UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

CORRAL CREEK QUADRANGLE,

CAMPBELL COUNTY, WYOMING

BY

INTRASEARCH INC.

ENGLEWOOD, COLORADO

OPEN-FILE REPORT 78-067
1978

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CONVERSION TABLE

TO CONVERT	MULTIPLY BY	TO OBTAIN
inches	2.54	centimeters (cm)
feet	0.3048	meters (m)
miles	1.609	kilometers (km)
acres	0.40469	hectares (ha)
tons (short)	0.9072	metric tons (t)
cubic yards/ton	0.8428	cubic meters/ metric ton
acre-feet	0.12335	hectare-meters
British thermal units/pound (Btu/lb)	2.326	kilojoules/kilogram (kj/kg)
British thermal units/pound (Btu/lb)	0.55556	kilocalories/kilogram (kcal/kg)
Fahrenheit	5/9 (F-32)	Celsius

I. INTRODUCTION

This report and accompanying maps set forth the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) of coal beds within the Corral Creek Quadrangle, Campbell County, Wyoming. This CRO and CDP map series includes 40 plates (U. S. Geological Survey Open-File Report 78-067). The project is compiled by IntraSearch Inc., 5351 South Roslyn Street, Englewood, Colorado, under KRCRA Eastern Powder River Basin, Wyoming, Contract Number 14-08-0001-17180. This contract is a part of a program to provide an inventory of unleased federal coal in Known Recoverable Coal Resource Areas (KRCRAs) in the western United States.

The Corral Creek Quadrangle is located on the Wyoming-Montana border in Campbell County, Wyoming, Townships 57 and 58 North, Ranges 73 and 74 West, in Wyoming, and covers the area: 44°52'30" to 45°00' north latitude; 105°37'30" to 105°45' west longitude.

Two maintained gravel roads provide access to the Corral Creek quadrangle. One is along Bitter Creek in the southwestern part of the quadrangle. The other road trends north through the east-central part of the area, follows Buffalo Creek toward the northwest and exits the quadrangle to the north. Minor roads and trails that branch out from these gravel roads provide access to most of the area. The two major gravel roads unite to the south and join U. S. Highway 14-16 some 6 miles (9.7 km) east of Spotted Horse, Wyoming. The closest railroad to the quadrangle is the Burlington Northern, 26 miles (42 km to the southwest at Arvada, Wyoming.

Principal drainages are Bitter, Dry, and Buffalo Creeks, ephemeral streams that flow northwestward into the Powder River. The creeks drain moderately rugged terrain overlooking minimum elevations in the quadrangle of 3,700 feet (1,128 m) along Bitter Creek. Maximum elevations of 4,200 feet (1,280 m) above sea level occur in the north-central part of the quadrangle. The somber grays, yellows, and browns of outcropping shales and siltstones contrast strikingly with the brilliant reds, oranges, and purples of "clinker", and deep greens of the juniper and pine tree growth.

The 13 to 14 inches (33 to 36 cm) of annual precipitation falling in this semi-arid region accrue principally in the springtime. Summer and fall precipitation usually originates from thunderstorms, and infrequent snowfalls of 6 inches (15 cm) or less generally characterize winter precipitation. Although temperatures ranging from less than -25°F (-32°C) to more than 100°F (38°C) have been recorded near Arvada, Wyoming, average wintertime minimums and summertime maximums range from +5° to +15°F (-15° and -9°C) and 75° to 90°F (24° to 32°C), respectively.

Surface ownership is divided among fee, state, and federal categories with the state and federal surface generally leased to ranchers for grazing purposes. Details of surface ownership are available at the Campbell County Courthouse in Gillette, Wyoming. Details of mineral ownership on federal lands are available from the U. S. Bureau of Land Management in Cheyenne, Wyoming. Federal coal ownership is shown on plate 2 of the Coal Resource Occurrence maps. The non-federal coal ownership comprises both fee and state coal resources.

