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# COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE NORTHEAST QUARTER OF THE THE KEMMERER QUADRANGLE, LINCOLN COUNTY, WYOMING

[Report includes 10 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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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 northeast quarter of the Kemmerer 15-minute quadrangle, Lincoln 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 1975 (P.L. 94-377). Published and unpublished public information available through April, 1978, was used as the data base for this study. No new drilling or field mapping was performed, nor was any confidential data used.

## Location

In this report, the term "quadrangle" refers only to the northeast quarter of the Kemmerer 15-minute quadrangle which is located in central Lincoln County, Wyoming, approximately 6 miles (10 km) north of Kemmerer and 18 miles (29 km) northeast of Sage, Wyoming. The quadrangle is unpopulated.

## Accessibility

Wyoming State Highway 223 cuts across the southwestern corner of the quadrangle, connecting the town of Frontier with the Bridger-Teton National Forest to the northwest. A light-duty road passes north-south through the eastern half of the quadrangle. The remainder of the quadrangle is served by numerous unimproved dirt roads and trails.

The Oregon Shortline Railroad, a branch of the Union Pacific Railroad, passes through the town of Kemmerer approximately 6 miles (10 km) south of the quadrangle. It is a major shipping route connecting Pocatello, Idaho with the Union Pacific Railroad main east-west line at Granger, Wyoming.

## Physiography

The northeast quarter of the Kemmerer 15-minute quadrangle lies on the eastern edge of the Wyoming Overthrust Belt. The landscape in the quadrangle is characterized by north-trending ridges and valleys. Oyster Ridge, on the eastern edge of the quadrangle, and Commissary Ridge, on the western edge, lie approximately 500 feet (152 m) and 800 feet (244 m), respectively, above the intervening valley of Pomeroy Basin. Altitudes range from approximately 7,040 feet (2,146 m) in the southwestern corner of the quadrangle to approximately 8,889 feet (2,709 m) on Commissary Ridge near the northwest edge of the quadrangle.

Hams Fork, a tributary of the Green River southeast of the quadrangle, flows southeast across the southwestern corner of the quadrangle. Willow Creek and its tributaries drain the quadrangle, flowing into Hams Fork south of the quadrangle. Streams in the area, with the exception of Hams Fork which flows year-round, are intermittent and flow mainly in response to snowmelt in the spring.

## Climate and Vegetation

The climate of southwest 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 annual precipitation averages approximately 10 inches (25 cm) and is fairly evenly distributed throughout the year (Wyoming Natural Resources Board, 1966).

The average annual temperature of the area is 39° F (4° C). The temperature during January averages 17° F (-8° C) and typically ranges from 4° F (-16° C) to 30° F (-1° C). During July, the average temperature is 62° F (17° C), and the temperature typically ranges from 43° F (6° C) to 82° F (28° C).(Wyoming Natural Resources Board, 1966; U.S. Bureau of Land Management, 1978).

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

The principal types of vegetation in the quadrangle include grasses, sagebrush, mountain mahogany, conifer, aspen, willow, and cottonwood (U.S. Bureau of Land Management, 1978).

## Land Status

The northeast quarter of the Kemmerer 15-minute quadrangle lies on the northern edge of the Kemmerer Known Recoverable Coal Resource Area and approximately two thirds of the quadrangle is within the KRCRA boundary. The Federal government owns the coal rights for less than three quarters of the land within the KRCRA boundary in this quadrangle. One active coal lease is present within the KRCRA boundary and is shown on plate 2.

