Text to Accompany:

Open-File Report 79-1023

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE BITTER CREEK NW QUADRANGLE, SWEETWATER COUNTY, WYOMING

[Report includes 16 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.

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INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Bitter Creek NW quadrangle, Sweetwater County, Wyoming. This report was compiled to support the land planning work of the Bureau of Land Management 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 Published and unpublished public information gathered through April, 1978, was used as the data base for this study.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 Bitter Creek NW quadrangle is located in central Sweetwater County, Wyoming, approximately 2 miles (3.2 km) east of the town of Point of Rocks, 7 miles (11.3 km) northwest of the town of Bitter Creek, and 26 miles (42 km) east of the city of Rock Springs, Wyoming. The quadrangle is unpopulated.

Accessibility

Interstate Highway 80 crosses east-west through the southern half of the quadrangle. An improved light-duty service road parallels Interstate Highway 80 across the quadrangle, and a second improved light-duty road extends northward along Deadman Wash on the western edge of the quadrangle. Numerous unimproved dirt roads and trails provide access through the remainder of the quadrangle.

The main east-west line of the Union Pacific Railroad crosses approximately 2 miles (3.2 km) south of the quadrangle. This line provides railway service across southern Wyoming, connecting Ogden, Utah to the west with Omaha, Nebraska to the east.

Physiography

The Bitter Creek NW quadrangle lies on the eastern flank of the Rock Springs uplift. Most of the landscape is characterized by gentle dip-slope topography. A broad valley along Deadman Wash is bordered on the east by 300-foot (91-m) high cliffs (Madden, 1977). Altitudes range from approximately 6,520 feet (1,987 m) on Deadman Wash along the western edge of the quadrangle to 7,220 feet (2,201 m) along the northern quadrangle boun-
dary.

Deadman Wash flows southward through a broad valley in the western third of the quadrangle, joining Bitter Creek just west of the quadrangle boundary. Tenmile Draw, a tributary of Deadman Wash, flows southwesterly across the central part of the quadrangle. All of the streams in the quadrangle are intermittent, flowing mainly in response to snowmelt in the spring.

Climate and Vegetation

The climate of southwestern Wyoming is semiarid and is characterized by low precipitation, rapid evaporation, and large daily temperature changes. Summers are usually dry and mild, and winters are cold. The annual precipitation averages 9 inches (23 cm), with approximately two thirds falling during the spring and early summer months (Wyoming Natural Resources Board, 1966).

The average annual temperature is 42°F (6°C). The temperature during January averages 18°F (-8°C), with temperatures typically ranging from 8°F (-13°C) to 28°F (-2°C). During July temperatures typically range from 54°F (12°C) to 84°F (29°C), with an average of 69°F (21°C) (Wyoming Natural Resources Board, 1966; U.S. Bureau of Land Management, 1978).

Winds are usually from the west-southwest and southwest with an average velocity of 11 miles per hour (18 km per hr) (U.S. Bureau of Land Management, 1978).

Principal types of vegetation in the area include sagebrush, saltbush, rabbitbrush, greasewood, and grasses (U.S. Bureau of Land Management, 1978).

Land Status

The Bitter Creek NW quadrangle lies in the eastern part of the Rock Springs Known Recoverable Coal Resource Area (KRCRA) and almost all of the quadrangle, except for a small area in the northeast corner, lies within the KRCRA boundary. However, all of the quadrangle will be considered in this report. The Federal government owns the coal rights for approximately half of the quadrangle, and three active coal leases are present within the KRCRA boundary, as shown on plate 2.

