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Strippable Coal Resources of Colorado

Location, Tonnage, and Characteristics of Coal and Overburden

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Strippable coal and lignite deposits

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Information Circular 8713

Strippable Coal Resources of Colorado

Location, Tonnage, and Characteristics of Coal and Overburden

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UNITED STATES DEPARTMENT OF THE INTERIOR
Thomas S. Kleppe, Secretary

BUREAU OF MINES
Thomas V. Falkie, Director

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

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PREFACE

This report estimates the coal resources of 12 separate coal regions, fields, or deposits in Colorado that occur near enough to the surface to be mined by stripping methods. The report augments previously published Bureau of Mines reports on strippable coal deposits in North Dakota and Wyoming and both underground-minable and strippable deposits in the eastern and western parts of the United States. However, the quantitative data in this report are not strictly comparable with those published in the other reports because of variances in the minimum bed thickness of the included deposits and the reliability of the data upon which the estimates were based. The basis for the data is explained in detail in the text of this report. Because of the unavailability of more precise data, this report includes some data based entirely upon geologic inference; it also includes quantitative estimates for all beds 24 inches or more in thickness. The report, therefore, is one that delineates the coal resources of Colorado rather than coal reserves.

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STRIPPABLE COAL RESOURCES OF COLORADO

Location, Tonnage, and Characteristics of Coal and Overburden

by

Charles N. Speltz[1]

ABSTRACT

Coal resource data from public and private sources, in conjunction with previously published data, were used by the Bureau of Mines to determine the location and extent of strippable coal resources in Colorado.

Total strippable resources of approximately 18 billion tons were estimated in 12 separate coal regions, fields, or deposits. Coal recoverable by contour mining techniques was not included. Criteria used in defining strippable resources were a minimum coalbed thickness of 2 feet and a maximum overburden thickness of 150 feet, except where the coalbeds are of exceptional thickness.

All Colorado coal is either Cretaceous or Tertiary in age. Cretaceous coals occur in the Dakota Sandstone, the Mesaverde Group, and equivalent formations while Tertiary coals occur in the Dawson Arkose, the Fort Union and the Wasatch Formations, and equivalent formations. The strippable coal ranges in rank from bituminous in the Yampa region to ligniferous in the Denver basin. All this coal is low in sulfur content (less than 1 percent); ash content is low to high; heating value ranges from 3,000 to 12,000 Btu's per pound. Ash from the lignite of the Denver basin was found to contain an abnormally high percentage of kaolinite which conceivably could be recoverable as alumina.

INTRODUCTION

Viewed in the perspective of an existing energy crisis, coal is the sole energy resource in which the United States is completely self-sufficient. Whereas the productive life of known oilfields and gasfields is measured in decades, coal resources, calculated at present rates of production, would be adequate for centuries. The overwhelming dominance of coal among domestic energy resources has made it an increasingly significant component of the total energy mix, not only as a direct source of energy, but as a probable indirect source via gasification or liquefaction.

[1]Mining engineer (now with Earth Resources Company, Golden, Colo.).

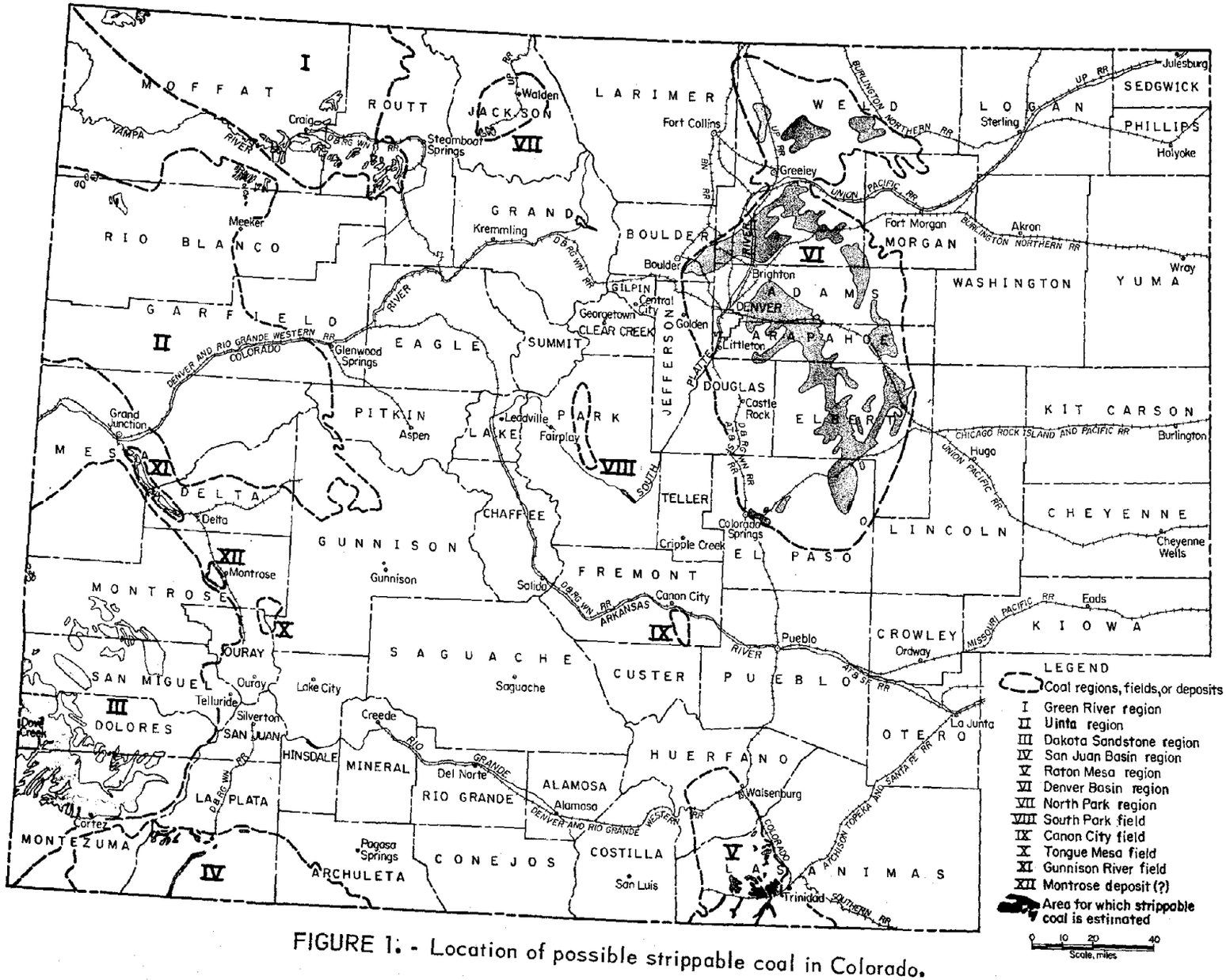

FIGURE 1. - Location of possible strippable coal in Colorado.

Of the 50 States, Colorado ranks 8th in demonstrated coal reserve base and 15th in 1973 production (1).[2] The location of Colorado at the center of the Rocky Mountain States, its transcontinental transportation facilities, and the low-sulfur content of its coal, all tend to enhance the utility and future importance of such resources to the national economy.

Now and in the foreseeable future, coal will not necessarily be mined simply because it exists in an area and is economically extractable. An increasing number of environmental and ecological safeguards have provided a new set of constraints upon the production of coal, and particularly strippable coal. No longer is it sufficient to consider coal within an economic framework alone; the constraints provided by environmental legislation also must be analyzed.

This report is the fourth in a series to define the strippable coal potential of States in the Upper Missouri River basin. The first three reports in the series defined the location, extent, and characteristics of strippable coal deposits in Montana, Wyoming, and North Dakota, and this, the fourth report, summarizes and interprets available information about strippable coal in Colorado. Coal reports from several sources, including the U.S. Geological Survey, were used extensively. Drill hole data, where available, were incorporated to extend published information. Corporate and individual data both of a proprietary and a public nature were used on a supplemental basis.

Unlike the three previous reports in the series, this report delimits coal resources rather than coal reserves. Available data are too sparse to permit the degree of certainty necessary to adequately define reserves. The U.S. Geological Survey subdivides resources into two categories--identified and undiscovered. Identified coal resources are specific deposits of coal whose location and quantity are known from geologic evidence supported by engineering measurements.

Undiscovered coal resources are probable deposits of coal surmised to exist on the basis of broad geologic data and/or meager engineering measurements. Undiscovered coal resources should not be considered reserves because at best their existence is either hypothetical or speculative.

The location of possible strippable coal deposits is shown in figure 1. A tabulation of estimated tonnage is presented in table 1.

[2]Underlined numbers in parentheses refer to items in the list of references preceding the appendix.

TABLE 1. - Estimated strippable coal resources of Colorado

Location number[1]	Area	Identified		Undiscovered		Total	
		Area (acres)	Strippable resource (million short tons)	Area (acres)	Strippable resource (million short tons)	Area (acres)	Strippable resource (million short tons)
I....	Green River region (figs. 4-5).	26,600	377	58,900	574	85,500	951
II....	Uinta region (figs. 6-7).	[2]3,050	33	17,500	227	20,550	260
III....	Dakota Sandstone region (fig. 8)	58,900	493	443,350	2,419	502,250	2,912
IV....	San Juan River region (fig. 9)	6,900	129	10,450	124	17,350	253
V....	Raton Mesa region (fig. 10)	0	0	25,300	136	25,300	136
VI....	Denver Basin region (fig. 11)	912,350	13,059	0	0	912,350	13,059
VII....	North Park field (fig. 12).	2,650	95	1,550	28	4,200	123
VIII....	South Park field	0	0	0	0	0	0
IX....	Canon City field	0	0	1,900	10	1,900	10
X....	Tongue Mesa field.	0	0	0	0	0	0
XI....	Gunnison River field (fig. 13)	19,350	91	0	0	19,350	91
XII....	Montrose deposit (?) (fig. 14).	0	0	13,700	176	13,700	176
Total	-	-	-	-	-	1,602,450	17,971

[1]Numbers in this column refer to locations in figure 1.
[2]Figure is incomplete because of lack of data on the Somerset field.

ACKNOWLEDGMENTS

Thanks are expressed to personnel of the U.S. Geological Survey, not only the authors cited in references at the end of this report, but also to authors J. P. Storrs, R. G. Dickinson, and A. L. Carver, all of Denver, who provided unpublished data that were not classified as company confidential. The majority of such data is available to the public in the Conservation Division of the Survey at Denver.

Numerous companies, State agencies, and individuals contributed information. Detailed information for the Denver basin was provided by Bruce Burbank of Public Service Company of Colorado. Dorothy E. Archer of the Colorado Division of Water Resources provided assistance in examining the State's files of water well logs. Marjorie T. Sutton of the Colorado Division of Mines

provided data on the coal mines of Colorado. Constance Mull of Mining and Oil Lease Service, Denver, provided coal ownership information. Richard D. Holt, Maynard F. Ayler, and Richard S. Bryson, all Denver consultants, aided the author in understanding specific coal regions within the State. D. Keith Murray, Chief, Mineral Fuels Section, Colorado Geological Survey, reviewed the manuscript for technical accuracy.

PREVIOUS INVESTIGATIONS

No detailed work has been published delineating Colorado strippable coal resources; however, hundreds of specialized reports and maps exist which, when added together, provide sufficient information so that strippable coal can be generally delineated. Landis (78) provided detailed information, presented by township and range, for coal reserves within 1,000 feet of the surface, but he made no attempt to separate these reserves into strippable or nonstrippable categories. The Bureau of Mines (108) has estimated 500 million tons of coal within 50 feet of the surface and having a maximum stripping ratio of 10 to 1.

Numerous studies have been published detailing specific coalfields. Most have been referred to in the appropriate sections of this report and are listed in the References section.

GENERAL INFORMATION

Colorado, one of the Rocky Mountain States, consists of four diverse physiographic provinces: the Great Plains, extending from the Kansas border on the east to a line drawn from the north to the south through the State and passing through Denver; the southern Rocky Mountains, extending from the Great Plains on the east to the Colorado Plateau and the Wyoming basin on the west; the Colorado Plateau; and the Wyoming basin, consisting of lower mountain ranges, plateaus, and mesas extending from the indefinite boundary of the southern Rocky Mountains westward to the Utah State line (49). Colorado lies astride the Continental Divide, which physically divides the State into two halves. Elevations range from about 4,000 feet at the eastern border to over 14,000 feet at the top of the highest peaks.

The climate of Colorado is semiarid; average annual rainfall is 16.5 inches. Precipitation ranges from 27.35 inches per year in Gunnison County to 6.83 inches in Conejos County. In the higher elevations, a significant percentage of annual precipitation falls as snow. Temperature variations within the State are extreme, depending on elevation and geographic location. Summers are hot and dry in most portions of the State, excluding the mountains where moderately cool temperatures prevail. Winters are characterized by extreme cold in the mountains and moderate cold in the rest of the State. Rarely is the climate so harsh as to preclude strip mining operations, provided that cold-weather procedures are followed.

Vegetation ranges from sparse in those areas above the timberline and in the arid portions of the State to heavy in the sheltered mountain valleys. The western slope is characterized by yucca, cactus, and scrub oak, supplemented by cottonwood trees along the streams and valleys. The predominant

trees in the mountains are ponderosa pine, Engelmann spruce, Douglas fir, and aspen. The Great Plains are characterized by grasslands, plus cottonwood trees along streams and rivers.

The southeast quadrant of Colorado is served by the Atchison, Topeka and Santa Fe Railroad, Colorado Southern Railroad, and Missouri Pacific Railroad. The northeastern quadrant of the State is served by the Union Pacific, Burlington Northern, and Rock Island and Pacific Railroads. Mountain regions and the western slope are provided rail service exclusively by the Denver & Rio Grande Western Railroad. Only the Denver basin, Raton Mesa, Uinta, and portions of the Green River and Dakota Sandstone coal regions are served by rail. A thin network of rail transport is the most significant contributor to the slow development of Colorado strip coal.

Colorado is traversed by numerous all-weather highways, the most notable being Interstate 70, which crosses the State from east to west and serves the Denver basin and the Uinta coal regions. Interstate 25 traverses the State from south to north and provides truck transportation to the Raton Mesa and the Denver basin coal regions. All other coal regions are served by a net of all-weather Federal and State highways. Topography of most coal regions, excepting the Denver basin, makes offroad transportation difficult or impractical.

Except for Denver and the area immediately adjacent to the Front Range, the population density of Colorado is low. Local markets for coal are limited, although they are steadily increasing. The principal consumer of Colorado coal is the power generation industry, which has 15 thermal generating plants in Colorado capable of burning coal (82). In 1972, coal consumption at the 15 plants ranged from 2 to 100 percent of total energy requirements. Two plants use coal imported from Wyoming. Future growth of the Colorado coal industry can be expected to parallel future demand for electric power. Gasification and liquefaction of coal may play a significant role in future demand. At present no plants are under construction although a proposal exists for constructing a high-Btu coal gasification plant, utilizing abundant lignite reserves in the Watkins area in Adams County east of Denver.

GENERAL GEOLOGY

Coal-bearing rocks of Colorado are all of Cretaceous or Tertiary age. Cretaceous coals are associated with marine sediments; Tertiary coals, however, are associated with lacustrine and fluval beds in intermountain basins. The geology of Colorado coal has been complicated by regional and local tectonic forces, ranging from mild disturbances in the eastern portion of the Denver basin to diastrophism in the Danforth Hills and the Tongue Mesa coalfields. The rank of Colorado coal generally is related to geologic age; Cretaceous coals typically are of higher rank than Tertiary coals. Most Colorado coal is bituminous or subbituminous in rank. However, fairly extensive lignites occur in the central Denver basin. Intrusives related to regional tectonic deformation have upgraded some coal to anthracite notably near Crested Butte and in the Raton Mesa area.

Many coals in the State have burned as a result of natural causes, creating beds of reddish, erosion-resistant clinkerlike material. Burning is generally limited to areas of thin overburden and to outcrops and does not extend to depth, possibly because of extensive occurrences of hard, compact sandstone overlying much of the coal, which precludes sufficient air to support combustion.

Coal-bearing formations of Colorado are the Dakota Sandstone; the Mesaverde Group (including the Menefee Formation); the Fruitland, Lance, Laramie, Vermejo, Raton, Fort Union, Wasatch, Denver, and Coalmont Formations; and the Dawson Arkose. The stratigraphy of Colorado coal, as adapted from Landis (78), is presented in figure 2.

Although Landis estimated that 28 percent of the land area of the State or about 29,600 square miles is underlain by coal-bearing rocks, only those areas where coal-bearing rocks crop out, or are shallowly buried, provide a strippable potential. A lack of coal-bearing strata at or near the surface is prima facie evidence that strippable coal does not exist.

Figure 3 shows surface or near-surface occurrences of coal-bearing rocks in Colorado. It shows geologically favorable terrain in which strippable coal could exist, but it does not confirm that such coal actually is present. Colorado coals are often lenticular and discontinuous, hence the existence of a favorable depositional environment may or may not indicate the presence of coal.

The shaded areas on figure 3 may be interpreted as those areas in which strippable coal, as defined by some present or future set of economic criteria, could exist. The unshaded areas represent those portions of the State in which no strippable coal should exist under any set of economic conditions.

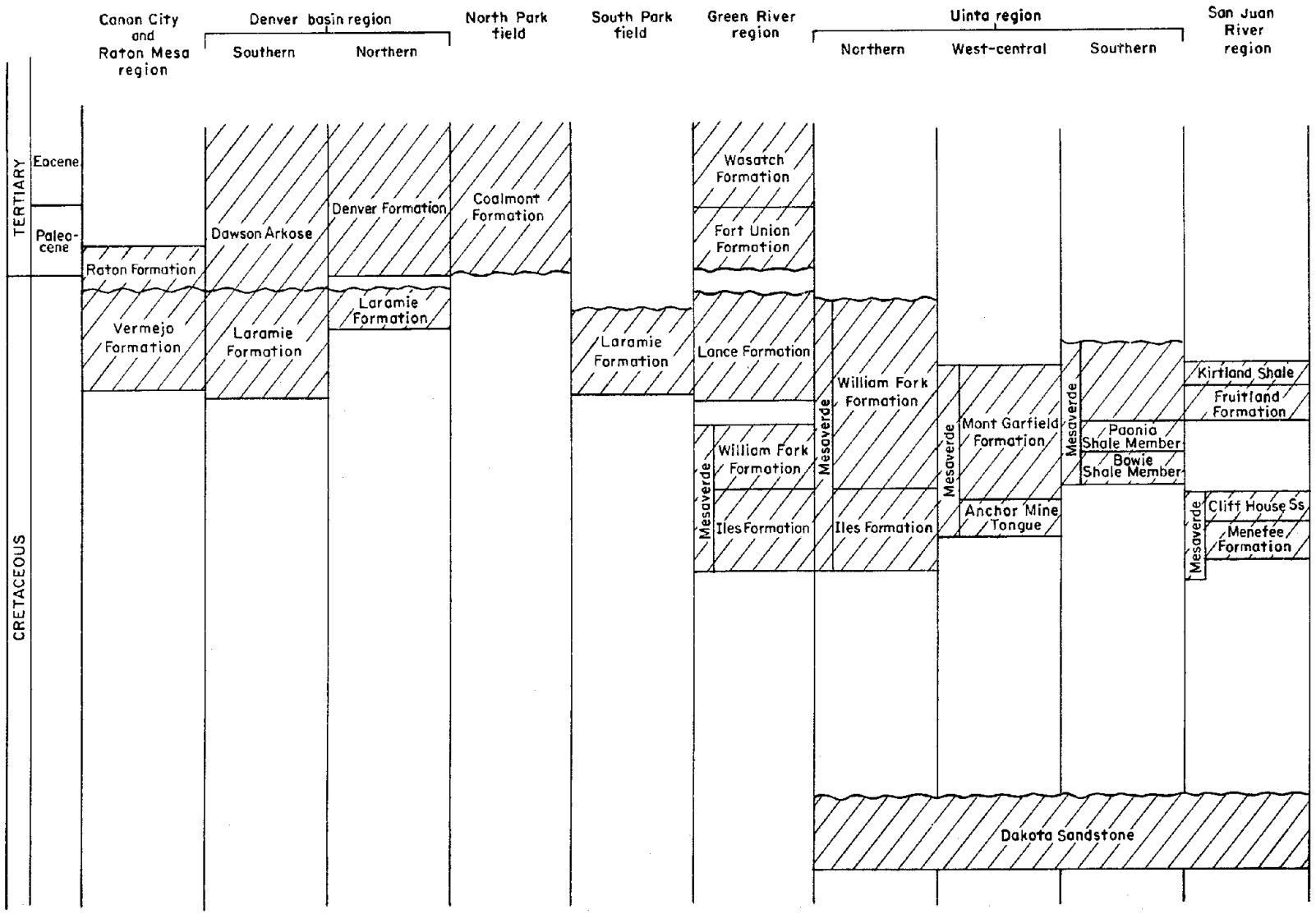

FIGURE 2. - Stratigraphic relationship of coal-bearing rocks in Colorado. (Adapted from E. R. Landis, USGS Bull. 1042, 1959.)

