to over 120 inches.

²These Northern Field (North Slope) reserves are included in the estimates even though an economic export market, which is essential for exploitation, does not currently exist.

³S--subbituminous coal.

⁴L--lignite.

TABLE A-5. - Strippable reserves of coal and lignite in Alaska, January 1, 1968, by coalfield and sulfur category

(Thousand short tons)

Coalfield	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
BITUMINOUS				
Northern.....	-	478,000	-	-
Matanuska.....	-	2,000	-	-
Total.....	-	480,000	-	-
SUBBITUMINOUS COAL AND LIGNITE				
Northern (S) ¹	-	3,387,000	-	-
Nenana (S) ¹	-	360,000	-	-
Broad Pass (L) ²	-	5,000	-	-
Susitna (S,L) ^{1 3}	-	163,000	-	-
Kenai (S,L) ^{1 2}	-	16,000	-	-
Total.....	-	3,931,000	-	-
Grand total.....	-	4,411,000	-	-

¹S--subbituminous coal.

²L--lignite.

TABLE A-6. - Strippable resources and reserves of subbituminous coal in Arizona, January 1, 1968, by deposit and formation

(Thousand short tons)

Deposit Formation	Average thickness (feet)	Remaining strippable resource (0-130 feet overburden)	Recoverable strippable resource	Strippable reserves
Black Mesa.....	-	500,000	400,000	-
Wepo (8 seams).....	10	-	-	387,000

TABLE A-7. - Strippable resources and reserves of subbituminous coal in Arizona, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (feet)	Recoverable strippable resource	Strippable reserves
Navajo.....	10	400,000	387,000

TABLE A-8. - Strippable subbituminous coal reserves in Arizona, January 1, 1968, by formation and sulfur category

(Thousand short tons)

Formation	Average thickness (feet)	Low sulfur	Medium sulfur	High sulfur
Wepo (8 seams).....	10	387,000	-	-

TABLE A-9. - Strippable resources and reserves of bituminous coal and lignite in Arkansas, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource ¹	Recoverable strippable resource	Strippable reserves
BITUMINOUS				
Upper Hartshorne.....	18	4,300	3,400	3,000
Lower Hartshorne.....	28	146,000	118,400	119,000
Charleston.....	16	38,500	30,800	22,000
Paris.....	18	9,600	7,700	6,000
Total.....	25	200,400	160,300	149,000
LIGNITE ²				
Wilcox.....	41	27,000	21,600	21,600
Claiborne.....	36	4,800	3,800	3,680
Jackson.....	29	200	200	-
Total.....	41	32,000	25,600	25,280
Grand total.....	27	232,400	185,900	174,280

¹ Resource calculated to maximum of 60 feet of overburden for bituminous coal and to 100 feet of overburden for lignite.

² Wilcox, Claiborne, and Jackson are geologic formation names. Beds of lignite have not been named.

TABLE A-10. - Strippable resources and reserves of bituminous coal and lignite in Arkansas, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness ¹ (inches)	Recoverable strippable resource	Strippable reserves
BITUMINOUS			
Crawford.....	-	7,400	7,000
Franklin.....	-	36,100	33,000
Johnson.....	-	51,900	48,000
Logan.....	-	7,800	7,000
Scott.....	-	3,400	3,000
Sebastian.....	-	53,600	51,000
Total.....	25	160,200	149,000
LIGNITE			
Dallas.....	-	3,920	3,920
Quachita.....	-	4,160	4,160
Pulaski.....	-	10,000	10,000
Saline.....	-	5,200	5,200
Other.....	-	2,320	2,000
Total.....	41	25,600	25,280
Grand total.....	27	185,800	174,280

¹ Average coalbed thickness by county not given.

TABLE A-11. - Strippable bituminous coal and lignite reserves in Arkansas, January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
BITUMINOUS				
Upper Hartshorne.....	18	3,000	-	-
Lower Hartshorne.....	28	-	118,000	-
Charleston.....	16	-	-	22,000
Paris.....	18	-	-	6,000
Total.....	25	3,000	118,000	28,000
LIGNITE ¹				
Wilcox.....	41	22,280	-	-
Claiborne.....	36	3,000	-	-
Total.....	41	25,280	-	-
Grand total.....	27	28,280	118,000	28,000

¹Wilcox and Claiborne are geologic formation names.

TABLE A-12. - Strippable resources and reserves of subbituminous coal in California, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (feet)	Remaining strippable resource ¹	Recoverable strippable resource	Strippable reserves
Unnamed.....	NA	100,000	80,000	25,000

NA--not available.

¹Resource calculated to unknown highwall thickness.

TABLE A-13. - Strippable resources and reserves of subbituminous coal in California, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (feet)	Recoverable strippable resource	Strippable reserves
Unnamed.....	NA	80,000	25,000

NA--not available.

TABLE A-14. - Strippable subbituminous coal reserves in California,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (feet)	Low sulfur	Medium sulfur	High sulfur
Unnamed.....	NA	25,000	0	0

NA--not available.

TABLE A-15. - Strippable resources and reserves of bituminous coal
in Colorado, January 1, 1968, by deposit and seam

(Thousand short tons)

Deposit Seam	Average thickness (feet)	Remaining strippable resource ¹	Recoverable strippable resource	Strippable reserves
Coalmont.....	-	77,000	62,000	-
Riach.....	10	-	-	4,000
McCallum.....	-	50,000	40,000	-
Sudduth.....	14	-	-	4,000
Craig.....	-	270,000	216,000	-
Mesa Verde Formation (8 seams) ²	13	-	-	134,000
Nucla.....	-	33,000	26,000	-
No. 1.....	5	-	-	24,000
Tongue Mesa.....	-	27,000	22,000	-
Low Creek.....	6	-	-	4,000
Twenty Mile.....	-	413,000	330,000	-
Mesa Verde Formation (6 seams) ³	8	-	-	330,000
Total.....	12	870,000	696,000	500,000

¹Resource calculated to overburden thicknesses ranging from 50 to 150 feet,
to 500 feet for Coalmont deposit.

²This coal is in Moffat County.

³This coal is in Routt County.

TABLE A-16. - Strippable resources and reserves of bituminous coal reserves in Colorado, January 1, 1958, by county

(Thousand short tons)

County	Average coalbed thickness (feet)	Recoverable strippable resource	Strippable reserves
Jackson.....	24	102,000	8,000
Moffat.....	13	216,000	134,000
Montrose.....	6	48,000	28,000
Routt.....	8	330,000	330,000
Total.....	12	696,000	500,000

TABLE A-17. - Strippable bituminous coal reserves in Colorado, January 1, 1958, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (feet)	Low sulfur	Medium sulfur	High sulfur
Riach.....	30	4,000	-	-
Sudduth.....	14	4,000	-	-
Mesa Verde Formation (8 seams).....	13	134,000	-	-
No. 1.....	5	-	24,000	-
Low Creek.....	6	4,000	-	-
Mesa Verde Formation (6 seams).....	8	330,000	-	-
Total.....	12	476,000	24,000	-

TABLE A-18. - Strippable resources and reserves of bituminous coal
in Illinois, January 1, 1968, by county¹

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Adams.....	22	495,200	54,500
Brown.....	24	309,200	37,100
Bureau.....	41	360,500	73,900
Calhoun.....	26	12,000	1,600
Cass.....	31	195,900	30,300
Fulton.....	40	1,650,900	330,200
Gallatin.....	51	189,600	48,300
Greene.....	31	478,300	74,100
Grundy.....	32	284,800	46,300
Hancock.....	30	23,900	3,600
Henderson.....	24	42,500	5,100
Henry.....	37	497,000	112,100
Jackson.....	63	305,900	96,400
Jersey.....	32	176,400	28,100
Kankakee.....	39	16,500	3,200
Knox.....	30	1,255,700	188,400
LaSalle.....	35	227,300	39,300
Livingston.....	44	39,400	8,800
Macoupin.....	42	220,400	46,100
Madison.....	55	492,300	134,900
Marshall.....	44	92,800	20,400
McDonough.....	25	467,500	58,400
Mercer.....	32	56,000	7,000
Monroe.....	48	5,400	1,300
Morgan.....	34	662,100	111,000
Peoria.....	41	1,732,200	355,100
Perry.....	69	845,400	291,700
Pike.....	18	115,500	10,400
Randolph.....	62	349,900	108,500
Rock Island.....	30	33,600	5,000
Saline.....	45	346,600	78,000
St. Clair.....	82	963,300	395,000
Schuyler.....	32	572,500	91,600
Scott.....	30	391,300	27,100
Stark.....	45	417,800	94,000
Tazewell.....	36	120,000	24,300
Warren.....	24	122,100	39,300
Will.....	36	17,300	3,100
Williamson.....	64	501,500	161,100
Total.....	41	17,075,550	3,246,600

¹ Insufficient information to present table by seams.

TABLE A-19. - Strippable bituminous coal reserves in Illinois,
January 1, 1968, by county and sulfur category

(Thousand short tons)

County	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Adams.....	22	-	-	54,500
Brown.....	24	-	-	37,100
Bureau.....	41	-	-	73,900
Calhoun.....	26	-	-	1,600
Cass.....	31	-	-	30,300
Fulton.....	40	-	-	330,200
Gallatin.....	51	-	-	48,300
Greene.....	31	-	-	74,100
Grundy.....	32	-	-	46,300
Hancock.....	30	-	-	3,600
Henderson.....	24	-	-	5,100
Henry.....	37	-	-	112,100
Jackson.....	63	-	77,100	19,300
Jersey.....	32	-	-	28,100
Kankakee.....	39	-	-	3,200
Knox.....	30	-	-	188,400
LaSalle.....	35	-	-	39,300
Livingston.....	44	-	-	8,800
Macoupin.....	42	-	-	46,100
Madison.....	55	-	-	134,900
Marshall.....	44	-	-	20,400
McDonough.....	25	-	-	58,400
Mercer.....	32	-	-	9,000
Monroe.....	48	-	-	1,300
Morgan.....	34	-	-	000
Peoria.....	41	-	-	353,100
Perry.....	69	-	-	291,700
Pike.....	18	-	-	10,400
Randolph.....	62	-	-	108,500
Rock Island.....	30	-	-	5,000
Salina.....	45	-	-	78,000
St. Clair.....	82	-	-	395,000
Schuyler.....	32	-	-	91,600
Scott.....	30	-	-	27,100
Stark.....	45	-	-	94,000
Tazewell.....	36	-	-	24,300
Warren.....	24	-	-	39,300
Will.....	38	-	3,100	-
Williamson.....	66	-	-	161,100
Total.....	41	-	80,200	3,166,400

TABLE A-20. - Strippable resources and reserves of bituminous coal
in Indiana, January 1, 1968, by seam
 (Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
Coal VII (Danville)....	45	519,245	415,395	207,699
Coal VI (Hymers).....	62	250,190	200,152	100,076
Coal Vb.....	59	1,518	1,214	607
Coal V (Springfield)...	57	842,003	673,601	336,801
Coal IV (Survant).....	44	227,378	181,902	90,953
Coal IIIa.....	48	4,270	3,416	1,708
Coal III (Seelyville)...	49	298,328	238,662	119,332
Unnamed coal in				
Staunton Formation....	44	83,903	67,112	33,563
Buffaloville.....	26	26,471	21,177	10,589
Minshall.....	32	86,546	69,337	34,619
Unnamed coal in Brazil				
Formation.....	32	531	425	213
Upper Block.....	26	133,264	106,611	53,307
Lower Block.....	32	132,652	106,122	53,061
Marish Hill.....	36	64,268	51,414	25,708
Blue Creek.....	32	69,738	55,790	27,895
Unnamed coal in				
Mansfield Formation...	42	807	645	323
Total.....	48	2,741,112	2,192,865	1,096,454

TABLE A-21. - Strippable resources and reserves of bituminous coal
in Indiana, January 1, 1968, by county
 (Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Clay.....	47	320,117	160,057
Daviess.....	38	137,041	68,521
DuBois.....	32	4,252	2,128
Fountain and Warren.....	46	32,544	16,273
Greene.....	52	206,442	103,223
Knox.....	58	142,285	71,143
Martin.....	24	82,721	41,386
Owen.....	31	50,777	25,387
Parke.....	54	9,536	4,767
Pike.....	53	219,814	119,907
Spencer.....	25	52,822	26,412
Sullivan.....	52	309,244	154,622
Vermillion.....	53	45,993	22,998
Wago.....	29	254,162	127,077
Warrick.....	48	305,107	152,554
Total.....	48	2,192,865	1,096,454

TABLE A-22. - Strippable bituminous coal reserves in Indiana,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Coal VII (Danville).....	45	-	170,366	37,333
Coal VI (Hymera).....	62	-	-	100,076
Coal Vt.....	59	-	-	607
Coal V (Springfield)....	57	-	-	336,801
Coal IV (Survant).....	44	-	46,195	64,758
Coal IIIa.....	48	-	-	1,708
Coal III (Seelyville)...	49	-	-	119,332
Unnamed coal in Staunton Formation.....	44	-	-	33,563
Buffaloville.....	26	-	-	10,589
Minshall.....	32	-	-	34,619
Unnamed coal in Brazil Formation.....	32	-	-	213
Upper Block.....	26	-	52,727	580
Lower Block.....	32	-	23,470	29,591
Marish Hill.....	36	-	-	25,708
Blue Creek.....	32	-	-	27,895
Unnamed coal in Mansfield Formation....	42	-	135	198
Total.....	48	-	292,893	803,561

