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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE DUCK LAKE QUADRANGLE, CARBON COUNTY, WYOMING

[Report includes 14 plates]

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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

	Page
Introduction	1
Purpose	1
Location	1
Accessibility	1
Physiography	2
Climate and vegetation	2
Land status	3
General geology	3
Previous work	3
Stratigraphy	4
Structure	7
Coal geology	7
Coal beds of the Fort Union Formation	8
Red Rim coal bed	8
Olson Draw coal bed	9
Fillmore Ranch coal bed	9
Isolated data points	10
Coal resources	11
Coal development potential	12
Development potential for surface mining methods	12
Development potential for subsurface and in-situ mining methods	14
References	20

ILLUSTRATIONS

Plates 1-14. Coal resource occurrence and coal development potential maps:

1. Coal data map
2. Boundary and coal data map
3. Coal data sheet
4. Isopach and structure contour map of the Red Rim coal bed
5. Overburden isopach map of the Red Rim coal bed .
6. Areal distribution and identified resources map of the Red Rim coal bed
7. Isopach and structure contour map of the Olson Draw coal bed
8. Overburden isopach map of the Olson Draw coal bed
9. Areal distribution and identified resources map of the Olson Draw coal bed
10. Isopach map of the upper and lower splits of the Fillmore Ranch coal bed
11. Structure contour map of the Fillmore Ranch coal bed
12. Overburden and interburden isopach and mining ratio map of the Fillmore Ranch coal bed
13. Areal distribution and identified and hypothetical resources map of the upper and lower splits of the Fillmore Ranch coal bed
14. Coal development potential map for surface and subsurface mining methods

TABLES

		Page
Table 1.	Chemical analyses of coals in the Duck Lake quadrangle, Carbon County, Wyoming	16
2.	Coal Reserve Base data for surface mining methods for Federal coal lands (in short tons) in the Duck Lake quadrangle, Carbon County, Wyoming	17
3.	Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Duck Lake quadrangle, Carbon County, Wyoming	18
4.	Sources of data used on plate 1	19

INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Duck Lake quadrangle, Carbon County, Wyoming. This report was compiled to support the land planning work of the Bureau of Land Management (BLM) 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 14-08-0001-17104. 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, 1979, was used as the data base for this study. No new drilling or field mapping was performed, nor was any confidential data used.

Location

The Duck Lake quadrangle is located in southwestern Carbon County, approximately 16 airline miles (26 km) south of the town of Creston Junction and 25 airline miles (40 km) northwest of the town of Baggs, Wyoming. The quadrangle is unpopulated.

Accessibility

Wyoming Highway 789 crosses north-south along the eastern side of the Duck Lake quadrangle, connecting Creston Junction and Interstate Highway 80 to the north of the quadrangle boundary with Baggs to the south. An improved light-duty road crosses through the southwestern third of the quadrangle connecting the town of Wamsutter, approximately 15 miles (24 km) northwest of the quadrangle, with Wyoming Highway 789 to the south in the adjacent Mexican Flats quadrangle. The remainder of the quadrangle is served by numerous unimproved dirt roads and trails. Interstate Highway 80 crosses east-west through southern Wyoming approximately 16 airline miles (26 km) north of the quadrangle (U.S. Bureau of Land Management, 1971; Wyoming State Highway Commission, 1978).

The main east-west line of the Union Pacific Railroad lies approximately 15 airline miles (24 km) north of the quadrangle. This line crosses southern Wyoming, providing railway service between Ogden, Utah, to the west and Omaha, Nebraska, to the east.

Physiography

The Duck Lake quadrangle lies on the eastern edge of the Washakie Basin. The landscape is characterized by buttes with steep escarpments, badlands and low irregular terrain. Altitudes range from approximately 6,550 feet (1,996 m) on Barrel Springs Draw in the southwestern corner of the quadrangle to approximately 7,080 feet (2,158 m) on a butte in the north-central part of the quadrangle.

Muddy Creek, a tributary of the Little Snake River to the south of the quadrangle, flows southward across the southeastern part of the quadrangle. Coal Gulch and Little Coal Gulch, tributaries of Barrel Springs Draw, drain the western half of the quadrangle and Antelope Creek drains the northeastern corner of the quadrangle. Both Barrel Springs Draw and Antelope Creek are tributaries of Muddy Creek. Duck Lake, located in the southwestern part of the quadrangle, drains into Coal Gulch. With the exception of Muddy Creek, all of the streams in the quadrangle are intermittent and flow mainly in response to snowmelt in the spring.