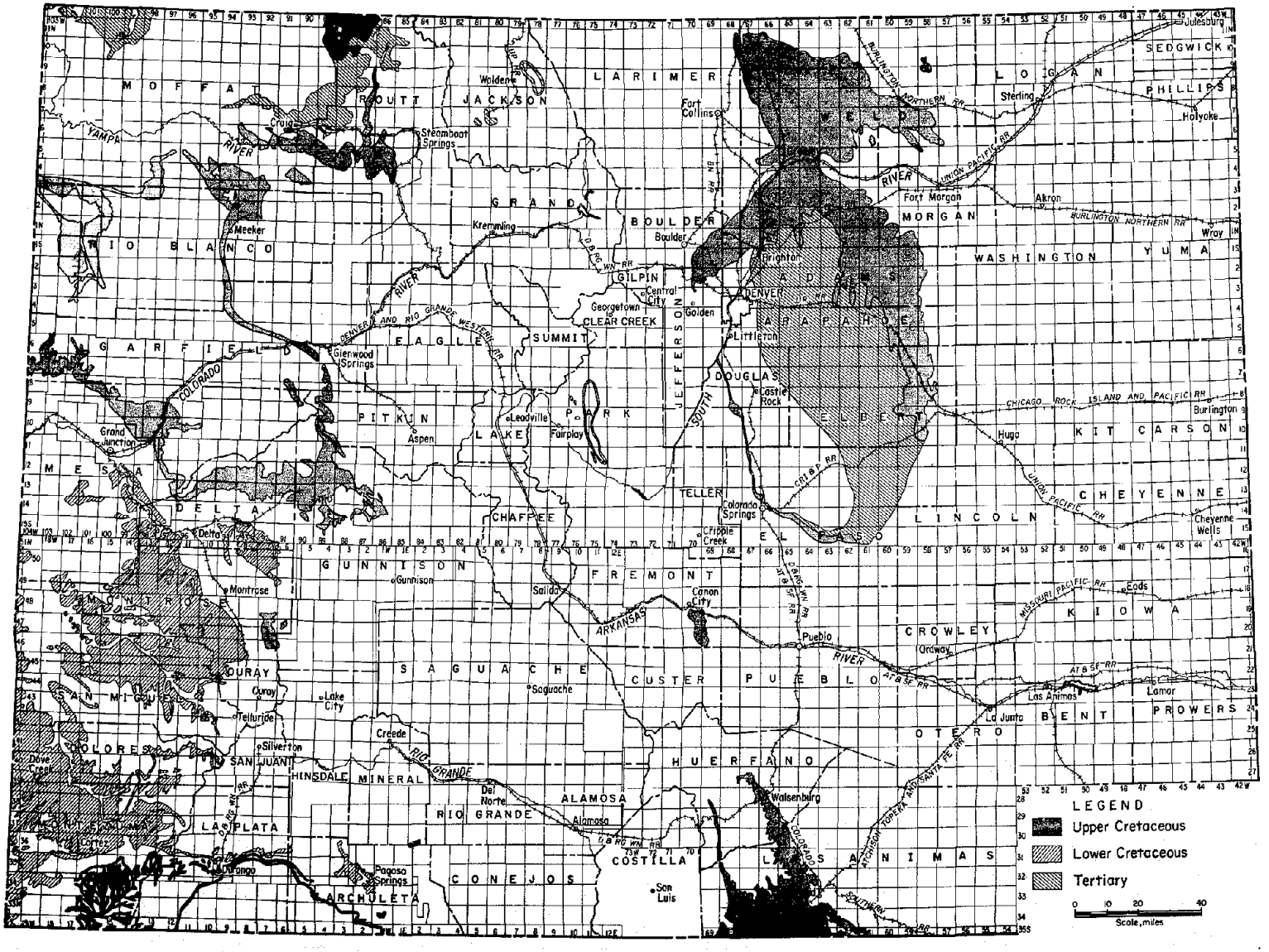

FIGURE 3. - Surface or near-surface occurrences of coal-bearing strata in Colorado.

STRIP COAL MINING AND PRODUCTION (28)

Total reported coal production in Colorado from 1864 through 1974 was 588,238,437 tons, most of which has been produced from underground mines. Not until 1965 did strip mining account for greater than 25 percent of total production. Since 1953, total production has been 98,409,000 tons, of which 27,989,682 came from strip mines. Annual production for the past 20 years is shown on table 2.

TABLE 2. - Coal production in Colorado, 1953-74

(Thousand short tons)

Year	Production from strip mines	Total production (underground and surface)
1974.....	3,636	6,961
1973.....	2,894	6,232
1972.....	2,449	5,530
1971.....	1,967	5,307
1970.....	2,160	6,021
1969.....	1,899	5,519
1968.....	1,810	5,579
1967.....	1,843	5,426
1966.....	1,621	5,228
1965.....	1,406	4,990
1964.....	983	4,401
1963.....	857	3,707
1962.....	556	3,393
1961.....	520	3,701
1960.....	694	3,625
1959.....	546	3,302
1958.....	413	2,972
1957.....	355	3,325
1956.....	358	3,304
1955.....	359	3,367
1954.....	297	2,922
1953.....	366	3,597

In 1974, 38 mines operated in Colorado employed 1,736 men and produced 6,960,686 tons of coal at an average productivity of 20 tons per man-shift. Nine of these mines were strip mines, of which six produced more than 100,000 tons. Data on operating strip mines are given in table 3.

TABLE 3. - Production characteristics of Colorado strip coal mines, 1974

Mines	County	Coal production (tons)	Men employed	Days worked	Coalbed thickness	
					Feet	Inches
Cedar Canon.....	Fremont.....	904	8	90	6	0
Corley.....	.....do.....	[1]117,236	19	286	2	6
Canadian.....	Jackson.....	-	12	27	40	0
Marr No. 1.....	.....do.....	7,899	16	26	55	0
Nucla.....	Montrose.....	106,723	16	303	5	6
Edna.....	Routt.....	1,134,089	69	343	6	0
Energy No. 1.....	.....do.....	1,240,150	80	320	7	6
Energy No. 2.....	.....do.....	575,393	23	320	4	6
Energy No. 3.....	.....do.....	-	26	84	10	0
Seneca No. 2.....	.....do.....	496,985	26	247	9	0

[1]Production by auger.

COAL LAND OWNERSHIP AND LEASING

The surface area of Colorado comprises 66,485,760 acres, of which 23,777,244 acres (35.76 percent) is owned by the Federal Government; 3,021,557 acres (4.54 percent) is owned by the State; 752,700 acres (1.13 percent) is Indian land; and the remainder, 38,671,473 acres (58.56 percent) is privately owned.

Generally, surface ownership carries coal rights, except for 1,348,288 acres held by the Federal Government and 1,015,486 acres held by the State for which only the mineral rights, not the surface, is owned. Information on the ownership of specific tracts of land or mineral rights is obtainable only from the county assessor of the county within which the tract is located or, in some cases, from the Colorado State Office of the Bureau of Land Management.

Because coal is not a locatable mineral, Federal coal lands cannot be claimed under the Mining Law of 1872; all leasable land is administered by the Bureau of Land Management under provisions of the Mineral Leasing Act of 1920 (41 Stat. 437; 30 U.S.C. 181 et seq.). From April 23, 1925, when the first Federal lease was issued, to June 6, 1973, when a general moratorium on prospecting permits was imposed by the then Secretary of the Interior, Rogers C. B. Morton, 56 competitive bid leases, aggregating 44,234 acres, and 56 preferential (resulting from prospecting permits) leases aggregating 77,631 acres were issued. Per-acre bonuses for competitive leases have ranged from zero dollars per acre in the case of the early leases to $60 per acre in the case of a Mid-Continental Coke and Coal Co. lease on January 1, 1965. Rental and royalty payments cannot be generalized because the subject is now in a state of flux, and new regulations have been issued.

Despite a minor recent exception, a general moratorium on coal prospecting permits and leases remains in effect. Leases may be obtained only if the following three conditions are met: (1) The coal is needed to maintain an existing mining operation or as a production reserve for the near future; (2) the land will be reclaimed; and (3) an acceptable environmental impact statement has been filed.

State lands, except where the Federal Government owns the mineral rights, are not administered by the Bureau of Land Management. Leases are obtained on an oral bid basis through the State Board of Land Commissioners.

Private (fee) lands, excepting those lands on which the Federal Government or the State owns the mineral rights, are not administered by the Bureau of Land management or the State Board of Land Commissioners. All negotiations must be made with the fee owner of the land. Because each lease is individually negotiated, no guidelines for lease payments or royalties can be defined.

Indian lands are administered by tribal councils as if they were private lands. Typical leasing agreements entail payment of royalties, rent, and compensation for surface damage.

Although both the Southern Ute and Mountain Ute Indian Reservations lie partly within Colorado, only the Southern Utes have consummated a coal lease within the State. Peabody Coal Company leased 19,000 acres at an annual rent of $1 per acre for the first 5 years and $2 per acre thereafter. A royalty rate of 5 percent of gross realization is charged on all coal sold and utilized off the reservation and 4 percent on all coal sold and utilized on the reservation. Additionally, a compensation-for-surface-damage fee of 1 percent is charged.

CRITERIA USED FOR RESOURCE ESTIMATES

Definition of strippable coal resources depends upon a number of geologic and physical criteria, such as the thickness and quality of the coal and the thickness and breaking characteristics of overburden. In this report, only two criteria are used in defining strippable coal. They are (1) a minimum coal thickness of 2 feet and (2) a maximum overburden thickness of 150 feet, except where the coal thickness is more than 20 feet. An overburden-to-coal ratio is not specified because it is a ratio based on the two criteria used and is useful only when considering economic feasibility.

Although a 5-foot-thick coalbed is generally conceded to be the minimum cutoff limit for defining strippable coal in regional studies, 2 feet was selected for use in this publication because of a sparsity of reliable data and because of a desire to target potentially strippable areas in which data are meager.

Most data on Colorado strippable coal, such as single drill hole logs or isolated outcrops, are unsupported by other data and are insufficient to prove or disprove the existence of strippable coal deposits. Because of the lenticularity of many of the coals, a single data point does not establish thickness except at that point; the coalbed may become thinner or thicker away from the point.

In this report, it is assumed that data indicating existence of a 2-foot bed of coal within 150 feet of the surface are prima facie evidence that coal exists within strippable depth. Although 2 feet of coal is probably not a commercially minable resource in 1975, nevertheless such a bed of coal is

considered to be a strippable resource because it may indicate potentially strippable coal of greater thickness.

The maximum overburden depth of 150 feet was arbitrarily selected owing to the quality of available data. A detailed economic analysis of both coal and overburden characteristics and thicknesses would have provided a more viable estimate of coal resources; however, the contour interval of most maps used and the inadequacy of most data available precluded such an analysis. Hence, 150 feet of overburden was selected as a maximum, even though such a selection will permit definition of strippable coal resources under conditions which are definitely uneconomical.

STRIPPABLE COAL AREAS AND DEPOSITS

Green River Region (5, 50)

The Green River coal region, located in parts of Moffat, Routt, and Rio Blanco Counties, constitutes the Colorado portion of the Washakie basin of southern Wyoming and northern Colorado (sometimes termed the Sand Wash basin in Colorado). The Washakie basin, in turn, is part of the greater Green River basin of Wyoming, northeastern Utah, and Colorado. Although coal probably underlies the entire Green River basin, only the margins of the basin, where outcrops occur, are of interest from the standpoint of strippable coal reserves.

The largest town in the region is Craig, terminus of a Denver & Rio Grande Western Railroad branch line. Steamboat Springs is located approximately 40 miles east of Craig, on the same branch line. Craig, the county seat of Moffat County, had 4,228 residents in 1972, or about two-thirds of the total population of Moffat County.

The Green River coal region is considered by Fenneman (49) to be in the Yampa Basin of the Wyoming Basin physiographic province. Topography of the region ranges from a broad plateau containing numerous mesas, tablelands, and fertile valleys in the west to high mountains in the east. Elevations range from 5,400 to 12,065 feet above sea level. Western portions of the region are quite arid, receiving little precipitation (12.54 inches annual average in Craig) and containing sparse vegetation. The eastern, more mountainous parts of the region are less arid than the western, averaging about twice as much precipitation and being more heavily vegetated.

The Green River region contains coal-bearing rocks of Cretaceous, Paleocene, and Eocene ages. The geology in this region is relatively simple; however, folding and faulting have created areas of local complexity. Formation dips range from horizontal to vertical. Coalbeds occur in the Willaim Fork and Iles Formations of the Mesaverde Group and in the Lance Formation, all of Upper Cretaceous age; and in the Fort Union and Wasatch Formations of lower Tertiary age. The Dakota Sandstone, which is coal bearing in southwestern Colorado is not reported to contain coal in the Green River region.

For purposes of this report, the Green River region has been subdivided into two fields or areas as follows: (1) the Yampa coalfield, which includes only the Cretaceous coal-bearing rocks and (2) the Tertiary subregion, which includes only the Tertiary coal-bearing rocks.

Yampa Coalfield (12, 36, 63-64, 93)

The Yampa field occurs at the extreme southeast edge of the Washakie (Green River) basin. The most productive areas of the field are in Routt County, although both Rio Blanco and Moffat Counties contain acres of significant potential.

The gentle folding present locally on the south side of the Washakie basin progressively becomes more complex towards the east. The southeast and east sides of the basin are structurally complex owing to folding, faulting, and igneous intrusives.

Most of the Mesaverde coal is noncoking, high-volatile C bituminous. Locally, some anthracite is present near intrusives.

A range of analyses for Routt County Mesaverde coals, regardless of bed, is as follows:

	As received--1,537 samples		
	High	Low	Mean
Moisture.....percent..	18.3	5.6	9.4
Volatile matter.....do....	45.9	36.0	41.1
Fixed carbon.....do....	58.2	46.8	51.8
Ash.....do....	16.5	2.6	6.9
Sulfur.....do....	2.8	0.2	0.9
Btu/lb.....	12,560	9,550	11,580

Range of analyses for Moffat County Mesaverde coals are as follows:

	As received--65 samples		
	High	Low	Mean
Moisture.....percent..	23.3	8.5	11.6
Volatile matter.....do....	49.7	37.4	42.0
Fixed carbon.....do....	56.3	47.2	53.8
Ash.....do....	9.4	2.7	4.3
Sulfur.....do....	1.0	0.2	0.3
Btu/lb.....	12,120	8,860	11,500

At least 19 zones in the Mesaverde Group contain coal of minable thickness. They are identified and correlated throughout the field and are named alphabetically in ascending order from A to S. Certainly other minor coals exist which may offer minable thicknesses on a local basis; moreover, some major coalbeds were omitted from the master alphabetical listing. Most coalbeds occur in the upper Iles or lower and upper Williams Fork Formations.

Coals of the upper Iles, lettered A through D, have been correlated with the "Black Diamond Group" of coalbeds in the Danforth Hills and increase in economic value toward the west. However, lower beds of the upper Iles Formation are generally absent in the western portions of the field.

Coals of the lower Williams Fork Formation are nominally termed "Middle Group" coals and are represented by letters "F" through "J." The "Middle Group" coals are generally the most important beds throughout the field.

Coals of the upper Williams Fork Formation are identified by the letters "L" through "S." They usually are termed the "Upper Group" coals. These "Upper Group" coals offer the best economic potential in the eastern portion of the field. In the western part of the field, as many as 16 beds of coal exist in the upper Williams Fork; however, no more than 8 are of known minable thickness.

At least 70 mines historically have operated in the Yampa field, most of which were underground operations. In 1974, eight mines were operating, of which five were strip mines. The strip mines, operators and production statistics are as follows:

Mine	Operator	1974 production (tons)
Edna Strip.....	Pittsburg & Midway Coal Mining Co.....	1,134,089
Energy No. 1.....	Energy Fuels Corp. (Western Nuclear Corp.)..	1,240,150
Energy No. 2.....	.....do.....	575,393
Energy No. 3.....	.....do.....	-
Seneca No. 2.....	Seneca Coals, Ltd. (Peabody Coal Co.).....	496,985

In April 1973, Utah International announced that a new strip mine would be opened in 1977 near Craig to provide 99 million tons of coal (2.8 million tons per year over 35 years) for two thermal generating plants to be constructed near Craig for Colorado-Ute Electric Association (36). The Utah International mine will almost double Colorado's current strip mine production.

Excluding previously mined coal, there may be as much as 750 million tons of strippable coal in 57,145 acres within the Yampa field in Cretaceous formations. Areas for which strippable coal is estimated are presented in figure 4. A tabulation of estimated bed thicknesses and tonnage is displayed in table 4.

Tertiary Subregion (8, 94, 98)

The Tertiary subregion is that part of the Green River region in which outcrops of Tertiary rocks occur. Although the Cretaceous Mesaverde Group is the most important coal-bearing rock sequence in the region, it crops out only around the margins of the Green River basin; younger Tertiary rocks, some of which are coal bearing, are exposed throughout much of the central part of the basin. Two Tertiary formations, the Fort Union and the Wasatch, are coal bearing in this region.

TABLE 4. - Estimated strippable coal resources in the Yampa coalfied, Green River region, northwestern Colorado

Location		Identified			Undiscovered			Total	
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Quantity (thousand short tons)
T 6 N	R 93 W	-	-	-	3,043	6.7	36,700	3,043	36,700
	R 92 W	-	-	-	4,518	12	88,350	4,518	88,350
	R 91 W	2,092	11	41,000	3,356	4	24,150	5,448	65,150
	R 91 W	-	-	-	427	25	18,600	427	18,600
	R 90 W	1,027	11	20,350	6,390	4	46,000	7,417	66,350
	R 89 W	-	-	-	618	4	4,450	618	4,450
	R 88 W	-	-	-	1,044	10	19,650	1,044	19,650
	R 87 W	238	8	3,400	-	-	-	238	3,400
	R 86 W	-	-	-	399	5	3,600	399	3,600
T 5 N	R 93 W	-	-	-	1,103	5	11,700	1,103	11,700
	R 93 W	-	-	-	219	6.7	2,600	219	2,600
	R 92 W	-	-	-	323	6.7	3,900	323	3,900
	R 92 W	-	-	-	4,203	10	75,650	4,203	75,650
	R 91 W	1,987	11	39,350	352	4	2,500	2,339	41,850
	R 90 W	627	11	12,200	1,759	7	22,150	2,386	34,350
	R 89 W	-	-	-	837	6	9,000	837	9,000
	R 89 W	-	-	-	1,208	10	21,750	1,208	21,750
	R 88 W	865	10	15,600	1,132	5	10,200	1,997	25,800
	R 87 W	453	10	8,150	-	-	-	453	8,150
	R 87 W	903	8	13,000	-	-	-	903	13,000
	R 87 W	390	3	2,100	-	-	-	390	2,100
	R 86 W	1,331	3	7,200	1,892	3	10,200	3,223	17,400
	R 86 W	-	-	-	846	5	7,600	846	7,600
	R 85 W	1,378	6	14,900	333	5	9,900	1,711	24,800
T 4 N	R 87 W	1,084	8	15,600	181	5	1,600	1,265	17,200
	R 86 W	2,872	8	41,350	3,642	5	32,800	6,514	74,150
	R 86 W	1,703	10	30,650	-	-	-	1,703	30,650
	R 85 W	1,227	10	22,100	-	-	-	1,227	22,100
T 3 N	R 87 W	-	-	-	67	5	600	67	600
	R 86 W	-	-	-	76	5	700	76	700
Total.....		18,177	-	286,950	37,968	-	464,350	57,145	751,300

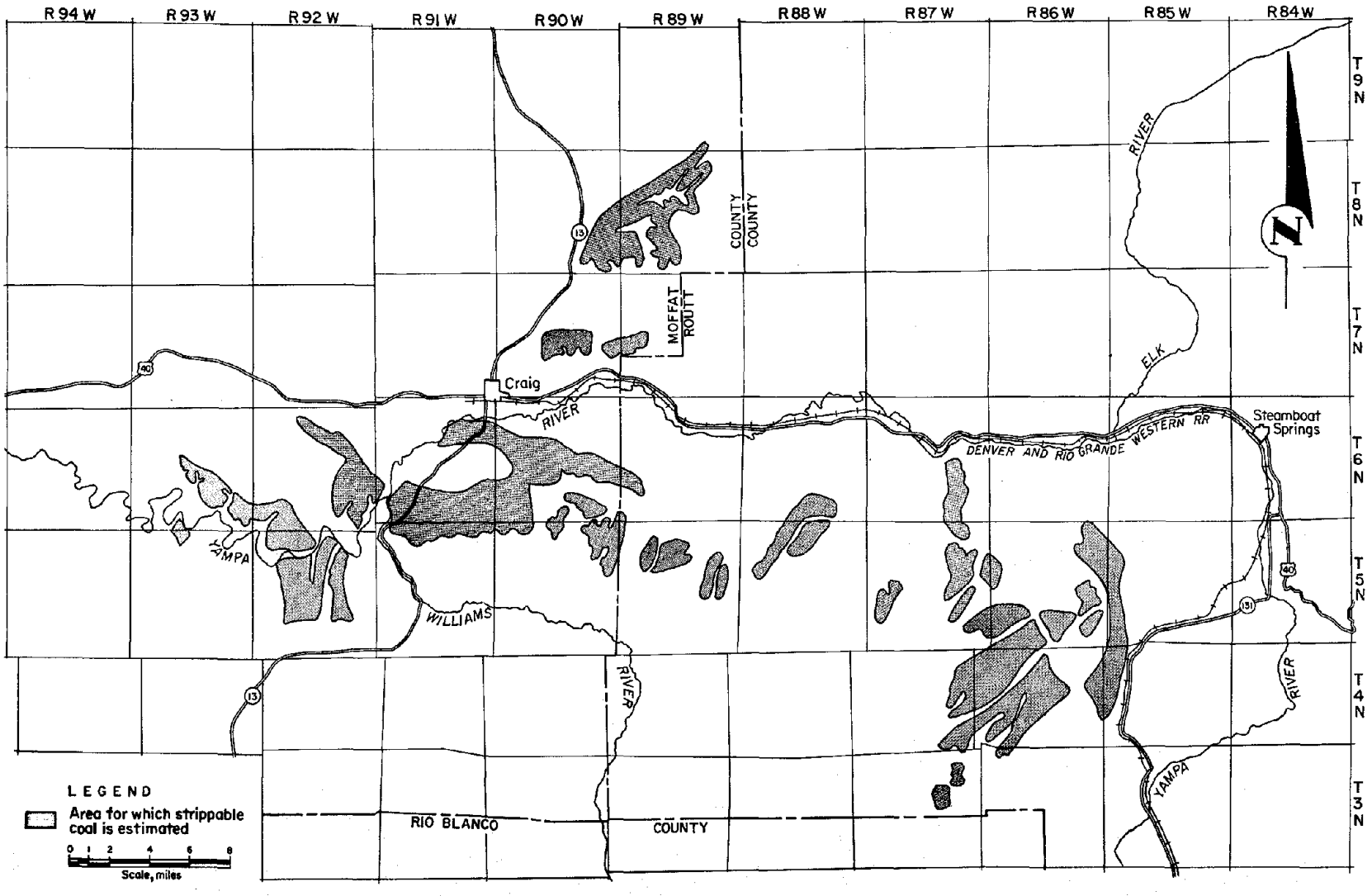

FIGURE 4. - Strippable coal areas in the Yampa coalfield.

