MIDYEAR

REVIEW OF WYOMING COAL FIELDS, 1972

by

GARY B. GLASS

THE GEOLOGICAL SURVEY OF WYOMING

DANIEL N. MILLER, JR., STATE GEOLOGIST

September, 1972

THE GEOLOGICAL SURVEY OF WYOMING
DANIEL N. MILLER, JR., State Geologist

MIDYEAR

REVIEW OF WYOMING COAL FIELDS, 1972

by

GARY B. GLASS

(This report supercedes Review of Wyoming Coal Fields, 1971)

BOX 3008, UNIVERSITY STATION
UNIVERSITY OF WYOMING
LARAMIE, WYOMING
SEPTEMBER, 1972

$1.00

PREFACE

"Coal? Wyoming has enough with which to run the forges of Vulcan, weld every tie that binds, drive every wheel, change the north pole into a tropical region or smelt all hell."

Hon. Fenimore Chatterton
Wyoming Secretary of State
February 18, 1902
Wyoming Industrial Convention

CONTENTS

CONTENTS
(cont.)

ILLUSTRATIONS

MIDYEAR
REVIEW OF WYOMING COAL FIELDS, 1972

by GARY B. GLASS

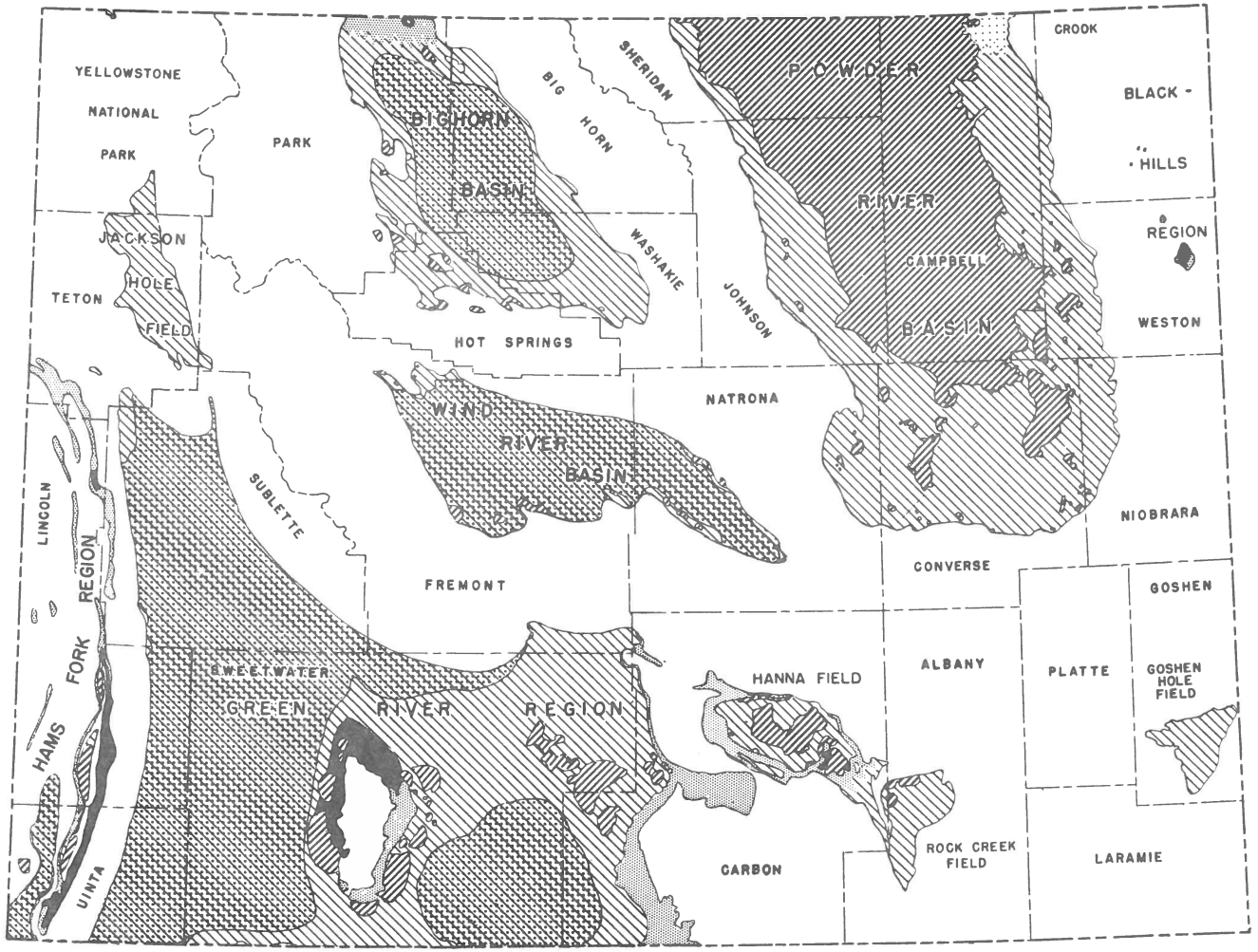
COAL-BEARING AREAS

As defined by the United States Geological Survey, Wyoming's coal fields fall into two coal-bearing provinces. The coals in northeastern Wyoming are within the Northern Great Plains Province while all other coal deposits of the State are in the Rocky Mountain Province. Additionally, the United States Bureau of Mines designates Wyoming as coal-producing District 19. Beyond these national designations, the State's coal-bearing areas are divided into the following 10 major regions, basins, or fields, which underlie more than 40,000 square miles or approximately 41% of the State and which collectively contain almost 17% of the nation's coal resources under less than 6000 feet of overburden (Figure 1):

1. Powder River Coal Basin
2. Green River Coal Region
3. Hams Fork Coal Region
4. Hanna Coal Field
5. Wind River Coal Field
6. Bighorn Coal Basin
7. Rock Creek Coal Field
8. Jackson Hole Coal Field
9. Black Hills Coal Region
10. Goshen Hole Coal Field

These major regions are further subdivided into 42 individual coal fields (Figure 2). Twelve fields are in the Powder River Basin while 8 are

FIGURE 1: WYOMING COAL-BEARING AREAS



EXPLANATION

BITUMINOUS COAL AREA

Containing coal beds more than 14 inches thick

Containing coal beds less than 14 inches thick or of unknown thickness

SUB-BITUMINOUS COAL AREA

Containing coal beds more than 30 inches thick

Containing coal beds less than 30 inches thick or of unknown thickness

LIGNITE AREA

Containing lignite beds less than 30 inches thick

PROBABLE COAL-BEARING AREA

Containing coal-bearing formations at unknown depths

FROM BERRYHILL, 1950

in the Bighorn Basin. The Wind River Basin and the Green River Region each consist of 5 fields while the Hams Fork Region and the Black Hills Region each have 4 fields. The remaining four major regions are single coal fields. The exact boundaries of many of these fields are not specifically defined.