Climate and Vegetation

The climate of south-central Wyoming is semiarid, characterized by low precipitation, rapid evaporation, and large daily temperature variations. Summers are usually dry and mild, and winters are cold. The average annual precipitation in the area is approximately 10 inches (25 cm). Approximately two thirds of the precipitation falls in the spring and summer during a seven-month period from April through October (Wyoming Natural Resources Board, 1966).

The average annual temperature in the area is 43°F (6°C). The temperature during January averages 21°F (-6°C) and typically ranges from

12°F (-11°C) to 31°F (-0.6°C). During July the average temperature is 68°F (20°C), and the temperature typically ranges from 51°F (11°C) to 84°F (29°C) (Wyoming Natural Resources Board, 1966).

Winds are usually from the southwest and the west-southwest with an average annual velocity of 12 miles per hour (19 km per hr) (U.S. Bureau of Land Management, 1978).

Principal types of vegetation in the quadrangle include grasses, sagebrush, greasewood, saltbush, rabbitbrush, and other desert shrubs.

Land Status

The Duck Lake quadrangle lies on the southwestern edge of the proposed Rawlins Known Recoverable Coal Resource Area (KRCRA). Approximately 80 percent of the quadrangle's total area lies within the proposed KRCRA boundary and the Federal government owns the coal rights for approximately half of this area, as shown on plate 2. No outstanding Federal coal leases, prospecting permits or licenses occur within the quadrangle.

GENERAL GEOLOGY

Previous Work

Ball and Stebinger described the geology and mineral resources of the eastern part of the Little Snake River coal field in 1910. The stratigraphy and depositional environments of Upper Cretaceous rocks in Wyoming and adjacent areas were described by Hale (1961), Haun (1961), Lewis (1961), and Weimer (1961). Masursky (1962) included a description of the depositional environments of the Wasatch Formation in a pubication on the uranium-bearing coal in the eastern part of the Red Desert area. Henderson (1962) described Cretaceous stratigraphy and the geology of the Doty Mountain-Dad area of Wyoming. Welder and McGreevy (1966) conducted a ground-water study of the Great Divide and Washakie Basins of southwestern Wyoming and included a regional geologic map of the area. Roehler (1969) discussed the stratigraphy and depositional environments of Eocene rocks in the Washakie Basin. Gill and others (1970) described the stratigraphy and nomenclature of some of the Upper Cretaceous and Lower Tertiary rocks found in south-central Wyoming. Land (1972) discussed the depositional environments of the Fox Hills Sandstone and the Lance Formation. Barclay and Zimmerman (1976) discussed the stratigraphy of the formations that were drilled by the U.S. Geological Survey in the eastern Doty Mountain area during 1975. Edson (1976) and Edson and Curtiss (1976) reported on the geology and coal resources of the High Point, Seaverson Reservoir, and Fillmore Ranch quadrangles to the north of the quadrangle. Tyler (1978) prepared correlation diagrams of geophysical logs from drill holes in the Washakie Basin. Recent geologic mapping by Hettinger has been performed in adjacent northwest and southwest quarters of the Doty Mountain 15-minute quadrangle (1978a and 1978c) and the Mexican Flats quadrangle (1978d). The U.S. Geological Survey (Hettinger, 1979) recently completed a drilling program in this and adjacent quadrangles.

Stratigraphy

The formations exposed in the Duck Lake quadrangle range in age from Late Cretaceous to Eocene and crop out in northeast-trending bands across the quadrangle. The Fort Union Formation of Paleocene age and the Wasatch Formation of Eocene age are known to be coal-bearing, and the Lance Formation of Late Cretaceous age contains coal beds at depths greater than 3,000 feet (914 m) in this quadrangle.

The Lance Formation is present in the subsurface of this quadrangle and crops out across the central part of the the adjacent northwest quarter of the Doty Mountain 15-minute quadrangle. It ranges in thickness from 1,165 to 1,456 feet (355 to 444 m) where measured in oil and gas wells drilled in the this quadrangle. The formation consists of a non-marine sequence of carbonaceous shale, sandstone, and siltstone with coal beds occurring immediately above the contact with the underlying Fox Hills Sandstone (Haun, 1961).

