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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE THORNBURGH QUADRANGLE, RIO BLANCO AND MOFFAT COUNTIES, COLORADO

[Report includes 12 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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Purpose

This text is to be used in conjunction with Coal Resource Occurrence and Coal Development Potential Maps of the Thornburgh quadrangle, Rio Blanco and Moffat Counties, Colorado. This report was compiled to support the land-planning work of the Bureau of Land Management (BLM) and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. This investigation was undertaken by Dames & Moore, Denver, Colorado, at the request of the United States Geological Survey under contract number 14-08-0001-15789. The resource information gathered for this report is in response to the Federal Coal Leasing Amendments Act of 1976 (P.L. 94-377). Published and unpublished public information available through April, 1978, was used as the data base for this study. No new drilling or field mapping was done as part of this study, nor was any confidential data used.

Location

The Thornburgh quadrangle is located in northwestern Colorado. The southern three quarters of the quadrangle is located in north-central Rio Blanco County, and the northern quarter is located in southeastern Moffat County. The quadrangle is approximately 19 airline miles (31 km) south-southwest of the town of Craig and approximatley 11 miles (18 km) northeast of the town of Meeker via an improved light-duty road and Colorado Highway 13 (also known as Colorado Highway 789). With the exception of a few scattered ranches, the quadrangle is unpopulated. The southeastern quarter of the quadrangle includes land within the White River National Forest.

Accessibility

Colorado Highway 13 lies 3 to 4 airline miles (5 to 6 km) west of the quadrangle. Rio Blanco County road 45 (Dyni, 1966a), an improved light-duty road, crosses northeasterly across the quadrangle connecting Colorado Highway 13 approximately 10 miles (16 km) to the southwest with the Thornburgh oil and gas field in the northeast corner of the quadrangle. It crosses Yellowjacket Pass in the southwest corner of the quadrangle. The remainder of the quadrangle is accessible by several improved light-duty roads, unimproved dirt roads and trails.

Railway service for the Thornburgh quadrangle is provided by the Denver and Rio Grande Western Railroad from Denver to the railhead at Craig. This railroad is the major transportation route for coal shipped east from northwestern Colorado (U.S. Bureau of Land Management, 1977).

Physiography

The Thornburgh quadrangle lies at the western edge of the Southern Rocky Mountain physiographic province as defined by Howard and Williams (1972). The quadrangle is approximately 14 miles (23 km) southwest of the Williams Fork Mountains and 55 miles (89 km) west-southwest of the Continental Divide.

The landscape in the northwestern and southern parts of the quadrangle is characterized by moderate to steep slopes cut by numerous creeks and gulches. The topography becomes flatter and more gentle along Milk Creek in the northeastern and north-central parts of the quadrangle. Thornburgh Mountain forms a northeasterly-trending ridge across the northwest corner of the quadrangle. Three Points Mountain in the southeastern part of the quadrangle and Uranium Peak on the south-central edge of the quadrangle lie on the northwestern edge of the White River uplift.

Altitudes in the quadrangle range from 9,351 feet (2,850 m) on Uranium Peak on the south-central edge of the quadrangle to less than 6,440 feet (1,963 m) along Milk Creek in the northwest corner.

Milk Creek and its tributaries flow northward into the Yampa River, draining all but the southwest corner of the quadrangle. A small area south of Yellowjacket Pass drains into Coal Creek and the White River to the southwest. With the exception of Milk Creek, the streams in the quadrangle are intermittent and flow mainly in response to snowmelt in the spring. Numerous small lakes are scattered over the southern half of the quadrangle.

Climate and Vegetation

The climate of northwestern Colorado is semiarid. Clear, sunny days prevail in the Thornburgh quadrangle area, with daily temperatures typically varying from 7° to 32° F (-14° to 1° C) in January and from 39° to 82° F (4° to 28° C) in July. Annual precipitation in the area averages approximately 18 inches (46 cm). Snowfall during the winter months accounts for the major part of the precipitation in the area, but rainfall from thundershowers during the summer months also contributes to the total. Winds, averaging approximately 3 miles per hour (5 km per hour), are generally from the west, but wind directions and velocities vary greatly depending on the local terrain (U.S. Bureau of Land Management, 1977).