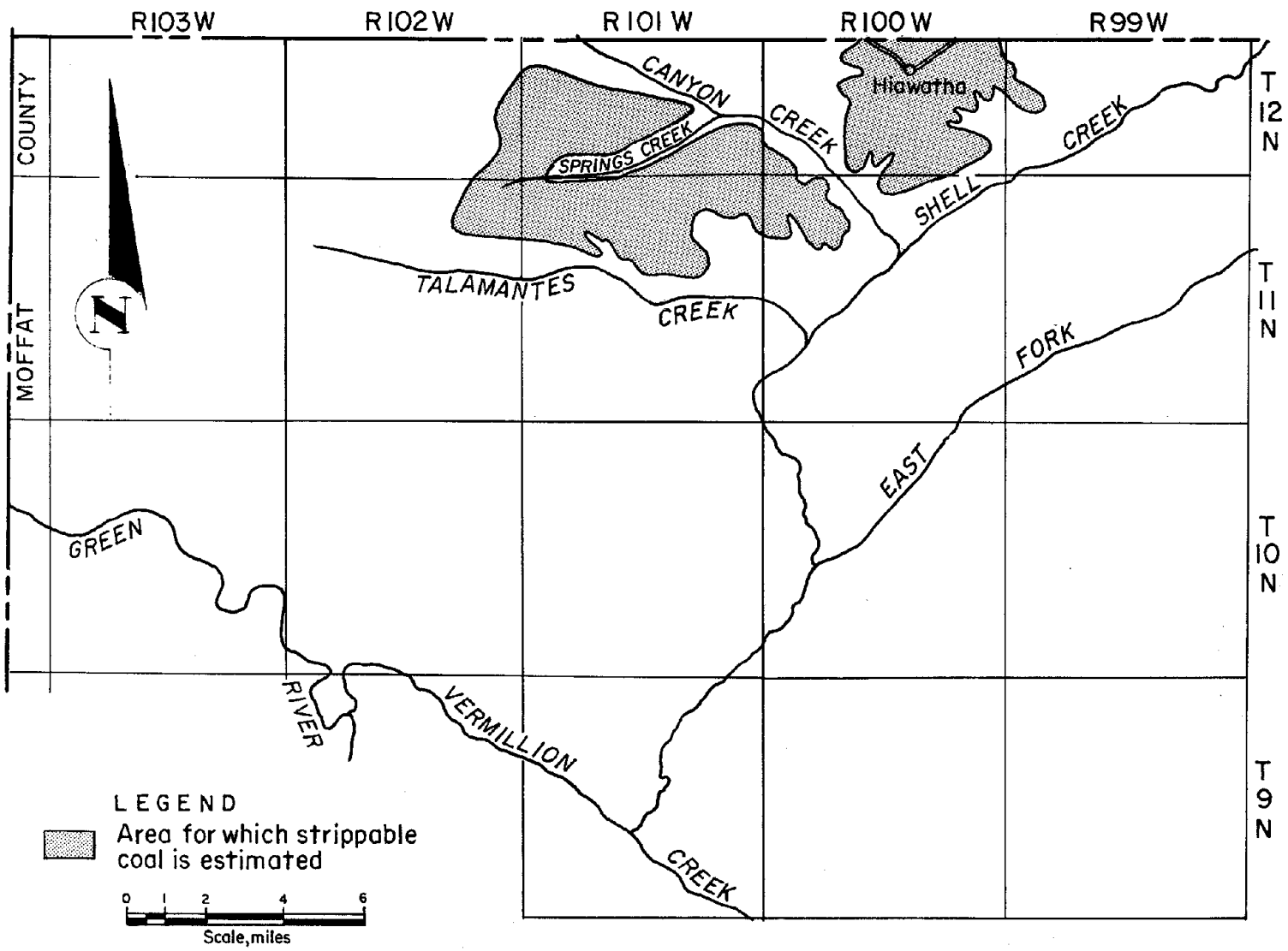

FIGURE 5. - Strippable coal areas near Hiawatha, Colo.

The Fort Union Formation, sometimes referred to as the post-Laramie formation, crops out along the east and south flanks of the basin and is apparently coal bearing throughout. Although U.S. Geological Survey Bulletins 415 and 1027 report commercial thicknesses of coal throughout the Fort Union, only one area, in T 8 N, Rs 89 and 90 W (see fig. 4), offers any significant strippable potential. Coal from the Fort Union is mostly subbituminous in rank. Typical analyses are as follow:

	Sample A[1]		Sample B[2]	
	As received	Dry	As received	Dry
Moisture.....percent..	18.5	14.2	17.08	12.47
Volatile matter.....do....	32.2	33.9	35.30	29.92
Fixed carbon.....do....	44.5	46.7	41.97	50.02
Ash.....do....	5.1	5.3	5.65	7.59
Sulfur.....do....	0.3	0.3	0.46	1.21
Btu/lb.....	9,842	10,360	9,330	10,290

[1]U.S. Geological Survey Bull. 1027, p. 208.
[2]U.S. Geological Survey Bull. 415, p. 248.

The Wasatch Formation, and particularly the Cathedral Bluffs tongue of the Wasatch Formation, is probably coal bearing throughout; however, the Wasatch coalbeds are lenticular, irregular, and discontinuous. The coal potential of the Wasatch has not been established, and published data are remarkably sparse.

Only one area is deemed to present a strippable coal potential. It is near Hiawatha, Tps 11 and 12 N, Rs 99 to 102 W. Two oil well logs (Nos. 324 and 327), published by the Colorado School of Mines (2), reported the existence of shallow coal. Sears and Bradley (94, p. 99) confirmed the existence of Wasatch coal in the vicinity of Lookout Mountain (T 10 N, R 98 W). Approximately 3 feet of coal is believed to be present, although it is unknown how much, if any, is recoverable. Figure 5 indicates those areas near Hiawatha for which a strippable resource was estimated. No analyses are available for Wasatch coal in Colorado.

Table 5 presents a tabulation of expected thicknesses and estimated tonnages of strippable coal in the Tertiary subregion. If strippable coal is contained throughout the area, approximately 200 million tons of subbituminous coal could be present in 29,456 acres.

Uinta Region

The Uinta coal region is in northwestern Colorado and corresponds to the Colorado portion of the Uinta Basin section of the Colorado Plateau physiographic province as defined by Fenneman (49, p. 304). The region includes parts of Garfield, Mesa, Delta, Gunnison, Pitkin, Rio Blanco, and Moffat Counties. Eight coalfields, identified as the Lower White River, Danforth Hills, Grand Hogback, Carbondale, Crested Butte, Somerset, Grand Mesa, and Book Cliffs, are within the region.

TABLE 5. - Estimated strippable coal resources in the Tertiary subregion, Green River coal region

Location		Identified			Undiscovered			Total	
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Quantity (thousand short tons)
T 12 N	R 102 W	-	-	-	1,293	3	6,750	1,293	6,750
	R 101 W	-	-	-	6,447	3	33,700	6,447	33,700
	R 100 W	1,141	3	5,950	4,593	3	24,000	5,734	29,950
	R 99 W	-	-	-	495	3	2,600	495	2,600
T 11 N	R 102 W	-	-	-	1,503	3	7,850	1,503	7,850
	R 101 W	1,075	3	5,600	5,277	3	27,600	6,352	33,200
	R 100 W	-	-	-	1,407	3	7,350	1,407	7,350
T 8 N	R 90 W	1,762	4	13,200	-	-	-	1,762	13,200
	R 89 W	2,065	9.5	34,700	-	-	-	2,065	34,700
	R 89 W	450	13	10,200	-	-	-	450	10,200
	R 89 W	1,948	6	20,350	-	-	-	1,948	20,350
Total.....		8,441	-	90,000	21,015	-	109,850	29,456	199,850

The Colorado River bisects and drains the central portion of the region; the Yampa and White Rivers drain the northern flank, and the Gunnison River drains that area on the south. Topographically, the region is a deeply dissected plateau in the west and mountainous in the east. Climate ranges from arid in the western portions of the region to alpine in the high mountains. Most precipitation occurs as snow.

The Denver & Rio Grande Western Railroad, whose main line follows the Colorado River through the region, provides the only rail service in the area. Branch lines of the Denver & Rio Grande Western serve the Grand Mesa, Carbondale, and Somerset coalfields.

Geologically, the region consists of a simple syncline with shallowly dipping strata, increasing to moderate or steep dips around the flanks and modified by faults, folds, and intrusives. Local areas are structurally complex. Coal occurs in the Mesaverde Group of Late Cretaceous age, which crops out or is shallowly buried about the entire perimeter of the region and is deeply buried in the central portion. Coal ranges from subbituminous in the Grand Mesa field to anthracite in the Crested Butte field.

Only the Lower White River and Danforth Hills coalfields demonstrate any significant strippable coal potential. The other six coalfields in the region contain only small, local coal deposits that may be susceptible to strip mining. If contour mining techniques were included, the potential of the six fields would be much enhanced; however, environmental considerations and pending legislation apparently preclude application of the method. Therefore, any strippable potential provided by contour mining is ignored.

Book Cliffs Field (46, 88)

The Book Cliffs coalfield is in the extreme southwest part of the Colorado portion of the Uinta region and is wholly within Garfield and Mesa Counties. Grand Junction, the largest city in the region, lies on the main line of the Denver & Rio Grande Western Railroad and serves the Book Cliffs field.

Coal occurs in the Mount Garfield Formation of the Mesaverde Group and in the Anchor Mine Tongue of the Mancos Shale. The Mount Garfield Formation contains lenticular beds of coal in the following three coal zones: the Palisade, Cameo, and Carbonera. Coal has been mined extensively only from the Cameo zone; the other zones have been exploited but to a much lesser degree.

The principal industry of the area is agriculture, which should not be adversely affected by coal mining because coal does not occur in the lowlands where most agricultural activity exists.

Excluding contour mining techniques, there is little strippable coal potential in the field. Numerous small deposits amenable to strip mining exist, particularly in the Coal Canyon area near Cameo; however, their small size, the inability to determine outcrops precisely, and extensive previous mining require that the field be considered as having no significant strippable coal resource.

Grand Mesa Field (62)

The Grand Mesa coalfield lies on the west and south sides of Grand Mesa and extends southeasterly from the Colorado River through parts of Mesa and Delta Counties.

Coal occurs throughout the mesa; however, it is deeply buried in most places, cropping out only on the west and south sides. Coal ranges from high-volatile C to high-volatile A bituminous in rank. Landis (78) reported that the coal occurs in six to eight persistent zones, of which no more than three are of minable thickness in any one location. Lee (79-80) provided a more complete description of the geology and coal resources of the field.

No strippable coal resource is estimated for the field. Although a number of small deposits can be identified as potentially strippable, their small size and the undesirability of contour mining on steep hillsides preclude inclusion within this report.

Somerset Field (38, 56-57, 60, 105-106)

The Somerset coalfield, in parts of Delta and Gunnison Counties, is bounded by the Grand Mesa coalfield on the west and the Crested Butte coalfield on the east. The area is mountainous, exhibits high relief, and is inaccessible except on established roads. A branch line of the Denver & Rio Grande Western Railroad from Grand Junction, via Delta, to the Oliver powerplant serves most of the field.

Coal occurs in the Paonia and Bowie Shale Members of the Mesaverde Formation (80). Johnson (77) redefined the coal zones as upper and lower members of the Mesaverde and stated that both members contain coalbeds of minable thickness in the western part of the field, whereas only the lower member contains minable thicknesses of coal in the east. The coal ranges between high-volatile B and high-volatile C bituminous throughout the field; however, small bodies of anthracite, related to the intrusives of the Anthracite range, exist in the eastern portion of the field. Coal in the eastern part usually is suitable for coke. The location of most coalbeds, in the valley bottoms and in the high relief of the surrounding mountains, generally preclude strip mining. However, a medium-size deposit, agregating some 7,500,000 tons in secs 16 and 21, T 14 S, R 90 W, may be amenable to stripping. A number of deposits would lend themselves to contour mining but, owing to proposed legal and environmental considerations, are not reported. Other than the medium-size deposit mentioned previously, no other strippable resource is credited to the field.

Crested Butte Field (45, 59)

The Crested Butte coalfield, comprising the extreme southeast portion of the Uinta coal region, lies wholly within Gunnison County and east of the West Elk Mountains.

Coal occurs in the lower member of the Mesaverde (77), corresponding to the Paonia Shale of the Somerset field (79). The coal-bearing rocks are folded, faulted, and intruded by igneous rocks. Coal ranges from bituminous to anthracite, depending upon the proximity of igneous intrusives. Landis (78) estimated that 244 million tons of coal originally was present of which 15 percent is anthracite or semianthracite, and the remainder is bituminous.

No strippable resource is estimated for the field. Most coalbeds are covered by excessive overburden; even though some outcrop areas may be amenable to contour stripping, their potential is limited and is not reported.

Carbondale Field

The Carbondale coalfield extends north from the Somerset coalfield to a point 4 miles southwest of Glenwood Springs and includes portions of Gunnison, Pitkin, and Garfield Counties. The field is served in part by a branch line of the Denver & Rio Grande Western Railroad from Glenwood Springs through Carbondale to Woody Creek.

Coalbeds occur in both the upper member (Paonia Shale) and the lower member (Bowie Shale) of the Mesaverde Formation. Only the lower member contains persistent beds of minable thickness; however, the upper member contains thin, bony beds of coal and carboniferous shale (78). Coal ranges in rank from high-volatile C bituminous to anthracite. Coal in the southern part of the field is moderately to strongly coking, and coal to the north, near Glenwood Springs, generally is noncoking.

The geology of the field has not been specifically treated in the literature. However, Gale (53, 55) discussed the Grand Hogback that lies north of the Carbondale field, and Johnson (77) reviewed the Somerset field that lies to the south.

Landis reported a total of 798 million tons of coal in the field of which 50 percent is bituminous coking coal and 7 percent is anthracite. In this report, no strippable coal resource is reported for the Carbondale field. The coalbeds usually dip steeply into adjacent mountains, causing deep burial and excessive overburden. As in the other coalfields on the south and east sides of the Uinta Basin, a few areas conceivably could be exploited by contour mining; however, no resource is reported for that mining method.

Grand Hogback Field (6, 53)

The Grand Hogback field, on the eastern side of the Colorado portion of the Uinta Basin, extends from a point 4 miles southwest of Glenwood Springs northwesterly to the White River, adjacent to Meeker. The field is bisected by the main line of the Denver & Rio Grande Western Railroad, running from Glenwood Springs to Grand Junction.

Physiographically, the coalfield is expressed as a large prominent hogback, which reflects the steeply dipping Mesaverde Group of the eastern Uinta region.

Coal never has been produced in significant quantities from the Grand Hogback although numerous small mines have operated in the field. Mines north of the White River fall in the Danforth Hills coalfield and are not considered in this section.

Coal occurs in the Mesaverde Group, which is approximately 1 mile thick in this field and is subdivided into the Williams Fork Formation and the Iles Formation. The Williams Fork Formation contains four or more beds of coal in the upper Keystone Group and nine or more beds (78) in the Middle Coal Group. The coal of the Iles Formation is generally thin, bony, nonpersistent, and of little economic value. Coal is largely high-volatile B or high-volatile C bituminous in rank and is mostly noncoking.

No strippable coal resources are reported for the field. Coalbeds dip very steeply, in some places vertically, and strip mining is impractical. There is a possibility that some portions of the hogback could be mined by open pit methods, much like the techniques in use at the Kemmerer Coal Co. mine at Kemmerer, Wyo., but because present economics and technology preclude exploitation of the hogback by such methods, no strippable potential was calculated.

Danforth Hills Field

The Danforth Hills coalfield lies between the White and Yampa Rivers, roughly due north of Meeker, and encompasses parts of Rio Blanco and Moffat Counties. The field is notably deficient in transportation facilities, being served neither by railroad nor interstate highway.

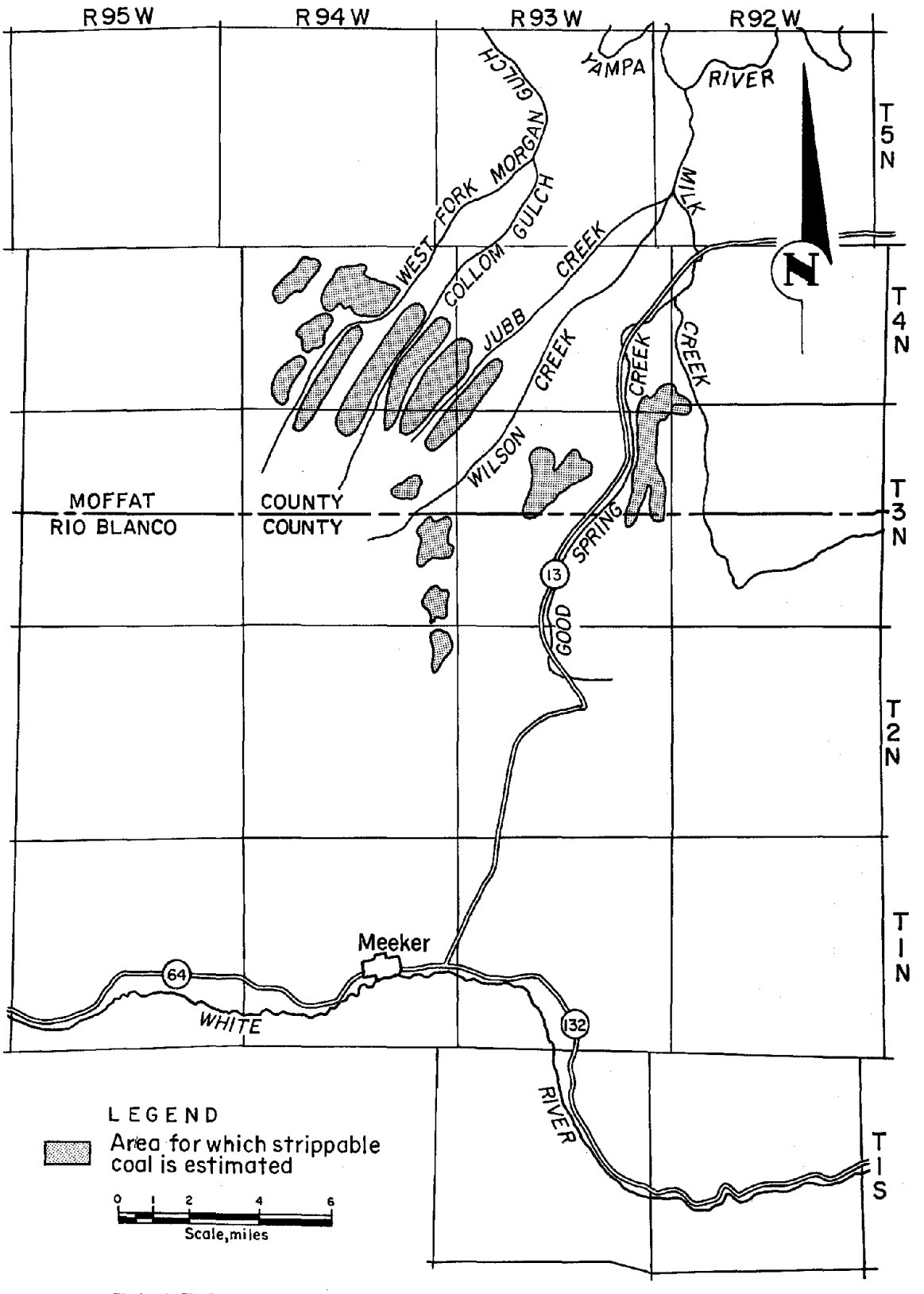

FIGURE 6. - Strippable coal areas in the Danforth Hills coalfield.

Geologically, the coalfield represents a transition zone between the northeastern outcrop of the Uinta Basin and the southwestern flank of the Axial Basin anticline. Local geology is extremely complex, with dips ranging from near-vertical in the western part of the field to near-horizontal in the east and north. Several publications have discussed the geology of the area, notably Gale (53, 55), Hancock (63), and Hancock and Ely (64).

Coalbeds of the field occur in the Williams Fork and Iles Formations of the Mesaverde Group. The Williams Fork Formation contains three coal groups, the Fairfield, Goff, and Lion Canyon. The Iles Formation includes two coal zones--the Black Diamond and the Lower Coal Groups. Individual coalbeds are lenticular, discontinuous, and are difficult to correlate laterally. As many as 32 separate beds of coal exist, of which only a few are of minable thicknesses. The eastern portion of the field exhibits evidence of extensive burning. In some areas, the burn is shallow, but a few drill holes indicate burned coal to a depth of 150 feet.

Excluding the area immediately adjacent to Meeker, where a large number of underground mines have operated in the past, the Danforth Hills have not been extensively exploited for coal. Only one large mine, the Red Wing, is north of Ninemile Gap. Production in 1972 was 135,991 tons.

The western and central portions of the field offer little or no strippable coal potential. Either the beds dip excessively or the coal-bearing rocks have been removed by erosion, notably in the area of Devil's Hole Gulch. A cursory examination of the eastern part of the field indicates substantial strippable potential; however, the relatively steep dips prevalent in the area, the inability to correlate the beds adequately, the uncertainty of how much coal has been burned, and the harsh topography preclude any valid estimate of strippable tonnage. In all probability, coal in the eastern portion must be mined by underground or open pit methods as opposed to classic strip mining techniques.

The northern flank of the field (fig. 6), adjacent to the Axial Basin syncline, apparently provides the only area amenable to strip mining. Coalbeds roughly parallel the slope of the terrain, thus offering a number of prospective dip slopes that may be minable. A total of 11,379 acres containing approximately 163,800,000 tons of bituminous coal are estimated to have been present originally. Table 6 provides a detailed tabulation of estimated strippable coal resources.

Lower White River Field (32-33, 39, 54, 58, 104)

The Lower White River coalfield occupies the extreme northwest part of the Colorado portion of the Uinta Basin and lies between the Danforth Hills coalfield and the Utah border. The largest town in the area is Rangely. The field is served neither by rail nor Federal highway, the sole transportation being State Highway 64. This factor of transportation apparently has been instrumental in the lack of development of the field.

TABLE 6. - Estimated strippable coal resources of the Danforth Hills coalfield

Location		Identified			Undiscovered			Total	
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Quantity (thousand short tons)
T 4 N	R 94 W	-	-	-	5,626	8	81,000	5,626	81,000
	R 93 W	-	-	-	618	8	8,900	618	8,900
	R 92 W	-	-	-	86	8	1,200	86	1,200
T 3 N	R 94 W	-	-	-	2,025	8	29,150	2,025	29,150
	R 93 W	-	-	-	2,682	8	38,600	2,682	38,600
	R 92 W	-	-	-	190	8	2,750	190	2,750
T 2 N	R 94 W	-	-	-	152	8	2,200	152	2,200
Total.....		-	-	-	11,379	-	163,800	11,379	163,800

All coal-bearing rocks in the field are contained in the Mesaverde Group. Gale (55) divided the Mesaverde into two parts, the upper (which contains the principal coals) and the lower (which contains only minor coalbeds). Landis (78) stated that both the Williams Fork and the Iles Formations (terminology borrowed from the Danforth Hills) contain coal, although information about the Iles is extremely sketchy.