Unconformably overlying the Lance Formation, the Fort Union Formation crops out in the eastern half of the quadrangle and ranges in thickness from 1,700 to 1,970 feet (518 to 600 m) where measured in oil and gas wells drilled in this quadrangle. At the base of the formation is from 700 to 1,000 feet (213 to 305 m) of white to brown fine- to coarse-grained, massive to thin-bedded, generally cross-bedded sandstone, chert-pebble conglomerate, and ironstone (Henderson, 1962). Above this basal sandstone and conglomerate unit, the formation grades into 900 to 1,100 feet (274 to 335 m) of interbedded light-colored sandstone, brown siltstone, gray sandy shale, dark-gray carbonaceous shale, and coal (Henderson, 1962). All of the major coal beds occur in a zone that ranges from 650 to 800 feet (198 to 244 m) thick and lies immediately above the basal sandstone and conglomerate unit.

The Wasatch Formation of Eocene age conformably overlies the Fort Union Formation and crops out in a northwest-trending band across the western three quarters of the quadrangle. The formation is divided into three parts, the basal main body, the Niland Tongue, and the Cathedral Bluffs Tongue. The tongues are separated from each other and the main body by tongues of the Green River Formation. The main body of the Wasatch Formation is approximately 2,000 feet (610 m) thick where it crops out in the quadrangle and consists primarily of fluviatile red mudstone and sandstone (Roehler, 1969). The Niland Tongue consists predominantly of gray mudstone and gray to nearly white lenticuar sandstone beds with interbedded carbonaceous shale and coal beds and lies between the Luman and Tipton Tongues of the Green River Formation (Bradley, 1964). This member is approximately 300 feet (91 m) thick but coalesces with the main body of the Wasatch Formation in this quarangle (Roehler, 1969). The Cathedral Bluffs Tongue, consisting of interbedded variegated mudstone and sandstone, overlies the Tipton Tongue. A total section of this member is not present in this quadrangle.

The Luman Tongue of the Eocene Green River Formation is overlain by the Niland Tongue of the Wasatch Formation and underlain by the main body of the Wasatch. According to Roehler (1969), the Luman Tongue thins and pinches out near the northeastern corner of T. 16 N., R. 93 W., and is composed of low-grade oil shale and thin beds of coquinal limestone, limy sandstone, and locally carbonaceous shale. The Tipton Tongue overlies the Niland Tongue and main body of the Wasatch Formation and underlies the Cathedral Bluffs Tongue of the Wasatch Formation. It maintains a thickness of approximately 160 feet (49 m) in the quadrangle and consists largely of soft papery low-grade oil shale, but contains a few thin, brownish fine-grained limy sandstone beds and layers of concretionary, sandy, coquinal or oolitic limestone (Bradley, 1964).

Holocene deposits of alluvium cover the stream valleys of Muddy Creek, Coal Gulch, and their tributaries.

The Upper Cretaceous formations in the subsurface of the Duck Lake quadrangle indicate the transgressions and regressions of a broad, shallow, north-south-trending seaway that extended across central North America. These formations accumulated near the western edge of the sea and reflect the location of the shoreline (Weimer, 1960 and 1961).

During the gradual recession of the last Cretaceous sea, marking the close of the Cretaceous period, carbonaceous shales, mudstones, and coal beds of the lower part of the Lance Formation were deposited in broad areas of estuarine, marsh, lagoonal, and coastal swamp environments (Land, 1972), while the uppermost sandstones and siltstones represent the accumulation of sediments in continental-fluvial environments (Beaumont, 1979).

After the final withdrawal of the Cretaceous sea, thick sections of detrital material, eroded from older formations, were deposited as the Fort Union Formation. The coarse conglomerates and sandstones of the lower sandy unit indicate a braided stream environment, and the interbedded sandstones, siltstones, shales, and coal beds of the upper part of the formation represent the development of broad, thick floodplain and backswamp deposits (Beaumont, 1979).

The coarse sediments at the base of the main body of the Wasatch Formation were deposited in a fluvial environment that resulted from renewed tectonic uplift to the southwest (Beaumont, 1979). The remainder of the main body, as well as the Niland and Cathedral Bluffs tongues of the formation, was deposited in alternating swamp, lake, and stream environments (Masursky, 1962). The oil shale and limestone beds of the tongues of the Green River Formation represent deposition in widespread lacustrine environments. This intertonguing of the Wasatch and Green River Formations represents a series of alternate withdrawals and flooding that interrupted otherwise continuous lacustrine Green River deposition (Roehler, 1969).