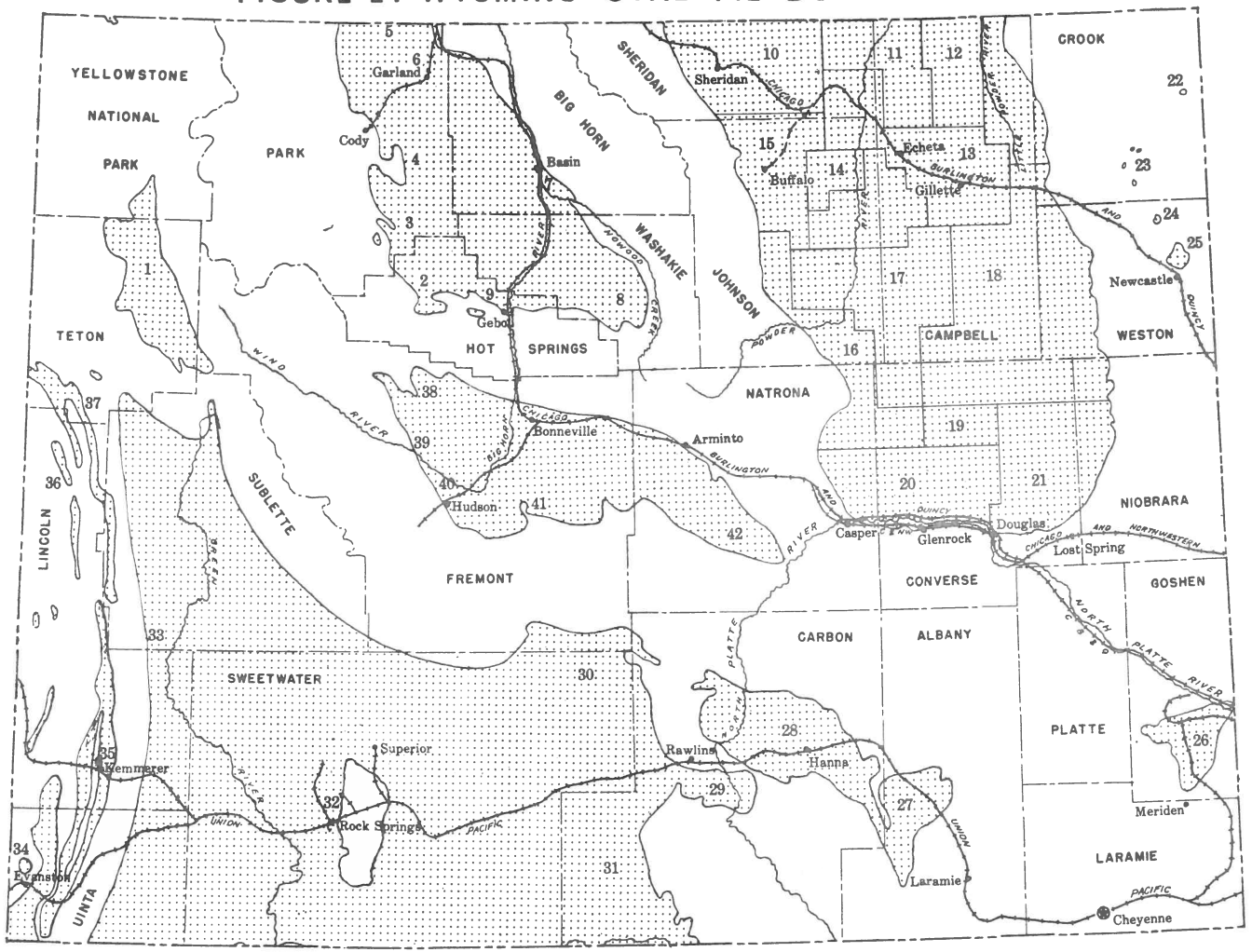
COAL-BEARING ROCKS

Coal-bearing rocks of Wyoming range in age from Lower Cretaceous to Eocene; however, Upper Cretaceous and younger rocks contain most of the calculated coal resources. Lower Cretaceous coals are restricted to the Black Hills Region. Upper Cretaceous coals are the most widespread and are found in all the major regions except the Black Hills Region. Paleocene coals are found in all but the Black Hills Region and the Goshen Hole Field. Eocene coals are the youngest and outcrop in the Powder River Basin, the Green River Region, the Hanna Field and the Rock Creek Field.

STRUCTURAL GEOLOGY OF COAL-BEARING AREAS

In general, Wyoming coal measures are situated in broad, asymmetrical, synclinal basins between various ranges of the Rocky Mountains. Except for seams that are tilted against the Rock Springs Uplift in the central portion of the Green River Region, most of the State's coal seams are relatively flat-lying in the more central portions of the basins. Steeper dips and significant folding are common at some basin margins as well as on the flanks of mountain ranges. While the Hams Fork Region and Hanna Field exhibit the greatest structural complexity, the Powder River

FIGURE 2: WYOMING COAL FIELDS



EXPLANATION

No. on map	Coal Field
1.	Jackson Hole
2.	Grass Creek
3.	Meeteetse
4.	Oregon Basin
5.	Silvertip
6.	Garland
7.	Basin
8.	Southeastern
9.	Gebo
10.	Sheridan
11.	Spotted Horse
12.	Little Powder River
13.	Powder River
14.	Barber
15.	Buffalo
16.	Sussex
17.	Pumpkin Buttes
18.	Gillette
19.	Dry Cheyenne
20.	Glenrock
21.	Lost Spring
22.	Aladdin
23.	Sundance
24.	Skull Creek
25.	Cambria
26.	Goshen Hole
27.	Rock Creek
28.	Hanna
29.	Kindt Basin
30.	Great Divide Basin
31.	Little Snake River
32.	Rock Springs
33.	Labarge Ridge
34.	Evanston
35.	Kemmerer
36.	Greys River
37.	McDougal
38.	Muddy Creek
39.	Pilot Butte
40.	Hudson
41.	Alkali Butte
42.	Powder River

FROM BERRYHILL, 1950

Basin shows the least. Faulting is most common in the southern and western coal regions, but it is not restricted to those areas.

RANK

The rank of Wyoming coal ranges from lignite to high volatile A bituminous. Lignite occupies a very small area in the northeastern part of the Powder River Basin. Bituminous coal is restricted to the Black Hills Region and portions of the Hanna Field, Green River Region, Hams Fork Region and Bighorn Basin. High volatile B and A bituminous coal is only reported in the Hams Fork Region. With few exceptions, the bituminous coals are all of Cretaceous age; however, the Cretaceous coals are not all of bituminous rank. Many Cretaceous coals are subbituminous rank.

Subbituminous coals are found in all the major coal regions of the State except the Black Hills Region. Figure 1 shows the geographic distribution of lignite, subbituminous and bituminous coals in Wyoming.

While the older coal beds in any given field are generally higher in rank than the younger beds, the rank of individual beds in a field also seems to increase toward the troughs of the structural basins. Both of these variations in rank have been attributed to increases in depth of burial (Unfer, 1951).

COAL MOISTURE, ASH AND SULFUR CONTENT

On an as-received basis, moisture contents range between 1.7% and 32.8%. The average moisture content of Wyoming coals is reported as 14.2% (USBM, 1971 b). Moisture contents are generally correlative to a coal's rank although some subbituminous coals exhibit lower moisture contents than expected.

The average ash content of Wyoming coal is 5.2% (USBM, 1971 b). Reported as-received ash values normally range between 1.4% and 17.2%. Washability studies suggest that most if not all Wyoming coals can be readily washed to a desirable ash level with minimal loss of yield (Deurbrouck, 1971).

Sulfur content on an as-received basis averages 0.7%, but is occasionally reported as high as 5.0%. More than 99% of Wyoming's total coal resource contains less than 1% sulfur, and about one-half of that is less than 0.7%. Ninety-six percent of Wyoming's known strippable reserves contain less than 1% sulfur, 3.5% is between 1-2% sulfur, and 0.5% is greater than 2% sulfur (USBM, 1971 a).

In Wyoming coals the sulfate form of sulfur averages less than 0.03% (3-5% of the total sulfur); the pyritic form averages less than 0.2% (25-29% of the total sulfur); the organic form averages less than 0.47% (70-72% of the total sulfur) (Walker, 1966). Because most of the sulfur in Wyoming's coals is in the organic form, conventional mechanical cleaning or preparation processes are not going to materially reduce the total sulfur content. Even if all the pyritic sulfur could be removed, total sulfur would only be reduced by a maximum of 30%. In this case the average sulfur content of Wyoming coals could theoretically be reduced to 0.5%.

HEAT VALUE

Heat values of Wyoming coals are commensurate with their rank. On a moist mineral-matter-free basis, the bituminous coals range between 14,400 Btu/lb. and 11,000 Btu/lb. while the subbituminous coals range between 8400 Btu/lb. and 13,000 Btu/lb. Based on published coal analyses, the average moisture-and ash-free heat value of the State's coal is 13,530 Btu/lb. On an as-received basis, this average heat value is 10,850 Btu/lb. (USBM, 1971 b).

For at least the subbituminous coals, the heat values increase noticeably under greater increments of overburden. An increase of 300 Btu/lb. per 110 foot increase in overburden has been reported in the Hanna Field (Unfer, 1951).

COKING COAL

Coal with weak to moderate coking properties occurs in the Kemmerer Field of the Hams Fork Region, the Rock Springs Field of the Green River Region and the Cambria Field of the Black Hills Region. The Cambria coal in the Cambria Field possesses the best coking qualities. Unfortunately most of the recoverable coal has already been removed. Reserves of this seam are believed to be very small (Berryhill, 1950). The Middle Main seam in the Kemmerer Field ranges between 3.1 feet and 6.5 feet thick and yields a weak coke. Recoverable reserves of this seam are estimated at 8,000,000 tons. Other seams in the Hams Fork Region also have coking potential.

The Rock Springs No. 7 seam of the Rock Springs Field ranges between 2 feet and 10 feet in thickness. Although there are more than 200,000,000 tons of measured resources of this coal, it is of poor coking quality.

CARBONIZING PROPERTIES

Most Wyoming coals are nonagglomerating but can be carbonized in fluidized systems. Chars produced at low temperatures contain about 17% to 23% residual volatile matter and are easily ignited. On a moisture-free basis, char heating values lie between 10,500 and 14,200 Btu/lb. and appear suitable as power plant fuel. Lump chars can be produced from most Wyoming coals, but they are relatively weak. These lump chars are a suitable substitute for coke breeze used in phosphate ore reduction (Landers, 1961).

At low temperatures, the yield of tar generally increases with increase in rank, but the variation in yield within ranks may be large. Tar-plus-light-oil yields range from 14 to 40 gallons/ton of raw coal processed (Landers, 1961).

COKING OPERATIONS IN WYOMING

Currently there are two coking facilities in Wyoming and a third is under construction. The FMC Corporation's pilot coke plant near Kemmerer was built in the early 1960's and utilizes the Adaville No. 1 seam from the Kemmerer Coal Field. The Adaville No. 1 is subbituminous in rank and noncoking by normal processes. The patented FMC process dries, carbonizes and calcines raw noncoking coal into a uniform carbon product called calcinate. The calcinate is then combined with a liquid binder and formed into pillow-shaped briquets. A typical composition for FMC coke in 1963 was as follows (Farr, 1966):

Moisture	1.9%
Moisture-free ash	4.5%
Moisture-free volatile matter	1.6%
Moisture-free fixed carbon	93.9%
Moisture-free sulfur	0.6%

Char produced in an early stage of the FMC process is suitable as a fuel to produce power and steam and can also be used for injection into blast furnaces. The calcinate is a suitable fuel for sintering iron ore.