Coal in the White River field is high-volatile C bituminous rank, all noncoking. Range of analyses for the coal, regardless of bed, is as follows:

	As received--four samples		
	High	Low	Mean
Moisture.....percent..	10.80	8.11	9.47
Volatile matter.....do....	35.95	31.66	33.86
Fixed carbon.....do....	50.50	39.04	44.86
Ash.....do....	21.19	4.20	11.82
Sulfur.....do....	0.50	0.35	0.43
Btu/lb.....	11,450	9,360	10,507

There is no reason to believe that the area is deficient in coal. Gale (55, plate 19) pointed out numerous outcrops in both the upper and lower Mesaverde. Landis indicated that 7,012 million tons of bituminous coal originally were present in 553 square miles of the field. The Mesaverde Group of the Lower White River field is identical to that of the Danforth Hills. If the area is deemed to contain little commercial coal, the conclusion must be attributed to a lack of exploration and not to a physical deficiency of coal-bearing strata.

The strippable potential of the area is uncertain. Published information is sparse, and drill hole data are extremely contradictory. Gale indicated that the local dips are moderate (less than 10°) in many places. The

flat-lying nature of the coal-bearing rocks, coupled with the extensive occurrence of coal outcrops, would indicate that a large number of small deposits should lend themselves to strip mining. However, an examination of outcrops and drill hole data compel a conservative estimate of strippable potential.

Areas for which a strippable reserve has been estimated are shown in figure 7. A tabulation of coalbed thicknesses and estimated tonnages are presented in table 7. It is estimated that 89,000,000 tons of bituminous coal amenable to strip mining is present in 9,168 acres of the field.

TABLE 7. - Estimated strippable coal resources of the Lower White River coalfield

Location		Identified			Undiscovered			Total	
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Quantity (thousand short tons)
T 3 N	R 104 W	-	-	-	352	3	1,900	352	1,900
	R 103 W	-	-	-	399	3	2,150	399	2,150
	R 102 W	1,826	3	9,850	1,465	3	7,900	3,291	17,750
T 2 N	R 101 W	1,217	8	16,100	-	-	-	1,217	16,100
	R 100 W	-	-	-	3,338	8	48,000	3,338	48,000
T 1 N	R 101 W	-	-	-	571	3	3,100	571	3,100
Total.....		3,043	-	25,950	6,125	-	63,050	9,168	89,000

Dakota Sandstone Region (9, 14, 26, 40, 51, 95, 102)

That portion of southwestern Colorado in which the Dakota Sandstone crops out, or is shallowly buried and contains coal, is defined herein as the Dakota Sandstone coal region. Omitted from the defined region is that area where the Dakota Sandstone is overlain by Cretaceous rocks of the San Juan basin, an area that more appropriately may be considered a subregion of the San Juan basin coal region. Parts of Delta, Dolores, Mesa, Montezuma, Montrose, and San Miguel Counties are included within the defined area.

Montrose, the county seat of Montrose County, is the largest town in the region. Cortez, the county seat of Montezuma County, is the second largest. The principal sources of income for the region are agriculture, tourism, and mining (coal and uranium). Rail transportation is limited to a branch line of the Denver & Rio Grande Western Railroad from Grand Junction through Montrose to Ridgway.

Fenneman (49) considered the area as part of the Canyon Lands section of the Colorado Plateau physiographic province. The entire area is a dissected (canyon-cut) plateau with elevations ranging from 5,000 to 7,000 feet above

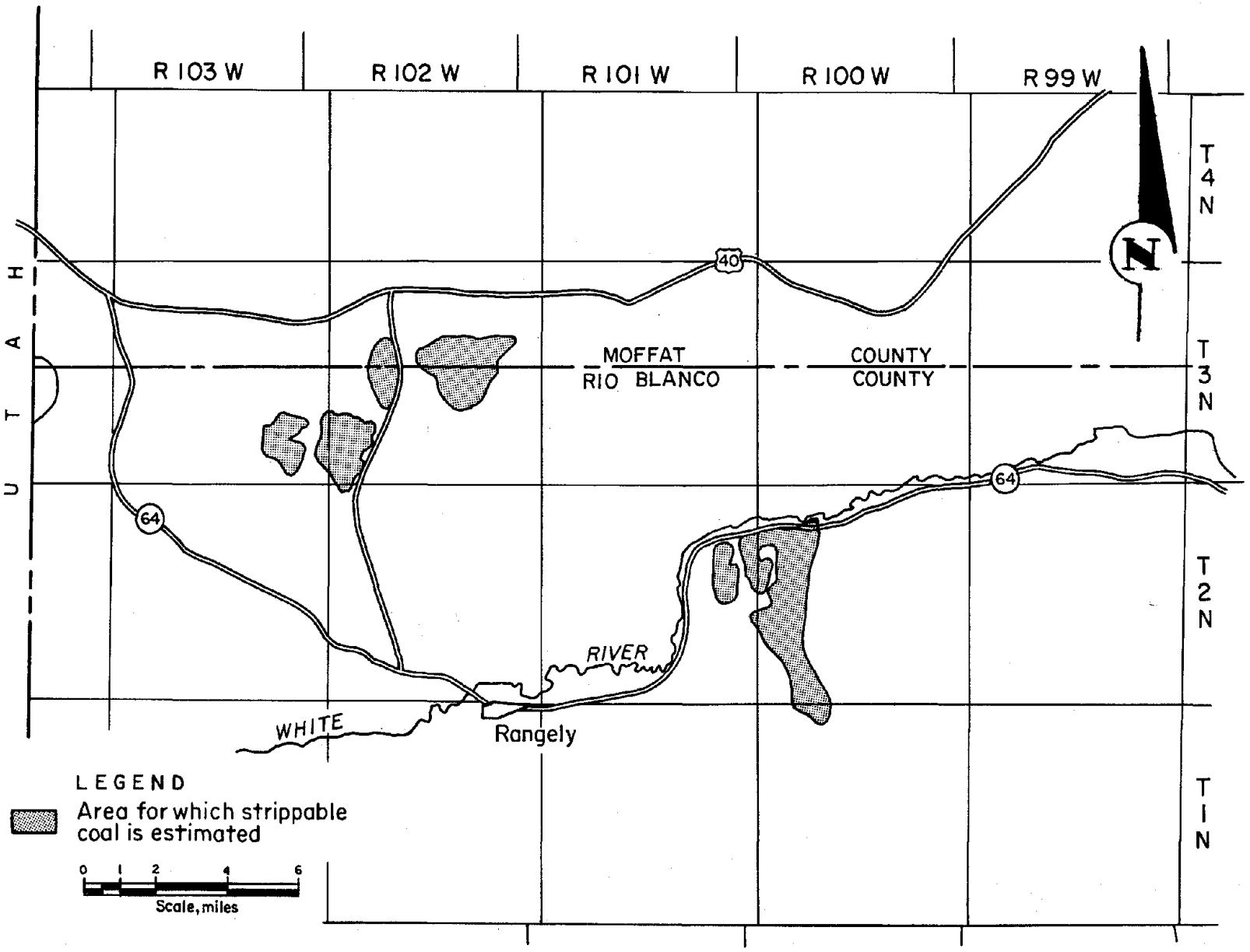

FIGURE 7. - Strippable coal areas in the Lower White River coalfield.

sea level. Average annual rainfall ranges from 7.75 inches in Delta County to 23.79 inches in San Miguel County. The region is drained by the Dolores River and its tributaries, and by the tributaries of the Gunnison and San Juan Rivers.

Coal occurs solely in the middle member of the Dakota Sandstone. Judging from the preponderance of near-surface, coal-bearing strata in the region, the surface area must largely be composed of middle-member Dakota Sandstone. At least one erosion-resistant sandstone layer has controlled the surface, and protected and preserved the coal. Coalbeds are extremely lenticular, discontinuous, and difficult to correlate. In most localities, only one bed of minable thickness is present; however, the Nucla-Naturita area contains at least three fairly thick beds (78). Multiple beds of minable thickness can be hypothesized in other areas; however, confirmation is limited by lack of extensive exploration.

The coal is of low quality, usually high-volatile B or C bituminous in rank, and contains a large percentage of impurities such as shale partings, sand, and bone. Typical analyses do not adequately reflect the inplace quality of Dakota coal because selective mining, as commonly used in such low-quality coals, tends to upgrade the mine-run product. A range of coal analyses (17 samples, as received) of the Dakota Sandstone in Montrose County follows:

	High	Low	Mean
Moisture.....percent..	13.5	2.8	5.4
Volatile matter.....do....	34.6	32.1	33.5
Fixed carbon.....do....	59.3	53.6	56.3
Ash.....do....	12.8	6.1	10.0
Sulfur.....do....	1.0	0,5	0.7
Btu/lb.....	13,100	10,010	12,390

Popular opinion holds that the Dakota coals are too low in quality to be of much commercial interest. Admittedly, the coal is of low quality; however, by selective mining, a reasonably high-quality product can be obtained. Lack of rail transportation and water resources are much more valid constraints to development of the coal potential of the region.

Numerous small underground mines have operated in the region in the past, but most coal mined was for local domestic purposes. Dakota coal was unable to compete for industrial markets with higher quality coals from the San Juan basin or Uinta regions. Near Nucla, the Peabody Coal Company's multiple-bench Nucla strip mine is mining Dakota coal. Five hundred tons per day is mined from an 8-inch bed approximately 30 feet below the surface and from a 4- to 5-foot bed located about 42 feet from the surface. The multiple-bench method of selective mining permits production of a reasonably high-quality product from an exceedingly low-quality coalbed. Typical analyses for mine-run coal, without benefit of washing or further processing, are as follows:

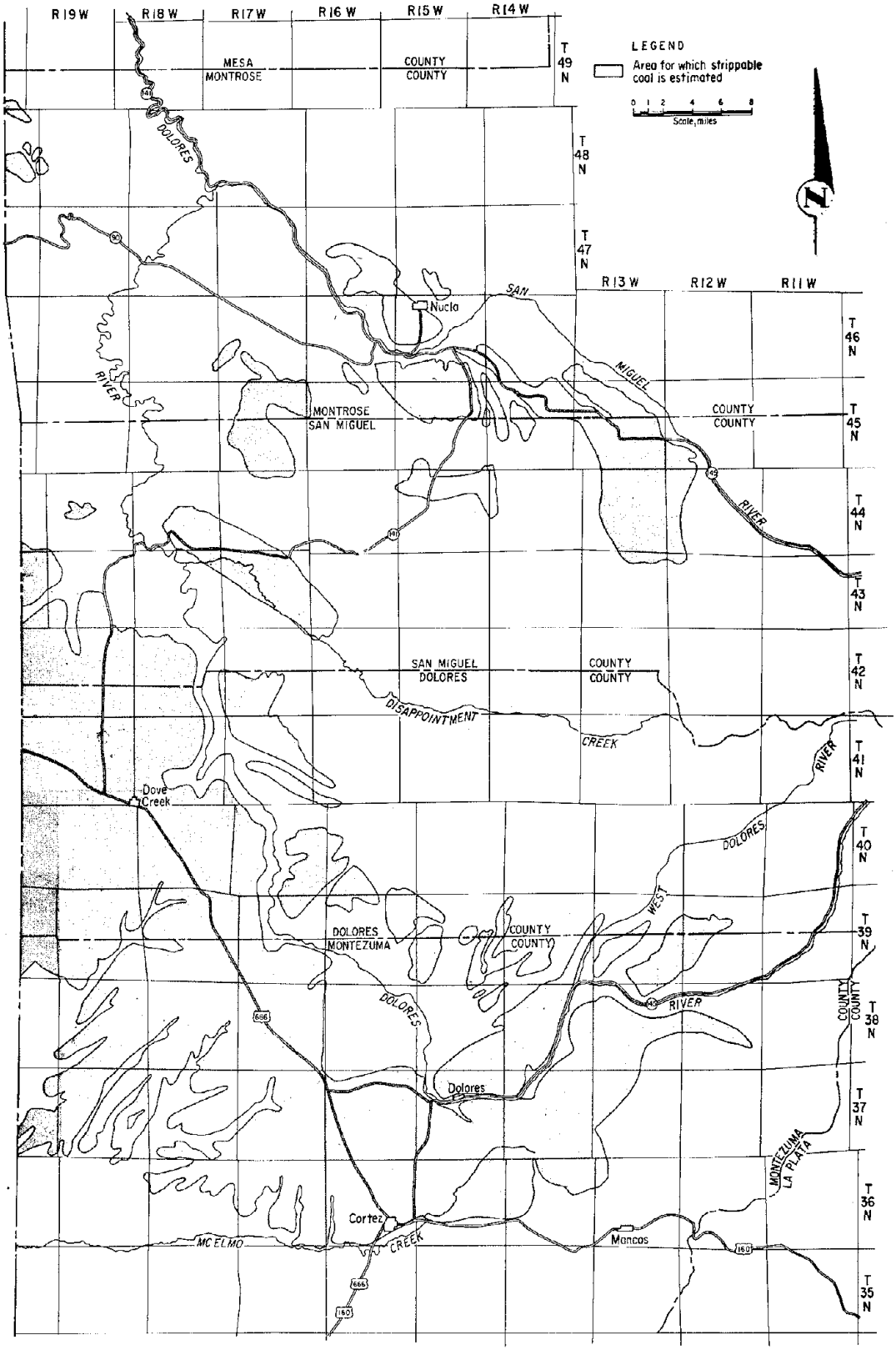

FIGURE 8. - Strippable coal areas in the Dakota coal region, southwestern Colorado.

	Moisture (percent)	Ash (percent)	Sulfur (percent)	Btu/lb
As received.....	5.65	12.45	0.68	12,003
Dry.....	-	13.20	.72	12,722
Moisture and ash free	-	-	-	14,657

Most production from the mine is used in the Colorado-Ute Electric Association's stoker-fired Nucla powerplant. The remainder is sold for local domestic consumption.

Data defining the extent and thickness of Dakota coals are sparse. Numerous waterwell logs showing coal of commercial thicknesses are on deposit in the Denver office of the Colorado Division of Water Resources. A general reconnaissance of the area reveals coal or carboniferous shale outcrops near the surface throughout the area between Nucla and Cortez.

Figure 8 defines the portion of the Dakota Sandstone region that was considered to offer some strippable resources. Within the shaded area are shown all areas in which coal is known to exist, either from drill hole data or outcrops, and all areas in which coal is inferred to be present. Table 8 contains a tabulation, by township, of estimated coal thicknesses and resources for the shaded areas in figure 8. Where definite data on coal thickness were not available, a coalbed thickness of 3 feet was assumed as a basis for computation. Tonnages were not reduced to account for impurities or partings in the coal.

If the entire shaded area contains coal amenable to strip mining, it is estimated that 2,912,115,000 tons of bituminous coal could be present in approximately 502,000 acres.

San Juan River Region (3-4, 90, 97, 103, 111, 121, 123)

The San Juan River region encompasses the northernmost portion of the San Juan basin of southwestern Colorado and northwestern New Mexico. Parts of Montezuma, La Plata, and Archuleta Counties are included in the region.

Durango, the county seat of La Plata County and the largest town in the area, has a population of over 11,000 (27). Average annual rainfall ranges from 13.20 inches in arid Montezuma County to 20.02 inches in Archuleta County. Average rainfall in La Plata County is 18.04 inches. The region is drained by the San Juan River and its tributaries. Although Durango is served by a narrow-gage railroad, there is no freight service. Two Federal highways and several State highways service the region. The principal industry of the region is agriculture; however, oil, gas, and uranium make significant contributions to the economy.

Coal occurs in the Dakota Sandstone, the Menefee Formation of the Mesaverde Group, and the Fruitland Formation. All are of Upper Cretaceous age. The Dakota is probably coal bearing throughout the region, but beds are thin, lenticular, discontinuous, and high in impurities. Little or no strippable coal potential is afforded by the Dakota Sandstone.

TABLE 8. - Estimated strippable coal resources of the Dakota coal region, southwestern Colorado

Location		Identified			Undiscovered			Total	
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Quantity (thousand short tons)
T 49 N	R 20 W	-	-	-	247	2	900	247	900
	R 10 W	-	-	-	7,674	8	92,000	7,674	92,000
	R 9 W	-	-	-	1,426	8	19,800	1,426	19,800
T 48 N	R 20 W	2,168	2	7,600	732	2	2,300	2,900	9,900
	R 10 W	-	-	-	4,137	8	57,600	4,137	57,600
	R 9 W	-	-	-	447	8	6,200	447	6,200
T 47 N	R 16 W	1,435	4	10,000	-	-	-	1,435	10,000
	R 16 W	1,987	3	10,400	3,081	3	16,100	1,987	10,400
	R 15 W	827	3	4,300	-	-	-	827	4,300
T 46 N	R 18 W	-	-	-	133	3	750	133	750
	R 17 W	-	-	-	1,559	3	8,250	1,559	8,250
	R 16 W	2,387	3	12,500	2,129	3	11,100	4,516	23,600
	R 15 W	6,143	3	32,150	5,268	3	27,600	11,411	59,750
	R 14 W	-	-	-	2,890	3	15,150	2,890	15,150
	R 13 W	-	-	-	941	3	4,900	941	4,900
T 45 N	R 17 W	-	-	-	8,378	3	43,750	8,378	43,750
	R 16 W	-	-	-	257	3	1,350	257	1,350
	R 15 W	-	-	-	7,008	3	36,550	7,008	36,550
	R 14 W	-	-	-	8,530	3	44,600	8,530	44,600
	R 13 W	9,595	3	50,100	4,650	3	24,300	14,245	74,400
	R 12 W	-	-	-	2,110	3	11,000	2,110	11,000
T 44 N	R 19 W	-	-	-	475	3	2,500	475	2,500
	R 18 W	4,250	10	74,000	-	-	-	4,250	74,000
	R 17 W	-	-	-	2,016	3	10,500	2,016	10,500
	R 15 W	1,930	11	37,000	6,572	3	34,300	8,502	71,300
	R 13 W	-	-	-	12,848	3	67,100	12,848	67,100
	R 12 W	-	-	-	2,814	3	14,700	2,814	14,700
T 43 N	R 20 W	-	-	-	4,251	3	22,200	4,251	22,200
	R 19 W	-	-	-	3,519	3	18,450	3,519	18,450
	R 18 W	-	-	-	1,103	3	5,800	1,103	5,800
	R 17 W	-	-	-	6,978	3	36,400	6,978	36,400
	R 16 W	1,959	7	23,900	912	3	4,800	2,871	28,700
	R 13 W	-	-	-	1,958	3	10,150	1,958	10,150
	R 12 W	-	-	-	258	3	1,340	258	1,340
T 42 N	R 20 W	-	-	-	4,345	3	22,700	4,345	22,700
	R 19 W	3,965	3	20,700	13,787	3	72,100	17,752	92,800
	R 18 W	-	-	-	7,236	3	37,700	7,236	37,700
	R 17 W	-	-	-	4,870	3	25,500	4,870	25,500
	R 16 W	-	-	-	941	3	4,900	941	4,900
T 41 N	R 20 W	1,692	4	11,800	2,206	3	11,500	3,898	23,300
	R 19 W	6,131	4	37,250	13,636	3	71,300	19,767	108,550
	R 18 W	-	-	-	9,691	3	50,700	9,691	50,700
	R 17 W	361	5	3,150	7,770	3	40,600	8,131	43,750
	R 16 W	1,074	5	9,400	1,693	3	8,800	2,767	18,200

TABLE 8. - Estimated strippable coal resources of the Dakota coal region, southwestern Colorado--Continued

Location		Identified			Undiscovered			Total	
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Quantity (thousand short tons)
T 40 N	R 20 W	237	4	1,650	5,145	3	26,900	5,382	28,550
	R 19 W	424	4	2,950	10,939	3	57,250	11,363	60,200
	R 19 W	1,809	10	31,500	-	-	-	1,809	31,500
	R 18 W	1,197	9	17,950	12,885	3	67,650	14,082	85,600
	R 17 W	223	5	1,100	9,300	3	48,600	9,523	49,700
	R 16 W	-	-	-	7,341	3	38,300	7,341	38,300
	R 15 W	-	-	-	105	3	550	105	550
T 39 N	R 20 W	749	8	5,200	4,217	3	22,050	4,966	27,250
	R 19 W	99	4	700	10,045	3	52,500	10,144	53,200
	R 19 W	865	8	12,000	-	-	-	865	12,000
	R 18 W	-	-	-	11,940	3	62,325	11,940	62,325
	R 17 W	-	-	-	8,503	3	44,400	8,503	44,400
	R 16 W	-	-	-	5,601	3	29,300	5,601	29,300
	R 15 W	-	-	-	5,923	3	30,950	5,923	30,950
	R 14 W	-	-	-	5,517	3	28,850	5,517	28,850
	R 13 W	-	-	-	4,868	3	25,400	4,868	25,400
	R 12 W	-	-	-	6,380	3	33,350	6,380	33,350
T 38 N	R 20 W	-	-	-	314	3	1,650	314	1,650
	R 19 W	-	-	-	7,446	3	38,900	7,446	38,900
	R 18 W	-	-	-	11,459	3	59,950	11,459	59,950
	R 17 W	-	-	-	14,845	3	77,575	14,845	77,575
	R 15 W	-	-	-	3,538	3	18,500	3,538	18,500
	R 14 W	-	-	-	12,858	3	67,200	12,858	67,200
	R 13 W	-	-	-	10,651	3	55,725	10,651	55,725
	R 12 W	-	-	-	3,956	3	20,675	3,956	20,675
T 37 N	R 20 W	-	-	-	428	3	2,250	428	2,250
	R 19 W	1,521	6	15,900	8,911	3	46,600	10,432	62,500
	R 18 W	-	-	-	5,392	3	28,200	5,392	28,200
	R 17 W	-	-	-	14,433	3	75,400	14,433	75,400
	R 16 W	-	-	-	17,432	3	91,100	17,432	91,100
	R 15 W	1,598	10	27,850	9,986	3	52,150	11,584	80,000
	R 14 W	779	3	4,100	11,942	3	62,450	12,721	66,550
	R 13 W	-	-	-	304	3	1,600	304	1,600
T 36 N	R 19 W	67	3	350	-	-	-	67	350
	R 18 W	-	-	-	1,930	3	10,100	1,930	10,100
	R 17 W	-	-	-	6,713	3	35,100	6,713	35,100
	R 16 W	-	-	-	13,389	3	69,950	13,389	69,950
	R 15 W	1,113	5	9,700	6,004	3	30,975	7,117	40,675
	R 14 W	1,816	5	15,800	-	-	-	1,816	15,800
	R 13 W	490	3	2,050	1,227	3	6,400	1,717	8,450
Total.....		58,891	-	493,050	443,343	-	2,419,065	502,234	2,912,115

The Menefee Formation contains coal only west of the Florida River and in the immediate vicinity of Yellowjacket Pass. Menefee Formation coal is high-volatile A, B, or C bituminous in rank and locally is of coking quality near Durango. A range of analyses of Menefee coal from La Plata County (270 samples, as received) is as follows:

	High	Low	Mean
Moisture.....percent..	10.7	1.5	3.9
Volatile matter.....do....	42.7	28.4	39.7
Fixed carbon.....do....	58.0	43.1	52.7
Ash.....do....	28.5	2.5	7.5
Sulfur.....do....	5.1	0.4	1.5
Btu/lb.....	14,410	10,380	13,120

Only a few small deposits west of Durango should offer strippable potential. In most places, the Menefee either dips too steeply or is covered by excessive overburden.