## General Geology

### Previous Work

The geology and economic resources of a large part of Lincoln and Uinta counties in southwestern Wyoming, including the northeast quarter of the Kemmerer 15-minute quadrangle, were described by Veatch in 1907. Schultz (1914) made an investigation of the geology and coal resources in the northern part of the Kemmerer coal field. Toenges and others (1945) described lithologic logs of coal test holes drilled in the Willow Creek coal bed and reported the results of chemical analyses of the coal. The stratigraphy of the coal-bearing Frontier Formation was described in papers by Cobban and Reeside (1952) and Hale (1960). Oriel and Tracey (1970) described the stratigraphy of the Evanston and Wasatch Formations in the Kemmerer area, and the geology of the Kemmerer 15-minute quadrangle was mapped by Rubey and others (1975). Glass (1975) reported coal analyses and measured sections of Adaville Formation coals from the Elkol and Sorensen strip mines located in the adjacent southeast quarter of the Kemmerer 15-minute quadrangle to the south. More recently, Glass (1977) described the coal-bearing formations and reported chemical analyses of the coal beds present in the Hams Fork coal region. The geology and coal resources of the Hams Fork coal region, including the Kemmerer coal field, were also described by Roehler and others (1977). Myers (1977) conducted a detailed study of the stratigraphy of the Frontier Formation in the Kemmerer area.

## Stratigraphy

The formations exposed in the northeast quarter of the Kemmerer 15-minute quadrangle range in age from Pennsylvanian to Eocene. Only the Frontier and Adaville Formations of Late Cretaceous age contain mineable coal in the quadrangle.

Formations of Pennsylvanian, Permian, Triassic and Jurassic age crop out along and to the northwest of Commissary Ridge in the northwestern corner of the quadrangle. All are non-coal-bearing.

The Bear River Formation of Early Cretaceous age crops out in a small area along the northeastern edge of the quadrangle. The Bear River Formation is approximately 1,400 feet (427 m) thick and consists of interbedded dark-gray to black fissile claystone, tan to olive-brown fine-grained sandstone and fossiliferous limestone (Rubey and others, 1975).

The Aspen Shale of latest Early Cretaceous age conformably overlies the Bear River Formation and crops out in a narrow band along the eastern edge of the quadrangle. It consists of approximately 1,025 to 1,225 feet (312 to 373 m) of light- to dark-gray arenaceous shale, siltstone and claystone, gray quartzitic sandstone and numerous porcelanite and bentonite beds. The porcelanite beds in the lower part of the Aspen Shale form vegetation-bare silver-gray ridges and hogbacks (Rubey and others, 1975).

The Frontier Formation of early Late Cretaceous age crops out along the eastern third of the quadrangle where it conformably overlies the Aspen Shale. Rubey and others (1975) mapped this formation as three informal map units (not shown on plate 3). The lower unit of the formation is composed of approximately 1,000 feet (305 m) of thin white and brown sandstone beds (which are less resistant to erosion than the rest of the formation), tan siltstone, dark-gray claystone, thin beds of gray, pink and white porcelanite, and the Spring Valley coal zone. The middle unit of the formation, approximately 625 feet (191 m) thick, consists of tan sandstone, dark shaly claystone, and the Willow Creek coal zone, capped by the prominent hogback-forming Oyster Ridge Sandstone Member of the Frontier Formation. The Oyster Ridge Sandstone Member consists of approximately 130 feet (40 m) of white to light-gray, thick-bedded resistant sandstone. The upper unit of the formation is composed of hogback-forming tan sandstone containing abundant large fossil oyster shells, lignitic claystone, and the Kemmerer coal zone (including the Main Kemmerer or Kemmerer No. 1 coal bed). The upper section ranges in thickness from approximately 600 to 750 feet (183 to 229 m) thick (Rubey and others, 1975).

The Hilliard Shale of early Late Cretaceous age conformably overlies the Frontier Formation. It crops out in a wide band through the central part of the quadrangle around the northern end of the Lazeart syncline. The Hilliard Shale is composed of a very thick sequence of dark-gray, gray and tan fissile marine claystone; light- to medium-gray, partly argillaceous and partly lignitic sandy siltstone; white to dark-gray, thin-bedded, very fine grained to gritty sandstone; and white to gray bentonite. The Shurtliff Member of the Hilliard Shale, approximately 750 feet (229 m) thick, divides the Hilliard Shale in half with its prominent sandstone ledges. The Hilliard Shale is approximately 6,600 feet (2,012 m) thick (Rubey and others, 1975).