The Coal Resource Occurrence and Coal Development Potential program pertains to unleased federal coal and focuses upon the delineation of lignite, subbituminous coal, bituminous coal, and anthracite at the surface, and in the subsurface. In addition, the program identifies total tons of coal in place (resources), as well as recoverable tons (reserves). These coal tonnages are then categorized in measured, indicated, and inferred identified reserves and resources, and hypothetical resources. Finally, recommendations are made regarding the potential for surface mining, underground mining, and in-situ gasification of the coal beds. This report evaluates the coal resources of all unleased federal coal beds in the quadrangle which are 5 feet (1.5 m) or greater in thickness and occur at depths down to 3,000 feet (914 m). No resources or reserves are computed for leased federal coal, state coal, fee coal, or lands encompassed by coal prospecting permits and preference-right lease applications.

Surface and subsurface geological and engineering extrapolations drawn from the current data base suggest the occurrence of approximately 3.6 billion tons (3.2 billion metric tons) of total, unleased federal coal-in-place in the Corral Creek Quadrangle.

The suite of maps that accompanies this report sets forth and portrays the coal resource and reserve occurrence in considerable detail. For the most part, this report supplements the cartographically displayed information with minimum verbal duplication of the CRO-CDP map data.

II. GEOLOGY

Regional. The thick, economic coal deposits of the Powder River Basin in northeastern Wyoming occur mostly in the Tongue River Member of the Fort Union Formation, and in the lower part of the Wasatch Formation. Approximately 3,000 feet (914 m) of the Fort Union Formation, including the Tongue River, Lebo, and Tullock Members of Paleocene age, are unconformably overlain by approximately 700 feet (213 m) of the Wasatch Formation of Eocene age. These Tertiary formations lie in a structural basin flanked on the east by the Black Hills uplift, on the south by the Hartville and Casper Mountain uplifts, and on the west by the Casper Arch and the Big Horn Mountain uplift. The structural configuration of the Powder River Basin originated in Late Cretaceous time, with episodic uplift thereafter. The Cretaceous Cordillera was the dominant positive land form throughout the Rocky Mountain area at the close of Mesozoic time.

Outcrops of the Wasatch Formation and the Tongue River Member of the Fort Union Formation cover most of the areas of the major coal resource occurrence in the Powder River Basin. The Lebo Member of the Fort Union Formation is mapped at the surface northeast of Recluse, Wyoming. The Lebo Member is east of the principal coal outcrops and associated clinkers (McKay, 1974), and it presumably projects into the subsurface beneath much of the basin. One of the principal characteristics for separating the Lebo and Tullock Members (collectively referred to as the Ludlow Member east of Miles City, Montana) from the overlying Tongue River Member is the color differential between the lighter-colored upper portion and the somewhat darker lower portion (Brown, 1958). Although geologists are trying to develop criteria for subsurface recognition of the Lebo-Tullock and Tongue River-Lebo contacts through use of subsurface data from geophysical logs, no definitive guidelines are known to have been published. Hence, for subsurface mapping purposes, the Fort Union Formation is not divided into its member subdivisions for this study.

During the Paleocene epoch, the Powder River Basin tropical to subtropical depositional environment included broad, inland flood basins with extensive swamps, marshes, freshwater lakes, and a sluggish, but active, northeastward-discharging drainage system. These features were superimposed on an emerging sea floor, near base level. Much of the vast area where organic debris collected was within a reducing depositional environment. Localized uplifts began to disturb the near sea level terrain of northeastern Wyoming, following retreat of the Cretaceous seas. However, the extremely fine-grained characteristics of the Tongue River Member clastics suggest that areas of recurring uplift peripheral to the Powder River Basin were subdued during major coal deposit formation.

The uplift of areas surrounding the Powder River Basin created a structural basin of asymmetric character, with the steep west flank located on the eastern edge of the Big Horn Mountains. The axis of the Powder River Basin is difficult to specifically define, but it is thought to be located in the western part of the Basin, and to display a north-south configuration some 15 to 20 miles (24 to 32 km) east of Sheridan, Wyoming. Thus, the sedimentary section described in this report lies on the east flank of the Powder River Basin, with gentle dips of 2 degrees or less disrupted by surface structure thought to relate to tectonic adjustment and differential compaction.

Some coal beds in the Powder River Basin exceed 200 feet (61 m) in thickness. Deposition of these thick, in-situ coal beds requires a delicate balance between subsidence of the earth's crust and and in-filling of these areas by tremendous volumes of organic debris. These conditions, in concert with a favorable ground water table, non-oxidizing clear water, and a climate amenable to the luxuriant growth of vegetation produce a stabilized swamp critical to the deposition of coal beds.