Structure

The Duck Lake quadrangle is located on the southeastern edge of the Wamsutter Arch which divides the Washakie Basin to the south from the Great Divide Basin to the north. Outcrops of beds in the quadrangle strike north and dip 3° to 35° to the west.

Numerous east-west trending normal faults were mapped by Hettinger (1978a) in the southeastern corner of the quadrangle.

COAL GEOLOGY

The Fort Union and Wasatch Formations contain coal in the Duck Lake quadrangle. The Fort Union Formation coal beds occur in a zone immediately above the lower sandy unit, and three of these coal beds have been isopached in this quadrangle. Several coal beds within the Wasatch Formation were encountered in an oil and gas well drilled in the quadrangle. However, only one coal bed exceeds Reserve Base thickness (5.0 feet or 1.5 meters) and has been treated as an isolated data point (see Isolated Data Points section of this report).

Chemical analyses of coals.--Chemical analyses were not available for coals in the Fort Union Formation in this quadrangle, but representative analyses from the northwest quarter of the Doty Mountain 15-minute quadrangle are listed in table 1. In general, coals in the Fort Union coal zone rank as subbituminous B or C on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Information was not available on the quality of the coal in the Wasatch Formation in this quadrangle. However, RMEC (oral communication, 1978) has indicated that the Wasatch Formation coals in the Creston quadrangle to the north are high in uranium and sulfur and range from lignite to subbituminous B or C in rank.

Coal Beds of the Fort Union Formation

The Fort Union is the most important coal-bearing formation in this and adjacent quadrangles to the north, east and south. Several coal beds occur in a zone that crops out in a northeast-trending band in the southeastern corner of the quadrangle, three of which have been isopached using oil and gas well data, surface measurements (Hettinger, 1978b), and recent data from a coal test hole (Hettinger, 1979).

Red Rim Coal Bed

The Red Rim coal bed (plate 4) is named for Red Rim ridge located in T. 20 N., R. 90 W., in the northwest quarter of the Bridger Pass 15-minute quadrangle (Edson, 1976). This is, stratigraphically, the lowest isopached coal bed in the Fort Union Formation in this quadrangle. It lies approximately 700 to 1,000 feet (213 to 305 m) above the unconformable contact of the Fort Union Formation and the underlying Lance Formation. Where penetrated by oil and gas wells at depths greater than 3,000 feet (914 m), the coal bed ranges in thickness from 3 to 5 feet (0.9 to 1.5 m). However, based on data projected into this quadrangle from the adjacent Doty Mountain 15-minute quadrangle to the east and the Mexican Flats quadrangle to the south, it is believed that this coal bed may be as much as 9 feet (2.7 m) thick in the southeast corner of this quadrangle.

In general, this coal bed is prominent and widespread in quadrangles to the northeast, east, and south. In the Seaverson Reservoir quadrangle, the coal bed has a maximum measured thickness of 21 feet (6.4 m) and could be even thicker in the northeastern corner of that quadrangle. In the Doty Mountain 15-minute quadrangle, maximum measured thicknesses range from 12.0 to 16.9 feet (3.7 to 5.2 m) and the coal bed contains a shale parting that is up to 1.6 feet (0.5 m) thick. In the Mexican Flats quadrangle, the Red Rim coal bed has a maximum measured thickness of 12 feet (3.7 m), with a shale parting 2 feet (0.6 m) thick, and may be as much as 15 feet (4.6 m) thick.

Olson Draw Coal Bed

This coal bed is named for Olson Draw located in T. 18 N., R. 91 W. (Edson, 1976). The Olson Draw coal bed (plate 7) is stratigraphically above and separated from the Red Rim coal bed by approximately 90 to 220 feet (27 to 67 m) of interbedded sandstone, siltstone and shale. In this quadrangle the coal bed was identified in oil and gas wells at depths greater than 3,000 feet (914 m) and has a maximum measured thickness of 8 feet (2.4 m) where penetrated by an oil and gas well in sec. 26, T. 17 N., R. 93 W. Although this coal bed persists over a widespread area, it tends to be generally less than Reserve Base thickness in this and adjacent quadrangles. However, based on data projected into this quadrangle from the east and south, it is believed that the Olson Draw coal bed exceeds 5.0 feet (1.5 m) in thickness in the extreme southeast corner of this quadrangle.