Cropping out in the southwestern corner of the quadrangle, the Adaville Formation of Late Cretaceous age conformably overlies the Hilliard Shale. The Adaville Formation consists of approximately 2,900 feet (884 m) of interbedded gray sandstone, siltstone, carbonaceous clay and the Adaville Coal Zone. The sandstone, which weathers to yellow and brown, is calcareous, fine- to coarse-grained, thin-bedded to massive, and is partly conglomeratic in the upper part of the formation. To the south of this quadrangle, the Lazeart Sandstone Member is the basal unit of the Adaville Formation. This member is composed of light-gray to white, fine- to coarse-grained sandstone. It is approximately 400 feet (122 m) thick near the southern end of the southeast quarter of the Kemmerer 15-minute quadrangle and thins to the north, pinching out approximately 3 miles (5 km) south of Hams Fork (Rubey and others, 1975).

The Adaville Coal Zone is present in the lower half of the Adaville Formation and crops out in the southwestern corner of the quadrangle. This zone may contain up to 32 subbituminous coal beds in the southeast quarter of the Kemmerer 15-minute quadrangle (Glass, 1977), including the extensively mined Adaville No. 1 coal bed. However, the beds thin and decrease in number to the north (Glass, 1977), and little information is available regarding the occurrence and thickness of coals in the Adaville Coal Zone in the northeast quarter of the Kemmerer 15-minute quadrangle.

The Evanston Formation lies unconformably on the Adaville Formation, cropping out along the southwestern edge of the quadrangle. The main body of the Evanston Formation is underlain by the Hams Fork Conglomerate Member of latest Cretaceous age and consists of up to 1,000 feet (305 m) of boulder-conglomerate beds, gray to brown cross-bedded sandstone and gray mudstone. The main body of the Evanston Formation, which is Paleocene in age, consists of gray siltstone, red mudstone, carbonaceous claystone, lignite and thin coal beds. It may be more than 1,000 feet (305 m) thick locally (Oriel and Tracey, 1970; Rubey and others, 1975).

The Tunp Member of the Eocene-age Wasatch Formation unconformably overlies the Evanston Formation and crops out along the northwestern border of the quadrangle. This member ranges from conglomeratic mudstone to a rubbly breccia. It is poorly stratified and extremely variable in thickness. It ranges from 100 to 200 feet (31 to 61 m) thick in most places, but exceeds 500 feet (152 m) locally. The Tunp Member consists chiefly of a dark- to medium-red conglomeratic mudstone and blocky breccia in a mudstone matrix (Oriel and Tracey, 1970).

Holocene deposits of alluvium cover the stream valley of Hams Fork and terrace deposits of gravel and sand cap hills bordering the Hams Fork valley.

The Upper Cretaceous formations in the northeast quarter of the Kemmerer 15-minute quadrangle indicate the transgressions and regressions of a broad, shallow north-south seaway that extended across central North America during Cretaceous time. Sediments accumulated near the western edge of the sea and reflect the location of the shoreline (Weimer, 1960 and 1961).

The sandstones, black claystones, and fresh water limestones of the Bear River Formation were deposited in coastal swamps and flood plains during a regression of the Cretaceous sea.

Deposition of the Aspen Shale marked a westward or landward movement of the sea. The marine shales, siltstones and sandstones of the Aspen Shale were deposited in water up to 120 feet (37 m) deep (Hale, 1960).

The Frontier Formation sediments were deposited during two major transgressions and regressions of the sea. The coal beds in the upper and lower portions of the formation were deposited in coastal swamps during periods when the sea retreated eastward. The Oyster Ridge Sandstone Member is a littoral or beach deposit marking the retreat of the Cretaceous sea from the area (Hale, 1960; Myers, 1977; Roehler and others, 1977).