The Fruitland Formation, cropping out in parts of Archuleta and La Plata Counties, is probably coal bearing throughout the Colorado portion of the San Juan basin. The coal is mostly high-volatile A or B bituminous in rank and generally is noncoking. A typical analysis follows:

	As received
Moisture.....percent..	5.4
Volatile matter.....do....	36.8
Fixed carbon.....do....	49.0
Ash.....do....	8.8
Sulfur.....do....	0.9
Btu/lb.....	12,660

The Fruitland Formation offers the greatest potential for strippable coal in the Colorado portion of the San Juan basin, particularly along its western outcrop from the New Mexico State line northward to Durango.

Numerous coal mines have operated in the Colorado portion of the San Juan basin; most have been underground mines in the general vicinity of Durango. Only four small strip mines have recorded production: the Sundance 1 and 2 mines (La Plata County, 1969, 2,870 tons); the Garcia mine (Archuleta County, 1948-56, 1,478 tons); and the Chimney Rock mine (Archuleta County, 1969, 342 tons). In 1972, four underground mines, all in La Plata County, produced 11,370 tons of coal. There were no strip operations.

Data for estimating strippable areas were taken primarily from published sources and from extensive drill hole data on deposit in the Denver office of the U.S. Geological Survey Conservation Division. Figure 9 defines that portion of Colorado in the San Juan basin that is considered to offer strippable potential. Areas for which strippable coal is estimated are shaded. Table 9 contains a tabulation of expected bed thicknesses, acreage containing strippable coal, and estimated tonnages for the shaded areas of figure 9. It is

estimated that 17,380 acres of the Colorado portion of the San Juan basin are underlain by strippable coal and that as much as 252 million tons could be present.

TABLE 9. - Estimated strippable coal resources of the Colorado portion, San Juan basin

Location		Identified			Undiscovered			Total	
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Quantity (thousand short tons)
T 35 N	R 12 W	-	-	-	3,502	5	31,500	3,502	31,500
	R 11 W	-	-	-	2,603	5	23,400	2,603	23,400
	R 10 W	-	-	-	1,930	4	13,900	1,930	13,900
	R 9 W	-	-	-	399	4	2,900	399	2,900
	R 8 W	-	-	-	694	17	21,200	694	21,200
	R 7 W	-	-	-	523	17	16,000	523	16,000
T 34½ N	R 9 W	-	-	-	67	20	2,400	67	2,400
T 34 N	R 11 W	324	11	6,400	-	-	-	324	6,400
	R 11 W	475	9	7,700	-	-	-	475	7,700
	R 10 W	2,454	15	66,250	-	-	-	2,454	66,250
	R 9 W	-	-	-	133	20	4,800	133	4,800
	R 4 W	-	-	-	408	7	5,150	408	5,150
T 33 N	R 12 W	190	6	2,050	-	-	-	190	2,050
	R 11 W	2,111	6	22,800	-	-	-	2,111	22,800
	R 2 W	-	-	-	208	7	2,600	208	2,600
T 32 N	R 12 W	1,236	10	22,250	-	-	-	1,236	22,250
	R 11 W	123	6	1,350	-	-	-	123	1,350
Total.....		6,913	-	128,800	10,467	-	123,850	17,380	252,650

Raton Mesa Region (70)

The Colorado portion of the Raton Mesa coal region, in the southcentral portion of the State, extends northward from the New Mexico State line through parts of Las Animas and Huerfano Counties. Trinidad, the county seat of Las Animas County, and Walsenburg, the county seat of Huerfano County, are the largest towns in the region. The area is served by Interstate Highway 70, U.S. Highway 160, Colorado State Highway 20, and several county and private roads. Rail transport is provided by the Atchison, Topeka and Santa Fe, the Denver & Rio Grande Western, and the Colorado Southern Railroads. Average rainfall is 14.13 inches in Huerfano County and 15.03 inches in Las Animas County. The principal industries in the area are mining and ranching.

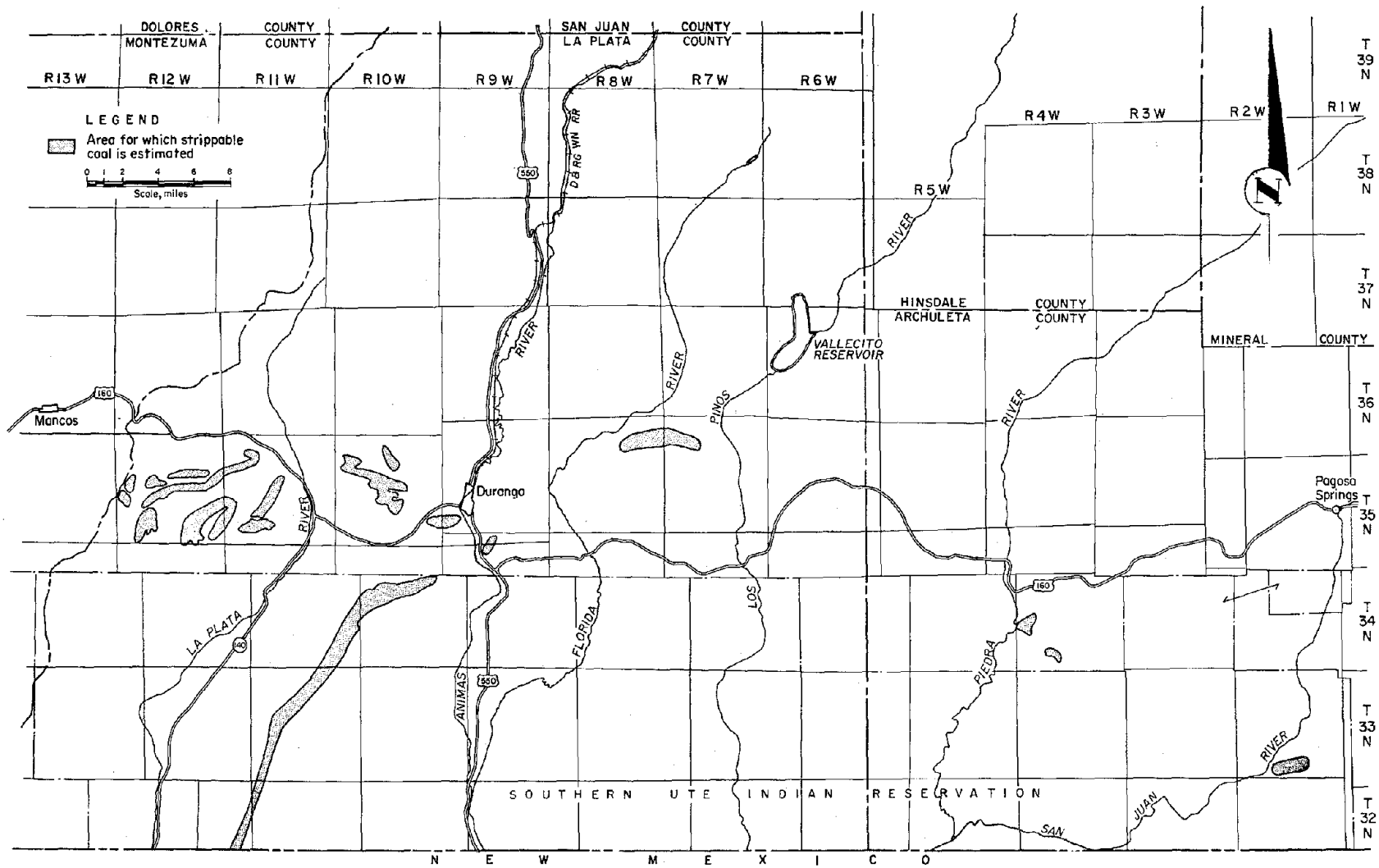

FIGURE 9. - Strippable coal areas in the Colorado portion of the San Juan basin.

Physiographically, the region is in the Great Plains province and is a trenched peneplain surmounted by dissected, lava-capped plateaus and mesas. Structurally, the coal region is part of the Raton basin, an asymmetric syncline, trending north-south, with its axis near the western side. Strata dip gently on the eastern margin and steeply on the western. The center of the basin is intruded by the graniferous Spanish Peaks and by associated dikes and sills. Faulting and folding cause local structural complexity.

The Vermejo Formation of Late Cretaceous age and the Raton Formation of Early Tertiary age (120) are the principal coal-bearing strata in the region. Coal occurs throughout the Vermejo and in all three members of the Raton (119). Three coal groups are generally recognized: A lower group in the Vermejo and middle and upper groups in the Raton. The lower group contains at least 14 coalbeds having a minimum thickness of 14 inches, but only 8 of these are important enough to be named. The middle group, 300 feet above the base of the Raton, contains between one and five coalbeds of commercial importance. The upper group, 700 to 1,000 feet above the middle group, generally contains only thin beds of little economic importance.

The coal region is divided into two coalfields--the Walsenburg field in Huerfano County and the Trinidad field in Las Animas County. Coals of the Trinidad field are coking coals, whereas those of the Walsenburg field to the north are usually noncoking.

Except for publications of the U.S. Geological Survey and mine map repository records of the Federal Bureau of Mines (Intermountain Field Operation Center, Denver, Colo.), data on the Raton Mesa coal region are notably meager. No drill hole data are available, and most underground mines operated below the strippable limit of 150 feet of overburden. For these reasons, the strippable areas shown in figure 10 and the tabulation of strippable resources displayed in table 10 are speculative. Strippable area was determined by correlation between topographic maps and outcrop data. Average recoverable coal thickness is conjectural. Most outcrops are thin, 2 feet thick or less, but the coalbeds tend to thicken away from the outcrops. A thickness of 3 feet was selected as a reasonable basis for resource calculation; however, actual thickness may be greater or smaller, and only exploration can provide more relevant figures.

Excluding coal that could be mined by contour methods, as much as 136 million tons of coal, amenable to area strip mining methods, may be present in the Colorado portion of the Raton Mesa. Figure 10 illustrates the areal extent of estimated strippable coal in the Raton Mesa. Table 10 provides a tabulation, by township, of estimated strippable resources.

TABLE 10. - Estimated strippable coal resources of the Colorado portion, Raton Mesa coal region

Location		Identified			Undiscovered			Total	
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Quantity (thousand short tons)
WALSENBURG FIELD									
T 28 S	R 66 W	-	-	-	1,284	3	6,900	1,284	6,900
T 30 S	R 65 W	-	-	-	257	3	1,400	257	1,400
Total.....		-	-	-	1,541	-	8,300	1,541	8,300
TRINIDAD FIELD									
T 31 S	R 65 W	-	-	-	1,635	3	8,800	1,635	8,800
T 31 S	R 67 W	-	-	-	238	3	1,300	238	1,300
	R 64 W	-	-	-	123	3	650	123	650
T 32 S	R 66 W	-	-	-	618	3	3,350	618	3,350
	R 65 W	-	-	-	1,417	3	7,650	1,417	7,650
	R 64 W	-	-	-	314	3	1,700	314	1,700
T 33 S	R 67 W	-	-	-	2,748	3	14,850	2,748	14,850
	R 66 W	-	-	-	3,001	3	16,200	3,001	16,200
	R 65 W	-	-	-	7,123	3	38,450	7,123	38,450
	R 64 W	-	-	-	2,159	3	11,650	2,159	11,650
T 34 S	R 68 W	-	-	-	181	3	1,000	181	1,000
	R 67 W	-	-	-	732	3	3,950	732	3,950
	R 66 W	-	-	-	979	3	5,200	979	5,200
	R 65 W	-	-	-	1,540	3	8,300	1,540	8,300
	R 64 W	-	-	-	504	3	2,700	504	2,700
T 35 S	R 66 W	-	-	-	95	3	500	95	500
	R 65 W	-	-	-	314	3	1,700	314	1,700
Total.....		-	-	-	23,721	-	127,950	23,721	127,950
Grand total		-	-	-	25,262	-	136,250	25,262	136,250

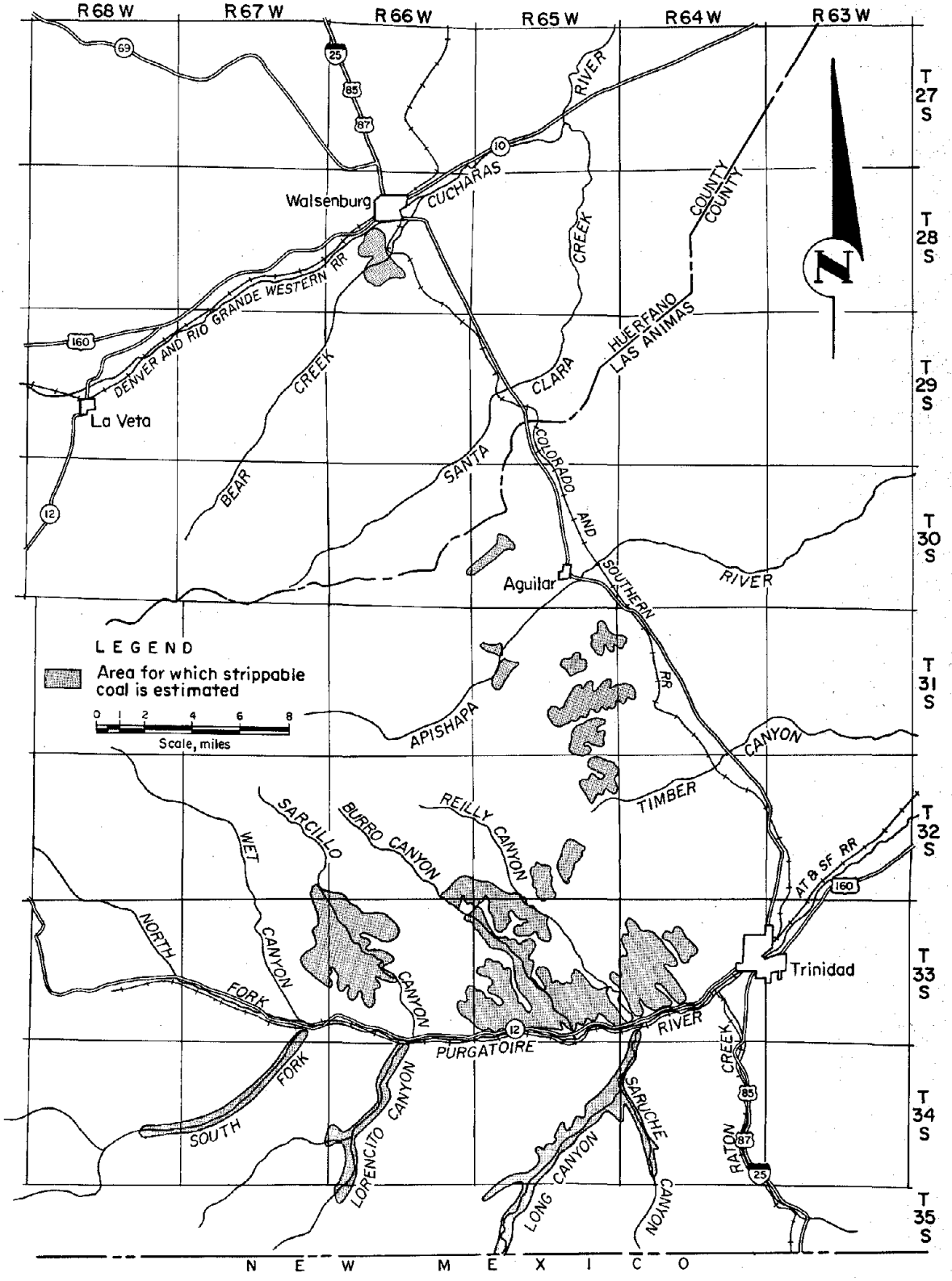

FIGURE 10. - Strippable coal areas in the Colorado portion of the Raton Mesa coal region.

Trinidad Field (66-68, 87, 118)

The Trinidad coalfield is that part of Las Animas County underlain by coal-bearing rocks of the Raton basin. Principal coal production in the field has come from the Vermejo and the Raton Formations, both of which contain numerous bituminous coalbeds of commercial thicknesses. The lower several hundred feet of the Poison Canyon Formation also is coal bearing; however, individual coalbeds are thin, lenticular, and small in areal extent. Coal has not been produced commercially from the Poison Canyon.

The Vermejo Formation ranges between 150 and 550 feet in thickness and contains at least 14 coalbeds having thicknesses of 14 inches or more. However, the Vermejo crops out, or is shallowly buried, only along the eastern escarpment of the basin and along the western edge of the syncline where dips are severe, in some places vertical. Hence, the Vermejo offers little strippable potential except along the eastern escarpment in Tps 31 and 32 S, R 65 W, where several ridges or spurs provide favorable terrain for strippable coal (fig. 10).

The Raton Formation ranges in thickness from 1,000 to 1,600 feet and crops out or is close to the surface throughout much of the southern part of the field. The lower member of the Raton provides the most significant possibility for strippable coal. Besides cropping out extensively north of the Purgatoire River, this member is exposed in all canyon bottoms south of the river.

All coal in the Trinidad field is high-volatile A or B bituminous coking coal. A range of analyses on an as received basis is as follows:

	Vermejo coal		Raton coal	
	High	Low	High	Low
Moisture.....percent..	7.9	1.0	5.8	1.0
Ash.....do....	26.7	7.5	26.3	7.1
Sulfur.....do....	1.0	0.5	0.8	0.4
Volatile matter.....do....	40.5	27.0	38.8	28.6
Fixed carbon.....do....	57.7	43.7	58.7	30.9
Btu/lb.....	13,890	10,640	13,880	10,310

Additional analytical detail is included in the appendix.

Estimation of strippable coal in the Trinidad field is highly speculative. The thickness of the coalbeds, as well as their continuity, is for the most part hypothetical. Extent of damage to the coalbeds caused by subsidence of old underground workings is unknown. Pending verification by exploration, 23,721 acres of the Trinidad coalfield may contain 128,050,000 tons of strippable coal.

Walsenburg Field (69, 75-76)

The Walsenburg coalfield is that portion of Huerfano County underlain by coal-bearing rocks of the Raton basin. The field is divided into two parts: a northeastern part, adjacent to Walsenburg, and a western part, near La Veta.

Principal coal production in the field has been from the Vermejo Formation, although limited mining of the upper group in the Raton has occurred. Both formations contain coal of commercial thickness. The Vermejo Formation contains from three to eight beds more than 14 inches thick, whereas the Raton contains one to three. Most beds are lenticular, irregular in thickness, and interbedded with shale and claystone (75). Both the Vermejo and the Raton Formations crop out, or are shallowly buried, only along the eastern escarpment of the Raton basin and on the western flank near La Veta. Most of the area is covered by the Poison Canyon or Cuchara Formations, neither of which contains commercial coal. Most coal in the field is nonagglomerating, nonslaking, noncoking, and high-volatile B or C bituminous in rank. The range of analyses of coal from the Walsenburg field is as follows:

	High	Low	Mean
Moisture.....percent..	19.2	2.0	5.2
Volatile matter.....do....	42.1	35.2	38.6
Fixed carbon.....do....	58.7	44.1	49.9
Ash.....do....	22.3	4.8	11.4
Sulfur.....do....	2.2	0.4	0.7
Btu/lb.....	13,460	9,900	11,910

More detailed analytical data are included in the appendix.

Excluding coal minable by contour stripping methods, the Walsenburg coalfield provides very limited possibilities for strippable coal. All coalbeds near La Veta dip too steeply to be strippable, whereas most coal near Walsenburg is buried by excessive overburden. Only one area offers a potential of sizable resources, that being in secs 16, 17, 20, 21, 28, and 29, T 28 S, R 66 W, on both the north and south sides of Unfug Ridge. At least eight beds of coal crop out on a gently sloping topographic surface. Exact bed thicknesses are unknown, but 2- to 4-foot beds are expected. The best beds have been mined previously by underground methods, but the possibility of additional coal, amenable to strip mining, still exists. If the coal has not been mined previously or made unrecoverable by earlier mining activity, and if the beds are reasonably continuous, 1,541 acres containing 8,300,000 tons of coal should be present.

Denver Basin Region (30, 35, 52, 81)

The Denver basin coal region consists of coal-bearing strata in eastern Colorado. Portions of Adams, Arapahoe, Boulder, Douglas, Elbert, El Paso, Morgan, and Weld Counties are included within the region. Physiographically, the region is in the dissected Colorado Piedmont of the Great Plains province of the Western United States (49, p. 30).

Denver, the capital of Colorado, is the largest metropolitan center in the region; wholesale, retail, and transportation facilities also are available in the nearby cities of Boulder, Colorado Springs, and Greeley. Excluding the metropolitan centers, the principal industry of the region is agriculture, principally livestock. The area is served by six railroads: Union Pacific; Chicago, Rock Island and Pacific; Colorado Southern; Atchison,

Topeka and Santa Fe; Denver & Rio Grande Western; and Burlington Northern. Additionally, the area is traversed by two interstate highways and numerous county roads. Off-road transportation is possible in most portions of the basin.

Topographically, the region is characterized by undulated plains, locally dissected by stream erosion. The northern portion of the basin is drained by the North Platte River and its tributaries; the southern part by the Arkansas River and its tributaries. Elevations range from 4,500 feet above sea level in Adams County to 6,000 feet above sea level in El Paso County. Average annual rainfall ranges between 11.96 inches in Weld County to 14.81 inches in Adams County. The region is semiarid, vegetation consists principally of grasses.