Aspen occur at higher altitudes in the southeastern and west-central parts of the quadrangle, where moisture and soil depth are adequate. At lower altitudes the typical vegetation is mountain shrub, which includes serviceberry, Gambel oak, and rabbitbrush. Sagebrush grows in the flatter areas along Milk Creek (U.S. Bureau of Land Management, 1977).

Land Status

The Thornburgh quadrangle lies on the eastern boundary of the Danforth Hills Known Recoverable Coal Resource Area (KRCRA). Approximately two fifths of the quadrangle lies within the KRCRA boundary and the Federal government owns the coal rights for approximately 95 percent of this area as shown on plate 2. There are no active coal leases within the KRCRA in this quadrangle.

GENERAL GEOLOGY

Previous Work

The first geologic description of the general area in which the Thornburgh quadrangle is located was reported by Emmons (1877) as part of a survey of the Fortieth Parallel. The decision to build a railroad into the region stimulated several investigations of coal between 1886 and 1905, including papers by Hewett (1889), Hills (1893), and Storrs (1902). Hancock (1925) described the geology and coal resources of the quadrangles to the north of the Thornburgh quadrangle, and Hancock and Eby (1930) described the geology and coal resources of the quadrangles to the west. Dyni (1966a and 1966b) described the geology of the Thornburgh and adjacent quadrangles. Tweto (1976) compiled a generalized regional geologic map which included this quadrangle. The most comprehensive work in the quadrangle is an unpublished geologic map and accompanying data by Reheis (no date).

Stratigraphy

The rock formations cropping out in the Thornburgh quadrangle range in age from Late Triassic to Late Cretaceous and include the coal-bearing Iles and Williams Fork Formations of the Mesaverde Group. Formations older than the Mancos Shale crop out over a large area in the central part of the southern half of the quadrangle. Although shown in the composite columnar section on plate 3, none of these older formations are coal-bearing in this quadrangle and their lithologic character is not discussed in this report.

The Mancos Shale of Late Cretaceous age crops out over most of the eastern half of the quadrangle and in a broad south-southwest-trending band across the southwestern and west-central parts of the quadrangle (Dyni, 1966a; Reheis, no date). The formation is composed of gray to dark-gray marine shale with ledge-forming thin-bedded sandstone occurring locally in the upper part of the formation (Hancock and Eby, 1930). The Mancos Shale is estimated to be approximately 5,100 to 5,300 feet (1,554 to 1,615 m) thick (Reheis, no date).

The Mesaverde Group of Late Cretaceous age conformably overlies the Mancos Shale and contains two formations, the Iles and the Williams Fork.

The Iles Formation crops out in a narrow north-northeast-trending band along the western edge of the quadrangle and across the northwestern quarter of the quadrangle (Dyni, 1966a; Reheis, no date). It consists of fine-grained tan to light-gray sandstone interbedded with shaly sandstone, gray mudstone, brown carbonaceous shale, and coal, and ranges in thickness from approximately 1,300 to 1,475 feet (396 to 450 m) (Reheis, no date). The "rim rock" sandstone (Hancock and Eby, 1930; Konishi, 1959), the basal unit of the formation, is a light-brown to white massive sandstone approximately 80 feet (24 m) thick. The Trout Creek Sandstone Member caps the formation and consists of approximately 70 to 100 feet (21 to 30 m) of massive cross-bedded fine-grained tan and white sandstone (Reheis, no date). Two coal-bearing sequences, the "lower" coal group and Black Diamond coal group (Hancock and Eby, 1930), occur in the Iles Formation below the Trout Creek Sandstone in this area. One sequence occurs approximately 100 to 250 feet (30 to 76 m) above the base of the formation and the other approximately 1,000 to 1,200 feet (305 to 366 m) above the base (Reheis, no date).

The Williams Fork Formation crops out in the west-central and northwestern parts of the quadrangle (Dyni, 1966a; Reheis, no date). It ranges in thickness from approximately 4,500 feet to 5,000 feet (1,372 to 1,524 m) in the Meeker area (Hancock and Eby, 1930), but the maximum formation thickness preserved in the Thornburgh quadrangle is reported to be approximately 2,000 feet (610 m) (Reheis, no date). Extensive surface areas are baked owing to the burning of underlying coal beds. The formation is divided into three units: a lower coal-bearing unit, the Twentymile (?) Sandstone Member, and an upper unit that also contains coal (Reheis, no date).