The marine sediments of the Hilliard Shale again marked the transgression of the Cretaceous sea and the fluctuations of the shoreline as the sequence of shale, claystone and sandstone were deposited (Roehler and others, 1977).

The Lazeart Sandstone Member at the base of the Adaville Formation is a beach deposit marking a transition from the marine deposition of the Hilliard Shale to the continental coastal plain deposition of the Adaville Formation. The sediments of the Adaville Formation were deposited in flood plains and swamps along the coastal plain (Roehler and others, 1977).

After the final withdrawal of the Cretaceous sea, thick sections of detrital material, eroded from older deposits to the west, were deposited by large streams as the conglomerates of the Hams Fork Conglomerate Member of the Evanston Formation. Environments of deposition for the main body of the Evanston Formation included streams, marshes, and, probably, ponds (Oriel and Tracey, 1970).

The Wasatch Formation is composed of continental sediments. The Tunp Member appears to have formed from mudflows and slides of fresh and weathered rocks on steep slopes (Oriel and Tracey, 1970).

## Structure

The northeast quarter of the Kemmerer 15-minute quadrangle is located on the southeastern edge of the structurally complex Wyoming Overthrust Belt. Folded Paleozoic and Mesozoic rocks are thrust eastward over folded Cretaceous-age rocks with younger Cretaceous- and Tertiary-age rocks resting unconformably on top of the older rocks. Coal-bearing strata crop out in eroded limbs of folds as long narrow belts bounded on the west by major thrust faults (Roehler and others, 1977).

The axial trace of the Lazeart syncline trends northeasterly across the central portion of the quadrangle. Beds of Cretaceous age dip about 30° on the eastern limb of the syncline and generally about 60° on the western limb, but locally may be vertical or overturned on the western limb. On the western limb, large parts of these formations are covered by thick sediments of Tertiary age (Rubey and others, 1975).

The Absaroka fault, an extensive thrust fault mapped for a linear distance of 205 miles (330 km) in Wyoming and Idaho (Rubey and others, 1975), brings Paleozoic strata in contact with the Frontier Formation of Upper Cretaceous age in this quadrangle. The Absaroka fault cuts northeasterly across the northwestern corner of the quadrangle along Commissary Ridge. At and near the surface, the fault dips steeply to the west (about 70°). According to Rubey and others (1975), the dip of the fault probably becomes much less as the depth of the fault increases to the west. Stratigraphic throw along the fault is about 15,000 feet (4,572 m) and the eastward movement or lateral displacement along the fault is at least 3 miles (4.8 km) within the Kemmerer 15-minute quadrangle. Major movement along the Absaroka fault occurred in very late Cretaceous time with probable minor movement in the Paleocene (Rubey and others, 1975).

An unnamed thrust fault (possibly a branch of the Absaroka fault at depth) cuts across the northwestern corner of the quadrangle about 1 mile (1.6 km) west of Commissary Ridge.

## COAL GEOLOGY

Coal zones in both the Frontier and Adaville Formations have been identified in this quadrangle as shown on plate 1. Three coal zones, the Spring Valley, the Willow Creek, and the Kemmerer, are present in the Frontier Formation. The structure of all of the coal beds in this quadrangle has been influenced by the Lazeart syncline that bisects the quadrangle.

Chemical analyses of coal.--Representative analyses of coal from the Spring Valley, Kemmerer, Willow Creek, and Adaville coal zones are listed in table 1. In general, coals in the Spring Valley and Kemmerer coal zones rank as high-volatile B bituminous, Willow Creek coal ranks as high-volatile A bituminous, and coal from the Adaville No. 1 coal bed ranks as subbituminous A. Coal from other Adaville coal beds are either subbituminous B or C (Glass, 1975). These coals have been ranked on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

### Frontier Formation Coal Zones

The Frontier Formation and its associated coal zones are exposed along both limbs of the Lazeart syncline in this quadrangle. The Frontier Formation coal zones were mapped by Veatch (1907) in an area trending north-south, bordered on the west by the Absaroka thrust fault as shown on plate 1. On the west limb of the syncline along the Absaroka fault the beds are intensely folded and, in many places, overturned.