GENERAL GEOLOGY

Previous Work

Schultz described the geology and coal resources of the northern part of the Rock Springs coal field in 1909. Hale described the stratigraphy and depositional history of the formations cropping out on the flanks of the Rock Springs uplift in 1950 and 1955. Yourston (1955) described the structure and stratigraphy of the coal-bearing formations in the Rock Springs coal field and reported chemical analyses for coals in the Rock Springs area. Weimer (1960), Heppe (1960), Smith (1961 and 1965), and Burger (1965) described the stratigraphy and discussed the depositional environment of Upper Cretaceous formations in the Rock Springs area. The depositional history of the Late Cretaceous-age formations exposed on the flanks of the Rock Springs uplift was also described by Weimer (1961), Lewis (1961), and Douglas and Blazzard (1961). Roehler (1961) described the Late Cretaceous-Tertiary unconformity present in the Rock Springs area. Lawson and Cowson described the geology of the Arch Unit and adjacent areas in 1961. Land mapped the Fox Hills Sandstone and associated formations on the eastern flank of the Rock Springs uplift in 1972 and described their stratigraphy and depositional history. Coal analyses and measured sections of coals in the Rock Springs coal field were described by Glass in 1975. Roehler and others described the geology and coal resources of the Rock Springs coal field in 1977. Roehler prepared a generalized geologic map of the Rock Springs uplift in 1977. The geology and coal resources of the Bitter Creek NW quadrangle were mapped by Madden in 1977.

Stratigraphy

The formations exposed in the Bitter Creek NW quadrangle range in age from Late Cretaceous to Paleocene and crop out in northwest-trending bands across the quadrangle. The Almond and the Lance Formations, both of Late Cretaceous age, and the Fort Union Formation of Paleocene age contain significant amounts of coal.

The Mesaverde Group of Late Cretaceous age is subdivided into four formations which are, in ascending order, the Blair Formation, the Rock Springs Formation, the Ericson Sandstone, and the Almond Formation. Only the Ericson Sandstone and the Almond Formation crop out in the quadrangle. The other formations occur in the subsurface.

The Rock Springs Formation, conformably overlying the Blair Formation, ranges in thickness from approximately 1,555 to 1,985 feet (474 to 605 m) where measured in the oil and gas wells drilled in the quadrangle. It consists of gray marine shale, thin sandstone, and minor thin deltaic coal beds. The Rock Springs Formation in this quadrangle is subdivided into members or tongues that are marine equivalents of the continental facies of the Rock Springs Formation found along the northwestern flanks of the Rock Springs uplift. The members (not shown on plate 3) are, from bottom to top: the Chimney Rock tongue, the Black Butte tongue, the Brooks Sandstone tongue, the Coulson tongue, the McCourt Sandstone tongue, and the Gottsche tongue (Hale, 1950; Smith, 1961 and 1965; Burger, 1965; Madden, 1977).

The Ericson Sandstone crops out in a small area in the southwestern corner of the quadrangle (Madden, 1977) and is composed of upper and lower units of white to light-gray, fine- to medium-grained massive sandstone separated by a middle member of shale and rusty-weathering sandstone. The units, from bottom to top, are the Trail member or zone (Smith, 1961), the Rusty member or zone (Hale, 1950), and the Canyon

Creek member or zone (Smith, 1961). The formation usually ranges in thickness from 900 to 1,000 feet (274 to 305 m), where measured in the oil and gas wells drilled in the quadrangle.

The Almond Formation, conformably overlying the Ericson Sandstone, crops out as a northwest-trending band in the southwestern corner of the quadrangle. The formation consists of interbedded dark-gray and brown carbonaceous shale, thin red siltstone, dark-gray and brown mudstone and gray fine-grained calcareous sandstone alternating with coal beds of variable thickness and quality. This sequence is topped by a predominantly buff-colored to light-gray, thick-bedded to massive fine-grained sandstone (Hale, 1950 and 1955, and Lewis, 1961). According to Heppe (1960), the Almond Formation thickens rapidly both to the northwest and to the south along the flanks of the Rock Springs uplift. It ranges in thickness from 225 to 340 feet (69 to 104 m) in the oil and gas wells drilled in the quadrangle.

The Lewis Shale of Late Cretaceous age, cropping out in a northwest-trending band across the western third of the quadrangle (Madden, 1977), conformably overlies the Almond Formation. This formation ranges in thickness from 720 to 1,045 feet (219 to 319 m) where measured in the oil and gas wells drilled in the quadrangle and consists of dark-bluish-gray gypsiferous silty shale with occasional thin beds of siltstone, sandy limestone, sandstone, and a number of thin, widespread bentonite beds (Heppe, 1960; Land, 1972).

