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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE RALPH WHITE LAKE QUADRANGLE, MOFFAT AND ROUTT COUNTIES, COLORADO

[Report includes 8 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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This report has not been edited for conformity with U.S. Geological Survey editorial standards or stratigraphic nomenclature.

CONTENTS

ILLUSTRATIONS

TABLES

INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence and Coal Development Potential Maps of the Ralph White Lake quadrangle, Moffat and Routt 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 U.S. 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 Published and unpublished public information available through February, 1979, was used as the data base for this study. No new drilling or field mapping was performed as a part of this study, nor was any confidential data used.

Location

The Ralph White Lake quadrangle is located in northwestern Colorado. The southeastern quarter of the quadrangle lies in western Routt County, while the remainder of the quadrangle is in eastern Moffat County. The quadrangle is 2.5 miles (4.0 km) east of the town of Craig, Colorado and approximately 30 (48 km) south of the town of Baggs, Wyoming. With the exception of a few scattered ranches, the area within the quadrangle is unpopulated.

Accessibility

U.S. Highway 40 crosses east-west through the southern part of the quadrangle connecting Craig with the town of Hayden, approximately 6 miles (10 km) southeast of the quadrangle. Colorado Highway 13 (also known as Colorado Highway 789) crosses the northwestern part of the quadrangle, joining Craig, Colorado, with Baggs, Wyoming. Several improved light-duty roads cross the quadrangle, one along Wymore Gulch in the northern part of the quadrangle and one along Elkhead Creek in the east-central part of the quadrangle. The remainder of the quadrangle is accessible along a number of unimproved dirt roads and trails.

Railway service for the Ralph White Lake quadrangle is provided by the Denver and Rio Grande Western Railroad from Denver to the railhead at Craig. The railroad parallels U.S. Highway 40 through the Yampa River valley across the southern part of the quadrangle. This railroad is the major transportation route for coal shipped east from northwestern Colorado (U.S. Bureau of Land Management, 1977).

Physiography

The Ralph White Lake quadrangle lies in the southern part of the Wyoming Basin physiographic province as defined by Howard and Williams (1972). The quadrangle is approximately 5 miles (8 km) north of the Williams Fork Mountains and 36 miles (58 km) west of the Continental Divide (Tweto, 1976).

Moderate slopes and narrow gulches are dominant throughout most of the quadrangle. Wide flat valleys occur along Fortification Creek in the northwestern part of the quadrangle and along Elkhead Creek and the Yampa River in the southern part of the quadrangle.

Approximately 730 feet (223 m) of relief is present in the Ralph White Lake quadrangle. Altitudes range from about 6,920 feet (2,109 m) in the northeast corner of the quadrangle to slightly less than 6,200 feet (1,890 m) along the Yampa River in the southwestern corner of the quadrangle.

The Yampa River, the major drainage system in the area, flows westward across the southern part of the quadrangle. Fortification Creek flows southward across the northwestern corner of the quadrangle joining the Yampa River at Craig, approximately 2.5 miles (4.0 km) west of the quadrangle. Elkhead Creek, a tributary of the Yampa River, drains the east-central part of the quadrangle. The remainder of the quadrangle is drained by numerous small intermittent creeks which flow mainly in response to snowmelt in the spring. Ralph White Lake is located on Fortification Creek in the northwestern corner of the quadrangle and Leftwich Reservoir lies at the mouth of Boone Gulch in the southwestern part of the quadrangle.

There are other numerous small, unnamed man-made lakes and ponds throughout the quadrangle.

Climate and Vegetation

The climate of northwestern Colorado is semiarid. Clear, sunny days prevail in the Ralph White Lake quadrangle area, and daily temperatures typically vary from 0° to 35° F (-18° to 2° C) in January and from 42° to 80° F (6° to 27° C) in July. Annual precipitation in the area averages approximately 14 inches (36 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).

The dominant vegetation throughout the Ralph White Lake quadrangle is sagebrush, although the flatter areas along the valleys of the Yampa River and Fortification Creek are utilized as cropland (U.S. Bureau of Land Management, 1977).

Land Status

The Ralph White Lake quadrangle lies in the north-central part of the Yampa 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 90 percent of this area as shown on plate 2. There are no active coal leases present in the Ralph White Lake quadrangle.