TABLE A-23. - Strippable resources and reserves of bituminous coal
in Iowa, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
Unnamed.....	36	1,000,000	800,000	180,000

TABLE A-24. - Strippable resources and reserves of bituminous coal
in Iowa, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Unnamed.....	36	800,000	180,000

TABLE A-25. - Strippable bituminous coal reserves in Iowa,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Unnamed.....	36	0	0	180,000

TABLE A-26. - Strippable resources and reserves of bituminous coal
in Kansas, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
Bowler.....	17	221,806	177,445	43,319
Cedar Vale.....	16	5,235	4,188	1,015
Crowburg.....	12	4,331	1,866	1,217
Elmo.....	16	18,165	14,692	6,622
Fleming.....	14	41,984	13,587	19,077
Mineral.....	20	144,596	115,597	58,993
Mulberry.....	24	611,500	489,200	129,000
Mulky.....	16	96,500	77,200	27,167
Nodaway.....	14	58,284	36,627	19,931
Rowa-Columbus.....	16	11,234	10,587	5,285
Upper Sibley.....	18	19,284	15,527	6,258
Upper Williamsburg.....	15	14,193	11,354	5,618
Weir-Pittsburg.....	36	137,824	110,260	51,871
Total.....	22	1,387,538	1,110,030	375,473

TABLE A-27. - Strippable resources and reserves of bituminous coal
in Kansas, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Atchison.....	16	7,000	2,054
Bourbon.....	20	167,840	60,955
Brown.....	16	7,692	4,568
Cherokee.....	21	219,897	80,565
Coffey.....	14	2,500	1,371
Cowley.....	16	4,188	1,015
Crawford.....	35	239,645	94,409
Franklin.....	15	503	402
Leavenworth.....	18	15,427	6,258
Linn.....	24	391,360	100,100
Osage.....	14	53,978	23,776
Total.....	22	1,110,030	375,473

TABLE A-28. - Strippable bituminous coal reserves in Kansas,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Bevier.....	17	-	-	43,319
Cedar Vale.....	16	-	-	1,015
Croweburg.....	12	-	-	1,217
Elmo.....	16	-	-	6,622
Fleming.....	14	-	-	19,077
Mineral.....	20	-	-	58,993
Mulberry.....	24	-	-	129,000
Mulky.....	16	-	-	27,167
Nodaway.....	14	-	-	19,931
Rowe-Columbus.....	16	-	-	5,385
Upper Sibley.....	18	-	-	6,258
Upper Williamsburg.....	15	-	-	5,618
Well-Pittsburg.....	36	-	-	51,871
Total.....	22	-	-	375,473

**TABLE A-29. - Strippable resources and reserves of bituminous coal
in eastern Kentucky, January 1, 1968, by seam**

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
Princess No. 9.....	29	3,538	2,330	410
Princess No. 8.....	29	16,638	13,310	1,930
Princess No. 7.....	36	149,038	119,230	21,461
Princess No. 6.....	37	35,325	28,260	5,228
Princess No. 5A.....	31	3,463	2,770	429
Princess No. 5.....	54	193,588	154,870	41,815
Hindman.....	61	196,500	157,200	47,946
Princess No. 4.....	39	408,713	326,970	63,759
Hazard No. 7.....	47	422,450	337,960	79,421
Princess No. 3.....	52	656,338	525,070	136,518
Haddix (Colvin).....	36	222,225	177,780	32,000
Copland.....	30	775	620	93
Upper Hamlin.....	41	24,775	19,820	4,023
Lower Hamlin (Hamlin).....	36	60,900	48,720	8,770
Stray.....	34	12,388	9,910	1,685
Gin Creek.....	29	3,450	2,760	400
Fire Clay Rider.....	33	64,100	51,280	8,461
Fire Clay.....	39	434,038	347,230	67,710
Upper Whitesburg.....	39	20,738	16,590	3,235
Lower Whitesburg (Whitesburg).....	32	15,813	11,850	1,896
Gin Creek.....	42	196,460	156,570	32,670
D.....	38	28,625	22,900	4,351
Upper Elkhorn No. 3 (Jellico).....	35	530,300	421,230	76,232
Elkhorn Leader.....	40	15,213	12,170	2,536
Elkhorn No. 2.....	38	230,425	184,330	35,025
Rich Mountain.....	29	5,675	3,740	542
Upper Elkhorn No. 1.....	41	120,163	96,130	19,707
Lower Split of Harlan.....	38	8,825	7,060	1,341
Lower Elkhorn (Laboden).....	46	196,650	157,320	36,184
Bingham.....	44	15,450	12,120	2,666
Eagle.....	40	2,388	1,910	382
Millard.....	36	5,850	4,680	842
Hagy.....	26	2,818	2,270	295
Auxier.....	33	938	750	125
Zaheriah.....	30	63,888	51,110	7,667
Upper Banner.....	35	588	470	82
Elswick.....	49	800	630	125
Barren Fork.....	37	27,325	21,860	5,034
Beattyville.....	42	65,663	52,530	11,031
Hudson.....	33	150,318	120,270	19,835
Total.....	42	5,608,895	4,687,116	780,830

TABLE A-30. - Strippable resources and reserves of bituminous coal
in eastern Kentucky, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Bell.....	39	137,220	26,484
Boyd.....	38	77,570	14,583
Breathitt.....	44	264,380	57,634
Carter.....	40	140,610	28,052
Clay.....	34	68,330	11,650
Clinton.....	42	3,230	678
Elliott.....	45	45,630	10,267
Floyd.....	39	160,850	31,285
Greenup.....	49	40,970	9,996
Harlan.....	42	342,550	71,079
Jackson.....	33	66,560	10,982
Johnson.....	39	149,670	28,961
Knott.....	46	186,180	43,194
Knox.....	38	74,090	14,040
Laurel.....	33	40,530	6,728
Lawrence.....	50	66,300	16,475
Lee.....	41	11,890	2,455
Leslie.....	48	198,000	47,421
Letcher.....	41	145,510	30,034
Magoffin.....	46	88,140	20,228
Martin.....	44	384,710	85,021
McCreary.....	38	33,380	6,292
Menifee.....	42	340	71
Morgan.....	46	44,870	10,250
Owsley.....	33	1,900	316
Perry.....	49	321,760	78,811
Pike.....	41	476,730	97,272
Powell.....	42	80	17
Polaski.....	42	4,940	1,037
Rockcastle.....	33	40,350	6,658
Wayne.....	42	18,160	3,814
Whitley.....	35	38,920	6,869
Wolfe.....	37	11,760	2,176
Total.....	42	3,687,110	780,830

TABLE A-31. - Strippable bituminous coal reserves in eastern Kentucky,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Princess No. 9.....	29	-	410	-
Princess No. 8.....	29	-	1,930	-
Princess No. 7.....	36	-	21,461	-
Princess No. 6.....	37	-	5,228	-
Princess No. 5A.....	31	-	429	-
Princess No. 5.....	54	41,815	-	-
Hindman.....	61	-	-	47,946
Princess No. 4.....	39	63,759	-	-
Hazard No. 7.....	47	79,421	-	-
Princess No. 3.....	52	136,518	-	-
Haddix (Colvin).....	36	32,000	-	-
Copland.....	30	93	-	-
Upper Hamlin.....	41	4,063	-	-
Lower Hamlin (Hamlin).....	36	-	8,770	-
Stray.....	34	-	1,685	-
Gin Creek.....	29	-	400	-
Fire Clay Rider.....	33	-	8,461	-
Fire Clay.....	39	67,710	-	-
Upper Whitesburg (Whitesburg).....	39	-	3,235	-
Lower Whitesburg.....	32	-	1,896	-
Gun Creek.....	42	-	32,670	-
D.....	38	-	4,351	-
Upper Elkhorn No. 3 (Jellico).....	35	-	74,242	-
Elkhorn Leader.....	40	-	3,414	-
Elkhorn No. 2.....	38	35,025	-	-
Rich Mountain.....	29	542	-	-
Upper Elkhorn No. 1.....	41	19,707	-	-
Lower Split of Harlan.....	38	1,341	-	-
Lower Elkhorn (Imboden).....	46	36,184	-	-
Bingham.....	44	2,666	-	-
Eagle.....	40	-	387	-
Millard.....	36	-	842	-
Hagy.....	26	-	295	-
Auxier.....	33	125	-	-
Zahariah.....	30	-	-	7,667
Upper Banner.....	35	-	-	82
Elswick.....	39	-	-	125
Barren Fork.....	37	-	-	4,044
Beattyville.....	42	11,031	-	-
Hudson.....	32	-	19,845	-
Total.....	42	532,000	188,966	59,864

TABLE A-32. - Strippable resources and reserves of bituminous coal
in western Kentucky, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-150 feet overburden)	Recoverable strippable resource	Strippable reserves
No. 14.....	28	120,000	108,000	15,000
No. 13.....	42	306,000	275,000	68,000
No. 12.....	48	814,000	733,000	176,000
No. 11.....	48	902,000	812,000	195,000
No. 9.....	54	1,316,000	1,184,000	320,000
No. 6.....	30	188,000	169,000	25,000
No. 4.....	42	563,000	507,000	106,000
Other.....	30	537,000	483,000	72,000
Total.....	45	4,746,000	4,271,000	977,000

TABLE A-33. - Strippable resources and reserves of bituminous coal
in western Kentucky, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Butler.....	38	206,000	39,000
Christian.....	42	32,000	7,000
Crittenden.....	36	4,000	7,000
Daviess.....	40	346,000	69,000
Edmonson.....	30	55,000	9,000
Grayson.....	30	7,000	1,000
Hancock.....	38	75,000	14,000
Henderson.....	49	670,000	165,000
Hopkins.....	44	687,000	152,000
McLean.....	50	173,000	43,000
Muhlenberg.....	48	1,070,000	258,000
Ohio.....	46	700,000	161,000
Union.....	43	117,000	25,000
Webster.....	43	126,000	27,000
Total.....	45	4,271,000	977,000

TABLE A-34. - Strippable bituminous coal reserves in western Kentucky,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
No. 14.....	28	-	-	15,000
No. 13.....	42	-	-	68,000
No. 12.....	48	-	-	176,000
No. 11.....	48	-	-	195,000
No. 9.....	54	-	-	320,000
No. 6.....	30	-	-	25,000
No. 4.....	42	-	-	106,000
Other.....	30	-	-	72,000
Total.....	45	-	-	977,000

TABLE A-35. - Strippable resources and reserves of bituminous coal
in Maryland, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserve
Waynesburg.....	33	8,500	2,000	300
Sewickley.....	30	8,500	4,400	700
Pittsburgh.....	107	4,400	3,500	1,900
Franklin.....	28	9,100	7,300	1,100
Barton.....	30	15,300	12,200	1,900
Bakerstown ¹	33	25,900	20,700	3,500
Upper Freeport.....	30	37,400	29,900	4,600
Upper Kittanning.....	38	11,800	9,400	1,700
Lower and Middle Kittanning..	36	25,900	20,800	3,800
Clarion.....	36	12,400	9,900	1,800
Total.....	35	150,200	120,100	21,300

¹Includes Upper and Lower Bakerstown coals.

TABLE A-36. - Strippable resources and reserves of bituminous coal
in Maryland, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Allegany.....	41	31,500	6,600
Garrett.....	33	88,600	14,700
Total.....	35	120,100	21,300

TABLE A-37. - Strippable bituminous coal reserves in Maryland,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Waynesburg.....	33	-	-	300
Sewickley.....	30	-	700	-
Pittsburg.....	107	-	1,900	-
Franklin.....	28	-	1,100	-
Barton.....	30	-	1,900	-
Bakerstown.....	34	-	-	3,500
Upper Freeport.....	31	-	-	4,600
Upper Kittanning.....	38	-	-	1,700
Lower and Middle Kittanning	36	-	3,000	800
Clarion.....	36	-	-	1,800
Total.....	35	-	8,600	12,700

TABLE A-38. - Strippable resources and reserves of bituminous coal
in Michigan, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-100 feet overburden)	Recoverable strippable resource	Strippable reserves
Unnamed.....	28	5,500	4,400	1,000

TABLE A-39. - Strippable resources and reserves of bituminous coal in Michigan, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Unnamed.....	28	4,400	1,000

TABLE A-40. - Strippable bituminous coal reserves in Michigan, January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Unnamed.....	28	0	0	1,000

TABLE A-41. - Strippable resources and reserves of bituminous coal in Missouri, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
Bevier.....	29	1,171,830	937,464	467,734
Croweburg.....	17	166,181	132,945	52,874
Fleming.....	14	14,759	11,807	5,505
Lexington.....	29	256,838	207,070	66,425
Mineral.....	30	240,315	192,252	75,713
Mulberry.....	18	90,170	72,136	27,566
Mulky.....	18	412,224	329,780	142,948
Rowe.....	14	120,067	96,054	41,966
Summit.....	16	37,617	30,094	13,685
Tebo.....	20	477,220	381,776	132,145
Weir-Pittsburg.....	22	436,233	348,986	132,983
Total.....	24	3,425,454	2,740,364	1,159,564