The Late Cretaceous-age Fox Hills Sandstone intertongues with the underlying Lewis Shale and crops out as a narrow northwest-trending band in the western half of the quadrangle (Madden, 1977). The Fox Hills Sandstone is composed of a lower light-brown, very fine to fine-grained, thin-bedded silty cross-bedded sandstone overlain by a light-gray, fine- to medium-grained massive cross-bedded sandstone. The two types of sandstone are separated by a marked erosional or scour surface (Land, 1972). The Fox Hills Sandstone ranges from 120 to 340 feet (37 to 104 m) thick as indicated by the oil and gas wells drilled in the quadrangle.

The Lance Formation of Late Cretaceous age conformably overlies the Fox Hills Sandstone and crops out as a broad northwest-trending band in the western two thirds of the quadrangle (Madden, 1977). This formation ranges from 650 to 900 feet (198 to 274 m) thick in the oil and gas wells drilled in the quadrangle. It consists of interbedded tan to light-gray, fine- to medium-grained calcareous cross-bedded sandstone, light- to dark-brown carbonaceous silty shale, brown lignitic shale, thin red-stained siltstone and coal (Lawson and Crowson, 1961; Madden, 1977).

The Fort Union Formation of Paleocene age unconformably overlies the Lance Formation, and is exposed as a broad northwest-trending band in the eastern part of the quadrangle (Madden, 1977). According to Roehler and others (1977), the Fort Union Formation ranges in thickness from approximately 1,000 to 1,500 feet (305 to 457 m). Approximately 1,330 feet (405 m) of the formation is exposed in this quadrangle. The Fort Union Formation consists of interbedded light-gray shale, sandy shale, mudstone, siltstone, thick beds of gray-white to white, coarse-grained unconsolidated sandstone, thin medium-grained cross-bedded sandstone, and coal (Lawson and Crowson, 1961; Madden, 1977).

Holocene deposits of alluvium cover the stream valleys of Deadman Wash and Tenmile Draw.

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

The Rock Springs Formation, in this quadrangle, consists of shales and sandstones deposited in a marine environment (Hale, 1950; Smith, 1961 and 1965).

Sandstones of the Ericson Sandstone were deposited in stream and floodplain environments with a source area to the northwest (Douglass and Blazzard, 1961; Gosar and Hopkins, 1969).

The Almond Formation reflects deposition in fresh-water coastal swamps, brackish-water lagoons and shallow-water marine environments (Hale, 1950).

The neritic shale and siltstone of the Lewis Shale were deposited in water depths ranging from a few tens of feet to several hundred feet (Hale, 1950 and 1955; Land, 1972).

The lower finer-grained sandstone of the Fox Hills Sandstone was deposited in littoral and near-shore marine environments while the upper coarser-grained sandstone was deposited in an estuarine or tidal river channel environment (Land, 1972).

The Lance Formation, consisting of swamp, lagoonal, floodplain and channel sand deposits, was formed on the landward side of the Late Cretaceous sea shoreline as the sea retreated to the east (Gosar and Hopkins, 1969; Roehler and others, 1977).

After the final withdrawal of the Cretaceous sea, the Fort Union Formation was deposited in a paludal or swamp environment (Roehler, 1961).

Structure

The Bitter Creek NW quadrangle lies on the eastern flank of the Rock Springs uplift which separates the Great Divide and Green River structural basins. The Rock Springs uplift is a doubly plunging asymmetric anticline with the west limb having the steeper dips (5° to 30° to the west). Dips along the east limb are from 5° to 8° to the east (Roehler and others, 1977).

The strike of the beds in the quadrangle is generally northwest, with dips of 3° to 5° to the northeast. One steeply dipping reverse fault and several normal faults cut the formations perpendicular to their strike. The faults dip from 60° to vertical. The stratigraphic displacement, measured along five fault traces, ranges from 95 to 1,000 feet (29 to 305 m) (Madden, 1977).

COAL GEOLOGY

Four formations are known to contain coal in the Bitter Creek NW quadrangle. In the Rock Springs Formation, a few thin coal beds of deltaic origins were encountered in several of the oil and gas wells drilled in the quadrangle. Lenticular coals occur throughout the Almond Formation and at least ten lenticular coal beds occur within the lower 300 feet (91 m) of the Lance Formation (Madden, 1977). The important and extensive Deadman coal bed(s) is present in the lower 200 feet (61 m) of the Fort Union Formation.