FMC now makes two grades of coke, chemical and metallurgical. Chemical coke, which is the lower grade, is used for reducing phosphate rock in electric furnaces at FMC's Pocatello, Idaho plant. Another use for this

coke is in the production of calcium-carbide. FMC's metallurgical grade coke is a much higher temperature coke that is suitable for blast furnace use.

Kemmerer Coal Company's subsidiary, Gunn-Quealy Coal Company, operates a small coke plant near Rock Springs and currently has a new plant under construction adjacent to the old one. The new plant will be approximately three times as large as the original one built in 1963. Gunn-Quealy's process uses poorly coking to noncoking bituminous coals to produce a chemical coke suitable for reducing phosphate in electric furnaces. The Rock Springs No. 7 and No. 11 seams of the Rock Spring Coal Field are currently being used in the process, which employs a rabble-type rotary oven. Gunn-Quealy's process can also use subbituminous coal. An average analysis of the coke produced from this plant in 1966 is as follows (Fagnant, 1966):

Moisture	0.5%
Moisture-free volatile matter	1.17%
Moisture-free fixed carbon	91.6%

COAL MINING AND PRODUCTION

Since 1909, coal production in Wyoming has fluctuated between a low of 1,631,232 tons in 1958 to a high of 9,836,798 tons in 1945(Figure 3). After the record annual production set in 1945, production rapidly decreased. In 1959, however, production again began increasing, first slowly, and then nearly doubling between 1969 and 1971 to 8,007,765 tons. Although somewhat below expectations because of a strike, the 1971 tonnage nevertheless exceeded 1970 by 626,835 tons. The present upward trend in coal production will undoubtedly continue with predictions of 15-20 million tons annually by 1975. In terms of dollar value, coal production in the last ten years has almost quadrupled to over $27,000,000 in 1971.

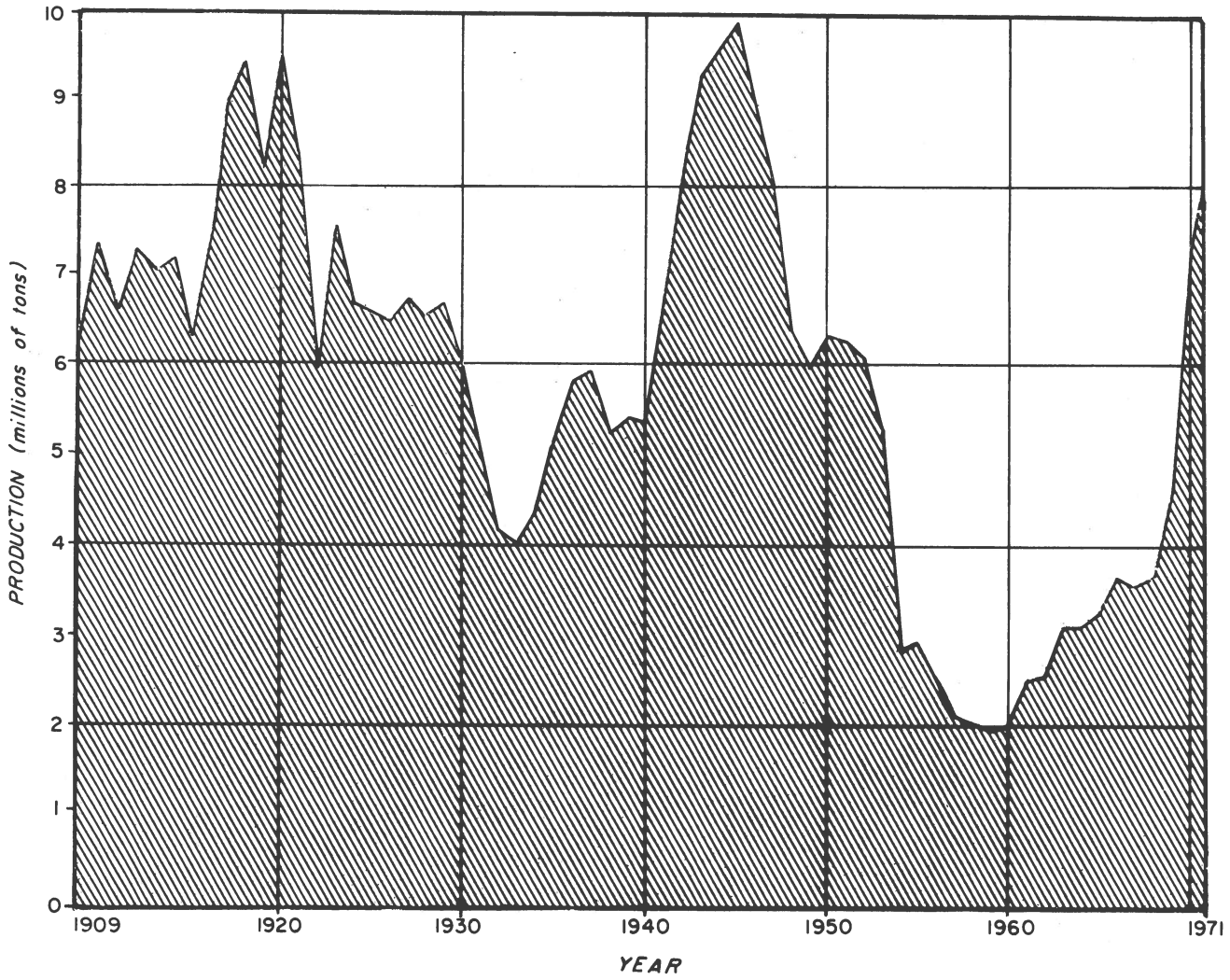


Figure 3: WYOMING COAL PRODUCTION 1909 TO 1971
(Revised from Glass, 1972 b, because of errors in production reported for years 1909-1917)

Coal production in Wyoming was dominated by underground mining until 1954. In that year strip mining tonnage barely exceeded that of the underground mines. Since then, however, strip mining production has more than quintupled to 7,866,706 in 1971 and accounts for 98.2% of Wyoming's production. At the same time, deep mining production decreased from 1,394,000 tons annually to 141,059 tons.

An estimate of the total coal production from Wyoming to January 1, 1972, is 451,266,265 tons of which 382,994,559 tons came from underground operations and 68,271,706 tons from strip mining.

In 1971, twelve coal mining companies produced 8,007,765 tons of coal. Eight of these operations were strip mines, three were underground, and one was a combined operation. Two deep mines produced 94% of the underground tonnage in 1971. Four of the strip mining companies accounted for more than 82% of the stripped tonnage. Of these four mining companies, each produced more than 1,500,000 tons.

It is estimated that while 3.5 million tons of the coal mined in 1971 was used for the generation of electric power in Wyoming, more than another 4 million tons were shipped out of the state for electric power generation. The remaining tonnage was used by the beet sugar industry, cement industry, coke industry, railroads, government, domestic and other miscellaneous users. Coal shipped out of Wyoming went to markets in Colorado, Iowa, Illinois, South Dakota, Wisconsin, Kansas, Minnesota, Nebraska, Idaho, Utah, Washington, Oregon and British Columbia.

Wyoming's 1972 coal production will again come from nine coal fields located in five of the major coal-bearing regions. The location of these mines by region, field, number, type and township-range designation are as follows:

Powder River Coal Basin		
Powder River Field:	1 strip mine	(Wyodak-T50N, R71W)
Gillette Field:	2 strip mines	(East Antelope-T41N, R71W)
		(Belle Ayr-T47N, R71W)
Sheridan Field:	2 strip mines	(Big Horn No. 1-T57N, R84W)
		(Welch-T57N, R85W)
Glenrock Field:	1 strip mine	(Dave Johnston Fuel Recovery Pit-T36N, R75W)
Green River Coal Region		
Rock Springs Field:	2 deep mines	(Rainbow No. 7-T18N, R105W)
		(Rainbow No. 8-T18N, R105W)
	1 strip mine	(Reliance-T20N, R105W)
Hanna Coal Field:	3 strip mines	(Energy Development-T22N, R82W)
		(Rosebud-T22N, R81W)
		(Seminoe-T22N, R83W)
	1 deep mine	(Vanguard No. 1-T22N, R82W)

Hams Fork Coal Region
Kemmerer Field: 1 strip mine (Sorensen-T21N, R116W)

Bighorn Coal Basin
Gebo Field: 1 deep mine (Roncco-T44N, R95W)
Grass Creek Field: 1 deep mine (Grass Creek-T46N, R99W)

The coal-producing counties in Wyoming are Campbell, Carbon, Converse, Hot Springs, Lincoln, Sheridan, and Sweetwater counties.

Two mines closed before August of 1972, Edwin L. Swanson's Van Dyke underground mine near Rock Springs and Rocky Mountain Associated Coal Company's Reliance strip mines also near Rock Springs. The Van Dyke mine produced no coal in 1972 while the Reliance strip mines were in production until July.

Arch Mineral Corporation's Seminoe strip mine in the Hanna Coal Field began production in 1972. Arch has already announced plans to open another strip mine south of the town of Hanna in the very near future (probably 1973). Amax Coal Company's new Belle Ayr strip mine in the Gillette Field is to begin production late this year as is Gunn-Quealy Coal Company's Rainbow No. 8 underground mine in the Rock Springs Field.