The lower unit extends from the top of the Trout Creek Sandstone Member to the base of the Twentymile (?) Sandstone Member and is approximately 750 to 850 feet (229 to 259 m) thick in this quadrangle. It consists of interbedded tan to gray sandstone, shaly sandstone, brown carbonaceous shale, and coal beds (Reheis, no date). This lower coal unit was designated the Fairfield coal group by Hancock and Eby (1930).

Reheis (no date) indicates that the coal beds are concentrated in zones from 0 to 300 feet (0 to 91 m) and from 750 to 850 feet (229 to 259 m) above the base of the formation.

The Twentymile (?) Sandstone Member is a light-tan to white, fine-grained cross-bedded massive sandstone approximately 100 to 200 feet (30 to 61 m) thick (Reheis, no date).

The upper unit of the Williams Fork Formation is approximately 850 to 950 feet (259 to 290 m) thick in this quadrangle and consists of interbedded tan to gray sandstone, shaly sandstone, brown carbonacous shale, and coal beds (Reheis, no date). Hancock and Eby (1930) designated the coals within this upper unit as the Goff coal group. These coals occur over 1,200 feet (366 m) above the base of the formation (Reheis, no date).

Holocene deposits of alluvium cover the stream valleys and gulches in this quadrangle (Reheis, no date).

The Late Cretaceous formations cropping out in the Thornburgh quadrangle accumulated close to the western edge of a Late Cretaceous epeirogenic seaway which covered part of the western interior of North America. Several transgressive-regressive cycles caused the deposition of a series of marine, nearshore-marine, and non-marine sediments in the Thornburgh quadrangle area (Ryer, 1977).

The Mancos Shale was deposited in an offshore marine environment which existed east of the shifting strand line. Deposition of the Mancos Shale in the quadrangle area ended with the eastward migration of the shoreline and the subsequent deposition of the Iles Formation (Konishi, 1959; Kucera, 1959).

The interbedded sandstone, shale, and coal of the Iles and Williams Fork Formations were deposited as a result of minor changes in the position of the shoreline. Near-shore marine, littoral, brackish-tidal, brackish and fresh-water supratidal, and fluvial environments existed during the deposition of the Iles and Williams Fork Formations. The major sandstone beds in the Iles and Williams Fork Formations were deposited in shallow-marine and near-shore marine environments as the shoreline fluctuated. Coal beds of limited areal extent were generally deposited in environments associated with fluvial systems, such as back-levee and coastal-plain swamps, interchannel basin areas, and abandoned channels (Konishi, 1959; Kucera, 1959).

Structure

The Danforth Hills KRCRA lies in the northern part of the Piceance structural basin of west-central Colorado (Howard and Williams, 1972). The Danforth Hills area is bordered on the northeast by the Axial Basin anticline and on the west by the Yampa Plateau (Grose, 1972). The Thornburgh quadrangle lies at the southeastern end of the Axial Basin anticline and is approximately 38 miles (61 km) east of the Yampa Plateau.

The Yellowjacket anticline trends north across the southern half of the Thornburgh quadrangle. In the central part of the quadrangle, the anticline strikes north-northwest and plunges in that direction. Dips on the western limb of this asymmetric fold range from about 25° to more than 70° (Reheis, no date). The Collom syncline trends in an easterly direction across the northwestern and north-central parts of the quadrangle and continues in a southeasterly direction in the northeastern part of the quadrangle. The axis of the northwest-trending Axial Basin anticline crosses the northeast corner of the quadrangle. The Thornburgh dome, the location of the Thornburgh oil and gas field, lies on the Axial Basin anticline in the northeastern part of the quadrangle (Dyni, 1966a; Reheis, no date).

The structure contour maps of the isopached coal beds are based on a structure map of the top of the Trout Creek Sandstone Member by Reheis (no date) and it is assumed that the structure of the coal beds nearly duplicates that of the Trout Creek Sandstone Member. Minor modifications were made where necessary in accordance with outcrop data.