GENERAL GEOLOGY

Previous Work

The first geologic description of the general area in which the Ralph White Lake quadrangle is located was prepared 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), Storrs (1902), and Parsons and Liddell (1903). Fenneman and Gale (1906) described the geology and coal occurrences of the Yampa coal field which included most of the Ralph White Lake quadrangle. In 1955, Bass and others expanded Fenneman and Gale's work in a report on the geology and mineral fuels of parts of Routt and Moffat Counties, and this is the most comprehensive work on the area. Tweto (1976) compiled a generalized regional geologic map which included this quadrangle.

Stratigraphy

The rock formations which crop out in the Ralph White Lake quadrangle include the Lewis Shale and Lance Formation, both of Late Cretaceous age, and the Fort Union and Wasatch Formations of Paleocene and Eocene age, respectively. Only the Lance and Fort Union Formations are known to contain coal in this quadrangle.

The Lewis Shale, a dark- to bluish-gray marine shale with interbedded sandstone, crops out on the south-central edge of the Ralph White Lake quadrangle (Bass and others, 1955; Tweto, 1976). Information is not available on the total thickness of the Lewis Shale in the quadrangle, but it is at least 2,295 feet (700 m) thick where measured in the Trend Exploration Company No. 1-5 State well drilled in the southeastern part of the quadrangle.

Bass and others (1955) did not map the Fox Hills Sandstone as a separate rock unit in this quadrangle, but have indicated that fossils of Fox Hills age are at the top of the basal sandstone sequence in the Lance Formation. Based on geophysical logs of oil and gas test wells drilled in this quadrangle, the basal sandstone sequence of the Lance ranges from about 210 to 340 feet (64 to 104 m) in thickness and appears to be correlative with the Fox Hills Sandstone as identified in other geophysical logs from wells drilled in quadrangles to the northwest. However, in keeping with Bass and others (1955), the Fox Hills Sandstone has not been shown as a separate unit in the composite columnar section on plate 3.

In general, the Fox Hills Sandstone consists of grayish-brown, fine-grained, thin-bedded to massive sandstone with lenses of gray sandy shale and coal (Dorf, 1942).

The Lance Formation conformably overlies and laterally intertongues with the Lewis Shale. It crops out across the southern and east-central parts of the quadrangle and ranges in thickness from approximately 1,100 to 1,433 feet (335 to 437 m) where measured in the oil and gas wells drilled in the quadrangle. It consists of gray shale interbedded with soft light-tan, fine-grained massive sandstone, sandy shale, and coal (Bass and others, 1955).

The Fort Union Formation unconformably overlies the Lance Formation and crops out in approximately the northern two thirds of the quadrangle. It consists chiefly of brown sandstone interbedded with gray shale and coal beds (Bass and others, 1955). Although the contact between the Fort Union and the overlying Wasatch Formation is difficult to distinguish on geophysical logs from oil and gas wells, it is estimated that approximately 800 to 1,450 feet (244 to 442 m) of the Fort Union Formation is present within the quadrangle.

The Wasatch Formation unconformably overlies the Fort Union Formation and crops out in the northwest corner of the quadrangle. Information is not available on the total thickness of the Wasatch in this quadrangle, but as much as 510 feet (155 m) of the formation may have been penetrated in the U.S. Smelting, Refining, & Mining Company No. 2-28 McWilliams well drilled in sec. 28, T. 8 N., R. 90 W. It consists of brown coarse-grained sandstone interbedded with red and gray clay shale (Bass and others, 1955).

Holocene deposits of alluvium cover the valleys of the Yampa River, Elkhead Creek, and Fortification Creek in the southern and west-central parts of the quadrangle.

The Cretaceous sedimentary rocks in the Ralph White Lake 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 offshore-marine, shallow-marine, marginal-marine and non-marine sediments in the Ralph White Lake quadrangle area (Ryer, 1977).

Deposition of the Lewis Shale marked a landward movement of the sea. The marine sediments of the Lewis Shale were deposited in water depths ranging from a few tens of feet to several hundred feet. A regional uplift west of the Yampa Basin area caused a regression of the sea and ended the deposition of the Lewis Shale in the area (Kucera, 1959).

The basal sandstone sequence of the Lance Formation (Fox Hills Sandstone) represents transitional and near-shore marine depositional environments between the deeper-water marine environment of the Lewis Shale and the lagoonal and continental environments of the Lance Formation. Deposition of this basal sequence occurred in shallow-marine, barrier bar, beach, estuarine and tidal channel environments (Weimer, 1959 and 1961).