Deposition of the unusually thick coal beds of the Powder River Basin may be partially attributable to short-distance water transportation of organic detritus into areas of crustal subsidence. Variations of coal bed thickness throughout the basin relate to changes in the depositional environment. Drill hole data that indicate either the complete absence or extreme attenuation of a thick coal bed probably relate to location of the drill holes within the ancient stream channel system servicing this lowland area in Early Cenozoic time. Where thick coal beds thin rapidly from the depocenter of a favorable depositional environment, it is not unusual to encounter a synclinal structure over the maximum coal thickness due to the differential compaction between organic debris in the coal depocenter and fine-grained clastics in the adjacent areas.

The Corral Creek Quadrangle is located in an area where surface rocks are classified into the Tongue River Member of the Fort Union Formation. Although the Tongue River Member is reportedly 1,200 to 1,300 feet ((366 to 396 m) thick (Olive, 1957), only 300 to 500 feet (91 to 152 m) are exposed in this area. Olive (1957) correlated coal beds in the Spotted Horse coal field with coal beds in the northward extension of the Sheridan coal field, Montana (Baker, 1929), and Gillette coal field, Wyoming (Dobbin and Barnett, 1927), and with coal beds in the Ashland coal field (Bass, 1932) in southeastern Montana. This report utilizes, where possible, the coal bed nomenclature used in previous reports. The Smith coal bed was named by Taff (1909). Baker (1929) assigned names to the Anderson, Canyon, and Wall coal beds. The Cook coal bed was named by Bass (1932), and the Pawnee and Cache coal beds were named by Warren (1959). The Oedekoven coal bed was informally named by IntraSearch (1978a).

Local. The Corral Creek Quadrangle lies on the eastern flank of the Powder River Basin, where the strata dip gently westward. The Tongue River Member of the Fort Union Formation crops out over the entire quadrangle. The Fort Union Formation is composed of very fine-grained sandstone, siltstone, claystone, shale, carbonaceous shale and numerous coal beds.

Two, east-west trending faults with 20 feet (6 m) of vertical displacement are present in the southwest corner of the quadrangle. The faults converge to the east, and a single fault extends from the point of convergence along the southern edge of the quadrangle. The displacement along the inferred fault is variable and ill-defined. A fault of minor displacement extends from the adjacent quadrangle on the east for 1 mile (1.6 km) into the east-central part of the Corral Creek Quadrangle. The outcrop nomenclature of Olive (1957) is augmented to agree with subsurface correlations. Photogeologic evaluation of 1:24,000 scale color aerial photography has been utilized to better define outcrop configurations along the southern boundary of the quadrangle. The specifics of these changes will be mentioned later in the report.

III. Data Sources

Areal geology of the coal outcrops and associated clinker is derived from the Preliminary Geologic Map of the Croton 1 NW (Corral Creek) Quadrangle (McKay, 1973b). Coal bed correlations between McKay's Corral Creek Quadrangle and the Moorhead coal field publication (Bryson and Bass, 1973) are difficult due to the paucity of subsurface control and the difference in coal bed nomenclature between the two publications. The following table sets forth the coal bed nomenclature relationship between the Corral Creek Quadrangle, Wyoming, of McKay, and the Three Bar Ranch Quadrangle, Montana, adjacent to and north of Corral Creek Quadrangle, that utilizes Bryson and Bass' publication.

Corral Creek Quadrangle	Three Bar Ranch Quadrangle
Anderson	Dietz
Upper Canyon	Canyon
Lower Canyon	Upper Cook
Cook	# 5
Wall	No equivalent
No equivalent	Upper Pawnee
Pawnee	Cache
Cache	# 11

The coal bed outcrops are adjusted to the current topographic maps in the area.

Geophysical logs from oil and gas test bores and producing wells compose the source of subsurface control. Some geophysical logs are not applicable to this study, for the logs relate only to the deep, potentially productive oil and gas zones. More than 80 percent of the logs include resistivity, conductivity, and self-potential curves. Occasionally, the suite of geophysical logs includes gamma, density, and sonic curves. These logs are available from several commercial sources.