Chemical analyses of coal.--No chemical analyses were available for coal beds in the Rock Springs, Almond, Lance, and Fort Union Formations in this quadrangle, but representative analyses from the Bitter Creek NW area are listed in table 1. In general, chemical analyses indicate that coal beds in the Rock Springs Formation rank as high-volatile C bituminous, and coal beds in the Almond, Lance and Fort Union Formations rank as subbituminous A or B on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Coal Beds of the Rock Springs Formation

The Rock Springs Formation is of deltaic origin in this quadrangle and contains very little coal. It bears little resemblance to the paludal sequences of thick coal beds found near the city of Rock Springs. Several coal beds in the Rock Springs Formation were penetrated by oil and gas wells in the western half of the quadrangle, but only two coal beds are greater than Reserve Base thickness (5.0 feet or 1.5 meters) and have been treated as isolated data points (see Isolated Data Points section of this report).

Coal Beds of the Almond Formation

A few Almond Formation coal beds, generally lenticular and thin, crop out in the southwestern part of the quadrangle. Two of these, the Almond [1] and the Almond [3] coal beds have been isopached (plate 4). The isopached Almond Formation coal beds are not formally named and have been given bracketed numbers for identification purposes. The Almond [1] coal bed crops out just north of the fault in sec. 12, T. 19 N., R. 101 W., and attains a maximum reported thickness of 8 feet (2.4 m). The Almond [3] coal bed is 6 feet (1.8 m) thick locally, and crops out in sec. 36, T. 20 N., R. 101 W. These coal beds can be traced to the northwest into the Point of Rocks quadrangle and to the southeast into the Black Buttes quadrangle where they are generally less than 5 feet (1.5 m) thick. The coal beds dip 4° to 5° to the northeast.

Coal Beds of the Lance Formation

Several coal beds of the Lance Formation have been identified in the Bitter Creek NW quadrangle and have been isopached (plates 4, 8 and 11). These coal beds crop out in a northwest-trending band across the quadrangle and dip approximately 3° to 6° to the northeast.

Hall Coal Bed

The Hall coal bed occurs, stratigraphically, near the base of the Lance Formation, just above the Fox Hills Sandstone. The coal bed thickens locally to 10.4 feet (3.2 m) in sec. 18, T. 20 N., R. 100 W. Madden (1977) reported a thickness of 7.5 feet (2.3 m) for the Hall coal bed in the northeastern corner of the Point of Rocks quadrangle. To the south, the Hall bed thickens and becomes quite extensive. It was mined at the now abandoned Hall Mine in the Black Buttes quadrangle (Roehler and others, 1977).

Maxwell Coal Bed

The Maxwell coal bed thickens locally to 6.5 feet (2.0 m) in sec. 32, T. 20 N., R. 100 W. It thickens to the south, as do many of the Lance Formation coal beds, and attains a thickness of 9.5 feet (2.9 m) where measured at the old Maxwell mine (Roehler and others, 1977) in the Black Buttes quadrangle.

Lance [2], [3], [4] and [5] Coal Beds

Previously unnamed coal beds that have been isopached have been given informal (bracketed numbers) names for identification purposes in this quadrangle only. Relative stratigraphic position within this formation is shown by member value; the higher the number, the higher the coal bed's stratigraphic position.

The Lance [2] coal bed is located, stratigraphically, approximately 90 feet (27.4 m) above the base of the Lance Formation and may be Roehler's Black Butte coal bed (Roehler and others, 1977). It is isopached in two areas on plate 8, attaining a maximum reported thickness of 9.5 feet (2.9 m) in sec. 1, T. 20 N., R. 101 W., in the northwestern corner of the quadrangle.

The Lance [3] coal bed thickens to 16.5 feet (5.0 m) in the southern half of the quadrangle (plate 4). The coal bed is stratigraphically located approximately 130 feet (39.6 m) above the base of the Lance Formation.

The informally named Lance [4] coal bed thickens to 8.5 feet (2.6 m) in sec. 4, T. 19 N., R. 100 W. This coal bed exists in the upper part of the Lance coal zone and could possibly be the Overland coal bed (Roehler and others, 1977).