TABLE A-42. - Strippable resources and reserves of bituminous coal in Missouri,
January 1, 1968, by county
 (Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Adair.....	29	25,815	9,827
Audrain.....	18	57,710	27,477
Barton.....	14	34,678	24,381
Bates.....	20	119,467	45,216
Boone.....	16	171,388	84,185
Callaway.....	29	106,256	53,128
Carroll.....	22	137,290	68,264
Cedar.....	14	14,456	6,425
Chariton.....	26	132,932	61,770
Dade.....	14	14,250	6,325
Henry.....	22	400,868	144,793
Howard.....	25	62,408	30,142
Jasper.....	19	49,390	18,920
Johnson.....	24	317,227	128,065
Lafayette.....	29	58,468	15,290
Livingston.....	23	53,886	24,220
Macon.....	26	211,728	105,141
Monroe.....	18	29,565	11,826
Montgomery.....	18	5,670	2,268
Pettis.....	17	28,082	10,779
Putnam.....	29	71,309	24,735
Ralls.....	18	13,285	5,314
Randolph.....	27	187,020	91,560
Ray.....	29	12,930	4,310
St. Clair.....	22	38,555	13,325
Saline.....	21	65,875	26,220
Schuyler.....	29	62,222	22,656
Sullivan.....	29	5,541	1,847
Vernon.....	27	231,993	91,155
Total.....	24	2,740,364	1,159,564

TABLE A-43. - Strippable bituminous coal reserves in Missouri, January 1, 1968,
by seam and sulfur category
 (Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Bevier.....	29	-	-	467,734
Croweburg.....	17	-	-	52,674
Fleming.....	14	-	-	5,305
Lexington.....	29	-	-	66,425
Mineral.....	30	-	-	75,733
Mulberry.....	18	-	-	27,566
Mulky.....	18	-	-	142,948
Rowe.....	14	-	-	41,966
Summit.....	16	-	-	13,685
Tebo.....	20	-	-	132,145
Weir-Pittsburg.....	22	-	-	132,983
Total.....	24	-	-	1,159,564

TABLE A-44. - Strippable resources and reserves of subbituminous coal
and lignite in Montana, January 1, 1968, by deposit
and seam

(Thousand short tons)

Deposit Seam	Average thickness (feet)	Remaining strippable resource ¹	Recoverable strippable resource	Strippable reserves
SUBBITUMINOUS				
Decker.....	-	1,020,000	816,000	-
Dietz.....	60	-	-	540,000
Hanging Woman Creek.....	-	331,000	265,000	-
Dietz No. 1.....	12	-	-	132,000
Kirby.....	-	82,000	66,000	-
Anderson-Smith.....	25	-	-	66,000
Roland.....	-	314,000	251,000	-
Roland.....	7	-	-	126,000
Smith.....	-	800,000	640,000	-
Smith.....	29	-	-	182,000
Foster Creek.....	-	590,000	472,000	-
Knoblock.....	14	-	-	224,000
Otter Creek.....	-	1,144,000	915,000	-
Knoblock.....	40	-	-	608,000
Greenleaf-Miller Creek..	-	191,000	153,000	-
Knoblock.....	14	-	-	30,000
Rosebud.....	8	-	-	9,000
Poker Jim-O'Dell.....	-	250,000	200,000	-
Knoblock.....	25	-	-	100,000
Sand Creek.....	-	69,000	55,000	-
Knoblock.....	12	-	-	37,000
Colstrip.....	-	1,322,000	1,057,000	-
Rosebud.....	24	-	-	718,000
Moorhead.....	-	1,500,000	1,200,000	-
Canyon.....	21	-	-	100,000
Dietz.....	8	-	-	100,000
Anderson.....	22	-	-	400,000
Birney.....	-	200,000	160,000	-
Brewster-Arnold.....	12	-	-	28,000
Total.....	28	7,813,000	6,250,000	3,400,000
LIGNITE				
Foster Creek.....	-	600,000	480,000	-
Flowers-Goodale.....	11	-	-	96,000
Terret.....	10	-	-	160,000
Pine Hills.....	-	91,000	73,000	-
E.....	25	-	-	73,000
Pumpkin Creek Divide....	-	60,000	48,000	-
Flowers.....	8	-	-	6,000
Terret.....	8	-	-	12,000

See footnote at end of table.

TABLE A-44. - Strippable resources and reserves of subbituminous coal and lignite in Montana, January 1, 1968, by deposit and seam--Continued

Deposit Seam	Average thickness (feet)	Remaining strippable resource ¹	Recoverable strippable resource	Strippable reserves
LIGNITE--Continued				
Thirteen Mile Creek.....	-	225,000	180,000	-
Pust.....	25	-	-	180,000
Weldon-Timber Creek.....	-	724,000	579,000	-
S.....	15	-	-	290,000
Red Water.....	-	300,000	240,000	-
S.....	18	-	-	120,000
Broadus.....	-	473,000	378,000	-
Broadus.....	20	-	-	240,000
Sonnette.....	-	206,000	165,000	-
Pawnee.....	22	-	-	95,000
Pumpkin Creek.....	-	1,901,000	1,520,000	-
Sawyer.....	27	-	-	910,000
Breezy F.....	-	200,000	160,000	-
Pust.....	14	-	-	80,000
Fox Lake.....	-	46,000	37,000	-
Pust.....	11	-	-	29,000
Fort Kipp.....	-	331,000	265,000	-
Fort Peck.....	5	-	-	73,000
Fort Kipp.....	9	-	-	131,000
Rosebud Creek.....	-	210,000	168,000	-
Terret.....	10	-	-	80,000
Coalridge.....	-	600,000	480,000	-
Unnamed.....	25	-	-	360,000
Reserve.....	-	246,000	197,000	-
Reserve.....	8	-	-	100,000
Four Buttes.....	-	91,000	73,000	-
C.....	10	-	-	36,000
Wibaux.....	-	754,000	603,000	-
C.....	20	-	-	426,000
Total.....	19	7,058,000	5,646,000	3,497,000
Grand total.....	24	14,871,000	11,896,000	6,897,000

¹Resource calculated to overburden thicknesses ranging from 120 to 220 feet.

TABLE A-45. - Strippable resources and reserves of subbituminous coal and lignite in Montana, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (feet)	Recoverable strippable resource	Strippable reserves
SUBBITUMINOUS			
Big Horn.....	37	1,964,000	1,009,000
Custer.....	13	148,000	64,000
Powder River.....	26	2,493,000	1,405,000
Rosebud.....	21	1,645,000	922,000
Total.....	28	6,250,000	3,400,000
LIGNITE			
Custer.....	13	601,000	347,000
Dawson.....	25	180,000	180,000
McCone.....	16	819,000	410,000
Powder River.....	26	2,064,000	1,245,000
Richland.....	13	196,000	109,000
Roosevelt.....	7	265,000	204,000
Rosebud.....	10	168,000	80,000
Sheridan.....	21	677,000	460,000
Wibaux.....	19	676,000	462,000
Total.....	20	5,646,000	3,497,000
Grand total.....	24	11,896,000	6,897,000

TABLE A-46. - Strippable subbituminous and lignite reserves in Montana,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
SUBBITUMINOUS				
Diatz.....	50	640,000	-	-
Diatz No. 1.....	12	132,000	-	-
Anderson-Smith.....	25	66,000	-	-
Smith.....	29	182,000	-	-
Anderson.....	22	400,000	-	-
Roland.....	7	126,000	-	-
Knoblock.....	14	-	224,000	-
Knoblock.....	40	608,000	-	-
Knoblock.....	20	167,000	-	-
Canyon.....	21	100,000	-	-
Brewster-Arnold.....	12	28,000	-	-
Rosebud.....	22	727,000	-	-
Total.....	28	3,176,000	224,000	-
LIGNITE				
Flowers-Goodale.....	11	96,000	-	-
Flowers.....	8	6,000	-	-
Terret.....	10	-	80,000	-
Terret.....	9	172,000	-	-
E.....	25	73,000	-	-
Pust.....	13	109,000	-	-
Pust.....	25	180,000	-	-
S.....	16	410,000	-	-
Broadus.....	20	240,000	-	-
Pawnee.....	22	95,000	-	-
Sawyer.....	27	910,000	-	-
Fort Peck.....	5	73,000	-	-
Fort Kipp.....	9	131,000	-	-
Unnamed.....	25	-	360,000	-
Reserve.....	8	-	100,000	-
G.....	19	62,000	-	-
Total.....	19	2,957,000	540,000	-
Grand total.....	24	6,133,000	764,000	-

TABLE A-47. - Strippable resources and reserves of subbituminous coal
in New Mexico, January 1, 1968, by deposit
and formation

(Thousand short tons)

Deposit Formation	Average thickness (feet)	Remaining strippable resource ¹	Recoverable strippable resource	Strippable reserves
San Juan Basin.....	-	3,307,000	2,646,000	-
Fruitland.....	11	-	-	2,418,000
Mesa Verde.....	5	-	-	56,000
Total.....	11	3,307,000	2,646,000	2,474,000

¹Resource calculated to overburden thicknesses ranging from 90 to 200 feet.

TABLE A-48. - Strippable resources and reserves of subbituminous coal
in New Mexico, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (feet)	Recoverable strippable resource	Strippable reserves
San Juan.....	11	2,494,000	2,370,000
McKinley.....	8	152,000	104,000
Total.....	11	2,646,000	2,474,000

TABLE A-49. - Strippable subbituminous coal reserves in New Mexico,
January 1, 1968, by formation and sulfur category

(Thousand short tons)

Formation	Average thickness (feet)	Low sulfur	Medium sulfur	High sulfur
Fruitland.....	11	2,418,000	-	-
Mesa Verde.....	5	56,000	-	-
Total.....	11	2,474,000	-	-

TABLE A-50. - Strippable resources and reserves of lignite in North Dakota,
January 1, 1968, by deposit and seam

(Thousand short tons)

Deposit Seam	Average thickness (feet)	Remaining strippable resource ¹	Recoverable strippable resource	Strippable reserves
Beach.....	-	460,000	368,000	-
C.....	18	-	-	224,000
Dickenson.....	-	800,000	640,000	-
D.....	15	-	-	210,000
E.....	9	-	-	160,000
Gascogna.....	-	273,000	218,000	-
Harmon.....	21	-	-	112,000
Bowman.....	-	228,000	182,000	-
Harmon.....	22	-	-	101,000
Harmon.....	-	971,000	777,000	-
Harmon.....	25	-	-	263,000
Slope I.....	-	170,000	136,000	-
Harmon.....	22	-	-	102,000
Slope II.....	-	140,000	112,000	-
Harmon.....	15	-	-	56,000
Kincaid.....	-	11,000	9,000	-
Noonan.....	8	-	-	9,000
Noonan.....	-	4,000	3,000	-
Noonan.....	8	-	-	3,000
Niobe.....	-	146,000	117,000	-
Bonus.....	9	-	-	17,000
Niobe.....	6	-	-	32,000
Wilton.....	-	15,000	12,000	-
Wilton.....	9	-	-	12,000
Dunn.....	-	29,000	23,000	-
Unnamed.....	11	-	-	23,000
Knife River.....	-	780,000	624,000	-
Beulah-Zap.....	15	-	-	295,000
Beulah South.....	-	75,000	60,000	-
Beulah-Zap.....	15	-	-	40,000
Glen Harold.....	-	22,000	18,000	-
Stanton-local.....	15	-	-	18,000
Washburn.....	-	100,000	80,000	-
Stanton.....	9	-	-	24,000
Center.....	-	180,000	144,000	-
Hagel-Keuther.....	8	-	-	80,000
Slope III.....	-	150,000	120,000	-
T-Cross.....	15	-	-	40,000
Slope IV.....	-	200,000	160,000	-
Hansen.....	15	-	-	133,000

¹See footnote at end of table.

TABLE A-50. - Strippable resources and reserves of lignite in North Dakota,
January 1, 1968, by deposit and seam--Continued

Deposit Seam	Average thickness (feet)	Remaining strippable resource ¹	Recoverable strippable resource	Strippable reserves
Velva.....	-	5,000	4,000	-
Coteau.....	12	-	-	4,000
Avoca.....	-	380,000	304,000	-
No. 1.....	5	-	-	22,000
No. 2.....	5	-	-	22,000
No. 3.....	9	-	-	35,000
No. 4.....	8	-	-	21,000
M & M.....	-	100,000	80,000	-
Top.....	12	-	-	17,000
Total.....	16	5,239,000	4,191,000	2,075,000

¹Resource calculated to overburden thicknesses ranging from 50 to 220 feet.