COAL GEOLOGY

Coal beds in the Iles and Williams Fork Formations have been identified in numerous outcrops in the western part of the quadrangle. Coal beds in the Iles Formation are usually confined in two groups: the "lower" coal group contains thin coal beds between 100 and 250 feet (30 and 76 m) above the base of the formation, and the Black Diamond coal group includes all coal beds within the interval from 150 to 350 feet (46 to 107 m) below the top of the Trout Creek Sandstone Member (Hancock and Eby, 1930).

According to Hancock and Eby (1930), coal beds in the Williams Fork Formation that lie below the Lion Canyon Sandstone Member [Twentymile (?) Sandstone Member in this quadrangle] are placed in the Fairfield and Goff coal groups. The Fairfield coal group includes the coal beds that occur in the basal 1,300 feet (396 m) of the formation and the Goff coal group generally includes the coal beds in the 700 feet (213 m) of coal-bearing strata below the Lion Canyon Sandstone Member [Twentymile (?) Sandstone Member].

Coal beds in the lower, Fairfield and Goff coal groups are not formally named, but where they exceed Reserve Base thickness (5.0 feet or 1.5 meters) they have been given bracketed numbers for identification purposes. In instances where coal beds have been identified at one location only and cannot be correlated with other coal beds, they are treated as isolated data points (see Isolated Data Points section of this report).

Chemical analyses of coal--Chemical analyses were not available for coals in the lower, Black Diamond, Fairfield, and Goff coal groups in this quadrangle, but representative analyses from nearby quadrangles are listed in table 1. In general, coals in these coal groups are high-volatile C bituminous in rank on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Lower Coal Group

Coal beds in the lower coal group crop out in a north-northeast-trending band in the western half of the quadrangle. Of the many coal beds identified in the lower coal group, only two coal beds exceed Reserve Base thickness and have been isopached. These two coal beds, the LG[1]) (i.e., lower coal group, coal bed [1]) and the LG[2], are located in the west-central part of the quadrangle and dip west-northwest at an average of 49°.

The LG[1] coal bed (plate 4) ranges in thickness from 1.3 to 6.0 feet (0.4 to 1.8 m) where measured at four locations along the outcrop. Rock partings were not reported to be included in the coal bed.

The LG[2] coal bed (plate 4) is 5.4 and 6.1 feet (1.6 and 1.9 m) thick where measured at two locations in sec. 5, T. 2 N., R. 92 W. This coal bed is not known to contain rock partings.

Black Diamond Coal Group

Numerous thin, lenticular coal beds have been identified in this coal group in the western part of the quadrangle. Of the five coal beds in the coal group that exceed Reserve Base thickness in this quadrangle, only one, the Black Diamond [5], has been isopached. The other four coal beds, the Black Diamond [3], [4], [7], and [206], were identified at one location only and treated as isolated data points.

The Black Diamond [5] coal bed (plate 5) crops out in the west-central part of the quadrangle and is known to exceed Reserve Base thickness only in sec. 5, T. 2 N., R. 92 W., where it ranges in measured thickness from 2.5 to 7.0 feet (0.8 to 2.1 m). The coal bed dips to the northwest at about 41° along the outcrop and lessens to approximately 13° in the subsurface.

Fairfield Coal Group

The Fairfield coal group crops out along the western edge of the quadrangle, and eight coal beds greater than Reserve Base thickness have each been identified at one location only. Therefore, the Fairfield [8], [9], [11], [12], [13], [15], [210], and [214] coal beds were treated as isolated data points.

Goff Coal Group

Coal beds in this coal group crop out in the northwest corner of the quadrangle. Two coal beds, the Goff [140] and [160], exceed Reserve Base thickness at one location only in this quadrangle, but because of data projected from the adjacent Ninemile Gap quadrangle, these coal beds have been isopached.

The Goff [160] coal bed (plate 7) is located in the northwest corner of the quadrangle and is 5.1 feet (1.6 m) thick where measured in sec. 7, T. 3 N., R. 92 W. In the northeast corner of the Ninemile Gap quadrangle to the west, the Goff [160] coal bed is 4.2 feet (1.3 m) thick where measured in a single outcrop. This coal bed dips to the west at about 18°.