As the sea regressed further, the sediments became increasingly terrestrial and the carbonaceous shale, mudstone, and coal comprising the Lance Formation was deposited in broad areas of estuarine, marsh, lagoonal, and coastal swamp environments (O'Boyle, 1955; Weimer, 1959 and 1961).

After the final withdrawal of the Cretaceous sea, thick sections of detrital material, eroded from older deposits, were deposited as the coarse conglomerate and sandstone of the Fort Union Formation. The sandstone, shale, and coal of the Fort Union Formation were deposited in stream, flood-plain, and swamp environments (Beaumont, 1979).

Depositional environments fluctuated between fluvial and lacustrine during the Eocene when the Wasatch Formation was deposited (Picard and McGrew, 1955).

Coal beds of limited areal extent, such as those which occur in the Ralph White Lake quadrangle, 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 Yampa KRCRA lies in the southern extension of the Washakie/ Sand Wash structural basin of south-central Wyoming. The basin is bordered on the east by the Park Range, approximately 36 miles (58 km) east of the Ralph White Lake quadrangle, and on the southwest by the Axial Basin anticline, approximately 18 miles (29 km) southwest of the quadrangle (Tweto, 1976).

The Ralph White Lake quadrangle lies on a broad northwest-trending syncline which plunges gently to the northwest. Coal beds in the southern part of the quadrangle dip to the north and northeast at 2° to 3°, while beds in the central and northern parts of the quadrangle dip at the same angles to the west-northwest. An exception is the Seymour coal bed in the Fort Union Formation that locally dips about 4° to the east.

COAL GEOLOGY

Coal beds in the Lance and Fort Union Formations have been identified in the Ralph White Lake quadrangle. Most of the coal beds in these two formations are thin and lenticular, and are usually less than Reserve Base thickness (5.0 feet or 1.5 meters). However, one coal bed in the Lance Formation and three in the Fort Union are greater than 5.0 feet (1.5 m) thick over small areas scattered throughout the quadrangle as shown on plate 4. Coal beds that are not formally named have been given bracketed numbers for identification purposes.

Chemical analyses of coals.--Analyses of the coal samples taken in this and the adjacent McInturf Mesa quadrangle are listed in table 1. In general, chemical analyses of coals in the Lance and Fort Union Formations indicate that these coals are subbituminous B in rank on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Dotted lines shown on the derivative maps represent a limit of confidence beyond which isopach, structure contour, overburden isopach, and areal distribution and identified resources maps are not drawn because of insufficient data, even where it is believed that the coal beds may continue to be greater than Reserve Base thickness beyond the dotted lines.

Coal Beds in the Lance Formation

Coal beds in the Lance Formation have been identified in drill holes and outcrops sporadically throughout the Ralph White Lake quadrangle, and four are known to exceed Reserve Base thickness. Two of these coal beds, the Lance [1] and the Kimberley, have been isopached; the remaining two coal beds, the Lance [2] and Lance [3], were identified in an outcrop at one location only and are treated as isolated data points (see Isolated Data Points sections of this report).

Lance [1] Coal Bed

This coal bed was penetrated at depths exceeding 2,000 feet (610 m) by two oil and gas test wells drilled in the central part of the quadrangle where measured thicknesses were 5.0 and 8.0 feet (1.5 and 2.4 m).

Kimberley Coal Bed

The Kimberley coal bed crops out in the southeastern and southwestern corners of the quadrangle and has been mined locally at the White mine in the NW 1/4 sec. 4, T. 6 N., R. 89 W., where the coal bed is reported to be 8.8 feet (2.7 m) thick. In the southwestern part of the quadrangle, the Kimberley coal bed ranges from 9.6 to 13.8 feet (2.9 to 4.2 m) thick where measured along the outcrop.

Coal Beds in the Fort Union Formation

Coal beds in the Fort Union Formation have been identified in drill holes and outcrops at widespread locations throughout the Ralph White Lake quadrangle. Three coal beds exceed Reserve Base thickness, but only two, the Boone Gulch and the Seymour, have been isopached. The other coal bed, the Fort Union [4], was treated as an isolated data point. The Campbell coal bed was also identified in this quadrangle (Bass and others, 1955) and is not known to attain Reserve Base thickness.

Boone Gulch Coal Bed

The Boone Gulch coal bed crops out near the central part of the quadrangle and ranges in thickness from 2.0 to 8.6 feet (0.6 to 2.6 m) where measured along the outcrop. Its maximum reported thickness occurs in sec. 26, T. 7 N., R. 90 W.