Stratigraphically, the Spring Valley coal zone is the lowest zone identified in this quadrangle and is separated from the overlying Willow Creek coal zone by approximately 680 feet (207 m) of sandstone, shale and limestone. The Kemmerer coal zone lies approximately 800 feet (244 m) above the Willow Creek coal zone and 470 feet (143 m) above the prominent Oyster Ridge Sandstone Member of the Frontier Formation.

Spring Valley Coal Zone

The Spring Valley coal zone crops out along the eastern limb of the Lazeart syncline and is approximately 200 feet (61 m) thick. Veatch (1907) mapped the Frontier Formation along the western limb of the Lazeart syncline adjacent to the Absaroka fault but did not show outcrops of this zone in that area.

The Spring Valley coal zone was named for Spring Valley Station located in T. 15 N., R. 118 W. (Glass, 1977). Dips on the eastern limb of the Lazeart syncline, as measured by Veatch (1907) and Schultz (1914), are 25° to 30° to the west. Coal beds in the Spring Valley coal zone are normally less than Reserve Base thickness (5 feet or 1.5 meters) in this quadrangle, averaging less than 3 feet (0.9 m). One exception is the Spring Valley [1] coal bed, which reaches a maximum reported cumulative coal thickness of 8.7 feet (2.7 m) with 2.2 feet (0.7 m) of rock partings in sec. 6, T. 22 N., R. 115 W. The coal bed decreases in thickness to the north and south as shown on plate 4. The Spring Valley [1] coal bed is a local bed, and is not correlative with coal beds in other quadrangles. It is designated by a bracketed number for identification purposes in this quadrangle only.

Willow Creek Coal Zone

The Willow Creek coal zone is exposed along both limbs of the Lazeart syncline and was also encountered in drill holes along the eastern limb of the syncline. The Willow Creek coal zone derives its name from its occurrence along Willow Creek in T. 23 N., R. 116 W. Coal occurs in three or more thin beds, seldom more than 4 feet (1.2 m) thick, separated from each other by mudstone, shale and sandstone and containing numerous shale partings less than 2 feet (0.6 m) thick (Toenges and others, 1945). Dips on the eastern limb of the syncline are 25° to 30° to the west. Dips on the western limb normally exceed 80° to the east with areas of overturned beds dipping 70° or more to the west (Veatch, 1907, and Schultz, 1914).

The Middle Willow Creek, or Willow Creek (No. 5), coal bed is the thickest and most persistent bed in the Willow Creek coal zone (Glass, 1977). The maximum measured thickness of the Middle Willow Creek coal bed is 7.5 feet (2.3 m) with a rock parting 0.3 feet (0.1 m) thick in sec. 6, T. 22 N., R. 115 W. The coal thins to less than 5 feet (1.5 m) in the southeastern quarter of the Kemmerer 15-minute quadrangle.

Kemmerer Coal Zone

The Kemmerer coal zone lies above the hogback-forming Oyster Ridge Sandstone Member of the Frontier Formation and approximately 200 feet (61 m) below the base of the Hilliard Formation. The Kemmerer coal zone was mined extensively around the turn of the century and the coal beds are named for the town of Kemmerer located in T. 21 N., R. 116 W. This zone extends north-south for more than 60 miles (97 km) along the outcrop in the Kemmerer area (Glass, 1977) and is approximately 100 feet (30 m) thick in this quadrangle. To the south in the southeast quarter of the Kemmerer 15-minute quadrangle the zone consists of several coal beds, but in this quadrangle the only significant coal bed present is the Main Kemmerer or Kemmerer No. 1.