All geophysical logs available in the quadrangle and its 3-mile perimeter area were scanned to select those with data applicable to Coal Resource Occurrence mapping. Paper copies of the logs were obtained and interpreted, and coal intervals were annotated. Maximum accuracy of coal bed identification was accomplished where gamma, density and resistivity curves were available. Coal bed tops and bottoms were identified on the logs at the midpoint between the minimum and maximum curve deflections. The correlation of coal beds within and between quadrangles was achieved utilizing a fence diagram to associate local correlations with regional coal occurrences.

The reliability of correlations, set forth by IntraSearch in this report, varies depending on: the density and quality of lithologic and geophysical logs; the details, thoroughness, and accuracy of published and unpublished surface geological maps, and interpretative proficiency. There is no intent on the part of IntraSearch to refute nomenclature established in the literature or used locally by workers in the area. IntraSearch's nomenclature focuses upon the suggestion of regional coal bed names applicable throughout the eastern Powder River Basin. It is expected and entirely reasonable that some differences of opinion regarding correlations, as suggested by IntraSearch, exist. Additional drilling for coal, oil, gas, water, and uranium, coupled with expanded mapping of coal bed outcrops and associated clinkers, will broaden the data base for coal bed correlations and allow continued improvement in the understanding of coal bed occurrences in the eastern Powder River Basin.

The topographic map of the Corral Creek Quadrangle is published by the U. S. Geological Survey, compilation date 1971. Land network and mineral ownership data are compiled from land plats available from the U. S. Bureau of Land Management in Cheyenne, Wyoming. This information is current to October 13, 1977.

IV. Coal Bed Occurrence

Fort Union Formation coal beds that are present in all or part of the Corral Creek Quadrangle include, in descending stratigraphic order: the Smith, Anderson, Upper Canyon, Lower Canyon, Cook, Wall, Pawnee, and Cache coal beds. A suite of maps composed of: coal isopach and mining ratio, where appropriate; structure; overburden isopach; areal distribution of identified resources; identified resources and hypothetical resources, where applicable, is prepared for each of these coal beds, except for the Smith coal bed, where insufficient data precludes detailed mapping. Mining ratios are presented on the coal isopach maps.

No physical or chemical analyses are known to have been published regarding the coal beds in the Corral Creek Quadrangle. For northern Campbell County coal beds, the "as received" proximate analysis; the Btu value computed on a moist, mineral-matter-free basis;* and the coal rank are as follows:

COAL BED NAME		DATE SOURCE IDENTIFICATION	AS RECEIVED BASIS						MOIST, M-M-F BTU/LB	COAL RANK
			ASH %	FIXED CARBON %	MOISTURE %	VOLATILES %	SULFUR %	BTU/LB		
Smith	(U)	Hole 7340	3.5	38.0	30.0	28.5	0.31	8371	8700	Subbtm. C
Anderson	(U)	Hole 746	6.3	31.1	32.6	30.0	0.33	7498	8045	Lignite A
Canyon	(U)	Hole 744	4.3	32.9	35.1	27.8	0.31	7298	7650	Lignite A
Cook	(**)	Hole SH-64	3.1	36.2	30.8	29.9	0.15	7948	8225	Lignite A
Wall	(U)	Hole 7426	9.5	29.3	32.2	29.0	0.50	7279	8112	Lignite A
Pawnee	(U)	Hole 7424	7.9	31.0	31.9	29.2	0.39	7344	8025	Lignite A
Cache	(U)	Hole 741	9.5	30.5	31.4	28.6	0.49	7271	7650	Lignite A

* The moist, mineral-matter-free Btu values are calculated in the manner stipulated in the publications by American Society for Testing and Materials (1971).

** Matson, R. E., and Blumer, J. W. (1973).

(U) U. S. Geological Survey and Montana Bureau of Mines and Geology (1976).