TABLE A-51. - Strippable resources and reserves of lignite
in North Dakota, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (feet)	Recoverable strippable resource	Strippable reserves
Billings.....	11	106,000	66,000
Bowman.....	21	400,000	213,000
Burke.....	7	129,000	61,000
Burleigh.....	9	12,000	12,000
Dunn.....	11	111,000	41,000
Golden Valley.....	18	368,000	224,000
McLean.....	9	80,000	24,000
Mercer.....	15	641,000	12,000
Oliver.....	10	205,000	121,000
Slope.....	22	1,305,000	594,000
Stark.....	12	446,000	286,000
Ward.....	12	4,000	4,000
Williams.....	9	384,000	117,000
Total.....	16	4,191,000	2,075,000

TABLE A-52. - Strippable lignite reserves in North Dakota,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (feet)	Low sulfur	Medium sulfur	High sulfur
C (Beach deposit).....	18	224,000	-	-
D (Dickenson deposit).....	15	210,000	-	-
E (Dickenson deposit).....	9	150,000	-	-
Harmon.....	24	-	375,000	-
Harmon.....	22	101,000	-	-
Harmon.....	19	158,000	-	-
Noonan.....	8	12,000	-	-
Bonus.....	9	17,000	-	-
Wilton.....	9	12,000	-	-
Niobe.....	6	32,000	-	-
Dunn.....	11	23,000	-	-
Beulah-Zap.....	15	335,000	-	-
Stanton and local.....	15	18,000	-	-
Stanton.....	9	24,000	-	-
Hagel-Keuther.....	8	80,000	-	-
T-Cross.....	15	40,000	-	-
Hansen.....	15	133,000	-	-
Coleau.....	12	9,000	-	-
No. 1 (Avoca deposit).....	5	-	22,000	-
No. 2 (Avoca deposit).....	5	22,000	-	-
No. 3 (Avoca deposit).....	9	35,000	-	-
No. 4 (Avoca deposit).....	8	21,000	-	-
Top.....	12	17,000	-	-
Total.....	16	1,678,000	397,000	-

TABLE A-53. - Strippable resources and reserves of bituminous coal
in Ohio, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
Sewickley.....	44	826,400	661,200	145,700
Redstone.....	46	265,700	212,500	50,100
Pittsburgh.....	56	986,700	789,500	212,700
Upper Freeport.....	45	683,700	547,000	121,200
Lower Freeport.....	44	23,500	18,800	3,800
Middle Kittanning.....	58	1,537,500	1,309,900	323,500
Lower Kittanning.....	37	729,800	583,700	106,400
Clarion.....	41	299,500	212,000	48,300
Brookville.....	43	122,800	98,200	21,400
Total.....	48	5,566,000	4,452,800	1,033,100

TABLE A-54. - Strippable resources and reserves of bituminous coal
in Ohio, January 1, 1968, by county
 (Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Athens.....	56	155,300	43,100
Belmont.....	55	258,300	66,900
Carroll.....	42	191,300	39,600
Columbiana... ..	40	152,300	31,300
Coshocton.....	56	252,300	50,500
Gallia.....	44	159,900	37,100
Guernsey.....	43	168,500	35,800
Harrison.....	51	191,400	48,500
Hocking.....	76	186,700	71,100
Holmes.....	36	53,800	9,700
Jackson.....	42	195,600	40,800
Jefferson.....	47	315,500	81,600
Lawrence.....	40	259,100	51,000
Mahoning	39	44,200	8,000
Meigs.....	47	97,400	22,900
Monroe.....	36	3,100	600
Morgan.....	54	90,900	20,700
skingum.....	44	239,700	47,400
Noble.....	45	378,800	86,400
Perry.....	49	258,700	82,500
Scioto.....	36	6,500	1,200
Stark.....	45	173,700	35,000
Tuscarawas.....	41	402,700	79,900
Vinton.....	37	143,400	27,200
Washington.....	40	66,600	13,300
Wayne.....	35	5,100	1,000
Total.....	48	4,452,800	1,033,100

TABLE A-55. - Strippable bituminous coal reserves in Ohio,
January 1, 1968, by seam and sulfur category
 (Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Sewickley.....	44	-	-	145,700
Redstone.....	46	-	-	50,100
Pittsburgh.....	56	-	-	212,700
Upper Freeport.....	45	-	37,400	83,800
Lower Freeport.....	44	-	-	3,800
Middle Kittanning.....	58	-	84,000	239,500
Lower Kittanning.....	37	-	-	106,400
Clarion.....	41	-	-	48,300
Brookville.....	43	-	4,700	16,700
Total.....	48	-	126,100	907,000

TABLE A-56. - Strippable resources and reserves of bituminous coal
in Oklahoma, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
Lower Hartshorne.....	42	43,954	35,163	11,676
Upper Hartshorne.....	36	17,540	14,032	3,277
McAlester (Lehigh).....	36	34,823	27,858	10,018
Stigler.....	18	59,505	47,604	17,752
Unnamed coal above Stigler...	18	1,150	920	180
Cavanal.....	27	6,952	5,562	1,523
Unnamed coal above Cavanal...	24	1,350	1,080	270
Lower Witteville.....	36	590	472	170
Secor.....	25	26,225	20,980	4,985
Henryetta.....	18 to 30	¹ 81,090	64,872	18,125
Morris.....	16	4,608	3,686	406
Iron Post (Fort Scott).....	16	² 136,872	109,498	38,693
Dawson.....	18	³ 19,469	15,575	3,587
Total.....	24	434,128	347,302	110,662

¹Craig County resource calculated to 70 feet.

²Craig and Nowata Counties coal resource calculated to 70 feet.

³Not calculated for Nowata County.

TABLE A-57. - Strippable resources and reserves of bituminous coal
in Oklahoma, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Atoka.....	38	9,575	3,320
Coal.....	37	15,130	5,460
Craig.....	19	63,794	21,142
Haskell.....	21	47,182	15,590
Latimer.....	37	16,920	4,850
Le Flore.....	35	38,790	11,680
McIntosh.....	25	4,360	1,090
Muskogee.....	36	2,970	990
Nowata.....	16	61,835	21,543
Okmulgee.....	24	14,574	3,526
Pittsburg.....	37	15,141	4,298
Rogers.....	20	38,891	11,823
Squoyah.....	36	7,719	2,573
Tulsa.....	20	7,186	1,852
Wagoner.....	25	3,235	925
Total.....	24	347,302	110,662

TABLE A-58. - Strippable bituminous coal reserves in Oklahoma,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Lower Hartshorne.....	42	7,081	4,595	-
Upper Hartshorne.....	36	2,610	667	-
McAlester (Lehigh).....	36	-	2,818	7,200
Stigler.....	18	-	16,762	990
Unnamed coal above Stigler.	18	-	180	-
Cavanal.....	27	-	-	1,523
Unnamed coal above Cavanal.	24	-	-	270
Lower Witteville.....	36	-	-	170
Secor.....	25	-	-	4,985
Henryetta.....	18 to 30	-	18,125	-
Morris.....	16	-	406	-
Iron Post (Fort Scott).....	16	-	-	38,693
Dawson.....	18	-	-	3,587
Total.....	24	9,691	43,553	57,418

TABLE A-59. - Strippable resources and reserves of subbituminous coal
in Oregon, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (feet)	Remaining strippable resource	Recoverable strippable resource	Strippable reserves
Unnamed.....	4	369	295	295

TABLE A-60. - Strippable resources and reserves of subbituminous coal
in Oregon, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (feet)	Recoverable strippable resource	Strippable reserves
Coos.....	4	295	295

TABLE A-61. - Strippable subbituminous coal reserves in Oregon,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (feet)	Low sulfur	Medium sulfur	High sulfur
Unnamed.....	4	148	147	0

TABLE A-62. - Strippable resources and reserves of bituminous coal
in Pennsylvania, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
Washington.....	57	76,100	60,900	34,700
Waynesburg.....	49	188,400	150,700	71,800
Sewickley.....	52	22,900	18,400	9,600
Redstone.....	39	65,200	52,200	20,100
Pittsburgh.....	68	72,000	57,600	37,900
Brush Creek.....	35	1,000	800	300
Mahoning.....	42	5,900	4,700	2,000
Upper Freeport.....	41	596,800	477,300	194,500
Lower Freeport.....	40	312,000	249,600	99,800
Upper Kittanning.....	38	154,300	123,500	46,700
Middle Kittanning.....	36	145,900	116,800	41,900
Lower Kittanning.....	37	306,000	244,800	89,900
Upper Clarion.....	40	95,500	76,400	30,200
Lower Clarion.....	34	53,800	43,000	14,600
Brookville.....	41	112,100	89,800	39,100
Homewood.....	42	9,000	7,200	3,000
Upper Mercer.....	42	2,000	1,600	700
Lower Mercer.....	42	29,900	24,000	8,300
Quakerstown.....	36	800	600	200
Sharon.....	38	22,900	18,300	7,000
Total.....	43	2,272,500	1,818,200	752,300

TABLE A-63. - Strippable resources and reserves of bituminous coal
in Pennsylvania, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Allegheny.....	49	38,500	18,700
Armstrong.....	38	173,500	66,300
Beaver.....	41	63,700	26,000
Butler.....	41	245,500	100,000
Cambria.....	37	74,200	27,400
Clarion.....	38	189,400	71,100
Clearfield.....	37	239,000	87,600
Fayette.....	45	97,800	44,100
Greene.....	63	56,300	35,300
Indiana.....	42	76,300	32,100
Jefferson.....	37	103,900	38,000
Lawrence.....	39	37,000	14,400
Mercer.....	41	74,700	30,900
Somerset.....	41	140,400	56,500
Washington.....	50	163,500	81,700
Westmoreland.....	50	44,500	22,200
Total.....	43	1,818,200	752,300

TABLE A-64. - Strippable bituminous coal reserves in Pennsylvania,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Washington.....	57	-	-	34,700
Waynesburg.....	49	-	-	71,800
Sewickley.....	52	-	-	9,600
Redstone.....	39	-	12,000	8,100
Pittsburgh.....	68	-	32,000	5,900
Brush Creek.....	36	-	-	300
Mahoning.....	42	-	-	2,000
Upper Freeport.....	41	-	52,500	142,000
Lower Freeport.....	40	-	59,000	40,800
Upper Kittanning.....	38	-	21,000	25,700
Middle Kittanning.....	36	-	-	41,900
Lower Kittanning.....	37	-	22,900	67,000
Upper Clarion.....	40	-	19,000	11,200
Lower Clarion.....	34	-	-	14,600
Brookville.....	41	-	-	39,100
Homewood.....	42	-	-	3,000
Upper Mercer.....	42	-	-	700
Lower Mercer.....	42	-	-	8,300
Quakerstown.....	36	-	-	200
Sharon.....	38	-	7,000	-
Total.....	43	-	225,400	526,900

TABLE A-65. - Strippable resources and reserves of lignite
in South Dakota, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (feet)	Remaining strippable resource (0-100 feet overburden)	Recoverable strippable resource	Strippable reserves
Unnamed.....	5	399,000	319,200	160,000

TABLE A-66. - Strippable resources and reserves of lignite
in South Dakota, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (feet)	Recoverable strippable resource	Strippable reserves
Unnamed.....	5	319,200	160,000

TABLE A-67. - Strippable lignite reserves in South Dakota,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (feet)	Low sulfur	Medium sulfur	High sulfur
Unnamed.....	5	160,000	-	-

TABLE A-68. - Strippable resources and reserves of bituminous coal
in Tennessee, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
Cold Gap.....	35	1,575	1,240	221
Grass Spring.....	56	1,900	1,520	426
Rock Spring.....	46	6,650	5,320	1,224
Lower Pine Bald.....	30	275	220	33
Pewee.....	39	17,250	13,800	2,691
Walnut Mountain.....	37	22,313	17,850	3,302
Red Ash.....	35	6,613	5,290	926
Big Mary.....	47	44,563	35,650	8,378
Windrock.....	38	22,125	17,700	3,363
Upper Pioneer.....	34	4,463	3,570	607
Pioneer.....	38	4,150	3,320	631
Jordan.....	37	6,338	5,070	938
Joyner.....	39	8,450	6,760	1,318
Jellico.....	35	25,225	20,180	3,532
Blue Gem.....	33	14,175	11,340	1,871
Coal Creek.....	37	23,763	19,010	3,517
Poplar Creek.....	35	32,875	26,300	4,603
Hooper.....	36	850	680	122
Rex.....	35	11,500	9,200	1,610
Nemo.....	43	15,575	12,460	2,804
Morgan Springs.....	33	3,363	2,690	444
Soddy No. 12.....	24	263	210	25
Lantana.....	28	16,938	13,550	1,897
Sewanee.....	39	126,475	101,180	19,730
Richland.....	32	15,213	12,170	1,947
Wilder.....	41	38,713	30,970	6,349
Lower Wilder.....	30	213	170	26
Bon Air.....	43	8,075	6,460	1,389
White Oak.....	30	3,100	2,480	372
Total.....	38	482,981	386,380	74,296

TABLE A-69. - Strippable resources and reserves of bituminous coal
in Tennessee, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Anderson.....	40	40,320	8,004
Bledsoe.....	32	11,320	1,800
Campbell.....	38	84,070	15,846
Claiborne.....	36	14,510	2,619
Cumberland.....	39	19,820	3,855
Fentress.....	41	25,180	4,752
Hamilton.....	38	23,640	4,468
Marion.....	42	21,020	4,393
Morgan.....	39	33,310	6,529
Overton.....	41	10,520	2,157
Pickett.....	41	100	21
Putnam.....	41	5,160	1,058
Rhea.....	41	12,100	2,468
Roane.....	39	260	51
Scott.....	39	33,820	6,544
Sequatchie.....	39	19,350	3,764
Van Buren.....	35	30,380	5,256
White.....	41	3,500	711
Total.....	38	385,380	74,296

TABLE A-70. - Strippable bituminous coal reserves in Tennessee,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Cold Gap.....	35	-	-	221
Grass Spring.....	56	-	-	426
Rock Spring.....	46	-	-	1,224
Lower Pine Bald.....	30	-	-	33
Pewee.....	39	2,691	-	-
Walnut Mountain.....	37	-	3,302	-
Red Ash.....	35	-	926	-
Fig Mary.....	47	-	-	8,378
Windrock.....	38	-	3,363	-
Upper Pioneer.....	34	-	607	-
Pioneer.....	38	-	631	-
Jordan.....	37	-	938	-
Joyner.....	39	-	-	1,318
Jellico.....	35	-	3,532	-
Blue Gem.....	33	-	1,871	-
Coal Creek.....	37	-	3,517	-
Poplar Creek.....	35	-	-	4,603
Hooper.....	36	-	122	-
Rex.....	35	1,610	-	-
Nemo.....	43	-	2,804	-
Morgan Springs.....	33	-	-	444
Soddy No. 12.....	24	-	25	-
Lantana.....	28	-	1,897	-
Sewanee.....	39	-	19,730	-
Richland.....	32	-	-	1,947
Wilder.....	41	-	-	6,349
Lower Wilder.....	30	-	-	26
Bon Air.....	43	-	-	1,389
White Oak.....	30	372	-	-
Total.....	38	4,673	43,265	26,358

TABLE A-71. - Strippable resources and reserves of lignite
in Texas, January 1, 1968, by formation

(Thousand short tons)

Formation ¹	Average thickness (feet)	Remaining strippable resource (0-90 feet overburden)	Recoverable strippable resource	Strippable reserves
Wilcox.....	7	2,871,500	2,297,200	1,149,000
Manning.....	6	145,600	116,500	58,000
Yegua.....	5	254,800	203,900	102,000
Total.....	7	3,271,900	2,617,600	1,309,000

¹ Beds of lignite have not been named.