Wyoming coal production in 1972 should exceed 10,000,000 tons and possibly reach 11,000,000. Both the Hanna Coal Field and the Powder River Coal Basin fields are each expected to produce more than 4 million tons of coal in 1972. The additional 1972 tonnage will come from fields in the Hams Fork, Green River and Bighorn coal-bearing regions.

POWDER RIVER COAL BASIN

The Powder River Coal Basin covers more than 12,000 square miles in northeastern Wyoming. The basin forms a gentle, asymmetrical syncline between mountain ranges on the east and west. The axis of the syncline is west of the center of the basin. Dips which are usually less than 5° on

the eastern side of the basin steepen against the Bighorn Mountains on the western side.

Most of the coal in the eastern part of the basin is subbituminous C rank. There is some lignite in the extreme northeastern corner. Coals in the western portion of the basin are subbituminous C and B ranks. In general, coal beds are thickest in the northern part of the basin and thin southward. There are notable exceptions to this however. The eastern and northern sides of the basin contain the most persistent seams.

Although the Lance Formation (Upper Cretaceous) contains coals, they are generally conceded to be of little commercial value and they have not been included in coal resource calculations. The Tongue River Member of the Fort Union Formation (Paleocene) and the Wasatch Formation (Eocene) contain most of the coals of commercial importance. Important coal seams in the Powder River Basin are as follows:

BADGER SEAM: This is a subbituminous C rank coal best developed in the Glenrock Field. The coal occurs at the top of the Fort Union Formation and may be correlative with the Roland seam in other fields. The Badger seam ranges between 17 and 20 feet in thickness. The U. S. Bureau of Mines conservatively estimates that there is at least 9.5 million tons of strippable reserves of this seam, (Smith, 1970).

As-received Basis	*Typical Analysis*
Moisture (%)	*25.7*
Volatile Matter (%)	*34.5*
Fixed Carbon (%)	*32.6*
Ash (%)	*7.2*
Btu/lb.	*8250*
Sulfur (%) (Dry)	*0.6*

Pacific Power and Light Company's Dave Johnston Fuel Recovery Pit began mining the Badger seam in 1972 along with the School seam, which occurs 110 to 180 feet below it.

CANYON SEAM: The Canyon seam is best developed in the Spotted Horse Field in portions of Campbell and Sheridan Counties. It is probably subbituminous C rank and is reported to average between 11 and 20 feet thick. This seam is in the Fort Union Formation and may be equivalent to one of the Dietz seams in the Sheridan Field. Strippable resources of this seam are estimated at 185 million tons (Smith, 1970). No analysis is available and there are no active mines on this seam.

CARNEY SEAM: This seam is a subbituminous C coal well developed in the Sheridan Field. In thickness, it ranges between 7 and 20 feet, but averages 15 feet. Partings are not uncommon. The Carney seam occurs in the Tongue River Member of the Fort Union Formation about 80 feet below the equally important Monarch seam. Although there are strippable reserves of this seam, no estimates have been made. The Carney seam is not currently mined.

As-received Basis	*Range Analysis*
Moisture (%)	*21.2 - 27.2*
Ash(%)	*2.6 - 9.5*
Sulfur (%)	*0.3 - 0.8*
Btu/lb.	*8320 - 9720*
Fusion Temp. (deg. F.)	*2040 - 2360*

D SEAM: This seam is important in the southern part of the Gillette Field. It is subbituminous and averages 8 to 16 feet in thickness. Maximum thickness of this seam is 65 feet. The D seam is found near the top of the Fort Union Formation and is believed to correlate with the Roland seam in other fields. According to U. S. Bureau of Mines' figures, strippable resources of this seam when combined with another seam 50 to 75 feet below it (E seam) total approximately 500 million tons (USBM, 1972).

	Tipple Analysis
Moisture (%) (As-rec'd.)	*25.7*
Btu/lb. (As-rec'd.)	*9060*
Volatile Matter (%) (Dry)	*44.0*
Fixed Carbon (%) (Dry)	*49.4*
Ash (%) (Dry)	*6.6*
Sulfur (%) (Dry)	*0.5*
Fusion Temp. (deg. F.)	*2370*

The D seam is presently being strip mined at Best Coal Company's East Antelope mine in the Gillette Field. Best Coal Company's 1971 tonnage was 1,829 tons.

E SEAM: This seam underlies the D seam in the southern portion of the Gillette Field. It occurs in the Fort Union Formation and averages 5 feet in thickness. Strippable resources of this subbituminous coal are combined with the D seam's to total about 500 million tons. No analysis of this seam is available. It is not currently being mined.

F SEAM: Although this seam is well developed in portions of the Dry Cheyenne and Gillette Fields in Converse County, it is not currently being mined. Bed F has a maximum thickness of 11.6 feet but averages only 7.5 feet. Strippable resources of this seam are estimated at 180 million tons (Smith, 1970). No analysis was found.

FELIX SEAM: The Felix seam is an important seam in the Spotted Horse Field in Campbell County. This seam, which is found in the Wasatch Formation, ranges between 5 feet and 21 feet in thickness. The average thickness is 12.5 feet. Partings are common and fairly persistent in places. Strippable resources of this seam total 481 million tons (Smith, 1970). The seam is subbituminous in rank, and is not being mined.

HEALY SEAM: The Healy seam in the Buffalo Field of Johnson County ranges between 5 feet and 25 feet at outcrop, but it is reportedly as much as 220 feet thick in some drill hole descriptions. Available data

suggest the seam is subbituminous C in rank. Upper portions of the seam are frequently found to be burned. Its strippable resource is approximately 1 billion tons. The seam is in the Wasatch Formation (Smith, 1970).

As-received Basis	*Average*
Moisture (%)	*27.0*
Volatile Matter (%)	*30.1*
Fixed Carbon (%)	*34.0*
Ash (%)	*8.1*
Sulfur (%)	*0.7*
Btu/lb.	*7940*

Reynolds Aluminum currently holds large reserves of this seam near Lake DeSmet, but they are not yet mining it. Reynolds is currently seeking permission from the A. E. C. to build a uranium-enrichment facility in that area and may use their coal reserves for power generation needed for the uranium processing.

MONARCH SEAM: The subbituminous Monarch seam is probably the most important seam in the Sheridan Field. It ranges from 18 feet to 57 feet thick. In the past, there has been extensive underground mining of this seam. The coal occurs in the lower part of the Tongue River member of the Fort Union Formation. The U. S. Bureau of Mines estimates that there are 32 million tons of strippable resources of this seam.

As-received Basis	*Typical Analysis*
Moisture (%)	*23.85*
Volatile Matter (%)	*32.36*
Fixed Carbon (%)	*38.49*
Ash (%)	*5.30*
Btu/lb.	*9300*
Sulfur (%)	*0.61*

Big Horn Coal Company, a subsidiary of Peter Kiewit Sons, Inc., operates the Big Horn No. 1 strip mine on the Monarch and an overlying seam, the Armstrong coal. The Monarch seam in the Big Horn No. 1 mine splits into two seams in portions of the mine with up to 100 feet of noncoaly material between the benches. When the Monarch seam is a single seam, it averages

44 feet in thickness. When it is split, the lower bench averages 22 feet thick and the upper only 19 feet. The Armstrong seam occurs 20-35 feet above the Monarch and averages 12 feet thick. Production from the Big Horn No. 1 mine in 1971 was 1,755,104 tons. Big Horn uses only scrapers and shovels in its mine.

Welch Coal Company, a subsidiary of Montana-Dakota Utilities, strip mines a 16 foot thick seam correlated with the Monarch seam of the area. The scraper and shovel operation produced 21,732 tons in 1971, which was used by the 12-megawatt Acme Power Plant about 10 miles away.

	Tipple Range Analysis
Moisture (As-rec'd.) (%)	*21.4 - 22.8*
Volatile Matter (Dry) (%)	*41.1 - 43.2*
Fixed Carbon (Dry) (%)	*44.8 - 46.4*
Ash (Dry) (%)	*11.1 - 13.3*
Sulfur (Dry) (%)	*0.6 - 2.7*
Btu/lb. (As-rec'd.)	*8490 - 9070*
Ash Softening Temp. (deg. F.)	*2130 - 2310*

ROLAND-SMITH SEAM: See Wyodak seam.

SCHOOL SEAM: This seam, which is from 110 to 180 feet below the Badger seam, is an important seam in the Glenrock Field of Converse County. The seam is subbituminous C rank and occurs near the top of the Fort Union Formation. It may be correlative with the Smith seam in other fields. The seam ranges between 22 feet and 38 feet in thickness but averages 35 feet. The quality of the seam deteriorates to the south due to shaley partings. Although its quality remains good to the north, the seam thins in that direction. The U. S. Bureau of Mines estimates that there are at least 126.2 million tons of strippable reserves of this seam.

As-received Basis	*Range Analysis*
Moisture (%)	*26.0*
Volatile Matter (%)	*33.0*
Fixed Carbon (%)	*32.0*
Ash (%)	*9.0 - 14.0*
Btu/lb.	*7500 - 8000*
Sulfur (%)	*0.5*

The School seam accounted for all of the 1971 production (1,730,058 tons) from Pacific Power and Light Company's Dave Johnston Fuel Recovery Pit. Production from this seam will also account for most of the 1972 tonnage. The seam averages 30-32 feet thick on the property. All tonnage from this mine is consumed in the 750-megawatt Dave Johnston Power Plant. Pacific Power removes overburden with a dragline equipped with a 39-or 41-cubic yard bucket. Coal is loaded into trucks with power shovels and then carried to a private 15 mile long railroad spur to the power plant.