The Coal Data sheets, plates 3A and 3B, show the down-hole identification of coal beds within the quadrangle as interpreted from U. S. Geological Survey and Montana Bureau of Mines and Geology drill holes and geophysical logs from oil and gas test bores and from producing sites. This portrayal is schematic by design; hence, no structural or coal thickness implications are suggested by the dashed correlation lines projected through No Record (NR) intervals. Inasmuch as the Cook coal bed underlies the entire quadrangle, it is designated as datum for the correlation diagram. The Anderson and the Lower Canyon coal beds show the thickest single bed occurrences throughout the quadrangle. The Wall, Pawnee, and Cache coal beds occur throughout the area. Subsurface data on the Smith, Anderson, and Upper Canyon coal beds develop a sporadic geographic orientation due to coal bed outcrop patterns in the high-relief area east of the Powder River. A deep coal bed, more than 300 feet (91 m) beneath the Pawnee coal bed, is mapped within this quadrangle as the Oedekoven coal bed. Neither the amount of data existent on this coal bed nor the coal thickness indicate full-scale mapping of the coal bed to be appropriate.

The Anderson coal bed is eroded from approximately 60 percent of the quadrangle. Where the coal bed is present, considerable burning is apparent along the outcrop. The Dietz No. 1 coal bed outcrop of McKay (1973b) has been changed in this report to the Anderson coal bed outcrop because of the subsurface absence of the Dietz No. 1 coal bed east of the Black Draw Quadrangle (IntraSearch, 1978b). This nomenclature change also honors the Anderson coal bed correlation as indicated by subsurface control.

Due to minimal subsurface data, structural and isopach mapping of the Anderson coal bed includes selected outcrop observations. A maximum observed thickness of 26 feet (8 m) occurs in the middle of the area. To the southeast, the coal bed thins to less than 5 feet (1.5 m), as indicated by data from adjacent quadrangles. The coal bed dips gently south-southwestward with a broad, anticlinal nose bisecting the quadrangle from east to west. The overburden above the Anderson coal bed attains a maximum thickness of approximately 180 feet (55 m).

The Upper Canyon coal bed lies 137 to 173 feet (42 to 52 m) beneath the Anderson coal bed. The Upper Canyon is eroded from approximately 30 percent of the quadrangle, and exhibits some burning at the outcrop (Canyon coal bed of McKay, 1973b). IntraSearch, utilizing photogeologic interpretation, refined the Upper Canyon outcrop along the southern border of the quadrangle for conformance with outcrop configurations in the adjacent quadrangle to the south. Observed thicknesses for the Upper Canyon range from 3 to 15 feet (0.9 to 5 m), but the coal bed is projected to 22 feet (7 m) in thickness in the north, and 0 feet (0 m) in the southwest, based on data in adjacent quadrangles. The Upper Canyon coal bed coalesces with the Lower Canyon coal bed in the east-central part of the quadrangle. The Upper Canyon coal bed dips southwestward, and an increased density of subsurface control aids structural and isopach mapping as compared to the Anderson coal bed. A prominent structural trough deforms the Upper Canyon coal bed diagonally from northeast to southwest. The feature is flanked by less prominent structural noses. The overburden thickness ranges from 0 feet (0 m) at the outcrop to approximately 360 feet (110 m).

From 0 to 109 feet (33 m) of interburden separate the Lower Canyon coal bed from the Upper Canyon coal bed. The Lower Canyon is eroded over 10 percent of the quadrangle, with some burning along the outcrop (Cook coal bed outcrop of McKay, 1973b). The observed thickness range of the Lower Canyon coal bed is 5 to 18 feet (1.5 to 5 m), and the coal thickens to 20 feet (6 m) in the southeast part of the quadrangle, where data from adjacent quadrangles provides exterior control. The coal bed is thinnest in the west half of the quadrangle (5 to 8 feet [1.5 to 2.4 m]), but thickens to 18 feet (4 m) in the east-central area. Folding on the Lower Canyon coal bed is similar to the Upper Canyon coal bed, with a prominent syncline bounded on the north and south by anticlines. These three features are superimposed upon a north-south trending structural nose that covers two-thirds of the eastern half of the quadrangle. The Lower Canyon coal bed lies from 0 to 480 feet (0 to 146 m) beneath the surface.

The Cook coal bed lies from 57 to 216 feet (17 to 66 m) below the Lower Canyon coal bed. The thickness of the Cook coal bed ranges from 12 to 31 feet (4 to 9 m), with a non-coal split of up to 47 feet (14 m) in the east-central part of the quadrangle. Structural contours on the Cook coal bed reflect a southwesterly dip modified by plunging anticlines and synclines of variable trend. The most prominent syncline crosses the quadrangle diagonally from the northeast. The Cook coal bed is buried from 0 to 600 feet (0 to 183 m).