Fillmore Ranch Coal Bed

This coal bed was named for Fillmore Ranch (Edson, 1976) located in sec. 6, T. 18 N., R. 90 W. The Fillmore Ranch coal bed (plate 10) is the thickest and most extensive coal bed in the Fort Union Formation in this and adjacent quadrangles. It lies approximately 715 feet (218 m) above the Red Rim coal bed and is split by a rock parting that varies in thickness from 1 to 54 feet (0.3 to 16.5 m) in this quadrangle. The lower, thicker split of the coal bed ranges in thickness from 10 feet

(3.0 m), where measured in an oil and gas well at a depth greater than 3,000 feet (914 m), to 14 feet (4.3 m) where measured in an oil and gas well located in sec. 36, T. 17 N., R. 93 W. The upper split ranges from 2 to 9 feet (0.6 to 2.7 m) in thickness. The dotted line across the northern part of plates 10, 11, 12, and 13 represents 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, although it is believed that the coal bed may continue to be of Reserve Base thickness beyond the dotted line.

In the northwest quarter of the Doty Mountain 15-minute quadrangle, the rock parting becomes thinner and less prominent, ranging in thickness from 0.3 to 15 feet (0.1 to 4.6 m) and averaging about 4 feet (1.2 m). The coal below the parting ranges from 7 to 23 feet (2.1 to 7.0 m) thick while the upper split ranges from 5 to 10 feet (1.5 to 3.0 m) thick. Because the rock parting becomes less significant and the splits of the Fillmore Ranch coal bed become thicker, this bed was not isopached as a split coal bed in the northwest quarter of the Doty Mountain 15-minute quadrangle.

In the Mexican Flats quadrangle and the southwest quarter of the Doty Mountain 15-minute quadrangle, the rock parting remains quite thick and the Fillmore Ranch coal bed is isopached as a split bed. In the Mexican Flats quadrangle, the parting ranges from 1.3 to 49 feet (0.4 to 14.9 m) thick, the lower coal split varies from 6 to 14 feet (1.8 to 4.3 m), and the upper coal split ranges from 2 to 10 feet (0.6 to 3.0 m) in thickness. In the southwest quarter of the Doty Mountain 15-minute quadrangle, the parting ranges in thickness from 2.1 to 19 feet (0.6 to 5.8 m), the lower split from 6 to 10.9 feet (1.8 to 3.3 m), and the upper split 2.3 to 10.9 feet (0.7 to 3.3 m).

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, mining ratio, and overburden isopach maps are not available. The lack of data concerning these 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. The isolated data point occurring in this quadrangle is listed below. The unidentified Wasatch coal bed is not formally named, but has been given a bracketed number for identification purposes in this quadrangle only.

Source	Location	Coal Bed	Thickness
Amoco Production Company	sec. 11, T. 17 N., R. 93 W.	Wa[1]	14 ft (4.3 m)

COAL RESOURCES

Information from oil and gas wells, and one coal test hole from the U.S. Geological Survey, as well as a geologic map by Hettinger (1978b), were used to construct outcrop, isopach, and structure contour maps of the coal beds in the Duck Lake quadrangle.

Coal resources were calculated using data obtained from the coal isopach maps (plates 4, 7, and 10). The coal bed acreage (measured by planimeter) multiplied by the average isopached 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 for each isopached 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 used in calculating Reserve Base and Reserve tonnages as stated in U.S. Geological Survey Bulletin 1450-B which calls for a maximum depth of 1,000 feet (305 m) for subbituminous coal.

Reserve Base and Reserve tonnages for the isopached beds are shown on plates 6, 9, and 13, 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 isolated data points. Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 393.67 million short tons (357.14 million metric tons) for the entire quadrangle, including tonnages from the isolated data point. Reserve Base tonnages in the various development potential categories for surface and subsurface mining methods are shown in tables 2 and 3. The source of each indexed data point shown on plate 1 is listed in table 4.

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 so as 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 shown on the following page:

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

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 potentials 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. Limited knowledge pertaining to the areal distribution, thickness, depth, and attitude of the coals in these areas prevents accurate evaluation of the development potential in the high, moderate, or low categories.