Seymour Coal Bed

The Seymour coal bed crops out in the central part and northeastern corner of the quadrangle. It ranges in thickness from 0.9 to 6.2 feet (0.3 to 1.9 m) where measured in isolated outcrops. Only in two small areas does the coal bed exceed Reserve Base thickness; one is in sec. 13, T. 7 N., R. 90 W., and the other is in sec. 28, T. 8 N., R. 89 W., where its maximum measured thickness was reported.

Isolated Data Points

In instances where single or isolated measurements of coal beds thicker than 5 feet (1.5 m) are encountered, the standard criteria for construction of isopach, structure contour, overburden isopach, and mining ratio 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 beds. For this reason, isolated data points are included on a separate sheet (in U.S. Geological Survey files) for non-isopached coal beds. Descriptions and Reserve Base tonnages for the isolated data points occurring in this quadrangle, and the influence from an isolated data point in the adjacent Breeze Mountain quadrangle, are listed in table 4.

COAL RESOURCES

Data from drill holes, mine measured sections, and outcrop measurements (Bass and others, 1955; U.S. Geological Survey, 1946 and 1966), as well as data from oil and gas wells, were used to construct outcrop, isopach and structure contour maps of the coal beds in the Ralph White Lake quadrangle. The source of each indexed data point shown on plate 1 is listed in table 5.

Coal resources for Federal lands were calculated using data obtained from the coal isopach maps (plate 4) and the areal distribution and identified resources (ADIR) maps (plate 6). The coal bed acreage (measured by planimeter), multiplied by the average thickness of the coal bed and by a conversion factor of 1,770 short tons of coal per acre-foot (13,018 metric tons per hectare-meter) for subbituminous coal, yields the coal resources in short tons of coal for each coal bed. Coal beds thicker than 5.0 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 maximum depth of 1,000 feet (305 m) for subbituminous coal.

Reserve Base and Reserve tonnages for the Lance [1], Kimberley, Boone Gulch, and Seymour coal beds are shown on plate 6, 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 10.60 million short tons (9.62 million metric tons) for the entire quadrangle, including the tonnages for the isolated data points. Reserve Base tonnages in the various development potential categories for surface and subsurface mining methods are shown in tables 2 and 3.

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 were 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 as follows:

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

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 0.48 million short tons (0.44 millon metric tons) of coal available for surface mining.

The coal development potential for surface mining methods is shown on plate 7. Of those Federal land areas having a known development potential for surface mining, 77 percent are rated high, 19 percent are rated moderate, and 4 percent are rated low. The remaining Federal lands within the KRCRA boundary are classified as having unknown development potential for surface mining methods.

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 coal beds of Reserve Base thickness 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 development potential for in-situ mining methods.

Areas of high, moderate, and low development potential for conventional subsurface mining are defined as areas underlain by coal beds of Reserve Base thickness 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) below the ground surface, 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 those areas influenced by isolated data points and areas where coal beds of Reserve Base thickness are not known, but may occur. There are no areas influenced by isolated data points in this quadrangle which are considered to be amenable to conventional subsurface mining methods.

The coal development potential for conventional subsurface mining methods is shown on plate 8. Of those Federal land areas classified as having known development potential for conventional subsurface mining methods, 60 percent are rated high, 33 percent are rated moderate, and 7 percent are rated low The remaining Federal land within the KRCRA boundary is classified as having unknown development potential for conventional subsurface mining methods.

Because the coal beds have dips less than 15°, the development potential for in-situ mining methods is rated as unknown for all Federal lands within the KRCRA boundary in this quadrangle.

Table 1. -- Chemical analyses of coals in the Ralph White Lake quadrangle, Moffat and Routt 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
NE¼ sec. 4, T. 6 N., R. 89 W., White Mine (Bass and others, 1955)	Kimberley	A	20.7	32.4	42.9	4.0	0.5	-	-	-	-	-	9,730
		B	13.1	35.5	47.0	4.4	0.5	-	-	-	-	-	10,600
		C	-	40.9	54.1	5.0	0.6	-	-	-	-	-	12,270
SW¼ sec. 33, T. 7 N., R. 90 W., Haughy Mine (Bass and others, 1955)	Kimberley	A	21.8	31.6	42.5	4.1	0.7	-	-	-	-	-	9,660
		B	13.5	35.0	47.0	4.5	0.8	-	-	-	-	-	10,690
		C	-	40.5	54.3	5.2	0.9	-	-	-	-	-	12,360
SE¼ sec. 18, T. 8 N., R. 89 W., Seymour Mine (Bass and others, 1955) from McInturf Mesa quadrangle	Seymour	A	17.9	33.4	44.4	4.3	0.2	-	-	-	-	-	9,970
		B	14.9	34.7	46.0	4.4	0.2	-	-	-	-	-	10,340
		C	-	40.7	54.1	5.2	0.3	-	-	-	-	-	12,140