The Wall coal bed lies from 27 to 117 feet (8 to 36 m) below the Cook coal bed. The Wall coal bed thins to 5 feet (1.5 m) in the northern sector, and achieves a maximum thickness of 26 feet (8 m) to the south. A thick trend of coal in excess of 20 feet (6 m) trends east-west through the southern third of the quadrangle. Several, thin, non-coal intervals are present locally within the coal bed. Structurally, the Wall coal bed exhibits southwesterly dip with minor accessory folding. Closed contours show a structurally high area in the southwest quadrant with a corresponding structural low immediately to the north. The dip of the Wall coal bed steepens in the southwest part of the quadrangle. The overburden above the Wall coal bed ranges from approximately 75 to 720 feet (23 to 219 m) thick.

From 13 to 195 feet (4 to 59 m) of interburden separates the Pawnee coal bed from the Wall coal bed. The observed variation of coal bed thickness within the quadrangle ranges from 0 to 10 feet (0 to 3 m). Local non-coal intervals of less than 10 feet (3 m) thick occur within the coal bed. An area, barren of coal, trends east-west across the north-central part of the quadrangle. The coal thickens to 8 feet (2.4 m) in the north and to 10 feet (3 m) in the south-central and west-central parts of the area. The Pawnee coal bed thins toward the south edge and southwest corner of the quadrangle. The thickest occurrence is in the southeast corner, where the coal bed attains a thickness of 16 feet (5 m), as projected from the subsurface control in adjacent quadrangles. The Pawnee coal bed dips generally westward. Two synclines, one trending northeast from the southwest quadrangle corner, and the other striking south from the north-central border complicate the structural picture in the west half of the area. The structural troughs are separated by an area of closure defining an anticlinal high in the west-central part of the quadrangle. Another area of structural closure is mapped in the northwest corner of the Corral Creek Quadrangle. The Pawnee coal bed lies from approximately 275 to 860 feet (84 to 262 m) beneath the surface.

The lowest mapped coal bed is the Cache coal bed that lies from 47 to 287 feet (14 to 87 m) below the Pawnee coal bed. The thickness of the Cache ranges from 0 to 15 feet (0 to 5 m). The Cache coal bed is absent from approximately 25 percent of the north half of the area. The maximum thickness of this coal bed occurs in the northwest and southeast parts of the quadrangle. Coal bed thickness ranges from 0 to 5 feet (0 to 1.5 m) in the southwest quadrangle corner. The coal bed dips westward and regional dip is interrupted by structural troughs adjacent to an area of closure. This closure is not as pronounced as the anticline mapped on the overlying Pawnee coal bed. The overburden thickness above the Cache coal bed ranges from approximately 380 to 1,020 feet (116 to 311 m).

V. Geological and Engineering Mapping Parameters

The correct horizontal location and elevation of drill holes utilized in subsurface mapping are critical to map accuracy. IntraSearch plots the horizontal location of the drill hole as described on the geophysical log heading. Occasionally this location is superimposed on or near to a drillsite shown on the topographic map, and the topographic map horizontal location is utilized. If the ground elevation on the geophysical log does not agree with the topographic elevation of the drillsite, the geophysical log ground elevation is adjusted to conformance. If there is no indication of a drillsite on the topographic map, the "quarter, quarter, quarter" heading location is shifted within a small area until the ground elevation on the heading agrees with the topographic map elevation. If no elevation agreement can be reached, the well heading or data sheet is rechecked for footage measurements and ground elevation accuracy. Inquiries to the companies who provided the oil and gas geophysical logs frequently reveal that corrections have been made in the original survey. If all horizontal location data sources have been checked and the information accepted as the best available data, the drillsite elevation on the geophysical log is modified to agree with the topographic map elevation. IntraSearch considers this agreement mandatory for the proper construction of most subsurface maps, but in particular, the overburden isopach, the mining ratio, and Coal Development Potential maps.