SMITH SEAM: This seam is particularly well developed in the Spotted Horse Field and the western side of the Little Powder River Field. The seam ranges between 5 and 13 feet thick and is subbituminous. It is found in the Fort Union Formation. In the southern part of the area, a local seam, which ranges between 4.5 and 13 feet thick, underlies the Smith seam by about 30 feet. Taken collectively, the U. S. Bureau of Mines estimates there are 236 million tons of strippable reserves of these seams. No analysis is available as the seam is not being mined at this time.

SUSSEX FIELD (LOWER BED): This "lower bed" in "Basin No. 4" of the Sussex Field averages 11.8 feet thick but reaches a maximum of 50 feet (Wegemann, 1910). A preliminary estimate of strippable resources of this seam is 13.6 million tons (Smith, 1970). Currently there is no mining of this seam.

As-received Basis	*Analysis*
Moisture (%)	*23.5*
Volatile Matter (%)	*35.6*
Fixed Carbon (%)	*35.7*
Ash (%)	*5.17*
Sulfur (%)	*0.49*
Btu/lb.	*9,160*

WYODAK SEAM: The Wyodak seam is a subbituminous coal best developed in the Powder River and Gillette Fields. This seam averages 71 feet thick

but ranges between 55 and 106 feet. It commonly has an 8-inch parting 38 feet above its base. The Wyodak seam splits into two separate seams to the west with the lower bench ranging between 22 and 35 feet in thickness. The interval between the two benches in this direction expands up to 100 feet. To the north the seam splits into 5 or more beds varying from 5 to 31 feet in thickness and separated by 4 to 33 feet of clay and shale. As the Wyodak seam is traced southward, it is represented by 60 to 80 feet of coal separated by partings up to 8 feet thick (Smith, 1970).

Although the Wyodak seam, which occurs at the top of the Fort Union Formation, has been correlated with the Roland and Smith seams, the correlation is questionable. Strippable resources of this seam are estimated at 18.5 billion tons and are the largest calculated for an individual seam in Wyoming.

As-received Basis	*Average*	*Range Analysis*
Moisture (%)	*28.1*	*22.3 - 32.8*
Ash (%)	*5.9*	*6.6 - 15.2*
Sulfur (%)		*0.4 - 1.4*
Btu/lb.	*8322*	*7640 - 8640*
Fusion Temp. (deg. F.)		*2110 - 2460*

The Wyodak deposit is currently mined in the Powder River Field by Wyodak Resources Development Corporation, a subsidiary of Black Hills Power and Light Company. The 1971 tonnage of 646,589 tons was used by the Neil Simpson (27.68-megawatt) and Osage (35.5-megawatt) power plants in Wyoming as well as two plants in South Dakota. Wyodak mines with scrapers, dozers and front-end loaders.

GREEN RIVER COAL REGION

The Green River Coal Region covers about 15,400 square miles of southwestern Wyoming. It is divided into two major structural basins by the Rock Springs anticline; the Green River Basin to the west and the Great Divide Basin to the east. Dips in this region are small except around the Rock

Springs Uplift and the western margin. Dips on the western side of the Rock Springs Uplift go up to 20°; and on the eastern side 10°. Along the western margin of the region, dips range between 20° and 50° in some areas.

Coal ranges in rank from subbituminous C to high volatile C bituminous. The higher rank coals occur on the eastern margins of the region as well as around the Rock Springs Uplift. The higher rank coals are of Cretaceous age.

Coal-bearing rocks in the Green River Region are largely concealed by younger rocks and very little is known about the total coal resources in the area. Coal beds in the region occur in the Mesaverde Group and the Lance Formation of Upper Cretaceous age, the Fort Union Formation of Paleocene age, and the Wasatch Formation of Eocene age. Coals of the Rock Springs Formation of the Mesaverde Group have historically been the most important. It may not be long, however, before their importance is surpassed by younger seams of the Fort Union and Wasatch Formations.

Rock Springs Formation coals are high volatile C bituminous and range up to 13.8 feet thick. Although they are designated by numbers, the numbers are not arranged consecutively. From the top down, some of the more important beds are No. 3, No. 1, No. 7 1/2, No. 7, No. 9, No. 10, No. 11, and No. 15.

Wasatch coals in the southern part of the Great Divide Basin Field are designated from youngest to oldest: Battle No. 3, Battle No. 2, Monument No. 1, Sourdough-Monument-Tierney seams, Hadsell No. 2, Creston No. 3, Creston No. 2 and Latham No. 3. These coal beds are lenticular and grade into shale to the east and west. The average, as-received analysis of these seams shows a moisture content of 21%, an ash content of 16%, a sulfur content of 2.5% and a heat value of 7900 Btu/lb. (Smith, 1970). Analysis

of drill core samples of these seams show that they yield from 7.8 to 25.2 gallons of oil per ton by the Fisher assay method. Additionally, the uranium content of these coals ranges between 0.001% and 0.009% U_3O_8. These Wasatch coals are estimated to contain over 55 million pounds of uranium with U_3O_8 contents 0.003% or greater (Masursky, 1962).

Important coal seams in Green River Coal Region are as follows:

B AND C SEAMS: These two unmined seams are subbituminous A coals of the Wasatch Formation and reach their maximum development in the northern part of the Little Snake River Field. The B seam ranges from 10 to 18 feet in thickness and normally has a 1 to 2 foot parting in it. The C seam, which is 40 - 70 feet below the B seam, ranges in thickness between 20 feet and 32 feet. It has a 1 to 1 1/2 foot parting. In places these two seams coalesce into a single seam of 30 to 40 feet in thickness, which has a parting up to 4 feet thick. Strippable resources of these seams collectively reach 168 million tons (Smith, 1970).

As-received Basis	*Range Analysis*
Moisture (%)	*15 - 25*
Volatile Matter (%)	*28 - 36*
Fixed Carbon (%)	*27 - 40*
Ash (%)	*10 - 25*
Sulfur (%)	*0.5 - 5.0*
Btu/lb.	*5009 - 9000*

BATTLE NO. 1 AND BATTLE NO. 2 SEAMS: These two subbituminous B, Wasatch Formation coals outcrop in the southeastern part of the Great Divide Basin Field, but are not currently mined. They average between 6.4 and 8.6 feet in thickness. Strippable resources of these two seams are estimated to be 38.1 million tons (Smith, 1970). A typical analysis of the Battle No. 3 seam is as follows:

As-received Basis	*Typical Analysis*
Moisture (%)	*21.9*
Volatile Matter (%)	*29.9*
Fixed Carbon (%)	*37.0*
Ash (%)	*11.2*
Sulfur (%)	*1.9*
Btu/lb.	*8650*

CRESTON NO. 2 AND NO. 3 SEAMS: These unmined seams are in the Wasatch Formation in the Great Divide Basin Field. They outcrop in the southeastern part of the field where they average about 18 feet in thickness. They are subbituminous B in rank. Strippable resources of these seams are 125.6 million tons (Smith, 1970). A typical analysis of the Creston No. 2 seam is:

As-received Basis	*Typical Analysis*
Moisture (%)	*20.7*
Volatile Matter (%)	*32.2*
Fixed Carbon (%)	*34.4*
Ash (%)	*12.7*
Sulfur (%)	*1.8*
Btu/lb.	*8710*

HADSELL NO. 2 SEAM: This is another unmined Wasatch seam outcropping in the southeastern part of the Great Divide Basin Field. It is subbituminous B in rank and averages 7.7 feet thick. There are 39.8 tons of strippable resources estimated from this seam (Smith, 1970).

As-received Basis	*Typical Analysis*
Moisture (%)	*23.0*
Volatile Matter (%)	*31.0*
Fixed Carbon (%)	*32.2*
Ash (%)	*13.8*
Sulfur (%)	*2.7*
Btu/lb.	*8250*

JIM BRIDGER SEAMS: Two coal seams of the Fort Union Formation are exceptionally well developed on the western edge of the Great Divide Basin Field. These seams have been referred to as the Jim Bridger deposits. Each seam averages 15 feet thick, and where the two seams coalesce into a single seam, it is 30 feet in thickness. The seams are probably subbituminous

in rank. Strippable resources are approximately 250 million tons (Smith, 1970).

As-received Basis	*Average or Range Analysis*
Moisture (%)	*20.0*
Ash (%)	*10.0*
Sulfur (%)	*0.36 - 0.77*
Btu/lb.	*10,000*

Pacific Power and Light and Idaho Power Company will mine these seams for their 1500-megawatt Jim Bridger Power Plant now under construction east of Rock Springs. Mining should begin in 1974 if construction of the plant is not delayed. In 1971, 28,736 tons of coal were mined for analysis and evaluation.

LATHAM NO. 3 AND NO. 4 SEAMS: The Latham seams are best developed in the southeastern part of the Great Divide Basin Field. They occur in the Wasatch Formation and are subbituminous B coals. Average thickness is 5.7 feet. Strippable resources of the two unmined seams total 70.7 million tons (Smith, 1970). A typical analysis of the Latham No. 3 seam is as follows:

As-received Basis	*Typical Analysis*
Moisture (%)	*22.6*
Volatile Matter (%)	*30.9*
Fixed Carbon (%)	*31.2*
Ash (%)	*15.3*
Sulfur (%)	*5.4*
Btu/lb.	*7980*

ROCK SPRINGS NO. 7 SEAM: This seam averages 4.5 feet in thickness; is high volatile C bituminous in rank; and occurs in the Rock Springs Formation of the Mesaverde Group in the Rock Springs Field. This seam has some coking properties.