Form of Analysis: A, as received
B, air dried
C, moisture 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 Ralph White Lake quadrangle, Moffat and Routt Counties, Colorado.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Seymour	330,000	130,000	-	-	460,000
Boone Gulch	320,000	210,000	420,000	-	950,000
Kimberley	2,290,000	950,000	880,000	-	4,120,000
Isolated Data Points	-	-	-	480,000	480,000
Totals	2,940,000	1,290,000	1,300,000	480,000	6,010,000

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 Ralph White Lake quadrangle, Moffat and Routt Counties, Colorado.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Kimberley	2,540,000	-	-	-	2,540,000
Lance {1}	-	730,000	1,320,000	-	2,050,000
Totals	2,540,000	730,000	1,320,000	-	4,590,000

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

Table 4.--Descriptions and Reserve Base tonnages (in million short tons) for isolated data points

Coal Bed	Source	Location	Thickness	Reserve Base Tonnages Surface	Reserve Base Tonnages Subsurface
La[2]	U.S. Geological Survey, 1946	sec. 33, T. 7 N., R. 89 W.	9.0 ft (2.7 m)	0.12	0
La[3]	U.S. Geological Survey, 1946	sec. 33, T. 7 N., R. 89 W.	9.0 ft (2.7 m)	0.11	0
FU[4]	Bass and others (1955)	sec. 18, T. 7 N., R. 89 W.	6.0 ft (1.8 m)	0.22	0
		From Breeze Mountain Quadrangle			
La[47]	Bass and others (1955)	sec. 7, T. 6 N., R. 89 W.	6.0 ft (1.8 m)	0.03	0

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

Table 5. -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	Bass and others (1955), U.S. Geological Survey Bulletin 1027-D, pl. 24	Mine-Measured Section No. 334
2		Measured Section No. 337
3	Trend Exploration Co.	Oil/gas well No. 1-5 State
4	Bass and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 24	Measured Section No. 338
5		Measured Section No. 339
6		Measured Section No. 340
7		Measured Section No. 341
8		Measured Section No. 342
9	U.S. Geological Survey, 1946, Inactive Coal Prospecting Permit No. Denver-053919, Kenneth D. Carroll	Measured Section
10	U.S. Smelting, Refining, & Mining Co.	Oil/gas well No. 1-4 Gooch
11		Oil/gas well No. 1-11 Government
12		Oil/gas well No. 1-12 Government
13	Bass and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 24	Measured Section No. 412
14		Measured Section No. 413
15		Measured Section No. 414
16		Measured Section No. 415

Page 1 of 3

Table 5. -- Continued

Plate 1 Index Number	Source	Data Base
17	Bass and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 24	Measured Section No. 420
18		Measured Section No. 419
19		Measured Section No. 418
20		Measured Section No. 416
21		Measured Section No. 421
22		Measured Section No. 417
23		Measured Section No. 422
24		Mine-Measured Section No. 423
25		Measured Section No. 370
26		Measured Section No. 371
27		Measured Section No. 372
28	U.S. Geological Survey, 1966, Inactive Coal Prospecting Permit No. Colorado-0125987, Peabody Coal Co.	Drill hole No. 305
29	Bass and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 24	Measured Section No. 424
30	U.S. Smelting, Refining, & Mining Co.	Oil/gas well No. 1-27 Gulf State
31		Oil/gas well No. 2-28 McWilliams
32		Oil/gas well No. 1 Federal-Winder
33		Oil/gas well No. 2-33 Gooch

Table 5. -- Continued

Plate 1 Index Number	Source	Data Base
34	U.S. Smelting, Refining, & Mining Co.; Sun Oil Co.; and Grynberg	Oil/gas well No. 1-2018 State
35	Gulf Oil Corp.	Oil/gas well No. 1 State
36	U.S. Smelting, Refining, & Mining Co.	Oil/gas well No. 1-34 Gulf State

Page 3 of 3

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