The coal development potential for surface mining methods is shown on plate 14. All of the Federal land areas having a known development potential for surface mining methods are rated high. The remaining Federal lands within the proposed 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 are those areas where the 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 a development potential for in-situ mining methods.

Areas of high, moderate, and low development potential for 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 areas where coal beds of Reserve Base thickness are not known, but may occur, and to that area influenced by the isolated data point. The area influenced by the isolated data point in this quadrangle contains approximately 4.89 million short tons (4.44 million metric tons) of coal available for conventional subsurface mining.

The coal development potential for subsurface mining methods is shown on plate 14. Of the Federal land areas having a known development potential for conventional subsurface mining methods, 4 percent are rated high, 32 percent are rated moderate, and 64 percent are rated low. The remaining Federal lands within the proposed KRCRA boundary are classified as having unknown development potential for conventional subsurface mining methods.

Based on criteria provided by the U.S. Geological Survey, coal beds of Reserve Base thickness dipping between 15° and 35°, regardless of tonnage, have low development potential for in-situ mining methods. Coal lying between the 200-foot (61-m) overburden isopach and the outcrop is not included in total coal tonnages available because it is needed for cover and containment in the in-situ process.

All of the Federal lands where the dip of the coal beds exceeds 15° are rated low for in-situ development potential because faults are present and only approximately 37.47 million short tons (33.99 million metric tons) of coal distributed through three different coal beds are believed to be available for in-situ mining. The remaining Federal lands within the proposed KRCRA boundary are classified as having unknown development potential for in-situ mining methods.

Table 1. -- Chemical analyses of coals in the Duck Lake quadrangle, Carbon County, Wyoming.

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, NW¼, sec. 5, T. 17 N., R. 91 W., (RMEC, CB-96)	Fillmore Ranch	A	22.7	30.4	42.1	4.8	0.2	-	-	-	-	-	9,206
		C	0.0	39.3	54.5	6.2	0.3	-	-	-	-	-	11,902
NE¼, SE¼, sec. 33, T. 18 N., R. 91 W., (RMEC, CB-81)	Red Rim	A	24.3	29.7	33.5	7.6	0.7	-	-	-	-	-	8,646
		C	0.0	39.2	50.8	10.1	0.9	-	-	-	-	-	11,416

Form of Analysis: A, as received
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 Duck Lake quadrangle, Carbon County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Olson Draw	0	0	0	0	0
Red Rim	0	0	0	0	0
Fillmore Ranch	1,120,000	60,000	0	0	1,180,000
Totals	1,120,000	60,000	0	0	1,180,000

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 Duck Lake quadrangle, Carbon County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Olson Draw	0	0	0	920,000*	920,000
Red Rim	0	0	18,660,000	12,920,000*	31,580,000
Fillmore Ranch	14,680,000	100,450,000[a]	216,340,000[b]	23,630,000*	355,100,000
Isolated Data Points	0	0	0	4,890,000	4,890,000
Totals	14,680,000	100,450,000	235,000,000	42,360,000	392,490,000

*Tonnages for coal beds dipping greater than 15 degrees.

a - This total includes 5.17 million tons of hypothetical resources. (See Plate 13)
b - This total includes 1.66 million tons of hypothetical resources. (See Plate 13)

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	Hettinger, 1979, U.S. Geological Survey	Drill hole No. DL-1
2	Kemmerer Coal Co.	Oil/gas well No. 10-1 Barrel Springs Unit
3	Pan American Petroleum Corp.	Oil/gas well No. 3 Barrel Springs Unit
4	Kemmerer Coal Co.	Oil/gas well No. 11-1 Barrel Springs Unit
5	John M. Hamilton	Oil/gas well No. 1-8 Government
6	↓	Oil/gas well No. 1-9 U.P.R.R. Eureka Pool
7	↓	Oil/gas well No. 1-18 Government
8	Amoco Production Co.	Oil/gas well No. 1 Champlin 226-Amoco "A"
9	William Moss Properties	Oil/gas well No. 26-17-93 Federal
10	Kemmerer Coal Co.	Oil/gas well No. 36-1 State
11	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 2AS
12	↓	Drill hole No. 3AS
13	↓	Drill hole No. 1AS
14	↓	Drill hole No. 2AS

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