As-received Basis	*Typical Analysis*
Moisture (%)	*8.26*
Ash (%)	*3.59*
Volatile Matter (%)	*38.55*
Fixed Carbon (%)	*49.50*
Btu/lb.	*12,452*
Sulfur (%)	*0.7*

Gunn-Quealy Coal Company, a subsidiary of Kemmerer Coal Company, opened a new underground mine in the Rock Springs Field on this seam in 1972. Most of the coal from this Rainbow No. 8 mine will be used for their new chemical coke plant being built at Rock Springs. Conventional mining techniques are used.

ROCK SPRINGS NO. 11 SEAM: The No. 11 seam is high volatile C bituminous coal ranges, from 44 to 54 inches in thickness, and averages 4 feet thick. It is an important seam in the Rock Springs Field. This seam is in the Rock Springs Formation. The No. 11 seam has some coking properties:

As-received Basis	*Range Analysis*
Moisture (%)	*6.56 - 8.46*
Ash (%)	*4.57 - 6.69*
Volatile Matter (%)	*38.42 - 39.74*
Fixed Carbon (%)	*47.69 - 48.55*
Btu/lb.	*12,379 -12,572*
Sulfur (%)	*0.7*

Gunn-Quealy Coal Company operates the Rainbow No. 7 deep mine on this seam in the Rock Springs Field. This mine is scheduled to close in late 1972 as the new Rainbow No. 8 mine goes into full production. Production from this mine in 1971 was 88,002 tons. Conventional mining techniques are used.

Rocky Mountain Associated Coal Corporation strip mined and augered the No. 11 seam north of Rock Springs in their Reliance strips until the end of July 1972. The seam ranged from 2-10 feet thick and averaged 8 feet. An analysis of the seam is as follows:

As-received Basis	*Typical Analysis*
Moisture (%)	*12.0*
Ash (%)	*5.0*
Sulfur (%)	*0.8 - 0.9*
Btu/lb.	*11,000*

Rocky Mountain Associated also stripped the No. 3 seam, which averaged 5.5-6 feet, the No. 4 seam, which averaged 4.5 feet, and the No. 3 seam, which ranged between 5 and 7 feet. Production from the Reliance strips in 1971 was 374,822 tons all of which went to the Wisconsin Service Company at Oak Creek, Wisconsin.

Rocky Mountain Associated Coal Corporation was a joint venture of Rocky Mountain Energy Company, a subsidiary of the Union Pacific Railroad Company, and Eastern Associated Coal Corporation, a subsidiary of Eastern Gas and Fuel Associates.

SOURDOUGH-MONUMENT-TIERNEY SEAMS: This group of coals is actually five seams that occur at about the same horizon in the Wasatch Formation in the southeastern part of the Great Divide Basin Field. Because at times these seams coalesce with one another, separation of the coals into individual beds is not always possible. In places, each of these subbituminous B coals exceeds 5 feet in thickness. Strippable resources for these unmined seams are 485.9 million tons (Smith, 1970). Below, is a typical analysis of the Sourdough No. 2 seam:

As-received Basis	*Typical Analysis*
Moisture (%)	*23.2*
Volatile Matter (%)	*33.6*
Fixed Carbon (%)	*33.0*
Ash (%)	*10.2*
Sulfur (%)	*2.9*
Btu/lb.	*8680*

HANNA COAL FIELD

Coal-bearing rocks of the Hanna Coal Field outcrop in a 750 square mile area of Carbon County in south-central Wyoming. Most simply, the Hanna

Field occupies a structural trough that is divided into two separate basins by a northeast-southwest trending anticline. The Hanna Basin lies to the northwest of the anticline while the Carbon Basin lies to the southeast. The Hanna Field is bounded on the north, west and south by mountain ranges. Faulting is common in the field.

Coal seams occur in the Mesaverde Group and Medicine Bow Formations of Upper Cretaceous age, the Ferris Formation of Upper Cretaceous and Paleocene age, and the Hanna Formation of Paleocene and Eocene age. The rank of the coals in the Hanna Field ranges from subbituminous C to high volatile C bituminous. The highest ranked coal, high volatile C bituminous, occurs in the Mesaverde Group. Collectively, coals of this Group and the Medicine Bow Formation range downward in rank to subbituminous B. The Hanna Formation and Ferris Formation coals are predominantly subbituminous although the Hanna No. 2 seam of the Hanna Formation has reportedly been ranked as high as high volatile C bituminous (Glass, 1972 a).

The U. S. Bureau of Mines has estimated that there is at least 10 million tons of strippable resources in just the Hanna Formation of the field. This figure was calculated on 8 seams of the formation. Total strippable resources in the Hanna Field are approximately 313 million tons (Glass, 1972 a).

The following seams are important in the Hanna Field:

BED NO. 25: Bed No. 25 is a mineable seam in the lower third of the Ferris Formation and is best developed on the west side of the Hanna Basin. It is probably correlative to the U. S. Geological Survey's Bed No. 31 (Glass, 1972 a). The seam averages 22 feet in thickness and is of subbituminous rank.

As-received Basis	*Average Analysis*
Moisture (%)	*13.96*
Ash (%)	*6.68*
Sulfur (%)	*0.37*
Btu/lb.	*10,000*

Arch Mineral Corporation, a joint venture of Ashland Oil Company and Hunt Enterprises, operates their Seminoe strip mine on this seam west of Hanna. To remove overburden, Arch utilizes the largest dragline bucket in Wyoming at a 62-cubic yard capacity. Production from this mine began in 1972 and is predicted to be approximately 2.5 million tons in its first year.

BED NO. 50: This coal seam occurs near the middle of the Ferris Formation and is a subbituminous coal. The seam is best developed in the Hanna Basin portion of the field. It averages 15 feet in thickness.

Although this seam is not currently mined, Energy Development Company, a subsidiary of Iowa Public Service Company, did strip mine it in 1970.

BED NO. 65: This Ferris Formation coal is of Paleocene age. It is subbituminous in rank and is the only seam currently being deep mined in the field. The seam is important in the Hanna Basin and ranges from 6 feet to 8 feet in thickness. Its average thickness is 7 feet.

As-received Basis	*Typical Analysis*
Moisture (%)	*11.6*
Ash (%)	*7.1*
Sulfur (%)	*0.7*
Btu/lb.	*11,020*

Energy Development Company began underground mining this seam in 1971 and reported production of 45,400 tons from its Vanguard No. 1 mine that year. Jeffrey continuous miners are used in the mine. Production in excess of 1 million tons per year is anticipated.

BED NO. 80: Bed No. 80 bed is a Paleocene coal of the Hanna Formation. The rank is subbituminous. This seam is well developed in the Hanna Basin

where it ranges from 15.5 to 24 feet in thickness. The No. 80 bed generally has a 1 to 1 1/2 foot parting 2 to 5 feet above its base.

As-received Basis	*Average*
Moisture (%)	*14.50*
Ash (%)	*6.94*
Sulfur (%)	*0.78*
Btu/lb.	*10,523*

Rosebud Coal Sales Company, a subsidiary of Peter Kiewit Sons, Inc., strip mines this seam north of Hanna. Rosebud first uses a dragline with a 45-cubic yard bucket to remove overburden and then uses power shovels to load the coal into trucks. Production from the Rosebud strip pits in 1971 was from Beds No. 80 and No. 82; therefore, only the combined tonnage of 1,503,507 tons can be given. Most if not all of Rosebud's production will be from this seam in 1972.

BED NO. 82: This seam is an Eocene coal in the Hanna Formation. It is a subbituminous coal, averages 9 feet thick, and is best developed in the Hanna Basin.

As-received Basis	*Average Analysis*
Moisture (%)	*13.46*
Ash (%)	*6.94*
Sulfur (%)	*0.78*
Btu/lb.	*10,699*

As mentioned above, Bed No. 82 was mined north of Hanna by Rosebud Coal Sales Company in 1971. Although little if any of it has been stripped in 1972, the seam still bears considerable reserves and will again be mined by Rosebud.

BROOKS SEAM: This seam is a subbituminous Paleocene coal near the base of the Hanna Formation. It ranges between 8 feet and 15 feet in thickness.

As-received Basis	*Typical Analysis*
Moisture (%)	*13.66*
Ash (%)	*6.50*
Sulfur (%)	*0.45*
Btu/lb.	*10,806*

Utilizing scrapers, Energy Development Company strip mines the Brooks seam west of Hanna. Production from its strip mines in 1971 was reported under Resource Exploration & Mining, Inc. at 300,784 tons. Energy is the only coal mining company in Wyoming that both strip mines and deep mines coal.

HANNA NO. 2 SEAM: Although this seam is not presently being mined, it has been extensively deep mined and strip mined in the Hanna Basin. This coal is normally of subbituminous A rank, but in places it is ranked as high volatile C bituminous. These higher ranked occurrences are where the seam is not weathering. The Hanna No. 2 seam ranges in thickness from 30 to 35 feet. The seam is usually divided into three benches by partings.