The Denver basin coal region is defined geologically by the exposure of the basal coal-bearing part of the Laramie Formation of Late Cretaceous age. Structurally, the region is a major synclinal depression, the axis of which trends from north to south; the deepest portion is located directly below Denver. The strata are near-vertical on the west flank where the basin sediments abut the Front Range; they are moderately inclined on the north, east, and south sides, where the Laramie crops out in the plains.

Coal of both Late Cretaceous and Early Tertiary (Paleocene) ages occurs in the Denver basin, the Cretaceous coal being in the Laramie Formation and Tertiary coal being in the Dawson Arkose or its lateral equivalent, the Denver Formation. The Laramie Formation correlates with the Vermejo Formation of the Raton Mesa region, with the Lance Formation of the Green River region, and with the upper part of the Mesaverde Group of the Uinta region. To the north, the Denver Formation corresponds to the Coalmont Formation of North Park and to the Fort Union Formation in northwest Colorado and in Wyoming and Montana.

The Laramie Formation is probably coal bearing throughout the Denver basin; however, information about the extent and quality of coal in the deeper areas of the basin is limited. The Dawson Arkose and Denver Formation coals are considerably less continuous than those of the Laramie. All Tertiary coals are discontinuous, lenticular, and impure.

Laramie coal ranges from subbituminous B rank in the western and northern portions of the basin to subbituminous C or lignite in the east and southeast. Tertiary coals are all lignite in rank. A range of analysis for all coals (as received) in the Denver basin, undifferentiated as to formation or location, follows:

	Low	High
Moisture.....percent..	6.6	35.0
Ash.....do....	4.3	14.6
Sulfur.....do....	0.2	2.2
Volatile matter.....do....	36.3	44.6
Fixed carbon.....do....	49.3	54.9
Btu/lb.....	6,330	12,130

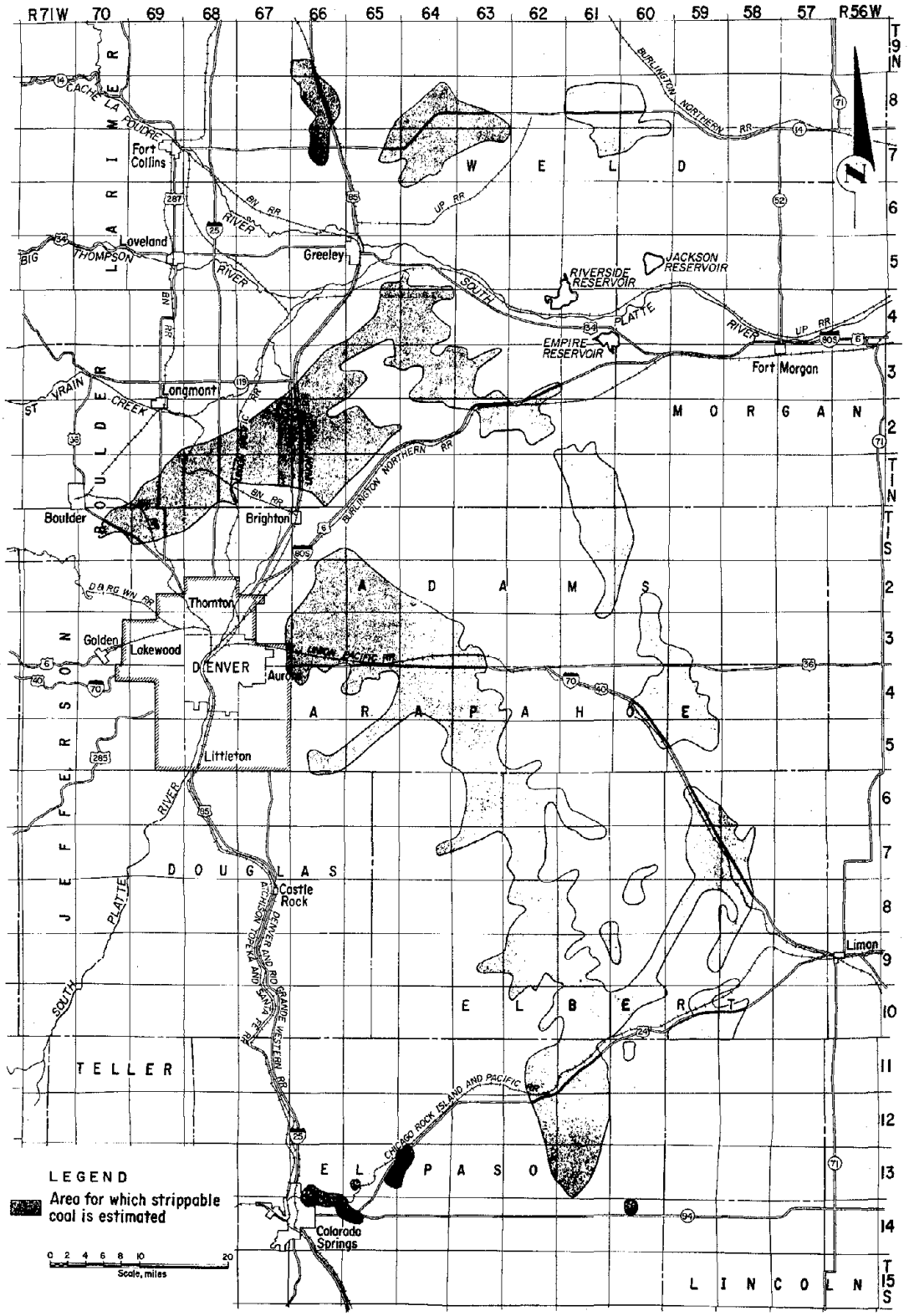

FIGURE 11. - Strippable coal areas of the Denver basin coal region.

Greater analytical detail is presented in the appendix by county and by coalbed.

Of extraordinary interest is the occurrence of kaolin interbedded with the lignites of the Dawson Arkose. Kaolin containing greater than 31 percent Al_2O_3 and less than 1.5 percent Fe_2O_3 makes up about 20 percent of the total lignite thicknesses. No insurmountable problems render the kaolin unrecoverable. Coal analysis of kaolin-free lignite is as follows:

Moisture	percent	4.63
Volatile matter	do	31.58
Fixed carbon	do	26.5
Ash	do	37.22
Btu/lb (as received)		6,905
Btu/lb (moisture and ash free)		11,874

The Bureau of Mines has estimated that more than 400 million tons of kaolin are contained in the lignite.

Most coal produced in the Denver basin has been mined by underground room and pillar methods. Only recently have the economics been such that large-scale surface mining appeared attractive. Three strip mines have operated in the basin, the Barker-Wright (1921-42; 38,516 total tons) in Elbert County; the Franceville (1948-65; 77,707 total tons) in El Paso County; and the Erie Strip (1948-53; 126,563 total tons) in Weld County.

During the past 10 years, coal exploration in the Denver basin has been extensive. No diminution of exploration interest is anticipated; if anything, activity should increase.

Coal resources of the Denver basin were computed using as a base the general highway maps of the counties involved. Data from many thousands of water-well logs, on deposit in the office of the Colorado Water Conservation Board, and from several hundred unpublished, coal-exploration drill-hole logs were used as a basis for defining strippable coal.

The Denver basin typically contains multiple beds of coal. All coalbeds, 2 feet thick or thicker and within 150 feet of the surface, were added together to develop a base for calculations. The strippable areas were defined as all areas containing at least 2 feet of coal within 150 feet of the surface. Average thickness was computed for each township, or portion of a township, by averaging all available data for each township. Coal resources were calculated assuming 1,700 tons of coal to the acre-foot.

The Denver basin offers significant potential strippable coal resource. Excluding previously mined coal, it is estimated that approximately 13 billion tons of coal or lignite may be mined by surface methods on 912,341 acres.

Figure 11 shows those areas considered to have some strippable coal resource. Table 11 contains a tabulation by township and range, of estimated strippable coal resources shown in figure 11.

TABLE 11. - Estimated strippable coal resources of the Denver basin coal region

Location		Identified[1]			Location		Identified[1]		
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)
T 9 N	R 66 W	3,220	5.8	31,750	T 2 N	R 67 W	17,091	6.3	183,000
						R 66 W	19,321	3.8	124,800
T 8 N	R 66 W	9,660	5.8	95,250		R 65 W	11,642	6.0	118,700
	R 65 W	495	6.5	5,450		R 64 W	1,982	4.0	13,500
	R 64 W	11,890	6.5	131,400		R 63 W	8,917	5.5	83,400
	R 63 W	6,688	6.5	73,000		R 62 W	8,917	7.1	107,600
	R 61 W	13,623	7.7	178,300		R 61 W	2,725	7.8	36,100
	R 60 W	9,908	7.7	129,700					
					T 1 N	R 69 W	11,146	5.3	100,400
T 7 N	R 66 W	4,459	5.8	43,950		R 68 W	17,091	4.9	142,400
	R 65 W	5,697	6.5	62,950		R 67 W	4,459	6.3	47,800
	R 64 W	18,577	6.5	205,300		R 66 W	11,890	4.6	93,000
	R 63 W	4,688	6.5	73,900		R 65 W	2,725	5.3	24,500
	R 61 W	7,183	7.7	94,000		R 64 W	991	4.0	6,700
	R 60 W	7,679	7.7	100,500		R 62 W	743	7.8	9,900
						R 61 W	17,339	7.2	212,200
T 6 N	R 65 W	495	6.5	5,500		R 60 W	1,734	8.0	23,600
	R 64 W	743	6.5	8,200					
					T 1 S	R 69 W	13,376	5.3	120,500
T 5 N	R 65 W	1,238	6.6	13,900		R 68 W	6,192	4.3	45,300
	R 64 W	991	6.3	10,600		R 66 W	743	5.0	6,300
						R 65 W	248	5.0	2,100
T 4 N	R 65 W	9,413	6.6	105,600		R 61 W	11,641	7.8	154,400
	R 64 W	6,608	6.3	71,600		R 60 W	7,183	7.8	45,200
T 3 N	R 67 W	248	7.5	3,200	T 2 S	R 66 W	13,376	3.1	70,500
	R 66 W	10,651	12.5	226,300		R 65 W	13,880	6.0	131,400
	R 65 W	6,192	8.5	89,500		R 64 W	2,229	4.5	17,100
	R 64 W	13,128	6.3	140,600		R 61 W	4,954	8.3	69,400
	R 63 W	11,146	10.0	189,500		R 60 W	4,458	9.6	72,800
	R 62 W	1,734	6.0	17,700					
	R 61 W	248	6.0	2,500	T 3 S	R 67 W	2,725	5.0	23,200
						R 66 W	20,806	9.3	329,000
T 2 N	R 69 W	248	5.3	2,200		R 65 W	21,054	15.1	540,500
	R 68 W	5,945	4.9	49,500		R 64 W	20,559	21.7	758,400

[1]All coal is indicated or inferred.

TABLE 11. - Estimated strippable coal resources of the Denver basin coal region--Continued

Location		Identified[1]			Location		Identified[1]		
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)
T 3 S	R 63 W	12,385	6.5	136,900	T 8 S	R 61 W	6,440	8.0	87,600
	R 62 W	495	5.0	4,200		R 60 W	3,220	9.7	53,100
	R 61 W	1,734	12.0	35,400		R 59 W	7,926	11.7	157,700
	R 60 W	7,183	6.9	84,300		R 58 W	9,536	6.0	97,300
	R 59 W	2,724	5.7	26,400					
					T 9 S	R 63 W	2,229	11.0	41,700
T 4 S	R 67 W	2,229	6.0	22,700		R 62 W	17,587	15.0	448,500
	R 66 W	1,486	5.0	12,600		R 61 W	12,385	20.0	421,100
	R 65 W	12,880	11.5	251,800		R 60 W	7,431	9.5	120,000
	R 64 W	17,091	18.7	543,300		R 59 W	4,706	11.0	88,000
	R 63 W	13,128	12.1	270,000		R 58 W	2,477	12.0	50,500
	R 60 W	5,449	5.0	46,300					
	R 59 W	9,908	5.0	84,200	T 10 S	R 62 W	3,715	4.5	28,400
						R 61 W	20,559	6.7	234,200
T 5 S	R 66 W	9,164	4.1	63,900		R 60 W	12,385	3.0	63,200
	R 65 W	6,440	11.0	120,400		R 59 W	10,651	7.8	141,200
	R 64 W	3,963	12.3	82,900		R 58 W	9,413	9.5	152,000
	R 63 W	17,834	11.2	339,600					
	R 60 W	3,468	5.0	29,500	T 11 S	R 62 W	10,403	11.4	201,600
	R 59 W	10,899	5.0	92,600		R 61 W	17,834	11.4	345,600
						R 60 W	990	5.0	8,400
T 6 S	R 63 W	5,945	5.2	52,600					
	R 62 W	12,880	12.0	262,800	T 12 S	R 62 W	9,960	6.4	105,100
	R 61 W	4,459	2.3	17,400		R 61 W	20,559	6.4	223,700
	R 59 W	7,926	5.0	67,400		R 60 W	990	6.4	10,800
	R 58 W	1,486	6.0	15,200					
					T 13 S	R 66 W	2,972	7.7	38,900
T 7 S	R 64 W	1,982	2.0	6,700		R 65 W	3,220	4.0	12,900
	R 63 W	6,688	3.0	34,100		R 64 W	3,715	6.0	37,900
	R 62 W	12,385	14.6	307,400		R 62 W	2,229	5.2	19,700
	R 61 W	3,963	3.0	20,200		R 61 W	12,632	5.2	111,700
	R 60 W	1,238	9.7	20,400					
	R 59 W	11,642	8.3	164,300	T 14 S	R 66 W	3,963	7.7	51,900
	R 58 W	10,156	7.1	122,600		R 65 W	1,733	7.7	22,700
						R 60 W	2,229	5.0	18,900
T 8 S	R 62 W	15,110	17.2	441,800	Total.....		912,341	-	13,058,750

[1]All coal is indicated or inferred.

North Park Field (61)

The North Park coalfield is located in North Park basin in north-central Colorado. North Park is bounded on the south and west by the Continental Divide, on the east by the Medicine Bow Mountains, and on the north by the Colorado-Wyoming State line. Geographically, North Park is a vast intermontane basin containing approximately 1,400 square miles of gently rolling terrain.

Walden, the seat of Jackson County, is the largest town in the basin, with a population of 1,018 in 1972 (27). The floor of the basin is approximately 8,100 feet above sea level and lies wholly within Jackson County. Annual mean precipitation is approximately 11 inches, most of which falls as snow. Transportation to and from North Park is limited. Four State highways and a branch line of the Union Pacific Railroad, terminating at Hebron, serve the area. Lack of transportation probably has been the single largest constraint to development of North Park coal.

Coal occurs in units of the Coalmont Formation of Tertiary (Paleocene) age. The Coalmont Formation correlates with the Fort Union Formation of Wyoming and Montana and with the Dawson Arkose of the Denver basin. Coal crops out in two quadrants of the basin--to the northeast, in the vicinity of McCallum anticline and to the southwest, in and about the town of Coalmont. At least three beds of coal are present on the flanks of McCallum anticline; locally steep dips render the coal of little interest as a strippable resource, although 10 to 15 million tons of bituminous coal may be recoverable by multiple-bench, open pit mining methods. The coal geology of the area around Coalmont is uncertain. The Coalmont Formation is strongly faulted, thereby providing considerable room for disagreement as to the number and nature of the coalbeds present. Beekly (7) and Landis (78) agreed that multiple coalbeds, perhaps as many as five, exist. Erdmann (47) argued that there is only one bed of coal, the Reich bed, and that the extreme local faulting gives the impression that there are more. A cursory examination of drill hole logs in the area does little to clarify the subject. Although some logs show multiple beds, others show only one. Neither argument has been proven invalid by the existing data. Future coal developers of the area should approach the subject with care.

Coal production in the area never has been extensive. Only four strip mines have operated in the field, two on the flanks of the McCallum anticline known as the Marr mine (1958-59; 32,776 tons) and the Monolith mine (1952; 1,055 tons), and two near Coalmont named the Moore (data unavailable) and the Rosebud (1958-60; 313,460 tons). Two surface operations, the Kerr and Grizzly Creek mines, are operating in the field.

Coal in the North Park field ranks as subbituminous A or B. Hornbaker and Holt provided the following range of analyses on an "as received" basis:

	High	Low
Moisture.....percent..	22.8	13.6
Ash.....do....	13.4	2.8
Sulfur.....do....	0.9	0.1
Btu/lb.....do....	10,870	8,840
Fusible temperature.....° F..	2,680	2,100

The Bureau of Mines coal data bank contains 34 analyses, the range and mean of which are as follows:

As received	High	Low	Mean
Moisture.....percent..	22.8	11.9	16.5
Volatile matter.....do....	43.4	39.4	40.0
Fixed carbon.....do....	56.4	47.1	53.3
Ash.....do....	13.4	3.1	7.1
Sulfur.....do....	1.0	0.1	0.4
Btu/lb.....	11,460	8,850	10,130

More detailed analyses are presented in the appendix at the end of this report.

Minable thicknesses of the coal ranges from 2 to 45 feet. Drill hole data are extremely erratic. However, it is believed that a minimum thickness of 20 feet of coal should be minable in the immediate vicinity of Coalmont. A smaller area in secs 27, 28, 33, and 34, T 7 N, R 81 W, should offer a minimum of 10 feet of strippable coal.

Landis stated that as much as 850 square miles is underlain by coal in the North Park field. Specifically, he believed that 102 square miles of the field contained 3,735 million tons of coal. Most of the coal would have to be mined by underground methods.

Estimates of strippable resources are based on data from Erdmann and from drill hole log data from several exploration programs. Criteria, as previously defined, were followed in all cases except for maximum strippable depth, which was extended to 300 feet owing to the exceptional thicknesses of coal present. A total of 123,200,000 tons of strippable coal resource is estimated to be present in 4,204 acres of the field. Specific areas for which a strippable coal resource is estimated are shown in figure 12 and a tabulation, by township and range, is provided in table 12. Other areas along the western side of the park may be strippable but are not included in this compilation owing to lack of data.

TABLE 12. - Estimated strippable coal resources of the North Park coalfield

Location		Identified			Undiscovered			Total	
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Quantity (thousand short tons)
T 7 N	R 81 W	1,588	20	57,200	1,560	10	28,000	3,148	85,200
	R 80 W	1,056	20	38,000	-	-	-	1,056	38,000
Total.....		2,644	-	95,200	1,560	-	28,000	4,204	123,200

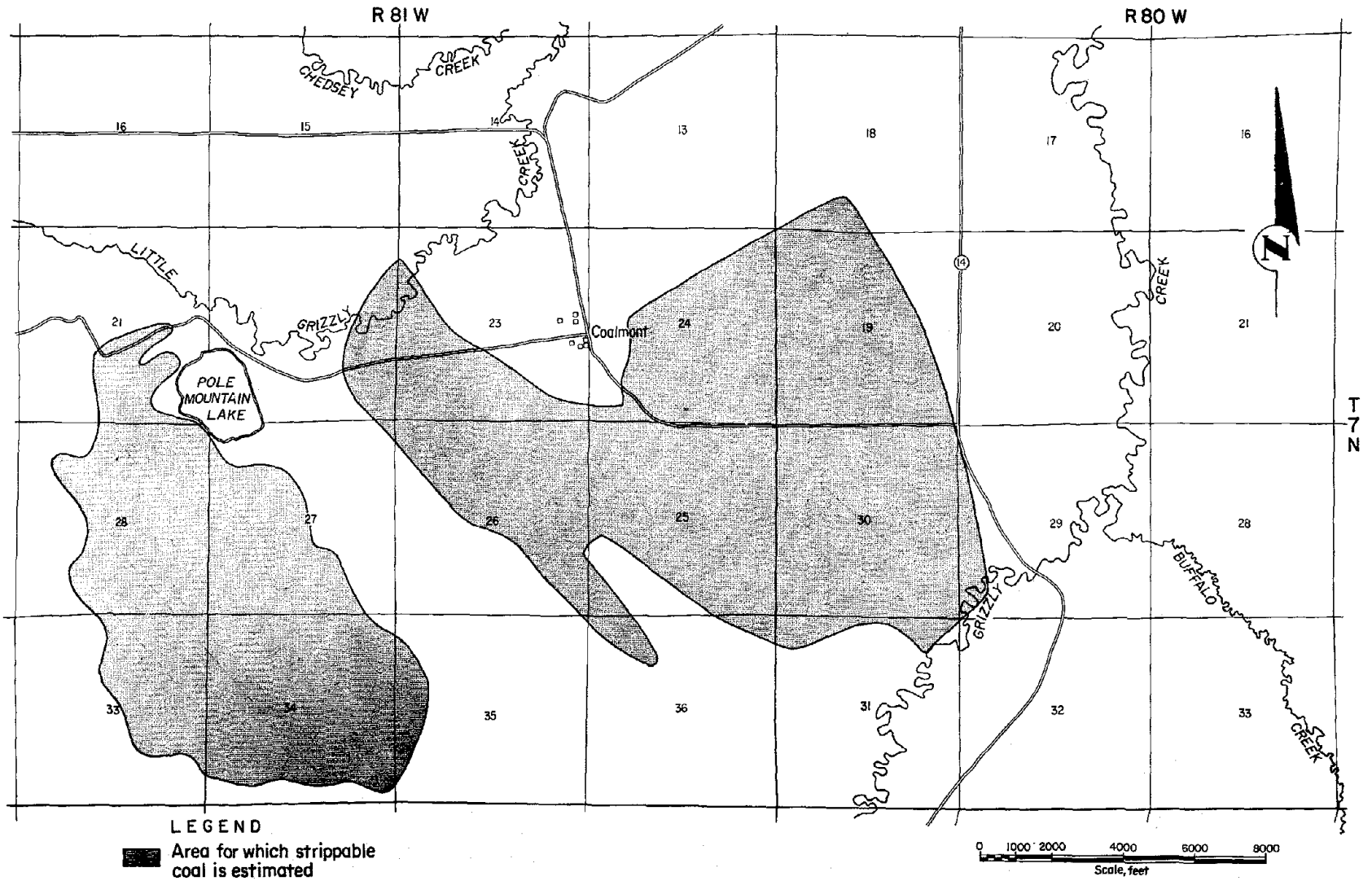

FIGURE 12. - Strippable coal areas in the North Park coalfield.

South Park Field

The South Park coalfield, in the South Park intermontane basin, is approximately 15 miles east of Fairplay in Park County.