The Main Kemmerer (Kemmerer No. 1) coal bed crops out in the eastern half of the quadrangle and just east of the Absaroka thrust fault along the east and west limbs of Lazeart syncline. Outcrop measurements show thicknesses ranging from 3 to 8 feet (0.9 to 2.4 m) with an average thickness of about 6 feet (1.8 m). To the south, in the Cumberland Gap quadrangle, the Main Kemmerer coal bed is called the Cumberland Seam (Rocky Mountain Energy Company, no date) and continues to average approximately 6 feet (1.8 m) in thickness with measurements up to 13 feet (4.0 m) recorded.

According to Veatch (1907) and Schultz (1914), the Main Kemmerer coal bed dips from 15° to 25° to the west on the eastern limb of the Lazeart syncline while dips on the western limb typically exceed 80° to the east with overturned beds common.

### Adaville Coal Zone

Coal beds in the Adaville coal zone crop out in the southwestern corner of the quadrangle on both limbs of the Lazeart syncline. The thickest coals lie immediately above the basal Lazeart Sandstone Member. Only one measurement (Schultz, 1914) has been reported for the Adaville coal beds in this quadrangle. An unidentified Adaville coal bed, 18 feet (5.5 m) thick, was measured in sec. 21, T. 22 N., R. 116 W., and this measurement has been treated as an isolated data point (see Isolated Data Points sections of this report).

### Isolated Data Points

In instances where isolated, or single, measurements of coal beds exceeding Reserve Base thickness are encountered, the standard criteria for construction of isopach, structure contour, mining ratio, and overburden isopach maps are not available. The lack of data concerning these coal beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other, better known coal beds. Also, where the inferred limit of influence from the isolated data point is entirely within non-Federal land areas or lands already leased for coal mining, isolated data point maps are not constructed for the coal bed, as is the case in this quadrangle.

## COAL RESOURCES

Drill hole and outcrop information from Toenges and others (1945) and measured sections from Veatch (1907) and Schultz (1914), as well as unpublished surface sections and drill hole information from the U.S. Geological Survey, 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 3.

Coal resources were calculated using data obtained from the coal isopach maps (plates 4 and 6). The coal bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed and by a conversion factor of 1,800 short tons of coal per acre-foot (13,238 metric tons per hectare-meter) for bituminous coal, or 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 isopached coal bed. 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 differs 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 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.

Reserve Base and Reserve tonnages for the isopached beds are shown on plate 8 and are rounded to the nearest 10,000 short tons (9,072 metric tons). Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 2.91 million short tons (2.64 million metric tons) for the entire quadrangle. Reserve Base tonnages in the various development potential categories for surface and in-situ 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 portion 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 affecting any portion 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 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.

Unknown development potentials have been assigned to those areas where coal data is absent or extremely limited. Even though these areas may contain coal thicker than 5 feet (1.5 m), 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 coal development potential for surface mining methods is shown on plate 9. All of the Federal land areas having a known development potential are rated high. The remaining Federal lands within the KRCRA boundary in this quadrangle are classified as having unknown development potential for surface mining methods.

Development Potential for
Subsurface and In-Situ Mining Methods

Areas where the coal beds of Reserve Base thickness lie between 200 and 3,000 feet (61 and 914 m) below the ground surface, having dips of 15° or less, are usually considered to have development potential for conventional subsurface mining methods. In this quadrangle, all known coal beds of Reserve Base thickness have dips greater than 15°. Therefore, all Federal lands have been rated as having an unknown development potential for conventional subsurface mining methods.

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. Based on criteria provided by the U.S. Geological Survey, coal beds of Reserve Base thickness dipping between 35° and 90° with a minimum Reserve Base of 70 million short tons (63.5 million metric tons) of subbituminous coal or 50 million short tons (45.4 million metric tons) of bituminous coal have a moderate potential for in-situ development.