As-received Basis	*Range Analysis*
Moisture (%)	*7.5 - 12.7*
Ash (%)	*3.9 - 6.6*
Sulfur (%)	*0.2 - 0.6*
Btu/lb.	*10640 - 11660*
Fusion Temp. (deg. F.)	*2200 - 2450*

HAMS FORK COAL REGION

This region is the westernmost of the coal-bearing areas. Because it is highly folded and thrust faulted, the coal-bearing rocks outcrop in long narrow belts. The coal-bearing rocks of this region are the Bear River, Frontier and Adaville Formations of Upper Cretaceous age and the Evanston Formation of Paleocene age. Coals in this region range between high volatile A bituminous and subbituminous B. Coals up to 20 feet thick occur in the Frontier Formation and are the higher ranking seams.

The Adaville Formation coals are subbituminous B rank and attain thicknesses over 100 feet. The Adaville Formation coals are the most important seams in the region.

ADAVILLE SEAMS: These seams are the most important coals in the region and are best developed in the Kemmerer Field. At least seventeen seams in this formation exceed 6 feet in thickness. The Adaville No. 1 seam is the thickest and attains thicknesses in excess of 100 feet. All the seams have partings which range from 1 inch to 15 feet in thickness. These coals are all subbituminous B in rank. Strippable resources calculated on 13 of the Adaville seams are greater than 1 billion tons (Smith, 1970).

The following analysis is a composite of the Adaville seams:

As-received Basis	*Average Analysis*
Moisture (%)	*21.24*
Ash (%)	*3.57*
Sulfur (%)	*0.59*
Btu/lb.	*9671*

Kemmerer Coal Company currently strip mines more than nine of the Adaville seams in the Kemmerer Field. They have tentative plans to mine portions of all 17 seams. Draglines, scrapers, power shovels and front-end loaders are all used in Kemmerer's Sorensen strip mines. All but the Adaville No. 1 seam, which is the stratigraphically lowest and also the thickest of the seams, are used for Utah Power and Light Company's 710-megawatt Naughton Power Plant adjacent to the mines. The Adaville No. 1 seam is retained as a commercial seam and is marketed at Kemmerer's Elkol tipple. While Kemmerer's production for the power plant in 1971 was 1,309,577 tons, its production at the Elkol tipple was 273,852 tons for a combined total of 1,503,545 tons. Some of the Elkol, tonnage was supplied to the FMC pilot coke plant, which is located fairly close to the tipple.

BIGHORN COAL BASIN

The Bighorn Coal Basin is a broad structural basin bounded on the east, south and west by mountain ranges. Coal-bearing rocks underlie about 4,400 square miles of the basin. They are exposed in the folded rocks around the margin. In these folded edges of the Bighorn Basin, dips as steep as 50° are common.

Coal-bearing rocks are the Mesaverde, Meeteetse and Lance Formations of Upper Cretaceous age and the Fort Union Formation of Paleocene age. These rocks outcrop in a 3 to 5 mile wide zone around the basin. Coals in the more central portion of the basin are under deep cover and little is known about them. Most of the coals are lenticular and of limited extent, expecially along the eastern side. Thicker and more extensive coal seams occur on the southern and western sides.

Coal in the northernmost part of the Bighorn Basin is high volatile C bituminous in rank while the remaining part of the basin contains sub-bituminous A and B coals.

GEBO FIELD SEAMS (UNCORRELATED): One uncorrelated coal seam is currently mined in the Gebo Field by Roncco Coal Company, Inc.. The seam ranges between 6 and 9 feet in thickness, but averages only 6.5 feet. The seam is mined underground by conventional methods. Production from this mine in 1971 was 3,215 tons.

	Tipple Range Analysis
Moisture (%) (As-rec'd.)	*11.2 - 15.3*
Volatile Matter (%) (Dry)	*40.1 - 44.7*
Fixed Carbon (%) (Dry)	*51.0 - 56.7*
Ash (%) (Dry)	*2.8 - 7.4*
Sulfur (%) (Dry)	*0.5 - 1.1*
Btu/lb. (%) (As-rec'd.)	*10810 - 11650*

GRASS CREEK FIELD SEAM (UNCORRELATED): Dusky Diamond Coal Company, which recently was acquired by Dal Petroleum, mines an uncorrelated seam in

the Grass Creek Field by conventional underground methods. The coal seam ranges from 20 to 32 feet in thickness and has been strip mined in the past. A preliminary strippable resource estimate for this seam is in excess of 3 million tons (Travis, 1951).

	Tipple Range Analysis
Moisture (%) (As-rec'd.)	*9.5 - 13.1*
Volatile Matter (%) (Dry)	*37.9 - 42.4*
Fixed Carbon (%) (Dry)	*48.0 - 51.6*
Ash (%) (Dry)	*8.4 - 12.0*
Sulfur (%) (Dry)	*0.4 - 0.6*
Btu/lb. (As-rec'd.)	*10370 - 11310*

WIND RIVER COAL BASIN

The Wind River Coal Basin is a large asymmetrical syncline in central Wyoming. Dips are steeper on the northern side than on the southern. Many minor folds and a number of faults complicate the basin. Coal-bearing rocks are the Cody Shale, Mesaverde and Meeteetsee Formations of Upper Cretaceous age and the Fort Union of Paleocene age. Coal-bearing rocks outcrop around the margins of the basin. Coals in the central part of the basin are under considerable cover. Coals are believed to be subbituminous.

JACKSON HOLE FIELD

The Jackson Hole Coal Field in northwestern Wyoming is underlain by mineable seams over an area of 700 square miles. Mineable coals occur in Upper Cretaceous, Paleocene and Eocene age rocks. The coal is probably subbituminous rank.

BLACK HILLS COAL REGION

The Black Hills Coal Region is in the extreme northeastern part of the State. Coal outcrops in a narrow, discontinuous belt through the region. Mineable coal is confined to the base of the Lakota Sandstone of Lower

Cretaceous age. The field as a whole is usually considered to be "mined out". The coal in this field is high volatile C bituminous and is a moderately good coking coal.

ROCK CREEK COAL FIELD

The Rock Creek Coal Field is a small field southeast of the Hanna Field. Coal-bearing rocks occur in the Mesaverde Group of Upper Cretaceous age and the Hanna Formation of Paleocene and Eocene age. The thickest and best exposed coal seams are in the northwestern part of the field. Coal in the field is subbituminous B rank.

GOSHEN HOLE COAL FIELD

The Goshen Hole Coal Field is in the southeastern part of the State. Coals in the field occur in the Lance Formation of Upper Cretaceous age. No coal more than 2.5 feet thick is known to exist in this field. Much of the field is covered by younger rocks which do not contain coals. The coal is probably of subbituminous rank.

COAL RESOURCES, PRODUCTION, AND RESERVES

Wyoming's original in-place coal resources between 0 and 3000 feet of overburden are estimated to be 136,891,430,000 short tons (modified, Berryhill, 1950). Approximately 2% of these resources are lignite, 4% bituminous coal and 94% subbituminous coal. These resources, however, were based on only 46.54% of the known or probable coal-bearing land in Wyoming as they were limited to mapped and explored areas. When an estimate of the resources of the previously omitted 53.46% of the State's coal-bearing land is added to the mapped and explored estimate, the U. S. Geological Survey estimates that Wyoming's original resources under less than 3000 feet of overburden increase to 445,710,000,000 tons. Wyoming's original

resource figure becomes 545,710,000,000 tons when the overburden category is extended to 6000 feet. In the 0 to 6000 feet overburden category, Wyoming has the largest in-place coal resources in the nation.

Estimates of Wyoming's original in-place coal resources by major coal-bearing region and by county are given in Tables 1 and 2. The original resources in these two tables include mapped and explored bituminous seams 14 inches or greater in thickness and subbituminous coals 2.5 feet and thicker. Measured, indicated, and inferred categories are combined; overburden limits for these figures are 0 to 3000 feet.

Table 4 shows the total original resources of the State, production and mining losses, and remaining resources. Coal reserves, which must be based on such factors as transportation and mining costs, are not tabulated. Wyoming's known strippable resources and recoverable resources of subbituminous coal are shown in Table 5. These strippable resources are limited to a few mapped and explored areas and are only a small portion of Wyoming's strippable coal potential.

DISTURBED SURFACE LAND

In 1969, it was estimated that a total of 3078 acres of surface land in Wyoming was disturbed by surface coal mining in five counties: Campbell, Converse, Carbon, Lincoln and Sheridan (Kovats, 1969). Disturbed lands in this estimate not only included the open pit acreage but also the spoil (waste) piles, roads and building acreages. A conservative estimate, which adds acreage not included in the 1969 estimate as well as acreage disturbed since 1969, would be 3500 acres to January 1, 1972. This area is less than 5 1/2 square miles or less than 1/6 of a township. It is also estimated that surface land disturbed by coal strip mining is currently increasing at a rate of ~~30~~ 170 acres per year.

Since August 1969, strip mined land is being reclaimed under Wyoming's Open Cut Land Reclamation Act (King, 1969). Most of the acreage above was disturbed prior to the implementation of that act. Approximately 10% of that disturbed acreage was voluntarily reclaimed before the Act (Kovats, 1969).