The coal-bearing strata correlate with the Laramie Formation of Cretaceous age in the Denver basin and with the Vermejo Formation of Raton Mesa. The coalfield, geologically, is a 20-mile-long syncline, trending north to south. Coalbeds cropping out in the northwest are covered by a thrust-fault block in the east, and are faulted and eroded away in the south.

The coal-bearing strata dip steeply, 25° to 90°, at all outcrops. Washburne (113, p. 312) reported the existence of three coalbeds. Hornbaker and Holt (72, p. 12) stated that deep weathering and steep dips made mining difficult.

Landis (78) estimated the existence of 92 million tons of bituminous coal in 8 square miles of the field. He also stated that an additional 12 square miles may have minable resources. Landis did not differentiate between underground and strippable resources. However, considering the steep dips and the deep weathering, the South Park coalfield is considered to have no strippable coal resource. Additional exploration is unlikely to change this interpretation of the status of the field.

Tongue Mesa Field (31)

The Tongue Mesa coalfield, lying on the northern flanks of the Uncompahgre Mountains, approximately 20 miles southeast of Montrose, is in parts in Gunnison, Montrose, and Ouray Counties. The largest town in the area is Montrose, the county seat of Montrose County. The field is served by U.S. Highway 550 and by a branch line of the Denver & Rio Grande Western Railroad terminating at Ridgway.

Tongue Mesa is an erosional outlier of the coal-bearing Cretaceous formations occurring in surrounding coalfields. The coal-bearing strata correlate with the Fruitland-Kirtland Formations of the San Juan basin and with the Paonia Shale of Grand Mesa in the Uinta region (72).

Coal-bearing strata of the mesa are intensely block-faulted; correlation of coalbeds between drill holes or outcrops is virtually impossible. There is some evidence that many of the outcrops are exposures of large slump or landslide blocks, which give a false picture of the orientation of coalbeds in the mesa. The overall picture of the mesa is further confounded by almost total concealment by heavy vegetation, landslides, volcanic talus, and glacial debris.

The mesa contains at least two and, in places, four beds of coal. At least one bed in the southern end of the field ranges in thickness up to 40 feet. Coal is typically subbituminous B in rank.

A range of analyses for coal (as received) follows:

Moisture.....percent..	14.2	16.0
Ash.....do....	6.7	8.4
Volatile matter.....do....	36.0	47.3
Fixed carbon.....do....	40.1	55.4
Sulfur.....do....	0.5	0.9
Btu/lb.....	9,360	10,220
Ash softening temperature.....° F..	2,450	2,480

Kemmerer Coal Co. holds leases on virtually the entire field. No plans have been announced, but Kemmerer officials have stated that they have no intention of mining the field by surface methods.

Landis (78) reported in 1959 an estimated 2,355 million tons of coal in 58 square miles of the field. Hornbaker and Holt (72) stated in 1972 that there may be as much as 4,000 million tons. No strippable resource is considered likely for the field within the constraints used in this report. If the stripping depth were increased to 300 feet, a sizable quantity of coal could be strip mined. However, lack of information and complexity of the geology lead to a present estimate of no strippable coal.

Gunnison River Field

The Gunnison River coalfield, on the northeast side of the Gunnison River, between Grand Junction and Delta, is in parts of Delta and Mesa Counties. Coal has never been produced from the field on a commercial basis; however, some coal was mined for local consumption around the turn of the century. Grand Junction, the county seat of Mesa County, is the largest city near the field. Access transportation is provided by U.S. Highway 50, which is immediately east of the shallow coal deposits, and by a branch line of the Denver & Rio Grande Western Railroad on the west side of the Gunnison River.

The coal-bearing strata are either in the Dakota Formation or the Mancos Shale. Insufficient work has been conducted to resolve the question definitely. Structurally, the field is a large monocline, originating on the flanks of the Uncompahgre uplift and dipping under Grand Mesa. Along the Gunnison River the strata dips gently northeasterly at an angle of 4° to 5°. The coalbeds are lenticular, thin, and discontinuous. The coal is probably bituminous. Although no recent analyses are available, the following range of analyses was provided by Woodruff (122).

	As received		Air dried	
Moisture.....percent..	3.1	5.7	2.5	3.7
Volatile matter.....do....	26.3	39.2	26.9	39.5
Fixed carbon.....do....	38.8	51.7	34.9	52.0
Ash.....do....	6.0	33.8	6.0	34.5
Sulfur.....do....	0.8	1.89	0.82	1.90
Btu/lb.....	8,370	12,110	8,550	13,170

The existence of strippable coal in the field is highly conjectural. Woodruff stated that all coalbeds were exceedingly thin, less than 2 feet; however, examination of a new road cut near Wells Canyon indicated that either the beds thicken away from the outcrop or that the thickest parts of the beds may be as much as 4 feet thick. This report cannot state definitively whether minable thicknesses of coal exist but there is a possibility that they do.

The area of interest consists of the rather extensive dip-slope occurring adjacent to the Gunnison River, generally between Highway 50 and the northeast side of the river canyon. A short distance east of Highway 50, the coalbeds are covered by excessive thicknesses of overburden. In the area of the dip-slope, overburden should be minimal, probably between 20 and 70 feet in thickness. At least one bed of hard, compact sandstone overlies the coal; therefore, coal weathering should be negligible.

The Gunnison River coalfield normally would not be considered a strippable coal resource owing to the apparent thinness of the coalbeds. However, the lateral extent of the dip-slope, the relative thinness of the overburden, and the proximity of rail transportation make further investigation desirable.

If minable coal, ranging in thickness between 2 and 4 feet, exists beneath the entire dip-slope, 19,334 acres containing 91,300,000 tons of coal may be present. Figure 13 shows the area deemed to contain some strippable resource. Table 13 contains a compilation of resources calculated for the area shown in figure 13.

TABLE 13. - Estimated strippable coal resources of the Gunnison River coalfield

Location		Identified			Undiscovered			Total	
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Quantity (thousand short tons)
T 2 S	R 100 W	276	3	1,450	-	-	-	276	1,450
	R 99 W	2,558	2	9,400	-	-	-	2,558	9,400
	R 2 E	380	2	1,300	-	-	-	380	1,300
T 3 S	R 99 W	1,503	2	5,250	-	-	-	1,503	5,250
	R 2 E	7,332	2	28,850	-	-	-	7,332	28,850
T 4 S	R 3 E	4,432	4	30,850	-	-	-	4,432	30,850
	R 2 E	1,227	4	6,400	-	-	-	1,227	6,400
T 15 S	R 97 W	609	4	4,250	-	-	-	609	4,250
	R 97 W	836	2	2,900	-	-	-	836	2,900
	R 96 W	181	2	650	-	-	-	181	650
Total.....		19,334	-	91,300	-	-	-	19,334	91,300

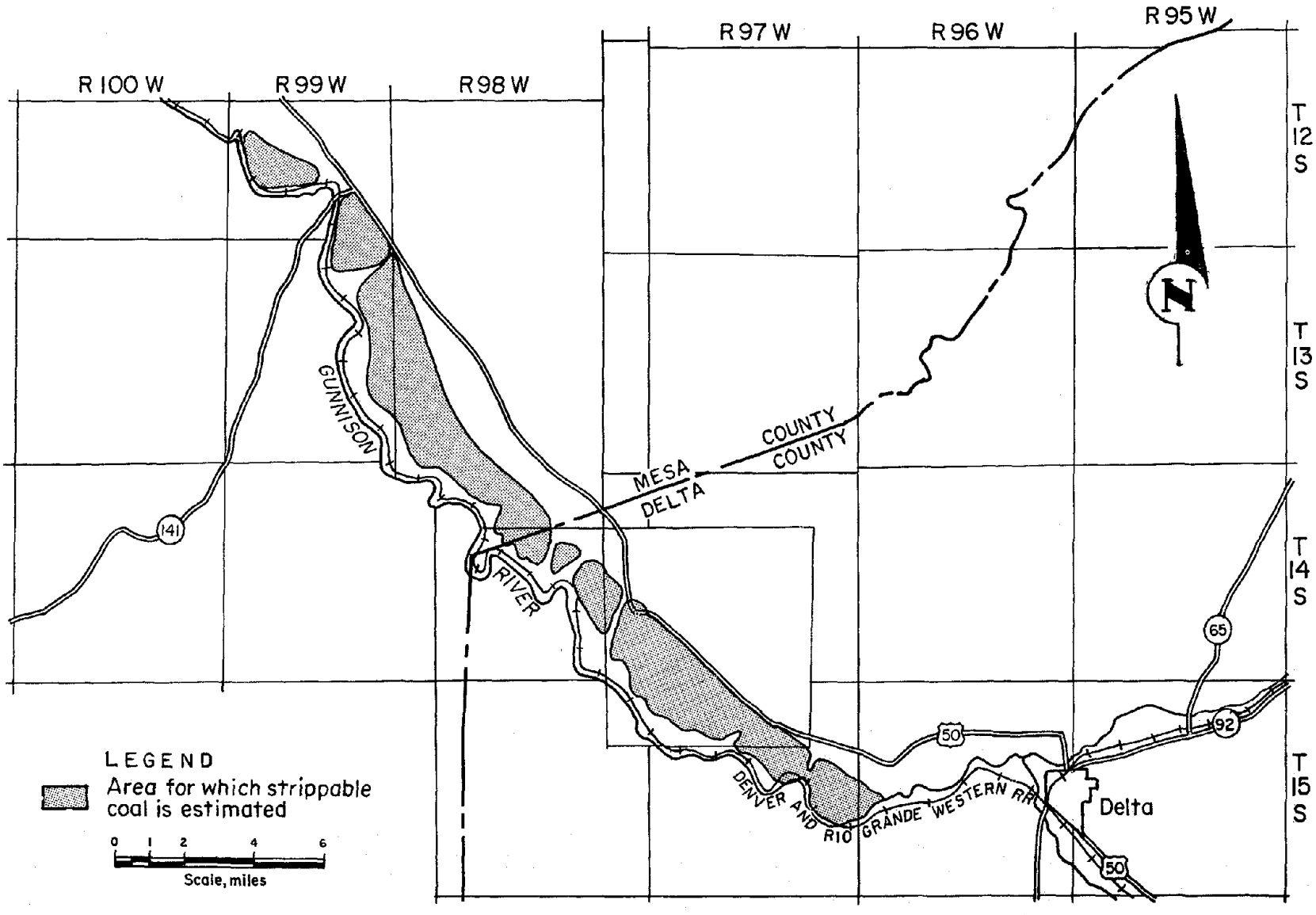

FIGURE 13. - Strippable coal areas in the Gunnison River coalfield.

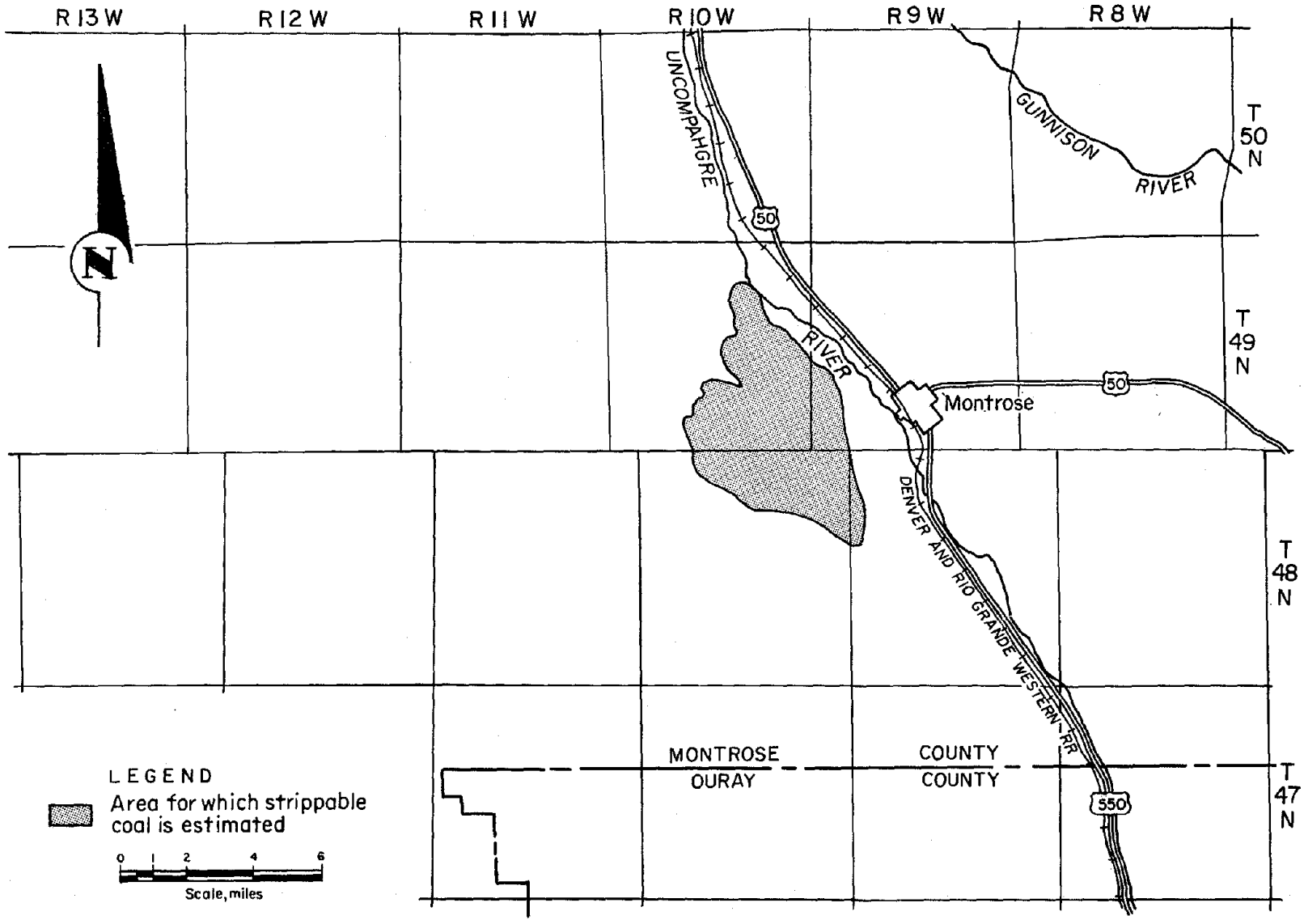

FIGURE 14. - A possible strippable coal deposit near Montrose.

Montrose Deposit (?)

Six water-well logs on file with the Colorado Division of Water Resources indicate the possible occurrence, near Montrose, of a significant, hitherto unreported deposit of coal which, if it exists, could be amenable to strip mining. The six logs reported the following information:

Log number	Data reported
1243	Coal zone at 143 feet
2038	Coal zone at 121 feet
2039	Coal zone at 127 feet
2742	3 feet of coal at 156 feet
18803	10 feet of coal at 97 feet
19144	10 feet of coal at 90 feet

The accuracy of these data cannot be determined. In the course of conducting this study, many instances were found where water-well log data did not correlate well with other reliable data; however, many instances were found where the correlation was excellent.

The deposit is located immediately west of Montrose, Montrose County (fig. 14). Little or no geologic data are available for the area. The surface is probably Mancos Shale, but it could be Dakota Sandstone. In either case, coalbeds of such significant thickness and lateral extent would not be expected.

The existence of coal in this area is conjectural. No backup data of any kind, other than the six water-well logs, are available. Pending confirmation by further exploration, 13,684 acres may be considered as coal bearing and, if coal thicknesses are comparable with those used in table 14, 175,600,000 tons of strippable coal could be present.

TABLE 14. - Estimated strippable coal resources of a possible deposit near Montrose, Colo.

Location		Identified			Undiscovered			Total	
Township	Range	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Thickness (feet)	Quantity (thousand short tons)	Area (acres)	Quantity (thousand short tons)
T 49 N	R 10 W	-	-	-	1,721	3	9,000	1,721	9,000
	R 10 W	-	-	-	5,953	8	83,000	5,953	83,000
T 49 N	R 9 W	-	-	-	1,426	8	19,800	1,426	19,800
T 48 N	R 10 W	-	-	-	4,137	8	57,600	4,137	57,600
	R 9 W	-	-	-	447	8	6,200	447	6,200
Total.....		-	-	-	13,684	-	175,600	13,684	175,600

Canon City Field (114)

The Canon City coalfield, an erosional remnant of the Vermejo Formation, is in Fremont County. Canon City, the largest town in the field, is the county seat of Fremont County, is situated 5,332 feet above sea level, has a population of approximately 9,500 persons (1972) and receives annual precipitation averaging 12.66 inches, much of which falls as snow. The field is served by State Highways 115 and 67, and by two railroads, the Denver & Rio Grande Western and the Atchinson, Topeka and Santa Fe.

Coal is contained in the Upper Cretaceous Vermejo Formation, a northward extension of the lower coal zone of the Raton Mesa region. As many as 16 coalbeds have been recognized in the field, but only 7 have significant commercial importance. In ascending order, with ranges of bed thickness, the commercially important beds are as follows: Rockvale, 3 feet to 3 feet 8 inches; Canon City, 3 feet to 7 feet 4 inches; Magnet, 4 feet 6 inches; Radiant (Jack-O-Lantern), 3 feet 4 inches to 4 feet 6 inches; Royal Gorge (Bassick), 4 feet; Chandler (Littel), 2 feet to 4 feet 6 inches; and Brookside, 4 feet 6 inches to 6 feet 7 inches (72).

Structurally, the Canon City field is an asymmetric syncline having gentle westerly dips on the east side and steep to moderate easterly dips on the west. The western flank is locally faulted.

More than 39,440,000 tons of coal has been produced from the field since its inception in 1884. In 1972, seven mines, two of which were surface pits, produced 214,948 tons, most of which was used locally or in Colorado Springs for power generation; none was exported from the State. Although coal mine openings exist around the entire perimeter of the field, most underground and all surface activity has been concentrated along the eastern edge. Ten strip mines have operated in the field since 1947:

Mine	Years operated	Total production (tons)
Annex No. 2	1963-72	108,935
Beaver Strip	NA	7,853
Beer Strip (B&B Strip)	1947-64	258,318
Beer Strip No. 2	1964-69	41,351
Black Diamond	NA	NA
Carestia	1963-65	2,380
Corley Strip	1958-72	414,518
Midway Strip (Beaver Strip)	1948-51	2,501
Pioneer Strip	1953-56	21,375
Rex Carbon Strip	1970	5,836

NA Not available.

Most coal in the field is high-volatile C bituminous, nonslaking, nonagglomerating, and noncoking. Hornbaker and Holt (72) provided the following range of analyses on an as received basis:

	Low	High
Moisture.....percent..	5.4	15
Ash.....do....	4.6	17.7
Sulfur.....do....	0.3	1.1
Btu/lb.....	10,110	12,010
Ash softening temperature...° F..	2,030	2,720

The Bureau of Mines data bank contains 1,272 analyses of Fremont County coals. A summation of values, as received, regardless of bed or location, follows:

	High	Low	Mean
Moisture.....percent..	15.7	5.9	10.1
Ash.....do....	23.4	4.3	9.8
Volatile matter.....do....	44.2	33.4	38.6
Fixed carbon.....do....	57.0	40.5	51.5
Sulfur.....do....	3.4	0.2	0.5
Btu/lb.....	12,170	9,070	11,030

Greater detail of analyses, by bed, is provided in the appendix.

Landis (78), in 1959, estimated 295 million tons of bituminous coal in 36 square miles of the field. Strippable coal was not differentiated from nonstrippable coal. Although strippable coal is definitely present, there are no deposits of large areal extent; the strippable coal is located in the transition zone between the foothills and the plains, southwest of Florence, and in the valleys of T 20 S, R 69 W. Individual deposits are difficult to identify without an extensive exploration program. However, it it reasonable to assume that at least 10,200,000 tons of strippable coal are contained in 1,911 acres of the field. Average recoverable thickness should approximate 3 feet, and overburden ratio should range between nil and 10:1.