TABLE A-72. - Strippable resources and reserves of lignite in Texas,
January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness ¹ (feet)	Recoverable strippable resource	Strippable reserves
Anderson.....	-	68,500	34,000
Angelina.....	-	16,300	8,000
Bastrop.....	-	167,000	84,000
Bexar.....	-	49,600	25,000
Bowie.....	-	46,100	23,000
Brazos.....	-	9,000	5,000
Burleson.....	-	12,800	6,000
Caldwell.....	-	121,600	61,000
Camp.....	-	21,800	11,000
Cass.....	-	57,300	29,000
Cherokee.....	-	35,200	18,000
Fayette.....	-	86,400	43,000
Franklin.....	-	9,600	5,000
Free zone.....	-	81,600	40,000
Gregg.....	-	13,100	6,000
Grimes.....	-	41,000	20,000
Harrison.....	-	28,900	50,000
Henderson.....	-	121,000	61,000
Hopkins.....	-	68,700	34,000
Houston.....	-	54,100	27,000
Lee.....	-	19,800	10,000
Leon.....	-	78,600	39,000
Madison.....	-	24,300	12,000
Marion.....	-	35,300	18,000
Milam.....	-	334,600	167,000
Morris.....	-	17,600	8,000
Nacogdoches.....	-	14,400	7,000
Panola.....	-	112,300	56,000
Rains.....	-	11,500	6,000
Robertson.....	-	89,900	45,000
Rusk.....	-	133,100	67,000
Shelby.....	-	59,500	30,000
Titus.....	-	116,800	58,000
Trinity.....	-	19,500	10,000
Van Zandt.....	-	221,800	111,000
Walker.....	-	25,300	13,000
Washington.....	-	17,300	9,000
Wood.....	-	106,400	53,000
Total.....	7	2,617,600	1,309,000

¹Average coalbed thickness by county not given.

TABLE A-73. - Strippable lignite reserves in Texas, January 1, 1968,
by formation and sulfur category

(Thousand short tons)

Formation	Average thickness (feet)	Low sulfur	Medium sulfur	High sulfur
Wilcox.....	7	574,000	575,000	-
Manning.....	6	-	58,000	-
Yegua.....	5	51,000	51,000	-
Total.....	7	625,000	684,000	-

TABLE A-74. - Strippable resources and reserves of bituminous coal
in Utah, January 1, 1968, by deposit and formation

(Thousand short tons)

Deposit Formation	Average thickness (feet)	Remaining strippable resource ¹	Recoverable strippable resource	Strippable reserves
Emery.....	-	20,000	16,000	-
Ferron Formation ²	5	-	-	6,000
Kaiparowitz.....	-	24,000	19,000	-
Christensen Zone.....	50	-	-	17,000
Kanab.....	-	200,000	160,000	-
Tropic I.....	11	-	-	120,000
Factory Butte.....	-	18,000	14,000	-
Ferron Formation ³	7	-	-	8,000
Total.....	14	262,000	209,000	150,000

¹Resource calculated to overburden thicknesses ranging from 60 to 200 feet.

²This coal is in Emery and Sevier Counties.

³This coal is in Wayne County.

TABLE A-75. - Strippable resources and reserves of bituminous coal
in Utah, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (feet)	Recoverable strippable resource	Strippable reserves
Emery-Sevier.....	5	16,000	6,000
Garfield.....	50	19,000	16,000
Kane.....	11	160,000	120,000
Wayne	7	14,000	8,000
Total.....	14	209,000	150,000

TABLE A-76. - Strippable bituminous coal reserves in Utah, January 1, 1968,
by formation and sulfur category

(Thousand short tons)

Formation	Average thickness (feet)	Low sulfur	Medium sulfur	High sulfur
Ferron.....	5	6,000	-	-
Ferron.....	7	-	-	8,000
Christensen Zone.....	50	-	16,000	-
Tropic I.....	11	-	120,000	-
Total.....	14	6,000	136,000	8,000

TABLE A-77. - Strippable resources and reserves of bituminous coal
in Virginia, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
High Splint (No. 12).....	54	13,900	11,200	3,000
Morris (No. 11).....	48	11,600	9,300	2,200
Pardee (Parsons) (No. 10). ...	71	23,200	18,500	6,600
Phillips (No. 7).....	43	10,900	8,700	1,800
Low Splint (No. 6).....	41	22,400	17,900	3,600
Cedar Grove.....	56	5,100	4,100	1,100
Lower Cedar Grove.....	48	5,200	4,200	1,000
Taggart (No. 5).....	45	32,800	26,200	5,900
Taggart-Marker.....	29	22,200	17,800	2,600
Harlan (Upper Standiford)....	48	20,700	16,600	4,000
Lower Standiford.....	32	1,200	1,000	200
Lower St. Charles.....	30	5,500	4,400	700
Kelly.....	40	43,400	34,800	6,900
Campbell Creek (Imboden)....	57	100,900	80,700	19,800
Clintwood.....	50	113,800	91,000	21,800
Eagle.....	42	73,800	59,000	12,300
Blair.....	40	33,200	26,500	5,200
Dorchester (Glamorgan).....	37	109,600	87,700	15,400
Norton.....	34	28,200	22,600	3,800
Hagy.....	36	63,500	50,800	9,100
Splash Dam.....	36	134,300	107,500	19,300
Upper Banner.....	30	104,700	83,800	20,700
Lower Banner.....	43	180,200	144,100	32,400
Big Fork.....	28	4,800	3,800	500
Kennedy.....	33	193,700	155,000	25,300
Aily.....	28	2,400	1,900	300
Raven.....	41	73,200	58,500	11,200
Jawbone.....	42	47,200	37,700	7,600
Tiller.....	56	28,500	22,700	5,300
Upper Seaboard.....	28	5,900	4,700	700
Greasy Creek.....	28	2,100	1,700	200
Middle Seaboard.....	30	5,400	4,300	600
Lower Seaboard.....	48	4,600	3,700	900
Upper Horsepen.....	60	6,700	5,400	1,600
Middle Horsepen.....	44	9,500	7,600	1,700
War Creek.....	40	4,500	3,600	700
Lower Horsepen.....	30	4,200	3,400	600
Pocahontas No. 5.....	60	1,000	800	200
Pocahontas No. 3.....	84	2,000	1,600	700
Total.....	42	1,556,000	1,244,800	257,500

TABLE A-78. - Strippable resources and reserves of bituminous coal
in Virginia, January 1, 1968, by county

(Thousand short tons)

County	Average collied thickness (inches)	Recoverable strippable resource	Strippable reserves
Buchanan.....	39	506,700	98,300
Dickenson.....	41	221,000	45,300
Lee.....	46	77,300	17,800
Russell.....	44	63,300	14,200
Tazewell.....	42	79,400	15,900
Wise.....	45	297,100	66,000
Total.....	42	1,244,800	257,500

TABLE A-79. - Strippable bituminous coal reserves in Virginia,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
High Splint (No. 12).....	54	2,600	400	-
Morris (No. 11).....	48	2,200	-	-
Pardee (Parsons) (No. 10).....	71	6,600	-	-
Phillips (No. 7).....	43	1,800	-	-
Low Splint (No. 6).....	41	3,600	-	-
Cedar Grove.....	56	1,100	-	-
Lower Cedar Grove.....	48	1,000	-	-
Taggart (No. 5).....	45	5,900	-	-
Taggart-Marker.....	29	2,600	-	-
Harlan (Upper Standiford).....	48	-	-	4,000
Lower Standiford.....	32	200	-	-
Lower St. Charles.....	30	-	-	700
Kelly.....	40	6,900	-	-
Campbell Creek (Imboden).....	57	11,500	8,300	-
Clintwood.....	50	4,900	16,900	-
Eagle.....	42	-	12,300	-
Blair.....	40	5,200	-	-
Dorchester (Glamorgan).....	37	-	15,400	-
Norton.....	34	-	3,800	-
Hagy.....	36	-	9,100	-
Splash Dam.....	36	19,300	-	-
Upper Banner.....	50	20,700	-	-
Lower Banner.....	45	32,400	-	-
Big Fork.....	28	-	-	500
Kennedy.....	23	2,200	23,100	-
Aily.....	28	-	300	-
Raven.....	41	8,700	2,500	-
Jawbone.....	42	3,700	3,900	-
Tiller.....	56	5,300	-	-
Upper Seaboard.....	75	700	-	-
Greasy Creek.....	28	-	200	-
Middle Seaboard.....	30	-	600	-
Lower Seaboard.....	48	900	-	-
Upper Horsepen.....	60	-	1,600	-
Middle Horsepen.....	44	1,700	-	-
War Creek.....	40	-	700	-
Lower Horsepen.....	30	600	-	-
Pocahontas No. 5.....	60	200	-	-
Pocahontas No. 3.....	84	700	-	-
Total.....	42	153,200	99,100	5,200

TABLE A-80. - Strippable resources and reserves of subbituminous coal in Washington, January 1, 1968, by deposit and seam

(Thousand short tons)

Deposit Seam	Average thickness (feet)	Remaining strippable resource ¹	Recoverable strippable resource	Strippable reserves
Centralia.....	-	500,000	400,000	-
Big.....	25	-	-	123,000
Smith.....	10	-	-	12,000
Total.....	22	500,000	400,000	135,000

¹Resource calculated to overburden thicknesses ranging from 100 to 250 feet.

TABLE A-81. - Strippable resources and reserves of subbituminous coal in Washington, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (feet)	Recoverable strippable resource	Strippable reserves
Lewis-Thurston.....	22	400,000	135,000

TABLE A-82. - Strippable subbituminous coal reserves in Washington, January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (feet)	Low sulfur	Medium sulfur	High sulfur
Big.....	25	123,000	-	-
Smith.....	10	12,000	-	-
Total.....	22	135,000	-	-

TABLE A-83. - Strippable resources and reserves of bituminous coal
in West Virginia, January 1, 1968, by seam

(Thousand short tons)

Seam	Average thickness (inches)	Remaining strippable resource (0-120 feet overburden)	Recoverable strippable resource	Strippable reserves
Washington.....	42	42,200	33,800	7,100
Waynesburg.....	39	119,100	95,200	18,400
Sewickley.....	34	50,300	40,300	10,900
Redstone.....	50	231,700	182,800	45,000
Pittsburgh.....	65	841,300	673,000	191,800
Elk Lick.....	38	39,500	31,600	5,900
Upper Bakerstown.....	36	11,700	9,400	1,700
Bakerstown.....	38	56,900	45,500	8,600
Brush Creek.....	34	4,600	3,700	600
Mahoning.....	38	10,600	8,500	1,600
Upper Freeport.....	39	297,200	237,600	44,900
Lower Freeport.....	37	18,100	14,500	2,700
Upper Kittanning.....	35	468,600	374,800	65,500
Middle Kittanning.....	39	267,100	213,700	41,000
Lower Kittanning.....	34	2,103,700	1,690,700	434,100
Clarion.....	41	71,400	57,100	11,300
Mercer.....	36	95,000	76,000	13,700
Stockton.....	53	1,038,100	830,500	214,700
Coalburg.....	51	1,067,400	853,900	216,100
Buffalo Creek.....	60	73,600	58,900	17,700
Winifrede.....	57	600,100	480,100	128,100
Chilton.....	43	361,300	289,100	60,200
Harnshaw.....	38	143,100	114,400	21,400
Williamson.....	30	45,600	36,500	5,500
Cedar Grove.....	44	315,100	252,000	54,100
Lower Cedar Grove.....	43	111,800	89,400	18,800
Alma.....	37	172,400	132,900	25,500
Campbell Creek.....	61	604,800	483,900	135,100
Powellton.....	38	107,100	85,600	16,300
Eagle.....	43	377,900	302,300	62,900
Little Eagle.....	34	81,800	65,300	11,100
Lower War Eagle.....	30	14,200	11,400	1,700
Gilbert.....	33	50,000	40,000	6,700
Laeger.....	36	36,000	28,800	5,200
Sewell.....	38	454,000	363,400	68,400
Welch.....	32	93,000	74,400	11,900
Little Raleigh.....	36	8,700	7,000	1,300
Beckley.....	41	157,900	134,300	27,400
Fire Creek.....	37	152,500	121,900	22,200
No. 9 Pocahontas.....	30	42,900	34,300	5,200
No. 7 Pocahontas.....	30	7,200	5,800	900
No. 6 Pocahontas.....	40	67,200	53,800	10,300
No. 5 Pocahontas.....	36	17,300	13,800	2,500
No. 4 Pocahontas.....	62	97,600	78,100	23,500
No. 3 Pocahontas.....	52	184,300	147,500	37,300
No. 2 Pocahontas.....	30	8,400	6,700	1,000
Total.....	51	11,230,300	8,984,200	2,117,700