The Lance [5] coal bed has been isopached near the center of the quadrangle (plate 4). It attains a maximum thickness of 7 feet (2.1 m) in sec. 33, T. 20 N., R. 100 W.

Deadman Coal Bed(s) of the Fort Union Formation

The Deadman coal bed(s) can be traced southeastward across the quadrangle from the Jim Bridger coal strip mine on the northern border of the quadrangle. The Deadman coal bed is typically split in this area and two separate beds have been isopached (plates 4 and 11).

The Upper and Lower Deadman coal beds are usually separated by 20 to 70 feet (6.1 to 21.3 m) of rock with the intervening rock interval thickening down-dip to the northeast. In many places, surface exposures are burned and covered with clinker. The Lower Deadman coal bed ranges in thickness from 5 to 14 feet (1.5 to 4.3 m) in the quadrangle (plate 11). It is commonly split but the upper split is thin and has not been included in thicknesses reported for the Lower Deadman coal bed on plate 11. The Upper Deadman coal bed is also split and, especially south of Tenmile Draw, contains as much as 19 feet (5.8 m) of rock partings as shown on plate 4. Coal thicknesses for the Upper Deadman coal bed, excluding rock partings, range from 5 to 16 feet (1.5 to 4.9 m).

The Deadman coal bed (or splits thereof) is the thickest and most extensive coal bed found on the east flank of the Rock Springs uplift. The Deadman, or Little Valley (Roehler, 1977), coal bed has been traced north to T. 22 N., R. 102 W. and south to T. 14 N., R. 102 W. Data from oil and gas wells indicate that the Deadman coal beds are also extensive in the subsurface in the quadrangles to the east (Bitter Creek and Bitter Creek NE). Generally, cumulative coal thicknesses (excluding rock partings) for the Deadman coal bed(s) range from 10 to 30 feet (3.0 to 9.1 m) along the northeast flank of the uplift. Dips recorded in the Bitter Creek NW quadrangle (Madden, 1977) near the Deadman coal bed exposures are 3° to the northeast.

Isolated Data Points

In instances where 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 found in this quadrangle and the influences from isolated data points in adjacent quadrangles are listed below. Coal beds identified by bracketed numbers are not formally named, but are used for identification purposes in this quadrangle only.

Source	Location	Coal Bed	Thickness
Chandler & Simpson, Inc.	sec. 12, T. 20 N., R. 101 W.	La[3]	7.0 ft (2.1 m)
Union Pacific Railroad Co.	sec. 25, T. 20 N., R. 101 W.	RS[2]	6.0 ft (1.8 m)
Prenalta Corp.	sec. 36, T. 20 N., R. 101 W.	RS[1]	6.0 ft (1.8 m)

COAL RESOURCES

Data from oil and gas wells and coal test holes (Madden, 1977), as well as surface mapping by Madden (1977), were used to construct outcrop, isopach, and structure contour maps of the coal beds in this quadrangle. The source of each indexed data point shown on plate 1 is listed in table 4.

Coal resources were calculated using data obtained from the coal isopach maps (plates 4, 7, 11, 15, and 19). 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, or 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 for each isopached coal bed. Reserve Base and Reserve tonnages for the isopached beds are shown on plates 7, 10, and 14, and are rounded to the nearest 10,000 short tons (9,072 metric tons). Coal beds of Reserve Base thickness (5 feet or 1.5 meters) or greater that lie less than 3,000 feet (914 m) below the ground surface are included. These criteria differ somewhat from that used in calculating Reserve Base and Reserve tonnages as stated in U.S. Geological Survey Bulletin 1450-B which calls for a minimum thickness of 28 inches (70 cm) for bituminous coal and a maximum depth of 1,000 feet (305 m) for both bituminous and subbituminous coal. Only Reserve Base tonnages (designated as inferred resources) are calculated for areas influenced by the isolated data points in this quadrangle.

Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 64.31 million short tons (58.34 million metric tons) for the entire quadrangle, including tonnages from 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 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 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 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, 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 the development potential in the high, moderate, or low categories. The areas influenced by the isolated data points in this quadrangle contain approximately 370,000 short tons (336,000 metric tons) of coal available for surface mining.