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APPENDIX.--AVERAGE COAL ANALYSES, BY BED, FOR COLORADO COAL

County and bed name	Number of analyses	Dry basis, percent															Btu/lb		
		Moisture			Volatile matter			Fixed carbon			Ash			Sulfur					
		High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean
Adams: Uncorrelated..	4	35.0	18.9	23.7	-	-	-	-	-	-	11.4	4.8	7.9	0.6	0.4	0.4	12,220	10,740	11,370
Archuleta:																			
Uncorrelated..	20	6.4	2.3	3.7	41.0	34.0	38.2	52.2	45.8	48.0	16.5	10.6	13.6	1.1	.4	.7	13,230	12,470	12,850
Boulder:																			
Laramie Tower.....	6	21.8	18.7	20.5	-	-	-	-	-	-	4.9	4.3	4.5	.6	.4	.5	12,800	12,410	12,560
Uncorrelated.....	159	23.3	11.3	19.1	41.3	36.3	38.9	57.9	47.2	53.7	14.6	4.7	7.3	.7	.2	.4	12,730	11,110	12,280
Delta:																			
B.....	1	3.9	3.9	3.9	41.9	41.9	41.9	53.5	53.5	53.5	4.6	4.6	4.6	.4	.4	.4	13,940	13,940	13,940
C.....	19	9.8	7.4	8.8	42.4	40.8	41.8	54.6	52.9	53.9	5.3	3.2	4.2	.6	.5	.5	13,750	13,360	13,570
Uncorrelated.....	254	20.0	2.9	9.8	43.1	36.6	40.0	56.5	46.9	52.9	13.9	3.0	7.0	1.7	.4	.6	14,060	11,730	13,150
B and C.....	1	6.6	6.6	6.6	39.6	39.6	39.6	51.9	51.9	51.9	8.5	8.5	8.5	.5	.5	.5	13,330	13,330	13,330
Douglas: Uncorrelated	2	-	-	-	-	-	-	-	-	-	8.7	8.7	8.7	2.2	1.4	1.8	-	-	-
Elbert: Uncorrelated.	1	32.9	32.9	32.9	42.2	42.2	42.2	45.8	45.8	45.8	12.0	12.0	12.0	.7	.7	.7	9,430	9,430	9,430
El Paso:																			
Laramie A.....	39	26.9	19.2	24.3	-	-	-	-	-	-	10.5	5.2	7.3	.6	.3	.4	13,020	10,750	11,500
Fox Hill.....	225	26.2	16.6	22.0	44.6	39.7	42.5	53.0	44.9	49.3	15.3	6.4	8.0	.6	.3	.3	12,200	10,820	11,450
Fremont:																			
Various.....	16	8.5	8.2	8.3	43.8	41.8	42.9	50.1	49.8	49.9	8.1	6.4	7.1	2.1	1.1	1.5	13,040	12,740	12,910
Do.....	146	11.9	10.4	11.0	40.4	36.9	38.2	53.1	49.3	51.4	13.8	8.4	10.2	.5	.4	.4	12,460	11,620	12,160
Nonac.....	19	10.7	6.9	8.6	42.1	38.1	40.1	54.3	48.8	51.6	12.3	5.6	8.1	1.0	.5	.7	13,140	11,940	12,710
Magnet.....	26	10.0	7.0	8.3	43.6	38.3	40.4	54.0	45.9	51.0	12.5	6.3	8.5	1.8	.4	.9	13,090	12,150	12,740
Zenith.....	2	11.5	9.8	10.6	40.3	40.2	40.2	49.0	48.5	48.7	11.2	10.8	11.0	3.4	1.8	2.6	12,100	12,100	12,100
Chandler.....	23	9.7	5.9	8.6	41.8	36.5	38.8	56.4	40.5	50.9	21.9	6.1	10.1	1.7	.5	.7	13,050	10,660	12,390
Rockvale.....	4	10.3	8.3	9.0	40.3	35.8	38.4	53.7	46.5	51.3	17.7	6.0	10.1	.7	.5	.6	13,210	11,350	12,540
Brookside.....	445	14.2	7.4	10.1	42.7	34.5	38.5	56.1	45.7	51.2	19.6	5.7	10.2	.7	.2	.4	13,000	10,750	12,190
Jack-O-Lantern.....	111	12.3	7.6	8.9	41.3	36.1	39.6	53.5	46.9	52.4	16.2	6.0	7.9	1.6	.5	.8	12,880	11,450	12,580
Radiant.....	9	10.5	8.3	9.1	41.9	37.8	39.9	51.6	45.8	49.5	16.4	6.8	10.5	1.8	1.3	1.4	12,960	11,530	12,390
Uncorrelated.....	470	15.7	7.8	10.3	44.2	33.4	38.2	57.0	43.2	51.7	23.4	4.3	9.9	2.4	.4	.5	13,150	10,400	12,240
Jack-O-Lantern and Monarch.....	1	10.9	10.9	10.9	39.4	39.4	39.4	49.8	49.8	49.8	10.8	10.8	10.8	1.0	1.0	1.0	12,110	12,110	12,110
Garfield:																			
Keystone.....	4	10.3	3.7	5.8	-	-	-	-	-	-	9.7	5.6	7.8	.4	.3	.3	13,700	12,290	13,110
Carbonera.....	1	11.4	11.4	11.4	-	-	-	-	-	-	10.6	10.6	10.6	.6	.6	.6	12,570	12,570	12,570
A.....	6	8.9	5.3	6.9	-	-	-	-	-	-	17.8	5.3	10.7	2.3	.7	1.0	13,120	11,150	12,580
Wheeler.....	17	8.3	3.4	5.5	42.5	39.8	41.3	51.4	46.3	49.8	13.9	5.9	9.0	.7	.3	.5	13,320	10,600	12,720
Anderson.....	5	6.3	3.8	4.4	42.2	38.9	39.7	56.1	54.6	55.2	6.5	3.1	4.6	.6	.5	.5	14,300	13,540	13,910
B/Somerset.....	1	7.7	7.7	7.7	-	-	-	-	-	-	7.7	7.7	7.7	.9	.9	.9	13,110	13,110	13,110
Bear/C/Juanita C....	3	6.9	5.6	6.3	-	-	-	-	-	-	5.5	3.7	4.8	1.2	.8	.9	13,170	13,170	13,170
D/Oliver.....	7	8.6	5.2	6.4	-	-	-	-	-	-	8.6	2.0	3.8	1.0	.5	.7	14,050	12,850	13,710
E/Red Canon.....	1	6.5	6.5	6.5	-	-	-	-	-	-	5.0	5.0	5.0	.5	.5	.5	13,250	13,250	13,250
Allen Sunshine.....	25	12.7	3.5	6.6	44.5	38.9	40.6	56.8	48.5	52.1	11.3	4.0	6.6	.8	.4	.5	14,140	12,310	13,250
Uncorrelated.....	188	16.4	2.9	6.7	44.7	34.1	40.1	57.0	44.4	51.4	21.5	2.3	8.3	2.8	.4	1.0	13,730	11,190	12,940

County and bed name	Number of analyses	Dry basis, percent															Btu/lb		
		Moisture			Volatile matter			Fixed carbon			Ash			Sulfur					
		High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean
Gunnison:																			
Various	21	6.8	5.4	5.5	39.9	38.3	38.9	52.9	48.1	50.2	13.6	7.5	10.7	0.5	0.5	0.5	13,460	12,270	12,820
Coal No. 1 Mesaverde	2	10.2	3.3	6.7	-	-	-	-	-	-	5.6	3.9	4.7	.9	.4	.6	14,510	13,430	13,970
Coal No. 2 Mesaverde	7	11.3	4.9	9.8	-	-	-	-	-	-	7.3	4.0	6.0	2.1	.4	.8	14,160	12,860	13,270
Coal No. 3 Mesaverde	2	5.5	3.9	4.7	-	-	-	-	-	-	5.3	3.7	4.5	.4	.4	.4	14,020	13,730	13,870
Coal No. 4 Mesaverde	1	9.4	9.4	9.4	-	-	-	-	-	-	5.3	5.3	5.3	.4	.4	.4	13,470	13,470	13,470
Coal No. 5 Mesaverde	1	6.1	6.1	6.1	-	-	-	-	-	-	4.6	4.6	4.6	1.1	1.1	1.1	12,960	12,960	12,960
Coal No. 6 Mesaverde	1	3.3	3.3	3.3	-	-	-	-	-	-	5.3	5.3	5.3	.7	.7	.7	14,470	14,470	14,470
Floresta	1	3.0	3.0	3.0	-	-	-	-	-	-	7.7	7.7	7.7	.7	.7	.7	13,920	13,920	13,920
B	33	8.2	4.4	5.2	41.0	38.2	39.8	52.9	49.2	51.1	12.0	7.0	9.0	.6	.4	.4	13,480	12,810	13,180
Juanita C	127	7.8	4.5	5.5	42.4	36.9	40.4	56.4	49.3	52.9	13.8	2.8	6.5	1.0	.4	.5	14,050	12,450	13,500
Oliver	40	8.5	4.2	5.8	41.8	38.9	40.4	54.3	50.5	52.5	10.4	4.6	7.0	.8	.4	.5	13,950	12,820	13,410
E	87	8.3	4.4	5.6	42.5	38.7	40.9	57.2	51.5	54.3	7.9	2.8	4.7	.9	.4	.5	14,130	13,350	13,830
Uncorrelated	86	18.5	1.3	7.0	45.1	6.2	35.0	88.1	49.8	58.5	12.6	3.3	6.4	1.3	.3	.6	14,620	12,450	13,420
Huerfano:																			
Various	3	6.2	5.6	5.9	40.7	39.2	39.7	49.4	45.0	46.9	15.6	9.9	13.2	.7	.6	.6	12,610	11,710	12,090
New Rouse	4	13.4	3.9	6.3	-	-	-	-	-	-	22.3	7.8	12.8	.7	.6	.6	13,600	11,430	12,850
Pryor	1	3.6	3.6	3.6	-	-	-	-	-	-	12.0	12.0	12.0	.6	.6	.6	12,860	12,860	12,860
Kebler No. 2	7	8.6	7.0	7.8	-	-	-	-	-	-	9.7	8.3	8.9	.7	.5	.5	12,970	12,420	12,710
Mammoth	9	19.2	5.3	7.5	-	-	-	-	-	-	17.8	8.0	10.7	.9	.5	.5	12,910	12,180	12,710
Lennox	5	8.3	6.0	7.2	-	-	-	-	-	-	14.8	11.3	13.5	.8	.6	.6	12,520	11,960	12,200
Upper Rugby	21	4.2	2.5	3.3	41.1	39.3	40.1	51.6	46.8	49.2	13.6	7.6	10.5	1.0	.6	.7	13,560	12,630	13,070
Walsen	23	8.2	4.7	6.6	41.0	37.1	38.7	52.1	46.3	49.0	14.5	7.5	12.2	.7	.5	.5	12,960	11,720	12,270
Lower Robinson	9	6.3	2.9	5.0	40.6	35.2	37.8	50.7	45.7	48.1	18.9	11.3	13.9	.7	.6	.6	12,950	11,180	12,230
Upper Robinson	92	6.7	3.2	5.1	41.3	36.6	38.4	54.2	44.4	50.5	19.0	7.6	11.0	.8	.5	.5	13,610	11,480	12,580
Cameron	115	7.9	2.0	5.0	42.1	35.5	38.7	53.0	44.1	49.6	19.7	7.4	11.6	2.2	.6	.8	13,620	11,550	12,620
Uncorrelated	70	9.7	3.2	5.2	42.0	35.4	38.1	58.7	45.8	50.4	16.9	4.8	11.4	1.4	.4	.7	13,900	11,350	12,490
Jackson:																			
Mitchell mine	2	20.7	16.8	18.7	-	-	-	-	-	-	12.6	11.5	12.0	1.0	1.0	1.0	11,400	11,330	11,370
Monohan	1	19.7	19.7	19.7	-	-	-	-	-	-	4.4	4.4	4.4	.9	.9	.9	12,810	12,810	12,810
Riach	5	22.8	13.6	18.7	-	-	-	-	-	-	13.0	8.9	10.7	.9	.3	.5	11,850	11,130	11,500
Sudduth	6	20.0	15.6	17.2	-	-	-	-	-	-	7.8	3.3	4.8	.8	.1	.2	12,970	11,930	12,550
Uncorrelated	22	21.9	11.9	15.4	43.4	39.4	40.0	56.4	47.1	53.3	13.4	3.1	6.6	.9	.2	.4	13,070	11,130	12,190
Jefferson:																			
Uncorrelated	24	21.5	16.4	18.9	43.0	38.3	40.8	55.7	50.1	53.4	7.0	4.8	5.7	.9	.3	.4	12,370	11,850	12,150
La Plata:																			
Carbonera	1	7.1	7.1	7.1	-	-	-	-	-	-	13.6	13.6	13.6	.6	.6	.6	-	-	-
Uncorrelated	270	10.7	1.5	3.9	42.7	28.4	39.7	58.0	43.1	52.7	28.5	2.5	7.5	5.1	.4	1.5	14,790	10,650	13,650
Larimer: Uncorrelated	7	33.0	29.3	31.9	-	-	-	-	-	-	14.7	8.7	12.0	4.8	.9	2.4	11,190	10,570	10,970
Las Animas:																			
Vermejo A	1	2.5	2.5	2.5	-	-	-	-	-	-	17.4	17.4	17.4	.9	.9	.9	12,300	12,300	12,30
Vermejo B	2	2.5	2.4	2.4	-	-	-	-	-	-	15.7	11.4	13.5	.7	.6	.6	13,380	12,750	13,070
Cokedale	5	2.7	2.1	2.4	-	-	-	-	-	-	20.0	11.6	16.4	.6	.5	.5	13,210	12,630	12,920
Lower Sopris	4	6.0	1.6	3.7	-	-	-	-	-	-	18.1	9.8	13.3	.7	.6	.6	14,120	13,530	13,830

Berwind.....	9	6.4	1.6	3.4	-	-	-	-	-	-	15.0	8.0	11.6	1.0	0.6	0.7	14,070	12,970	13,470
Vermejo No. 2.....	1	2.0	2.0	2.0	-	-	-	-	-	-	16.0	16.0	16.0	.7	.7	.7	12,720	12,720	12,720
Vermejo No. 3.....	1	2.3	2.3	2.3	-	-	-	-	-	-	11.3	11.3	11.3	.7	.7	.7	13,760	13,760	13,760
Allen.....	7	5.8	1.0	4.0	38.8	32.4	34.3	50.1	41.3	44.3	26.3	11.1	21.3	.5	.4	.4	13,300	10,940	11,740
Hastings.....	3	2.0	1.9	1.9	35.1	33.7	34.3	48.8	48.5	48.6	17.8	16.1	17.0	.7	.7	.7	12,770	12,400	12,570
Lower Starkville....	16	2.6	1.2	1.8	31.6	28.2	30.0	52.6	49.6	51.4	22.2	16.1	18.4	.9	.6	.7	12,820	11,870	12,440
Morley.....	13	2.4	1.3	1.8	32.2	30.8	31.4	55.7	50.5	53.5	17.9	12.2	15.0	.9	.6	.7	13,440	12,450	12,920
Upper Ludlow.....	1	2.1	2.1	2.1	33.9	33.9	33.9	46.9	46.9	46.9	19.2	19.2	19.2	.7	.7	.7	12,180	12,180	12,180
Upper Rugby.....	1	3.1	3.1	3.1	-	-	-	-	-	-	11.1	11.1	11.1	.5	.5	.5	12,960	12,960	12,960
Rapson.....	35	3.9	1.0	2.2	37.3	33.1	36.0	53.6	45.3	51.2	20.1	9.4	12.7	.8	.5	.6	13,510	11,650	12,900
Walsen.....	115	4.0	1.9	2.3	38.6	32.8	35.7	55.4	45.8	51.4	19.6	9.6	12.7	.8	.5	.6	13,430	11,810	12,900
Frederick.....	7	2.1	1.6	1.8	31.8	28.6	30.3	56.1	48.5	53.2	22.9	12.1	16.4	.6	.5	.5	13,510	11,550	12,760
Lower Robinson.....	4	2.9	2.7	2.7	38.9	36.1	37.1	52.5	51.9	52.1	11.8	8.6	10.7	.8	.6	.6	13,420	12,970	13,140
Cass.....	9	2.6	2.0	2.4	37.5	34.9	36.2	49.1	46.8	47.6	17.7	13.4	16.1	.8	.7	.7	12,770	12,110	12,880
Delagua No. 1.....	1	3.1	3.1	3.1	37.2	37.2	37.2	52.4	52.4	52.4	10.4	10.4	10.4	.5	.5	.5	13,120	13,120	13,120
Majestic.....	22	2.3	1.6	1.9	32.5	29.6	31.2	53.3	43.7	49.8	26.7	14.5	18.9	.7	.5	.5	12,940	10,850	12,210
Lower Ludlow.....	67	2.2	1.0	1.6	34.5	27.0	32.4	56.6	48.8	52.4	19.9	8.9	15.1	.8	.5	.6	13,840	11,990	12,800
Empire.....	6	4.5	2.8	3.4	34.4	30.4	32.1	57.7	54.5	56.0	13.3	9.7	11.7	.8	.6	.7	13,540	12,880	13,220
Primero.....	57	4.6	1.4	2.7	34.2	30.9	32.4	57.1	45.3	50.4	23.8	10.2	17.1	.7	.4	.5	13,520	11,210	12,320
Cameron.....	37	7.9	1.0	2.1	40.5	34.7	35.6	55.2	49.9	53.3	14.9	7.5	10.9	.8	.6	.6	13,670	12,620	13,290
Bear Canyon No. 6...	105	4.3	1.4	1.8	36.8	31.3	35.0	58.7	49.1	54.7	14.3	7.1	10.2	.8	.5	.6	14,080	12,800	13,510
Uncorrelated.....	82	3.9	1.3	2.4	40.4	28.2	34.6	66.2	45.6	52.6	22.6	5.6	12.7	1.1	.4	.6	14,510	11,700	13,010
Upper and Lower Ludl	56	2.2	1.3	1.6	36.2	31.5	34.6	51.1	45.5	49.8	21.8	13.5	15.4	.8	.6	.7	12,990	11,680	12,700
Mesa:																			
Anchor.....	1	9.4	9.4	9.4	-	-	-	-	-	-	6.5	6.5	6.5	1.2	1.2	1.2	13,380	13,380	13,380
Palisade.....	129	11.8	3.3	8.7	41.5	35.7	39.6	55.2	39.0	51.2	25.3	4.9	9.0	2.1	.5	.8	13,840	10,310	12,960
Cameo.....	160	10.2	4.1	7.5	40.5	36.4	38.5	54.5	47.2	50.7	15.2	5.2	10.6	1.2	.5	.6	13,590	11,920	12,710
Uncorrelated.....	20	10.0	6.8	8.8	42.0	37.4	40.1	54.1	48.5	52.1	11.2	5.9	7.7	1.7	.6	.9	13,590	12,600	13,240
Moffat:																			
A.....	5	23.3	11.7	17.6	-	-	-	-	-	-	9.4	4.7	7.0	1.0	.3	.5	12,670	11,550	12,050
Black Diamond group.	1	12.5	12.5	12.5	-	-	-	-	-	-	7.8	7.8	7.8	.8	.8	.8	12,410	12,410	12,410
Collum.....	72	14.7	8.5	10.8	49.7	39.3	42.3	56.3	47.2	53.7	6.2	2.7	3.8	.5	.2	.3	13,340	12,770	13,130
Uncorrelated.....	7	16.0	13.7	14.6	39.9	37.4	38.8	55.6	53.2	54.4	9.4	5.4	6.7	.5	.3	.3	12,730	12,030	12,470
Montezuma:																			
Uncorrelated.....	18	7.8	3.0	5.5	41.9	31.4	36.1	61.7	49.7	55.4	17.1	3.7	8.4	1.0	.5	.6	14,340	12,200	13,510
Montrose:																			
Uncorrelated.....	17	13.5	2.8	5.4	34.6	32.1	33.5	59.3	53.6	56.3	12.8	6.1	10.0	1.0	.5	.7	13,760	11,570	13,090
Ouray: Uncorrelated..	2	16.0	15.5	15.7	-	-	-	-	-	-	9.9	8.0	8.9	.9	.6	.7	12,170	11,890	12,030
Park:																			
Como.....	1	15.5	15.5	15.5	-	-	-	-	-	-	7.5	7.5	7.5	.5	.5	.5	11,570	11,570	11,570
Uncorrelated.....	1	15.5	15.5	15.5	-	-	-	-	-	-	7.6	7.6	7.6	.6	.6	.6	11,570	11,570	11,570
Pitkin:																			
Placita.....	1	2.2	2.2	2.2	-	-	-	-	-	-	6.8	6.8	6.8	.5	.5	.5	14,440	14,440	14,440

County and bed name	Number of analyses	Dry basis, percent															Btu/lb		
		Moisture			Volatile matter			Fixed carbon			Ash			Sulfur					
		High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean
Pitkin (Con.):																			
A	1	3.5	3.5	3.5	30.3	30.3	30.3	55.6	55.6	55.6	14.1	14.1	14.1	1.2	1.2	1.2	13,300	13,300	13,300
B	1	2.6	2.6	2.6	30.8	30.8	30.8	60.3	60.3	60.3	8.9	8.9	8.9	1.0	1.0	1.0	14,110	14,110	14,110
Anderson	4	3.6	2.3	3.0	34.9	32.4	33.6	59.5	57.5	58.5	8.1	7.5	7.6	.7	.6	.6	14,230	13,980	14,100
Allen/Sunshine	12	3.8	1.0	2.3	38.5	37.6	38.1	53.7	53.5	53.5	9.0	3.6	7.5	.8	.4	.5	15,370	13,380	14,070
Uncorrelated	4	7.6	.8	4.0	23.4	22.7	23.0	69.0	66.1	68.0	11.2	8.1	8.9	.7	.6	.6	14,550	13,900	14,360
A and Anderson	1	4.8	4.8	4.8	30.3	30.3	30.3	56.8	56.8	56.8	12.9	12.9	12.9	.9	.9	.9	13,330	13,330	13,330
A and B	1	3.1	3.1	3.1	29.5	29.5	29.5	58.2	58.2	58.2	12.3	12.3	12.3	1.1	1.1	1.1	13,640	13,640	13,640
Rio Blanco:																			
Uncorrelated	65	15.5	7.9	11.7	44.4	37.0	40.7	56.1	49.1	52.3	12.0	3.7	6.9	1.1	.3	.5	13,300	12,000	12,710
Routt:																			
Upper part Mesaverde	4	15.9	14.2	15.0	-	-	-	-	-	-	5.9	4.5	5.1	1.0	.4	.6	12,970	12,730	12,870
Middle group William	3	12.5	11.0	11.8	-	-	-	-	-	-	12.0	6.2	8.2	.6	.5	.5	-	-	-
Bear River	6	10.5	9.1	9.8	-	-	-	-	-	-	7.2	5.5	6.0	.7	.3	.5	13,110	12,920	13,040
Lower group--Iles	7	12.2	8.6	10.5	-	-	-	-	-	-	11.2	4.7	6.3	1.8	.5	1.0	13,340	12,960	13,150
Lower group 3--Iles	1	9.0	9.0	9.0	-	-	-	-	-	-	5.9	5.9	5.9	.5	.5	.5	13,150	13,150	13,150
Wolf Creek	7	13.0	7.9	9.9	43.0	36.0	41.0	49.2	46.8	47.9	15.5	9.2	11.0	.7	.5	.5	12,550	11,230	12,120
Pinnacle	178	12.6	5.9	8.4	42.9	36.1	40.3	58.2	47.2	52.2	16.5	2.8	7.3	.9	.3	.6	13,640	11,510	12,930
Wadge	786	18.3	6.2	9.8	43.3	37.0	40.3	55.4	47.7	52.0	13.2	3.4	7.6	1.8	.3	.5	13,450	11,620	12,610
Lennox	335	15.5	7.6	8.7	45.9	39.9	44.0	54.6	48.8	51.5	8.1	2.6	4.4	2.8	.6	1.9	13,370	12,510	13,170
Dry Creek	5	14.7	14.2	14.4	38.2	36.8	37.6	56.2	55.8	55.9	7.4	5.6	6.4	.5	.4	.4	12,840	12,510	12,700
Uncorrelated	205	16.7	5.6	9.4	43.8	36.3	40.2	58.2	47.7	51.5	12.4	3.2	8.2	2.1	.2	.9	13,450	11,470	12,730
San Miguel:																			
Uncorrelated	1	2.8	2.8	2.8	36.1	36.1	36.1	55.7	55.7	55.7	8.2	8.2	8.2	1.5	1.5	1.5	13,790	13,790	13,790
Weld: Uncorrelated	2,012	26.2	6.6	21.2	42.9	36.8	38.7	57.5	49.6	54.9	10.1	4.4	6.2	.9	.2	.4	13,210	11,900	12,460

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