TABLE A-84. - Strippable resources and reserves of bituminous coal
in West Virginia, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (inches)	Recoverable strippable resource	Strippable reserves
Barbour.....	52	205,800	53,600
Boons.....	52	1,197,300	310,800
Braxton.....	39	200,000	38,700
Brooke.....	46	31,900	7,200
Cabell.....	33	44,500	7,300
Calhoun.....	32	9,600	1,600
Clay.....	35	295,700	52,500
Payette.....	53	558,300	148,700
Gilmer.....	44	30,900	6,800
Grant.....	49	29,400	7,200
Greenbrier.....	37	79,800	14,600
Hancock.....	39	20,100	4,000
Harrison.....	70	128,700	44,800
Kanawha.....	50	1,143,100	284,100
Lewis.....	50	180,100	45,800
Lincoln.....	41	165,700	34,100
Logan.....	48	588,100	142,400
Marion.....	52	111,100	29,000
Mason.....	54	5,000	1,400
Marshall.....	72	900	300
McDowell.....	44	383,000	84,100
Mercer.....	48	52,800	12,700
Mineral.....	38	33,500	6,200
Mingo.....	48	686,600	165,800
Monongalia.....	55	129,000	35,700
Nicholas.....	38	476,800	91,700
Ohio.....	43	61,300	13,200
Pocahontas.....	36	63,800	11,500
Preston.....	39	87,200	17,000
Putnam.....	66	10,300	3,400
Raleigh.....	51	438,900	112,800
Randolph.....	42	227,800	48,400
Roane.....	31	9,400	1,500
Summers.....	37	6,400	1,200
Taylor.....	66	49,600	16,500
Tucker.....	45	19,200	4,300
Upshur.....	46	204,000	46,900
Wayne.....	41	162,200	33,000
Webster.....	42	564,000	119,400
Wyoming.....	37	292,400	57,500
Total.....	51	8,984,200	2,117,700

TABLE A-85. - Strippable bituminous coal reserves in West Virginia,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (inches)	Low sulfur	Medium sulfur	High sulfur
Washington.....	42	-	-	7,100
Waynesburg.....	39	-	-	18,400
Sewickley.....	54	-	-	10,900
Redstone.....	50	-	5,000	40,000
Pittsburgh.....	65	-	18,000	173,800
Black Lick.....	38	-	1,000	4,900
Upper Bakerstown.....	36	-	-	1,700
Bakerstown.....	38	2,000	5,000	1,600
Brush Creek.....	34	-	-	600
Mahoning.....	38	-	1,600	-
Upper Freeport.....	39	-	31,000	13,900
Lower Freeport.....	37	-	2,700	-
Upper Kittanning.....	35	-	40,500	25,000
Middle Kittanning.....	39	13,000	27,000	1,000
Lower Kittanning.....	54	203,100	231,000	-
Clarion.....	41	9,000	-	2,300
Mercer.....	36	-	13,700	-
Stockton.....	53	115,000	99,700	-
Coalburg.....	51	216,100	-	-
Buffalo Creek.....	60	17,700	-	-
Winifrede.....	57	128,100	-	-
Chilton.....	43	58,000	2,100	-
Hernshaw.....	38	-	21,400	-
Williamson.....	30	-	5,500	-
Cedar Grove.....	44	-	54,100	-
Lower Cedar Grove.....	43	16,000	2,800	-
Alma.....	37	14,000	11,500	-
Campbell Creek.....	61	45,000	90,100	-
Powellton.....	38	16,300	-	-
Eagle.....	43	53,000	-	9,900
Little Eagle.....	34	11,100	-	-
Lower War Eagle.....	30	-	1,700	-
Gilbert.....	33	6,000	700	-
Jaeger.....	36	4,000	1,200	-
Sewell.....	38	68,400	-	-
Welch.....	32	11,900	-	-
Little Raleigh.....	36	-	1,300	-
Beckley.....	41	27,400	-	-
Fire Creek.....	37	22,200	-	-
No. 9 Pocahontas.....	30	5,200	-	-
No. 7 Pocahontas.....	30	900	-	-
No. 6 Pocahontas.....	40	10,300	-	-
No. 5 Pocahontas.....	36	2,300	-	-
No. 4 Pocahontas.....	62	23,500	-	-
No. 3 Pocahontas.....	52	37,300	-	-
No. 2 Pocahontas.....	30	1,000	-	-
Total.....	51	1,138,000	668,600	311,100

TABLE A-86. - Strippable resources and reserves of subbituminous coal
in Wyoming, January 1, 1968, by deposit and seam

(Thousand short tons)

Deposit Seam	Average thickness (feet)	Remaining strippable resource ¹	Recoverable strippable resource	Strippable reserves
Clear Creek.....	-	185,000	148,000	-
Canyon.....	20	-	-	148,000
Gillette.....	-	16,100,000	12,880,000	-
Roland-Smith.....	71	-	-	11,800,000
Spotted Horse.....	-	716,000	573,000	-
Felix.....	12	-	-	192,000
Smith-local.....	10	-	-	94,000
Cherokee.....	-	168,000	134,000	-
B-C.....	25	-	-	93,000
Antelope.....	-	500,000	400,000	-
D-E.....	35	-	-	160,000
Dry Cheyenne.....	-	180,000	144,000	-
F.....	8	-	-	48,000
Hanna.....	-	10,000	8,000	-
Hanna Formation (8 seams).....	10	-	-	8,000
Dave Johnson.....	-	136,000	109,000	-
School.....	32	-	-	38,000
Badger.....	18	-	-	7,000
Lake DeBmet.....	-	2,000,000	1,600,000	-
Healy.....	130	-	-	800,000
Sorensen.....	-	1,000,000	800,000	-
Adaville (13 seams).....	20	-	-	140,000
Acme-Kleenburn.....	-	50,000	40,000	-
Monarch.....	23	-	-	40,000
Jim Bridger.....	-	250,000	200,000	-
Fort Union Formation (2 seams).....	15	-	-	110,000
Red Desert.....	-	733,000	586,000	-
Battle 2 and 3.....	7	-	-	15,000
Sourdough.....	8	-	-	184,000
Hadsell 2.....	8	-	-	16,000
Creston 2 and 3.....	18	-	-	50,000
Latham.....	6	-	-	28,000
Total.....	67	22,028,000	17,622,000	13,971,000

¹Resource calculated to overburden thicknesses ranging from 60 to 300 feet.

TABLE A-87. - Strippable resources and reserves of subbituminous coal
in Wyoming, January 1, 1968, by county

(Thousand short tons)

County	Average coalbed thickness (feet)	Recoverable strippable resource	Strippable reserves
Campbell.....	68	13,527,000	12,160,000
Carbon.....	24	142,000	101,000
Converse.....	25	653,000	253,000
Johnson.....	130	1,600,000	800,000
Lincoln.....	20	800,000	140,000
Sheridan.....	21	114,000	114,000
Sweetwater.....	11	786,000	403,000
Total.....	67	17,622,000	13,971,000

TABLE A-88. - Strippable subbituminous coal reserves in Wyoming,
January 1, 1968, by seam and sulfur category

(Thousand short tons)

Seam	Average thickness (feet)	Low sulfur	Medium sulfur	High sulfur
Canyon.....	20	148,000	-	-
Roland-Smith.....	71	11,800,000	-	-
Felix.....	12	192,000	-	-
Smith-local.....	10	94,000	-	-
B-C.....	25	-	-	93,000
D-E.....	35	-	-	160,000
F.....	8	-	-	48,000
Hanna Formation (8 seams).....	10	8,000	-	-
School.....	32	38,000	-	-
Badger.....	18	7,000	-	-
Hasly.....	130	800,000	-	-
Adaville (13 seams).....	20	140,000	-	-
Monarch.....	23	40,000	-	-
Fort Union Formation (2 seams)	15	110,000	-	-
Battle 2 and 3.....	7	-	15,000	-
Sourdough.....	8	-	-	184,000
Hadsell 2.....	8	-	-	16,000
Creston 2 and 3.....	18	-	50,000	-
Latham.....	6	-	-	28,000
Total.....	67	13,377,000	65,000	529,000

APPENDIX B.--SUMMARY OF STRIP-MINING LAWS IN THE UNITED STATES, BY STATES

TABLE B-1. - A summary of the regulations governing surface mining on lands under the jurisdiction of the U.S. Government¹

Law and date.....	Code of Federal Regulations. Title 43, Part 23, January 18, 1969, and Title 43, Part 3501.1-4(b)(1), June 13, 1970. The Mineral Leasing Act of February 25, 1920, as amended and supplemented (30 U.S.C. 181-287), the Mineral Leasing Act for Acquired Lands (30 U.S.C. 351-359), and the Materials Act of July 31, 1947, as amended (30 U.S.C. 601-604).
Minerals subject to.....	All leasable or salable minerals owned by the U.S. Government.
Regulating agency.....	The District Manager, Bureau of Land Management, in cooperation with the Federal agency having jurisdiction over the land, if appropriate, and in consultation with the Regional Mining Supervisor, U.S. Geological Survey, and, if necessary, in consultation with the Federal Water Quality Administration, and in consultation with the private owners of the surface rights, if appropriate.
Permit requirements:	
Basic fee.....	Each application for permit, lease, or license must be accompanied by a service charge of \$10.
Additional.....	A minimum annual rental of 25 cents per acre for the first year, 50 cents per acre for the second through the fifth years, and \$1 per acre thereafter. Each permit may include up to 5,120 acres. An individual or corporation may hold up to 46,080 acres in permits or leases.

¹Applies principally to Alaska, Arizona, California, Idaho, Montana, Nevada, New Mexico, North Dakota, Utah, Washington, and Wyoming.

**TABLE B-1. - A summary of the regulations governing surface mining
on lands under the jurisdiction of the
U.S. Government¹--Continued**

Mining and reclamation reports...	Within 30 days of the end of each calendar year, or within 30 days of the cessation of operations, the operator shall file with the Mining Supervisor a description of the operation, including the area affected and the area reclaimed, the method of reclamation and results, and the reclamation yet to be done.
Penalty for failure to reclaim:	
Bond forfeiture.....	Yes, for failure to comply with the surface protection and reclamation aspects of an approved mining plan.
Denial of new permit.....	Yes, for forfeiture of bond unless the disturbed land has been subsequently reclaimed without cost to the Federal Government.

TABLE B-1. - A summary of the regulations governing surface mining on lands under the jurisdiction of the U.S. Government¹--Continued

Penalty for failure to comply....	Failure of an operator to comply with the terms of a permit or lease shall be cause for the Mining Supervisor or District Manager to take action to cancel the permit or lease and forfeiture of bond.
Bond requirements:	
Minimum.....	\$2,000. In lieu of a performance bond, the operator may deposit cash or negotiable bonds of the U.S. Government.
Additional.....	The amount of the bond shall be sufficient to satisfy the reclamation requirements of an approved mining plan.
Reclamation requirements:	
Plan required.....	Yes, to be filed with the Mining Supervisor and outlining the mining operation and the measures to be taken to protect the environment and eliminate any hazards to health and safety.
Backfilling and grading.....	The mining plan shall show the proposed methods and timing of grading and backfilling of the areas affected by the mining operation. The mining plan is subject to review and approval by the Mining Supervisor or the District Manager. Mutual acceptance of a mining plan is binding on the part of the operator. The mining plan may be amended if warranted by unforeseen circumstances.
Replanting.....	If stipulated in the permit, lease, or contract, the mining plan shall show the method of preparing and fertilizing the soil, and the types and mixtures of grasses, shrubs or trees, and the amount, per acre.
Substitution of lands permitted..	No.

**TABLE B-2. - Summary of the laws regulating strip mining
in the United States, by States**

ALABAMA

Law and date.....	Alabama Surface Mining Act of 1969.
Regulating agency.....	State Department of Industrial Relations.
License requirements:	
Basic fee.....	\$250 per acre.
Additional.....	\$50 per acre for mining contiguous areas.
Bond requirements:	
Minimum.....	\$150 per acre.
Additional.....	Proportion to increase in acreage over original permit.
Reclamation requirements:	
Backfilling and grading.....	Grade peaks and ridges to a rolling topography. Ridges graded to minimum width of 10 feet; peaks graded to width of 15 feet. Face of seam and any toxic material to be buried to depth of 2 feet or covered with water. Diversion of water to reduce siltation and to protect natural water courses.
Replanting.....	Plant with seeds or seedlings of native commercial species; stipulated number of trees per acre is required. Recreational facilities may be constructed in lieu of planting.
Mining and reclamation reports.	Aerial photographs or maps must be submitted 90 days after the expiration of permit or completion of mining.

ARIZONA

Law and date.....	None.
Regulating agency.....	Regulated by Federal Law applying to the Navajo and Hopi Indian Reservations. Individual agreements are made between the coal producers and the tribe concerned.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

COLORADO

Law and date.....	Colorado Open Cut Land Reclamation Act of 1969.
Minerals subject to.....	Coal.
Regulating agency.....	Colorado Department of Natural Resources.
License requirements:	
Basic fee.....	\$50.
Additional.....	None.
Penalty for failure to comply....	No legal obligation other than that provided in the contract agreement.
Bond requirements:	
Minimum.....	\$2,000 for mining on Indian lands or the public domain--Federal requirement.
Additional.....	Not to exceed \$100 per acre of disturbed land.
Reclamation requirements:	
Plan.....	Only after mining is completed. Maps are required.
Backfilling and grading.....	Exposed face of seam must be covered by at least 2 feet of earth or spoil or by at least 2 feet of water. Strike off ridges to minimum top width of 10 feet; strike off peaks to a minimum of 15 feet; impound water. Grade to a rolling topography, operator shall provide access roads.
Replanting.....	Operator may reclaim land for forest, range, crop, or other use in cooperation with the State.