The Goff [140] coal bed (plate 4) lies approximately 25 feet (7.6 m) stratigraphically above the Goff [160] and is 5.0 feet (1.5 m) thick where measured at the outcrop in sec. 7, T. 3 N., R. 92 W. In the adjacent Ninemile Gap quadrangle, the Goff [140] coal bed is 4.0 and 6.3 feet (1.2 and 1.9 m) thick where measured at two outcrops in sec. 7, T. 3 N., R. 92 W.

Isolated Data Points

In instances where single or isolated measurements of coal beds thicker than 5.0 feet (1.5 m) are encountered, the standard criteria for construction of isopach, structure contour, mining ratio, and overburden isopach maps are not available. The lack of data concerning these coal beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other, better known coal beds. For this reason, isolated data points are included on a separate plate for non-isopached coal beds (plate 10).

COAL RESOURCES

Data from outcrop measurements (Dyni, 1966b; Reheis, no date), were used to construct outcrop, isopach, and structure contour maps of the coal beds in the Thornburgh quadrangle. The source of each indexed data point shown on plate 1 is listed in table 4.

Coal resources for Federal land were calculated using data obtained from the coal isopach maps (plates 4 and 7), the areal distribution and identified resources maps (plates 6 and 9), and the isolated data point maps (plate 10). The coal bed acreage (measured by planimeter), multiplied by the average thickness of the coal bed and by a conversion factor of 1,800 short tons of coal per acre-foot (13,238 metric tons per hectare-meter) for bituminous coal, yields the coal resources in short tons of coal for each coal bed. Coal beds thicker than 5 feet (1.5 m) that lie less than 3,000 feet (914 m) below the ground surface are included. These criteria differ somewhat from those stated in U.S. Geological Survey Bulletin 1450-B which call for a minimum thickness of 28 inches (70 cm) and a maximum depth of 1,000 feet (305 m) for bituminous coal.

Reserve Base and Reserve tonnages for the isopached and non-isopached coal beds are shown on plates 6, 9, and 10, and are rounded to the nearest 10,000 short tons (9,072 metric tons). Only Reserve Base tonnages (designated as inferred resources) are calculated for areas influenced by the isolated data points. Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 5.08 million short tons (4.61 million metric tons) for the entire quadrangle, including the tonnages for the isolated data points.

Dames & Moore has not made any determination of economic recoverability for any of the coal beds described in this report.

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn to coincide with the boundaries of the smallest legal land subdivisions shown on plate 2. In sections or parts of sections where no land subdivisions have been surveyed by the BLM, approximate 40-acre (16-ha) parcels have been used to show the limits of the high, moderate, or low development potentials. A constraint imposed by the BLM specifies that the highest development potential affecting any part of a 40-acre (16-ha) lot, tract, or parcel be applied to that entire lot, tract, or parcel. For example, if 5 acres (2 ha) within a parcel meet criteria for a high development potential; 25 acres (10 ha), a moderate development potential; and 10 acres (4 ha), a low development potential; then the entire 40 acres (16 ha) are assigned a high development potential.

Development Potential for Surface Mining Methods

Areas where the coal beds of Reserve Base thickness are overlain by 200 feet (61 m) or less of overburden are considered to have potential for surface mining and are assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios for surface mining of coal is shown below:

$$MR = \frac{t_o\ (cf)}{t_c\ (rf)}$$

where MR = mining ratio

t_o = thickness of overburden in feet

t_c = thickness of coal in feet

rf = recovery factor (85 percent for this quadrangle)

cf = conversion factor to yield MR value in terms of cubic yards of overburden per short tons of recoverable coal:

0.911 for subbituminous coal

0.896 for bituminous coal

Note: To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply MR by 0.8428.

Areas of high, moderate, and low development potential for surface mining methods are defined as areas underlain by coal beds having respective mining-ratio values of 0 to 10, 10 to 15, and greater than 15. These mining ratio values for each development potential category are based on economic and technological criteria and were provided by the U.S. Geological Survey.