The coal development potential for surface mining methods (less than 200 feet or 61 meters of overburden) is shown on plate 15.

Of the Federal land areas having a known development potential for surface mining methods, 65 percent are rated high, 13 percent are rated moderate, and 22 percent are rated low. The remaining Federal lands within the quadrangle are classified as having unknown development potential for surface mining methods, indicating that no known coal beds 5 feet (1.5 m) or more thick, excluding isolated data points, occur within 200 feet (61 m) of the ground surface but that coal-bearing units are present.

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. 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 influenced by isolated data points and to those areas where coal beds of Reserve Base thickness are not known, but may occur. The areas influenced by isolated data points in this quadrangle contain approximately 980,000 short tons (889,000 metric tons) of coal available for conventional subsurface mining.

The coal development potential for subsurface mining methods is shown on plate 16. All of the Federal land areas classified as having known development potential for conventional subsurface mining methods are assigned a high development potential. The remaining Federal lands within the quadrangle are classified as having unknown development potentials for conventional subsurface mining methods.

Because the coal beds in this quadrangle have dips of less than 15°, all Federal land areas within the quadrangle have been rated as having an unknown development potential for in-situ mining methods.

Table 1. -- Chemical analyses of coals in the Bitter Creek NW quadrangle, Sweetwater 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
Representative analysis from Bridger Coal Company (Glass, 1975)	Deadman (upper and lower benches combined)	A	20.52	29.09	40.71	9.68	0.47	-	-	-	-	-	9,350
		C	0.0	36.60	51.22	12.18	0.59	-	-	-	-	-	11,759
SW¼, sec. 16, T. 18 N., R. 100 W., Rock Springs - Gilbraltar Mine (Yourston, 1955)	Lance Formation, undifferentiated	A	20.8	28.4	47.1	3.7	0.4	-	-	-	-	-	9,910
		C	0.0	35.8	59.5	4.7	0.5	-	-	-	-	-	12,510
SW¼, SW¼, sec. 26, T. 20 N., R. 101 W., Point of Rocks Mine (Yourston, 1955)	Almond Formation, undifferentiated	A	16.6	30.2	44.0	9.2	0.7	-	-	-	-	-	9,410
		C	0.0	36.3	52.7	11.0	0.8	-	-	-	-	-	11,290
Sec. 21, T. 21 N., R. 102 W., Superior C Mine (Bureau of Mines, 1931)	Rock Springs Formation, undifferentiated	A	13.7	32.4	51.0	2.9	0.7	-	-	-	-	-	11,460
		C	0.0	37.6	59.0	3.4	0.8	-	-	-	-	-	13,390

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 Bitter Creek NW quadrangle, Sweetwater County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Upper Deadman	1,120,000	3,080,000	3,200,000	-	7,400,000
Lower Deadman	30,000	50,000	2,220,000	-	2,300,000
Lance {3}	240,000	120,000	120,000	-	480,000
Lance {2}	70,000	90,000	260,000	-	420,000
Lance {1}	1,840,000	970,000	1,760,000	-	4,570,000
Almond {1}	260,000	190,000	120,000	-	570,000
Isolated Data Points	-	-	-	370,000	370,000
Totals	3,560,000	4,500,000	7,680,000	370,000	16,110,000

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 Bitter Creek NW quadrangle, Sweetwater County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Upper Deadman	24,160,000	-	-	-	24,160,000
Lower Deadman	20,840,000	-	-	-	20,840,000
Lance {3}	260,000	-	-	-	260,000
Lance {2}	20,000	-	-	-	20,000
Lance {1}	1,930,000	-	-	-	1,930,000
Isolated data points	-	-	-	980,000	980,000
Totals	47,210,000	-	-	980,000	48,190,000