GEORGIA

Law and date.....	Surface Mining Act of 1968. January 1, 1968.
Minerals subject to.....	All except dimension stone.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

GEORGIA--Continued

Regulating agency.....	Surface Mined Land Use Board.
License requirements:	
Basic fee.....	\$100 annually for first 50 mining employees.
Additional.....	\$50 for each increment of 50 mining employees or fraction thereof.
Penalty for failure to comply....	\$100 to \$1,000 plus \$100 to \$1,000 for each day violation continues.
Bond requirements:	
Minimum.....	None.
Additional.....	\$100 to \$500 per acre.
Reclamation requirements:	
Plan.....	Required.
Backfilling and grading.....	Restoration of the land is to be consistent with the land use in the area.
Substitution of lands.....	Permitted with approval of the Board.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond forfeiture and denial of new permit.

IDAHO

Law and date.....	Idaho Surface Mining Act, May 31, 1971.
Minerals subject to.....	Coal, clay, stone, sand, gravel, metallic and nonmetallic ores or other substances of value recovered from the earth.
Regulating agency.....	Board of Land Commissioners.
Bond requirements:	
Minimum.....	Sufficient to insure compliance with the restoration requirements but not to exceed \$500 per acre. Cash and government securities may be deposited in lieu of bond.
Additional.....	None.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

IDAHO--Continued

Reclamation requirements:

Plan..... Required.

Backfilling and grading..... Strike off ridges to minimum width of 15 feet. Abandoned roads to be cross-ditched as necessary to avoid erosion. Exploratory holes to be plugged or otherwise rendered harmless. Tailings ponds shall not constitute a hazard. The Board may defer the cross-ditching of roads. All reclamation to be performed within 1 year after abandonment.

Replanting..... Revegetation required in mined areas, waste piles, and on roads as is feasible.

Penalty for failure to reclaim:

Bond forfeiture..... Civil penalties may be lodged against unbonded operators for failure to comply.

ILLINOIS

Law and date..... The Surface Mined Land Reclamation Act--1961, amended 1963, 1967.

Minerals subject to..... All under 10 feet or more of overburden.

Regulating agency..... Department of Conservation.

License requirements:

Basic fee..... 10 acres or less, \$50 for first acre. Up to 50 acres, \$153.50 for first 10 acres. More than 50 acres, \$143.50 for first 50 acres. Renew annually.

Additional..... \$11.50 per acre, up to 10 acres. \$6.50 per additional acre over 10. \$5.50 per additional acre.

Penalty for failure to comply.... \$50 to \$1,000 plus \$50 to \$1,000 for each day violation continues. Violation of Act or noncompliance, forfeiture of bond. Injunctive procedures may be used to close down any operation that does not have a permit.

**TABLE B-2. - Summary of the laws regulating strip mining
in the United States, by States--Continued**

ILLINOIS--Continued

Bond requirements:	
Minimum.....	\$1,000 for mining. \$3,000 for gob disposal.
Additional.....	\$200 per acre in excess of 5 acres for mining, \$600 per acre in excess of 5 acres for gob disposal.
Reclamation requirements:	
Plan.....	Plan and map to be submitted by December 1, following termination of the permit year.
Backfilling and grading.....	All ridges and peaks graded to a rolling topography. No slopes to exceed 30 percent grade, but not less than original grade. Land for pasture shall have peaks and ridges struck off to at least 18 feet. That for crops should be traversable by farm machinery. Construct dams to impound water. Cover the exposed seam with water or fertile earth.
Replanting.....	Operator must revegetate when land will support plant life.
Substitution of lands.....	Permitted with approval of the Department.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond forfeited for noncompliance.

INDIANA

Law and date.....	Chapter 344 of the Acts of 1967, 1941, amended 1963, 1967.
Minerals subject to.....	Coal, clay, and shale.
Regulating agency.....	Department of Natural Resources, Natural Resources Commission.
License requirements:	
Basic fee.....	\$50 per application, annually.
Additional.....	\$15 per acre.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

INDIANA--Continued

Penalty for failure to comply....	\$1,000 to \$5,000, with suspension of permit and forfeiture of bond.
Bond requirements:	
Minimum.....	\$300 per acre, minimum \$2,000.
Additional.....	\$300 per acre.
Reclamation requirements:	
Plan.....	Required.
Backfilling and grading.....	Reduce peaks and ridges to rolling topography. Impound water and cover exposed face of seam with water or earth. Dispose of refuse by burial.
Replanting.....	Revegetate according to plan approved by Director of Department.
Mining and reclamation reports.	Required with 60 days of permit expiration, completion, or abandonment.
Penalty for failure to reclaim:	
Bond forfeiture.....	Forfeited bond money used to plant area for which posted. Revocation of permit causes bond forfeiture. New permit is denied.

IOWA

Law and date.....	Senate File 279, 1967.
Minerals subject to.....	All solid minerals.
Regulating agency.....	Department of Mines and Minerals; State Mining Board; Land Rehabilitation Advisory Board.
License requirements:	
Basic fee.....	\$50. Renewable for \$10.
Additional.....	Registration fee based on estimated administrative costs.
Penalty for failure to comply....	\$50 to \$500 or 30 days' jail sentence, or both. Each day of activity constitutes a separate violation.

TABLE B-2. - Summary of the laws regulating strip mining
in the United States, by States--Continued

IOWA--Continued

Bond requirements:	
Minimum.....	Equal to estimated cost of rehabilitating site.
Additional.....	None.
Reclamation requirements:	
Backfilling and grading.....	Grade peaks and ridges to rolling topography. Strike off peaks and ridges to width of at least 24 feet. Slope not to exceed 33 percent except where originally steeper. Impound water and cover exposed seam with water or earth to depth of 2 feet.
Mining and reclamation reports.	Reclamation report filed annually and within 30 days of completing operations.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond forfeited and new permit denied.
<u>KANSAS</u>	
Law and date.....	Mined-Land Conservation and Reclamation Act--July 1, 1968.
Minerals subject to.....	Coal.
Regulating agency.....	Mined-Land Conservation and Reclamation Board, State Labor Department.
License requirements:	
Basic fee.....	\$50.
Additional.....	None.
Penalty for failure to comply....	\$250 plus \$250 for each day violation continues.
Bond requirements:	
Minimum.....	\$2,000.
Additional.....	\$200 to \$500 per acre.

TABLE B-2. - Summary of the laws regulating strip mining
in the United States, by States--Continued

KANSAS--Continued

Reclamation requirements:

Plan.....	Required with maps.
Backfilling and grading.....	Grade spoil to a substantially flat surface equal to 60 percent of original stripped area. No slope to exceed 67 percent. Grading of highwall or spoil not required if an approved water impoundment is formed. Cover face of coal with 2 feet of earth or water. Bury or remove all refuse. Must be completed in 180 days after mining ceases. Control flow of runoff water.
Replanting.....	Planting in accordance with plan approved by Board, planting may be seeds or plants, trees, shrubs, or grasses.
Mining and reclamation reports.	Planting reports form required with statement of reclamation accomplished.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond forfeited and new permit denied.

KENTUCKY

Law and date.....	Chapter 350, Kentucky Revised Statutes 1954. Revised 1966.
Minerals subject to.....	Coal, clay.
Regulating agency.....	Department of Natural Resources, Division of Reclamation.
License requirements:	
Basic fee.....	\$50 annually.
Additional.....	\$25 per acre of area affected.
Penalty for failure to comply....	\$100 to \$1,000, each day's violation constitutes a separate offense; \$500 to \$5,000 for willful violation of the law or any determination or order.
Bond requirements:	
Minimum.....	\$2,000.
Additional.....	\$100 to \$500 per acre.

**TABLE B-2. - Summary of the laws regulating strip mining
in the United States, by States--Continued**

KENTUCKY--Continued

Reclamation requirements:

Plan.....	Required.
Backfilling and grading.....	Backfill to top of highwall and grade to original contour. Eliminate spoil peaks. Floor of pit must be filled to depth of 4 feet. Water must be impounded. Bury all debris and acid-forming materials. No strip mining on slopes greater than 27°.
Replanting.....	Revegetating required, resulting in acceptable growth.
Mining and reclamation reports.	Required.
Substitution of lands.....	Permitted with prior approval.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond forfeited for failure to reclaim. New permit is denied pending approval of reclamation on reclaimed land. A bond of \$100 per acre is withheld pending acceptable growth of vegetation.

MARYLAND

Law and date.....	Article 66C, Sections 657-674, June 1967
Minerals subject to.....	Coal.
Regulating agency.....	Bureau of Mines, Land Reclamation Advisory Committee.
License requirements:	
Basic fee.....	\$100. Annual renewal fee of \$10.
Additional.....	None.
Penalty for failure to comply....	\$5,000 to \$10,000 or up to 6 months imprisonment, or both.
Bond requirements:	
Minimum.....	\$1,600.
Additional.....	\$200 per acre.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

MARYLAND--Continued

Reclamation requirements:

Plan..... Required. Operator must furnish map and monthly and annual reports to the State Advisory Committee.

Backfilling and grading..... Restore terrain to near normal, grade over final pit, and impound water if necessary.

Replanting..... Revegetation required within 1 year of backfilling. \$50 per acre may be substituted in lieu thereof.

Mining and reclamation reports. Monthly report on production, number of employees, and accidents. Also an annual report.

Penalty for failure to reclaim:

Bond forfeiture..... Bond forfeited for failure to comply with the Act. New permit is denied.

MISSOURI

Law and date..... Land Reclamation Act, October 1971.

Minerals subject to..... Coal and barite.

Regulating agency..... Land Reclamation Commission.

License requirements:

Basic fee..... \$50.

Additional..... \$17.50 per acre or fraction thereof to be affected by strip mining. A separate permit is required for each mine. All permits are on a calendar year basis.

Penalty for failure to comply.... Operating without a permit may result in a fine not to exceed \$1,000 per day on the day violation occurred or continues to occur. A permit may be revoked or suspended for the violation of any rules promulgated by the Commission or any condition imposed on the permit or condition of the bond.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

MISSOURI--Continued

Bond requirements:	
Minimum.....	\$2,000.
Additional.....	For each acre or portion thereof, the bond shall not be less than \$300 nor more than \$700 for coal; for barite, the bond shall not be less than \$200 nor more than \$500.
Reclamation requirements:	
Plan.....	The application for a permit must be accompanied by a reclamation plan that meets the requirements of the law, stating the method of operation, grading, and the reclamation and conservation planned for the affected area.
Backfilling and grading.....	All peaks and ridges must be graded to a rolling topography traversable by farm machinery, but not to exceed the slope existing prior to mining. The overburden slope resulting from a box cut need not be reduced to less than 25 degrees from the horizontal; 25 percent of the reclaimed acreage may be leveled off to a minimum width of 30 feet for wildlife purposes. All trees, logs, stones, and other debris shall be disposed of to the satisfaction of the Commission. Grading shall be done within 12 months following the expiration of the permit.
Replanting.....	The sowing of seeds, plants, trees, or shrubs shall be appropriate to the designated reclamation based on the recommendations of trained foresters and agronomists.
Mining and reclamation reports.	Within 60 days of the expiration of a permit, the operator must file a report stating the number of acres affected and the extent of reclamation accomplished. The operator must file another report within 30 days of the completion of

TABLE B-2. - Summary of the laws regulating strip mining
in the United States, by States--Continued

MISSOURI--Continued

	grading, or within 60 days after 1 year following the expiration of the permit, stating the extent of grading. The operator must file a planting report within 30 days after revegetation is completed.
Substitution of lands.....	With the approval of the Commission, an operator may substitute for all or any part of the affected land to be reclaimed, an equal number of acres previously mined and not reclaimed.
Penalty for failure to reclaim:	
Bond forfeiture.....	Two-thirds of the bond may be released for the satisfactory completion of grading. One-third is released for the satisfactory completion of revegetation. After due consideration by the Commission, bond may be forfeited and no new permit will be issued until the violation causing the revocation is corrected.

MONTANA

Law and date.....	Chapter 245, 1967 Session Laws.
Minerals subject to.....	Coal.
Regulating agency.....	Montana Bureau of Mines and Geology.
License requirements:	
Basic fee.....	\$0.05 per ton tax on excess of 50,000 tons.
Additional.....	None.
Penalty for failure to comply....	A contract agreement prevails between the State and the operator.
Bond requirements:	
Minimum.....	None.
Additional.....	None.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

MONTANA--Continued

Reclamation requirements:
 Backfilling and grading..... Reclamation costs are extended as credit toward paying the coal mines license tax.

NEW MEXICO

Law and date..... None.
 Minerals subject to..... On Indian lands, mining is in accordance with the individual agreement between the operator and the Indians.