Coal beds dipping from 15° to 35°, regardless of tonnage, and coal beds dipping from 35° to 90° with less than 50 million short tons (45.4 million metric tons) of coal have a low development potential for in-situ mining methods. Coal lying between the 200-foot (61-m) overburden line and the outcrop is not included in total coal tonnages available because it is needed for cover and containment in the in-situ process.

The coal development potential for in-situ mining methods is shown on plate 10. All of the Federal land areas having a known development potential for in-situ mining are rated low because only 1.56 million short tons (1.42 million metric tons) of coal are believed to be available for in-situ mining. The remaining Federal land areas that have not already been leased are classified as having an unknown development potential.

Table 1. -- Chemical analyses of coals in the northeast quarter of the Kemmerer 15-minute quadrangle, Lincoln 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 |
| SE¼ NW¼ sec. 20, T. 21 N., R. 116 W., Elkol Mine, (Glass, 1975) | Adaville No. 1 | A | 16.7 | 36.5 | 42.8 | 4.0 | 1.3 | - | - | - | - | - | 10,530 |
| | | C | 0.0 | 43.8 | 51.4 | 4.8 | 1.5 | - | - | - | - | - | 12,640 |
| SW¼ NW¼ sec. 19, T. 22 N., R. 115 W., Willow Creek Prospect,(U.S. Bureau of Mines, 1931) | Willow Creek | A | 4.0 | 36.2 | 55.0 | 4.8 | 0.8 | - | - | - | - | - | 13,500 |
| | | C | 0.0 | 37.7 | 57.3 | 5.0 | 0.8 | - | - | - | - | - | 14,060 |
| SW¼ NE¼ sec. 12, T. 22 N., R. 116 W., No. 6 Mine, (U.S. Bureau of Mines, 1931) | Kemmerer | A | 3.9 | 40.1 | 49.0 | 7.0 | 0.6 | - | - | - | - | - | 12,890 |
| | | C | 0.0 | 41.7 | 51.0 | 7.3 | 0.6 | - | - | - | - | - | 13,420 |
| Sec. 4, T. 20 N., R. 116 W., Fitzpatrick Mine, (U.S. Bureau of Mines, 1931) | Spring Valley | A | 7.1 | 35.2 | 50.8 | 6.9 | 0.4 | - | - | - | - | - | 12,470 |
| | | C | 0.0 | 37.9 | 54.7 | 7.4 | 0.5 | - | - | - | - | - | 13,420 |

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 northeast quarter of the Kemmerer 15-minute quadrangle, Lincoln County, Wyoming.

| Coal Bed or Zone | High Development Potential | Moderate Development Potential | Low Development Potential | Unknown Development Potential | Total |
|---|---|---|---|---|---|
| Main Kemmerer | 170,000 | 90,000 | 270,000 | -0- | 530,000 |
| Middle Willow Creek | 10,000 | -0- | -0- | -0- | 10,000 |
| Spring Valley {1} | 320,000 | 220,000 | 270,000 | -0- | 810,000 |
| Totals | 500,000 | 310,000 | 540,000 | -0- | 1,350,000 |

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

Table 3. -- Coal Reserve Base data for in-situ mining methods for Federal coal lands (in short tons) in the northeast quarter of the Kemmerer 15-minute quadrangle, Lincoln County, Wyoming.

| Coal Bed or Zone | Moderate Development Potential | Low Development Potential | Total |
|---|---|---|---|
| Main Kemmerer | -0- | 460,000 | 460,000 |
| Middle Willow Creek | -0- | 30,000 | 30,000 |
| Spring Valley {1} | -0- | 1,070,000 | 1,070,000 |
| Totals | -0- | 1,560,000 | 1,560,000 |