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	Chandler & Simpson, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 2 Rowland-Gov't (Drill hole No. 2)
2	Chandler & Simpson, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1 Rowland-Gov't (Drill hole No. 1)
3	Chandler & Associates, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 8-2 Rowland-Federal (Drill hole No. 3)
4	Union Pacific Railroad Co. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 44-9-D-U.P.R.R. (Drill hole No. 4)
5	Chandler & Associates, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1-10 Rowland-Federal (Drill hole No. 5)
6	Texaco, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1 Gov't-Mesaverde NCT-1 (Drill hole No. 6)
7	Exploration Drill Co. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1 Gov't-Gilbert (Drill hole No. 7)
8	Union Pacific Railroad Co. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 11-A-15-U.P.R.R. (Drill hole No. 8)

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Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
9	Chandler & Simpson, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1 Husky-State (Drill hole No. 9)
10	Chandler & Simpson, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 2 Husky-State (Drill hole No. 10)
11	Chandler & Associates, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1 Monsanto-Gov't (Drill hole No. 11)
12	Madden, 1977, U.S. Geological Survey, unpublished data, plate 7	Drill hole No. 12
13		Drill hole No. 13
14		Drill hole No. 14
15		Drill hole No. 15
16		Drill hole No. 16
17		Drill hole No. 18
18		Drill hole No. 19
19		Drill hole No. 17
20		Drill hole No. 21
21		Drill hole No. 20
22		Drill hole No. 22
23		Drill hole No. 23
24		Drill hole No. 24

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
25	Chandler & Simpson, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1 Winegardner-Gov't (Drill hole No. 25)
26	Madden, 1977, U.S. Geological Survey, unpublished data, plate 7	Drill hole No. 26
27		Drill hole No. 29
28		Drill hole No. 27
29	Chandler & Simpson, Inc., and Monsanto Co. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. A-1-Burg-Gov't (Drill hole No. 28)
30	Madden, 1977, U.S. Geological Survey, unpublished data, plate 7	Drill hole No. 30
31		Drill hole No. 31
32		Drill hole No. 32
33	True Oil Co. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 11-18 True-Bluewater-Husky-Federal (Drill hole No. 33)
34		Oil/gas well No. 14-20 Shanahan-Federal (Drill hole No. 34)
35	El Paso Natural Gas Co. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1-1 WDH (Drill hole No. 35)

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
36	Lion Oil Co. (Division of Monsanto) (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1 Towne (Drill hole No. 36)
37	Madden, 1977, U.S. Geological Survey, unpublished data, plate 7	Drill hole No. 37
38		Drill hole No. 38
39		Drill hole No. 39
40		Drill hole No. 40
41		Drill hole No. 41
42		Drill hole No. 42
43		Drill hole No. 43
44		Drill hole No. 44
45	Union Pacific Railroad Co. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 44-27 U.P.R.R. (Drill hole No. 45)
46	Chandler & Simpson, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1 Burg-Gov't (Drill hole No. 46)
47	Forest Oil Co.	Oil/gas well No. 31-1 FOC Shiprock
48	Madden, 1977, U.S. Geological Survey, unpublished data, plate 7	Drill hole No. 47
49		Drill hole No. 48

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
50	Madden, 1977, U.S. Geological Survey, unpublished data, plate 7	Drill hole No. 49
51	↓	Drill hole No. 50
52	Chandler & Simpson, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1-C-State (Drill hole No. 51)
53	↓	Oil/gas well No. 2-C-State (Drill hole No. 52)
54	Madden, 1977, U.S. Geological Survey, unpublished data, plate 7	Drill hole No. 53
55	Chandler & Simpson, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1 Gov't-Stroock (Drill hole No. 54)
56	Union Pacific Railroad Co. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 44-25 U.P.R.R. (Drill hole No. 55)
57	Prenalta Corp. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 41-36-20-101 (Drill hole No. 56)
58	Chandler & Simpson, Inc. (Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	Oil/gas well No. 1 Harris-State (Drill hole No. 57)

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Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
59	Chapman & Poland, Inc.	Oil/gas well No. 1-Gov't
	(Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	(Drill hole No. 58)
60	Madden, 1977, U.S. Geological Survey, unpublished data, plate 7	Drill hole No. 60
61	Chandler & Simpson, Inc.	Oil/gas well No. 1-A State
	(Madden, 1977, U.S. Geological Survey, unpublished data, plate 7)	(Drill hole No. 61)
62	Prenalta Corp.	Oil/gas well No. 11-36-20-101

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