ACKNOWLEDGMENTS

In addition to all the cited references, the author also wishes to acknowledge the help and data supplied by officials and employees of all the coal mining companies in the State, Denver staff members of both the U. S. Bureau of Mines and the U. S. Geological Survey, the State Inspector of Mines and the Natural Resources Research Institute of the University of Wyoming. Without the cooperation and aid of all these people, this report could not have been compiled in such a rapid fashion.

Final commendations go to Mrs. Starla Yekel who typed, duplicated, and stapled this report and Mr. Richard W. Jones, who helped tabulate much of the statistical data.

REFERENCES

Berryhill, H. L., et. al., 1950, Coal resources of Wyoming: U. S. Geol. Survey Circ. 81, 78 p.

DeCarlo, J. A., et. al., 1966, Sulfur content of U. S. coals: U. S. Bur. of Mines IC 8312, 44 p.

Deurbrouck, A. W., 1971, Washability examinations of Wyoming coals: U. S. Bur. of Mines RI 7525, 47 p.

Fagnant, J. A., 1966, Carbon for industry from noncoking coal: Coal Age, Volume 71, No. 9, p. 94-98, September

Farr, Walter, 1966, Coal carbonization. . .new methods and objectives: Coal Age, Volume 71, No. 12, p. 88-96, December

Glass, G. B., 1972 a, Mining in the Hanna coal field: Geological Survey of Wyoming, Laramie, 45 p.

Glass, G. B., 1972 b, Review of Wyoming coal fields, 1971: Geological Survey of Wyoming, Laramie, 32 p.

King, A. E., 1969, Rules and regulations promulgated under the Open Cut Land Reclamation Act: Commissioner of Public Lands, Cheyenne, 24 p.

Kovats, J. A., 1969, The condition of surface mine reclamation in Wyoming: A report to the State of Wyoming, Dept. of Economic Planning and Development, Cheyenne, 10 p.

Landers, W. S., et. al., 1961, Carbonizing properties of Wyoming coals: U. S. Bur. of Mines RI 5731, 74 p.

Lane, D. W.; Root, F. K.; Glass, G. B., 1972, Energy resources map of Wyoming: colored, 1:500,000, Wyoming Geological Survey, Laramie, Wyoming

Masursky, H., 1962, Uranium-bearing coal in the eastern part of the Red Desert area, Great Divide Basin, Sweetwater County, Wyoming : U. S. Geol. Survey Bull. 1099-B, p. BI-B52.

Smith, J. B., et. al., 1970, Strippable coal resources of Wyoming: U. S. Bur. of Mines Preliminary Report 181, 44p.

Smith, J. B., et. al., 1972, Strippable coal reserves of Wyoming: U. S. Bur. of Mines Information Circular IC 8538, 51 p.

Travis, R. G., 1951, A study of coal mines, resources, and power requirements in the Big Horn River Basin, Wyoming, and Carbon County, Montana: U. S. Bur. of Mines Preliminary Report No. 56, 73 p.

Unfer, L., Jr., 1951, Study of factors influencing the rank of Wyoming coals: Unpublished M. A. Thesis, Univ. of Wyoming, Laramie, 54 p.

U. S. Bureau of Mines, Staff, 1971 a, Strippable reserves of bituminous coal and lignite in the United States: U. S. Bur. of Mines Information Circular IC 8531, 148 p.

U. S. Bureau of Mines, Staff, 1971 b, United States coal resources and production: U. S. Bur. of Mines Interim Report, June 1971, 47 p.

Walker, F. E. and Hartner, F. E., 1966, Forms of Sulfur in U. S. coals: U. S. Bur. of Mines IC 8301, 51 p.

Wegemann, C. H., 1912, The Sussex coal field, Johnson, Natrona, and Converse Counties: U. S. Geol. Survey Bulletin 471, p. 441-471.

Wyoming Geological Survey, 1970, Mines and Minerals Map of Wyoming: colored, scale 1:500,000, Laramie, Wyoming.

Wyoming State Inspector of Mines, (annual) 1902 through 1971, Annual report of the State Inspector of Mines of Wyoming: Rock Springs, Wyoming, (Year ending December 31, 1971, 87 p.).

Table 1: Estimated Original In-Place Coal Resources (millions of short tons) in Wyoming by Counties and Rank (modified after Berryhill, 1950)

County	Bituminous	Subbituminous	Total
Albany		293.59	293.59
Big Horn		17.90	17.90
Campbell*		69,033.84	69,033.84
Carbon	100.24	4,843.28	4,943.52
Converse		4,153.97	4,153.97
Crook	1.15	8.64	9.79
Fremont		733.76	733.76
Hot Springs		261.08	261.08
Johnson*		12,235.66	12,235.66
Lincoln	1,670.07	1,154.65	2,824.72
Natrona		192.88	192.88
Niobrara		14.31	14.31
Park	17.90	196.59	214.49
Sheridan*		24,461.42	24,461.42
Sublette	1.60	5.21	6.81
Sweetwater	9,878.04	5,030.98	14,909.02
Teton	.26	121.91	122.17
Uinta	1,525.75	523.23	2,048.98
Washakie		88.21	88.21
Weston	39.94	285.37	325.31
Total	13,234.95	123,656.48	136,891.43

**This figure has been changed to reflect resources delimited after Berryhill's 1950 calculations (Doss White, personal communication).*

Table 2: Estimated Original In-Place Coal Resources in Wyoming by Major Coal-Bearing Regions and Rank (modified after Berryhill, 1950)

(millions of short tons)

Coal-Bearing Region	Bituminous	Subbituminous	Total
Powder River Coal Basin*		110,218.95	110,218.95
Green River Coal Region	9,904.84	6,051.04	15,955.88
Hams Fork Coal Region	3,197.68	1,676.86	4,874.54
Hanna Coal Field	73.44	3,843.52	3,916.96
Wind River Coal Basin		875.66	875.66
Bighorn Coal Basin	17.90	563.78	581.68
Rock Creek Coal Field		305.18	305.18
Jackson Hole Coal Field		121.49	121.49
Black Hills Coal Region	41.09		41.09
Total	13,234.95	123,656.48	136,891.43

NOTE: There has never been an estimate of the resources of the Goshen Hole Coal Field.

**This figure has been changed to reflect resources delimited since Berryhill's figures were calculated in 1950 (Doss White, personal communication).*

Table 3: Reported coal production by county to January 1, 1972 (short tons)[1]

Albany	5,711	Natrona	30,131
Big Horn	382,683	Niobrara	0
Campbell	12,913,567	Park	36,404
Carbon	51,818,674	Sheridan	57,406,335
Converse	16,974,078	Sublette	16,828
Crook	60,815	Sweetwater	200,987,296
Fremont	3,808,960	Teton	11,140
Hot Springs	11,841,828	Uinta	22,416,900
Johnson	387,818	Washakie	200
Lincoln	58,687,313	Weston	12,427,948

County Total	450,214,629
Total Miscellaneous Reported Tonnage[2]	1,051,636
Grand Total	451,266,265

[1] *Sources: U. S. Geological Survey, U. S. Bureau of Mines and Wyoming State Mine Inspectors*

[2] *Most of this tonnage was reported during various years, in the 1800's and early 1900's, but was not recorded by county. Since the grand total is a summation of the reported annual tonnages and not a summation of the county totals, some small measure of this tonnage may result from reporting errors or discrepancies in figures supplied by the three sources above.*

Table 4: Estimate of Remaining Coal Resources of Wyoming to January 1, 1972

Categories of Original Resources	Mapped and Explored Areas (0-3000 ft. of cover)	Mapped and Estimate of Unexplored Areas (0-6000 ft. of cover)
Original Resources[1]	136,891,430,000	545,710,000,000
Production from[2] strip mining	68,271,706	
Production from[2] deep mining	382,994,559	
Total production	451,266,265	451,266,265
Losses due to strip mining (20% lost)	13,654,341	
Losses due to deep mining (50% lost)	382,994,559	
Total production and mining losses	847,915,165	847,915,165
Remaining Resources	136,043,514,835	544,862,084,835

[1]Source: U. S. Geological Survey and U. S. Bureau of Mines

[2]Source: U. S. Geological Survey, U. S. Bureau of Mines and Wyoming State Inspectors of Mines

Table 5: Remaining Strippable Subbituminous Coal Resources of Wyoming to January 1, 1972 by Coal-bearing Region (Modified from U. S. Bur. of Mines)

Coal-bearing Region	Original Strippable Resource Estimate to Jan. 1, 1968	Production and Mining Losses Since Jan. 1, 1968	Remaining Strippable Resource to Jan. 1, 1972	Remaining Recoverable Strippable Resource (80% recovery)
Powder River Basin	21,262,400,000	15,190,211	21,247,209,789	16,997,767,832
Green River Coal Region	1,151,100,000	34,483	1,151,065,517	920,852,414
Hams Fork Coal Region	1,000,000,000	6,598,403	993,401,597	794,721,278
Hanna Coal Field	313,000,000[1]	15,132,000[2]	297,868,000	218,294,400
Bighorn Coal Basin	3,000,000	0[3]	3,000,000	2,400,000
Total	23,729,500,000	36,955,097	23,692,544,903	18,934,035,924

[1]This approximation is based on Berryhill's 1950, original resource estimates (Glass, 1972 a)

[2]This is strip mine production and mining losses since 1950

[3]Probably very little to no strippable tonnage has been removed