Areas where the coal data is absent or extremely limited between the 200-foot (61-m) overburden line and the outcrop are assigned unknown development potential for surface mining methods. This applies to areas where coal beds 5 feet (1.5 m) or more thick are not known, but may occur, and to those areas influenced by isolated data points. Limited knowledge pertaining to the areal distribution, thickness, depth, and attitude of the coal beds prevents accurate evaluation of development potential in the high, moderate, and low categories. The areas influenced by isolated data points in this quadrangle total approximately 2.21 million short tons (2.00 millon metric tons) of coal available for surface mining.

The coal development potential for surface mining methods is shown on plate 11. All of the Federal land areas having a known development potential for surface mining are rated high. The remaining Federal lands within the KRCRA boundary in this quadrangle are classified as having unknown development potential for surface mining methods. Reserve Base tonnages in the various development potential categories for surface mining methods are listed in table 2.

Development Potential for Subsurface and In-Situ Mining Methods

Areas considered to have a development potential for conventional subsurface mining methods include those areas where the coal beds are between 200 and 3,000 feet (61 and 914 m) below the ground surface and have dips of 15° or less. Unfaulted coal beds lying between 200 and 3,000 feet (61 and 914 m) below the ground surface, dipping greater than 15°, are considered to have a development potential for in-situ mining methods.

Areas of high, moderate, and low development potential for conventional subsurface mining methods are defined as areas underlain by coal beds at depths ranging from 200 to 1,000 feet (61 to 305 m), 1,000 to 2,000 feet (305 to 610 m), and 2,000 to 3,000 feet (610 to 914 m), respectively.

Areas where the coal data is absent or extremely limited between 200 and 3,000 feet (61 and 914 m) below the ground surface are assigned unknown development potentials. This applies to the areas where coal beds of Reserve Base thickness are not known, but may occur, and to those areas influenced by isolated data points. The areas influenced by isolated data points in this quadrangle contain approximately 0.22 million short tons (0.20 million metric tons of coal available for conventional subsurface mining.

The coal development potential for conventional subsurface mining methods is shown on plate 12. All of the Federal land areas having known development potential for conventional subsurface mining methods are rated high. The remaining Federal lands within the KRCRA boundary are classified as having unknown development potentials for conventional subsurface mining methods. Reserve Base tonnages in the various development potential categories for conventional subsurface mining methods are listed in table 3.

Based on criteria provided by the U.S. Geological Survey, coal beds of Reserve Base thickness dipping between 35° and 90° with a minimum Reserve Base of 50 million short tons (45.4 million metric tons) for bituminous coal and 70 million short tons (63.5 million metric tons) for subbituminous coal have a moderate potential for in-situ development; coal beds dipping from 15° to 35°, regardless of tonnage, and coal beds dipping from 35° to 90° with less than 50 million short tons (45.4 million metric tons) of coal have a low development potential for in-situ mining methods. Coal lying between the 200-foot (61 m) overburden line and the outcrop is not included in the total coal tonnages available as it is needed for cover and containment in the in-situ process.

Areas where faulted coal beds of Reserve Base thickness dip greater than 15° between 200 and 3,000 feet (61 and 914 m) below the ground surface are classified as having an unknown development potential for in-situ mining methods. These criteria also apply to those areas influenced by isolated data points where the coal beds are not faulted. The areas influenced by isolated data points in this quadrangle contain approximately 1.74 million short tons (1.58 million metric tons) of coal available for in-situ mining.

Coal development potential for in-situ mining methods is shown on plate 12. All of the Federal land areas classified as having known development potential for in-situ mining methods are rated low. The remaining Federal lands within the KRCRA boundary in this quadrangle are classified as having unknown development potential for in-situ mining methods. Reserve Base tonnages in the various development potential categories for in-situ mining methods are listed in table 4.

Table 1. -- Chemical analyses of coals in the Thornburgh quadrangle, Rio Blanco and Moffat Counties, Colorado.