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 | Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 100 | Measured Section No. 3, |
| 2 | ↓ | Measured Section No. 2 |
| 3 | U.S. Geological Survey, 1935, Inactive Coal Lease No. Evanston-08809 | Drill hole No. 11 |
| 4 | Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 100 | Measured Section No. 1 |
| 5 | ↓ | Measured Section No. 4 |
| 6 | U.S. Geological Survey, 1935, Inactive Coal Lease No. Evanston-08809 | Drill hole No. 10 |
| 7 | ↓ | Drill hole No. 9 |
| 8 | Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 100 | Measured Section No. 5 |
| 9 | ↓ | Measured Section No. 6 |
| 10 | ↓ | Measured Section No. 8 |
| 11 | ↓ | Measured Section No. 7 |
| 12 | ↓ | Measured Section No. 9 |
| 13 | U.S. Geological Survey, 1935, Inactive Coal Lease No. Evanston-08809 | Measured Section |
| 14 | Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 100 | Measured Section A |
| 15 | ↓ | Measured Section B |
| 16 | ↓ | Measured Section C |

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Table 4. -- Continued

| Plate 1 Index Number | Source | Data Base |
|---|---|---|
| 17 | Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 120 | Measured Section No. 6 |
| 18 | ↓ | Measured Section No. 5 |
| 19 | ↓ | Measured Section No. 7 |
| 20 | U.S. Geological Survey, 1935, Inactive Coal Lease No. Evanston-08809 | Drill hole No. 4 |
| 21 | Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 120 | Measured Section No. 8 |
| 22 | ↓ | Measured Section No. 9 |
| 23 | ↓ | Measured Section No. 10 |
| 24 | U.S. Geological Survey, 1935, Inactive Coal Lease No. Evanston-08809 | Drill hole No. 5 |
| 25 | ↓ | Drill hole No. 6 |
| 26 | Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 120 | Measured Section No. 11 |
| 27 | Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 101 | Measured Section I |
| 28 | Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 120 | Measured Section No. 12 |
| 29 | Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 101 | Measured Section K |
| 30 | Toenges and others, 1945, U.S. Bureau of Mines Technical Paper 673 | Drill hole No. 4-6 |
| 31 | Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 101 | Measured Section No. 18 |
| 32 | ↓ | Measured Section No. 19 |

Table 4. -- Continued

| Plate 1 Index Number | Source | Data Base |
|---|---|---|
| 33 | Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 101 | Measured Section No. 20 |
| 34 | Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 102 | Measured Section No. 21 |
| 35 | ↓ | Measured Section No. 22 |
| 36 | Toenges and others, 1945, U.S. Bureau of Mines Technical Paper 673 | Drill hole No. 2-12 |
| 37 | ↓ | Drill hole No. 4-12 |
| 38 | ↓ | Drill hole No. 1-12 |
| 39 | ↓ | Drill hole No. 3-12 |
| 40 | Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 102 | Measured Section No. 28 |
| 41 | Toenges and others, 1945, U.S. Bureau of Mines Technical Paper 673 | Drill hole No. 3-13 |
| 42 | ↓ | Drill hole No. 1-13 |
| 43 | ↓ | Drill hole No. 4-13 |
| 44 | ↓ | Drill hole No. 2-13 |
| 45 | Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 102 | Measured Section No. 30 |
| 46 | ↓ | Measured Section No. 31 |
| 47 | ↓ | Measured Section No. 29 |
| 48 | ↓ | Measured Section No. 32 |
| 49 | ↓ | Measured Section No. 33 |
| 50 | ↓ | Measured Section No. 34 |

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Table 4. -- Continued

| Plate 1 Index Number | Source | Data Base |
|---|---|---|
| 51 | Toenges and others, 1945, U.S. Bureau of Mines Technical Paper 673 | Drill hole No. 1-24 |
| 52 | U.S. Geological Survey, 1935, Inactive Coal Lease No. Evanston-08809 | Drill hole No. 12 |
| 53 | Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 120 | Measured Section No. 2 |

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