NORTH DAKOTA

Law and date..... Chapter 38-01 through 14. North Dakota Century Code. Effective 1919, as revised. Reclamation of Strip Mined Lands, Chapter 38-14, January 1, 1970, and amended July 1, 1971.
 Minerals subject to..... Any mineral where the overburden exceeds 10 feet in depth.
 Regulating agency..... State Mine Inspector (mining); Public Service Commission (reclamation).
 License requirements..... \$5 annually for 100 tons or less; \$15 for 101 to 1,000 tons; \$45 for 1,001 to 5,000 tons; \$65 for 5,001 to 10,000 tons; \$85 for 10,001 to 20,000 tons; \$125 for 20,001 to 50,000 tons; \$200 for 50,001 to 200,000 tons; \$300 for more than 200,000 tons.
 Permit requirements..... Permit term is for 3 years. For 10 acres or less, \$25 and an amount equal to \$7.50 times the number of acres affected. For 11 to 50 acres, \$100 and an amount equal to \$3.50 times the number of acres. For over 50 acres, \$275 and an amount equal to \$2.50 times the number of acres. Permit applications shall describe the area and the estimated acreage to be affected in the following 3 years. Permits may be amended.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

NORTH DAKOTA--Continued

	Extensions may be granted on an annual basis.
Penalty for failure to comply....	Willful neglect or violation of the regulations is a misdemeanor punishable by fine or imprisonment, or both, to the extent of \$500 or 6 months in jail.
Bond requirements.....	\$200 per acre of land mined, or fraction thereof, where the overburden exceeds 10 feet.
Reclamation requirements:	
Plan.....	Required. A plan and map shall be submitted not later than the first day of December following date of the mining permit. The plan and approval thereof are subject to the advice of other agencies and persons having experience in reclamation. The plan must designate the intended future use of the disturbed area. The landowner is granted the option of determining the method of reclamation.
Backfilling and grading	Depends on the proposed future use. For crops and hay, peaks and ridges graded and valleys filled to extent necessary to enable the traverse of farm machinery. For pasture, peaks and ridges must be struck off to minimum width of 35 feet. For forest planting, peaks and ridges are to be struck off to a minimum width of 35 feet. Negotiable access roads must be provided. Earth dams must be provided to prevent runoff except that lakes and ponds shall not interfere with mining. Land within 660 feet of, and visible from any public road, building or cemetery must be graded to a rolling topography with slopes of not more than 20 percent grade.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

NORTH DAKOTA--Continued

Replanting.....	Bond or other surety may be forfeited for failure to comply with the reclamation plan. However, two plantings or seedings relieve the miner from further obligation, regardless of success or failure of the planting efforts.
Mining and reclamation reports.	The operator shall submit by September 1 of each year of the permit term, a map showing pit location with a description of the land affected.
Substitution of lands.....	Not permitted.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond is forfeited. No new permits will be issued and all other mining operations in North Dakota must cease in 30 days. The Commission has the authority to reclaim any affected land on which a bond has been forfeited.
<u>OHIO</u>	
Law and date.....	Chapter 1513, Ohio Revised Code 1965.
Minerals subject to.....	Coal.
Regulating agency.....	Division of Forestry and Reclamation, Reclamation Board of Review.
License requirements:	
Basic fee.....	\$75.
Additional.....	\$15 per acre affected.
Penalty for failure to comply....	\$300 to \$1,000; each day violation exists constitutes a separate offense.
Bond requirements:	
Minimum.....	\$2,000.
Additional.....	\$300 per acre.
Reclamation requirements:	
Plan.....	Required.

**TABLE B-2. - Summary of the laws regulating strip mining
in the United States, by State--Continued**

OHIO--Continued

Backfilling and grading.....	Grade peaks and fill depressions to rolling topography. Tops of isolated peaks graded to level surface of at least 30 feet in width. Impound water as necessary; cover exposed seam with earth or water, bury all debris and remove unnecessary structures.
Replanting.....	Required.
Mining and reclamation reports.	Map and report required upon completion of mining or within 60 days after anniversary date of license.
Substitution of lands.....	Permitted with approval.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond forfeited. Denied for noncompliance or for actions causing siltation of streams or adjacent property.

OKLAHOMA

Law and date.....	The Open Cut Land Reclamation Act, January 1, 1968.
Minerals subject to.....	All mined by open cut.
Regulating agency.....	Department of Mines and Mining, Office of Chief Mine Inspector.
License requirements:	
Basic fee.....	\$50 per year.
Additional.....	None.
Penalty for failure to comply....	\$50 to \$1,000. Each day of violation is considered a separate offense.
Bond requirements:	
Minimum.....	Assessed value of the land in preceding year or \$50 per acre, whichever is the lesser.
Additional.....	None.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

OKLAHOMA--Continued

Reclamation requirements:

Plan.....	Required, with maps showing pit locations and reclamation program.
Backfilling and grading.....	Peaks and ridges reduced to rolling topography with ridges to be topped to at least 10 feet and peaks to at least 15 feet; impound water; cover exposed seam by at least 2 feet of earth; maintain access roads.
Replanting.....	For forest, pasture, crop. Planting must be completed within 3 years, but may be extended up to 10 years.
Mining and reclamation reports.	Maps showing reclaiming program.
Substitution of lands.....	Permitted with approval of the Department.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond forfeited for noncompliance or violation.

PENNSYLVANIA

Law and date.....	Act No. 418, Public Law 1198, and the Bituminous Coal Open Pit Mining Conservation Act.
Minerals subject to.....	Coal.
Regulating agency.....	Department of Mines and Mineral Industries, Bureau of Conservation and Reclamation, and Land Reclamation Board.
License requirements:	
Basic fee.....	\$300 annually.
Additional.....	None.
Penalty for failure to comply....	For mining without a license, \$5,000 to \$10,000, 6 months' imprisonment, or both. For mining without a permit, amended permit, or proper bond, \$500 to \$5,000, or 3 months' imprisonment, or both.

**TABLE B-2. - Summary of the laws regulating strip mining
in the United States, by States--Continued**

PENNSYLVANIA--Continued

Bond requirements:	
Minimum.....	\$5,000 per operation.
Additional.....	\$500 to \$1,000 per acre.
Reclamation requirements:	
Plan.....	Required, or maps.
Backfilling and grading.....	Backfill to original contour, fill depressions. Graded slope from highway not to exceed 45°. Provide ditches, dikes, or other facilities necessary to prevent pollution of streams.
Replanting.....	Trees, shrubs, or grasses.
Mining and reclamation reports.	Monthly report on coal production, employees, and accidents. Also, annual reports and completion report and planting report.
Substitution of lands.....	Not permitted.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond forfeited for noncompliance. New permit denied.

TENNESSEE

Law and date.....	The Tennessee Strip Mine Law of 1967. July 1967.
Minerals subject to.....	All except limestone, marble, or dimension stone.
Regulating agency.....	Department of Conservation and Board of Reclamation Review.
License requirements:	
Basic fee.....	\$250.
Additional.....	\$25 per acre, but not to exceed \$750 annually.

TABLE B-2. - Summary of the laws regulating strip mining
in the United States, by States--Continued

TENNESSEE--Continued

Penalty for failure to comply....	\$100 to \$5,000 for each offense. Each day of violation constitutes a separate offense.
Bond requirements:	
Minimum.....	None.
Additional.....	\$100 to \$200 per acre.
Reclamation requirements:	
Plan.....	Required.
Backfilling and grading... ..	Grade crests to minimum width of 20 feet; maintain access roads; cover seam face; control water.
Replanting.....	Trees, grasses, legumes, or shrubs. These may not be required if vegetation is undesirable.
Mining and reclamation reports.	Annual report and map must be filed. Periodic reports are required to show reclamation progress.
Substitution of lands.....	Not provided for.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond forfeited for noncompliance. New permit denied at the discretion of the Commissioner, for noncompliance.

UTAH

Law and date.....	None.
Regulating agency.....	Regulated by Federal laws, enforced by the Industrial Commission of Utah and the Utah State Division of Health.

VIRGINIA

Law and date.....	Chapter 15; Strip Mining, June 27, 1966.
Minerals subject to.....	Coal.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

VIRGINIA--Continued

Regulating agency.....	Department of Labor and Industry; Division of Mines; Department of Conservation and Economic Development.
License requirements:	
Basic fee.....	\$6 per acre. Maximum, \$150.
Additional.....	None.
Penalty for failure to comply....	\$1,000 or 1 year in jail, or both.
Bond requirements:	
Minimum.....	\$500.
Additional.....	\$100 per acre, maximum, \$2,500.
Reclamation requirements:	
Plan.....	Required.
Backfilling and grading.....	Grade surface to gently rolling topog- raphy; fill depressions; maintain access roads; impound water; remove all debris.
Replanting.....	Plant trees, shrubs, grasses, where practical.
Mining and reclamation reports.	Map and reclamation report to be filed annually.
Substitution of lands.....	Not permitted.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond forfeited for noncompliance. New permit denied at the discretion of the Director, Department of Conservation and Economic Development.

WASHINGTON

Law and date.....	Title 76, RCW, January 1, 1971.
Minerals subject to.....	All in which more than 10,000 tons are produced in 1 year, or which newly disturbs more than 2 acres of land in 1 year.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by State--Continued

WASHINGTON--Continued

Regulating agency.....	Board of Natural Resources.
License requirements:	
Basic fee.....	\$25 per year per separate mining operation.
Additional.....	\$5 per acre for the excess over 10 acres disturbed during the previous year.
Penalty for failure to comply....	Operating without a permit is a gross misdemeanor. Each day of such operation constitutes a separate violation.
Bond requirements:	
Minimum.....	Not less than \$100 per acre. Cash, savings, or other suitable securities may be substituted in lieu of bond.
Additional.....	The estimated cost of reclaiming that area to be disturbed during the next 12 months plus any area for which a permit has been issued and the reclamation not completed. The amount shall not exceed \$1,000 per acre or fraction thereof.
Reclamation requirements:	
Plan.....	Required. It should state the proposed subsequent use of the land, method of restoration, revegetation, water control, and the prevention of hazards.
Backfilling and grading.....	Spoil banks shall be reduced to a gently rolling topography. Banks of pits shall be sloped. Quarry walls shall be stepped or backfilled to eliminate any hazards. Drainage shall be provided for surface waters and all acid-forming material shall be covered by clean fill.
Replanting.....	Vegetative cover is required commensurate with the future use of the restored land.

TABLE B-2. - Summary of the laws regulating strip mining in the United States, by States--Continued

WASHINGTON--Continued

Mining and reclamation reports.	Operator is required to file an activities report within 30 days after the completion of mining, or within 30 days of the anniversary of the operating permit, whichever is earlier.
Penalty for failure to reclaim:	
Bond forfeiture.....	Bond forfeited if reclamation is not completed within 2 years of the completion of mining. New permit denied for failure to complete the required reclamation work.

WEST VIRGINIA

Law and date.....	Article 6, Chapter 20, The Code of West Virginia, July 1967.
Minerals subject to.....	Coal, surface clay, manganese, and iron ore.
Regulating agency.....	Department of Natural Resources, Division of Reclamation.
Licenses requirements:	
Basic fee.....	\$100.
Additional.....	\$50 renewal fee. For surface mine coal, \$30 per acre, payable to Special Reclamation Fund.
Penalty for failure to comply....	\$1,000 to \$10,000, or imprisonment for not more than 6 months, or both. Each day's violation continues to constitute a separate offense.
Bond requirements:	
Minimum.....	\$3,000.
Additional.....	\$100 to \$500 per acre.
Reclamation requirements:	
Plan.....	Required, showing grading, backfilling, soil preparation, and planting.

**TABLE B-2. - Summary of the laws regulating strip mining
in the United States, by States--Continued**

WEST VIRGINIA--Continued

Backfillin and grading.....	Grade to maximum slope of 45°; fill depressions; cover toxic materials and face of coal; impound water; remove or bury trash and other debris.
Replanting.....	600 trees or other plants per acre, or 70 percent cover with grasses or legumes.
Mining and reclamation reports.	Monthly report required for number of employees, accidents, and production. Maps are required of mined area to show progress. Final map needed at completion of operations.
Substitution of lands.....	Not permitted.
Penalty for failure to reclaim: Bond forfeiture.....	Bond forfeited.
<u>WYOMING</u>	
Law and date.....	Open Cut Land Reclamation Act, May 23, 1969.
Minerals subject to.....	All underlying sufficient overburden to require disturbing the cover.
Regulating agency.....	Commissioner of Public Lands.
License requirements: Lic fee.....	\$50.
Additional.....	None.
Penalty for failure to comply....	\$1,000. Each operating day is considered a separate offense.
Bond requirements: Minimum.....	Depending on the acreage disturbed and that reclaimed in the past year, the amount of bond may be set by the Commissioner in an amount sufficient to reclaim the land. Cash or other security may be posted in lieu of bond.

**TABLE B-2. - Summary of the laws regulating strip mining
in the United States, by States--Continued**

WYOMING--Continued

Reclamation requirements:

Plan.....	Reclamation plan is required, with mine map.
Backfilling and grading.....	Exposed seams may be covered to a depth of at least 2 feet. Peaks and ridges must be reduced to a rolling topography. Dangerous effluent must be impounded.
Replanting.....	Replanting is required in conformance with the recommendations by the Soil Conservation Service and compatible with the surrounding area.
Mining and reclamation reports.	Must be filed annually, and may be followed by inspection.
Substitution of lands.....	May be permitted at the discretion of the regulating agency.
Penalty for failure to reclaim...	Bond will not be released until reclamation is completed. New permit may be denied. On Federal land, the Bureau of Land Management may permit the operator the option of complying with the State regulations rather than with those stipulated by the U.S. Government.