Location	COAL BED NAME	Form of Analysis	Proximate				Ultimate					Heating Value	
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu/Lb
SW¼ sec. 24, T. 5 N., R. 91 W., Hamilton (Badger Creek) Mine (George and others, 1937) from Hamilton quadrangle	Lower coal group	A	12.5	29.7	48.0	9.8	0.8	-	-	-	-	-	10,650
		C	-	33.9	54.9	11.2	1.0	-	-	-	-	-	12,170
		D	-	38.2	61.8	-	1.1	-	-	-	-	-	13,700
SW¼ sec. 15, T. 1 N., R. 94 W., Black Diamond Mine (Hancock, 1925) from Meeker quadrangle	Black Diamond coal group	A	10.8	37.2	44.0	7.98	0.49	-	-	-	-	-	11,220
		B	8.5	38.2	45.1	8.18	0.50	-	-	-	-	-	11,510
		C	-	41.8	49.3	8.95	0.55	-	-	-	-	-	12,580
NE¼ sec. 30, T. 2 N., R. 92 W., Wesson Mine (Gale, 1907) from Rattlesnake Mesa quadrangle	Wesson (Fairfield coal group)	A	13.60	36.17	45.57	4.66	0.45	-	-	-	-	-	10,931
SW¼ sec. 10, T. 2 N., R. 93 W., Cornrike Mine (Hancock and Eby, 1930) from Ninemile Gap quadrangle	Cornrike (Goff coal group)	A	13.9	42.0	41.9	2.2	0.28	-	-	-	-	-	11,270
		B	10.6	43.6	43.5	2.3	0.29	-	-	-	-	-	11,700
		C	-	48.8	48.6	2.6	0.33	-	-	-	-	-	13,000

Form of Analysis: A, as received
B, air dried
C, moisture free
D, moisture and ash free

Note: To convert Btu/pound to kilojoules/kilogram, multiply by 2.326

Table 2. -- Coal Reserve Base data for surface mining methods for Federal coal lands (in short tons) in the Thornburgh quadrangle, Rio Blanco and Moffat Counties, Colorado.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Goff {160}	10,000	-	-	-	10,000
Black Diamond {5}	30,000	30,000	60,000	-	120,000
Lower coal group {2}	60,000	60,000	50,000	-	170,000
Lower coal group {1}	20,000	20,000	30,000	-	70,000
Isolated Data Points	-	-	-	2,210,000	2,210,000
Totals	120,000	110,000	140,000	2,210,000	2,580,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 3. -- Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Thornburgh quadrangle, Rio Blanco and Moffat Counties, Colorado.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Goff {160}	-	-	-	-	-
Black Diamond {5}	40,000	-	-	-	40,000
Lower coal group {2}	-	-	-	-	-
Lower coal group {1}	-	-	-	-	-
Isolated Data Points	-	-	-	220,000	220,000
Totals	40,000	-	-	220,000	260,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 4. -- Coal Reserve Base data for in-situ mining methods for Federal coal lands (in short tons) in the Thornburgh quadrangle, Rio Blanco and Moffat Counties, Colorado.

Coal Bed or Zone	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Goff {160}	-	-	-	-
Black Diamond {5}	10,000	-	-	10,000
Lower coal group {2}	470,000	-	-	470,000
Lower coal group {1}	20,000	-	-	20,000
Isolated Data Points	-	-	1,740,000	1,740,000
Totals	500,000	-	1,740,000	2,240,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 4. -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	Reheis, (no date), U.S. Geological Survey, unpublished data and geological map	Measured Section No. 4
2		Measured Section
3		Measured Section
4		Measured Section No. 3
5		Measured Section No. 2
6		Measured Section
7		Measured Section No. 1
8		Measured Section No. 19
9		Composite Section No. 18
10		Composite Section No. 18
11		Measured Section
12		Measured Section
13		Measured Section No. 16
14		Measured Section No. 15
15		Measured Section No. 14
16		Measured Section
17		Composite Section No. 17
18		Composite Section No. 17

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Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
19	Reheis, (no date), U.S. Geological Survey, unpublished data and geological map	Measured Section No. 11
20		Measured Section No. 9
21		Measured Section No. 10
22		Measured Section No. 8
23		Measured Section No. 13
24		Measured Section No. 12
25		Measured Section No. 6
26		Measured Section
27	Dyni, 1966b, U.S. Geological Survey open-file report	Measured Section No. 1
28	Reheis, (no date), U.S. Geological Survey, unpublished data and geological map	Measured Section No. 7
29		Measured Section No. 5

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