Subsurface mapping is based on geologic data within, and adjacent to, the Corral Creek Quadrangle area. Data from geophysical logs are used to correlate coal beds and control contour lines for the coal thickness, structure, and overburden maps. Isopach lines are also drawn to honor selected measured sections where there is sparse subsurface control. Where coal isopach contours do not honor surface measured sections, the surface thicknesses are thought to be attenuated by oxidation and/or erosion: hence, they are not reflective of total coal thickness. Isopach lines extend to the coal bed outcrops, the projections of coal bed outcrops, and the contact between porcellanite (clinker) and unoxidized coal in place. Attenuation of total coal bed thickness is known to take place near these lines of definition; however, the overestimation of coal bed tonnages that results from this projection of total coal thickness is insignificant to the Coal Development Potential maps. Structure contour maps are constructed on the tops of the main coal beds. Where subsurface data are scarce, supplemental structural control points are selected from the topographic map along coal outcrops.

In preparing overburden isopach maps, no attempt is made to identify coal beds that occur in the overburden above a particular coal bed under study. Mining ratio maps for this quadrangle are constructed utilizing a 95 percent recovery factor. Contours of these maps identify the ratio of cubic yards of overburden to tons of recoverable coal. Where ratio control points are sparse, interpolated points are computed using coal structure, coal isopach, and topographic control. On the Areal Distribution of Identified Resources Map (ADIR), coal bed reserves are not calculated where the coal is less than 5 feet (1.5 m) thick, where the coal occurs at a depth greater than 500 feet (152 m), and where non-federal coal exists, or where federal coal leases, preference-right lease applications, and coal prospecting permits exist.

Coal tonnage calculations involve the planimetering of areas of measured, indicated, and inferred parts of identified resources, and hypothetical resources to determine their areal extent in acres. An Insufficient Data

Line is drawn to delineate areas where surface and subsurface data are too sparse for CRO map construction. Various categories of resources are calculated in the unmapped areas by utilizing coal bed thicknesses mapped in the geologically controlled area adjacent to the insufficient data line. Acres are multiplied by the average coal bed thickness and 1,750, or 1,770--the number of tons of lignite A or subbituminous C coal per acre-foot, respectively (12,874 or 13,018 metric tons per hectare-meter, respectively)--to determine total tons in place. Recoverable tonnages (reserves) are calculated at 95 percent of the total tons in place. Where tonnages are computed for the CRO-CDP map series, resources and reserves are expressed in millions of tons. Frequently, the planimetering of coal resources on a sectionized basis involves complexly curvilinear lines (coal bed outcrop and 500-foot stripping limit designations) in relationship with linear section boundaries and circular resource category boundaries. Where these relationships occur, generalizations of complex curvilinear lines are discretely utilized, and resources and/or reserves are calculated within an estimated 2 to 3 percent, plus or minus, accuracy.

VI. Coal Development Potential

Strippable Coal Development Potential. Areas where coal beds are 5 feet (1.5 m) or more in thickness and are overlain by 500 feet (152 m) or less of overburden are considered to have potential for surface mining and are assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios for subbituminous coal is as follows:

$$MR = \frac{to\ (0.911)^*}{tc\ (rf)}$$

where MR = mining ratio
to = thickness of overburden
tc = thickness of coal
rf = recovery factor
0.911 = conversion factor (cu. yds./ton)

*A conversion factor of 0.922 is used for lignite.

A surface mining development potential map (plate 39) was prepared utilizing the following mining ratio criteria for coal beds 5 feet to 40 feet (1.5 to 12 m) thick:

1. Low development potential = 15:1 and greater ratio.
2. Moderate development potential = 10:1 to 15:1 ratio.
3. High development potential = 0 to 10:1 ratio.

The surface mining development potential is high for most of the Corral Creek Quadrangle. The topographic relief of 500 to 600 feet (152 to 183 m) and multiple coal bed occurrences in the quadrangle cause a high development potential for surface mining for five coal beds. In areas of deep erosion, such as along Bitter and Buffalo Creeks, the Cook and Wall coal beds lie less than 500 feet (152 m) beneath the surface. As elevations along the valley walls increase away from the valley floor, the Lower Canyon and Upper Canyon coal beds are encountered at depths of less than 500 feet (152 m) over some of the quadrangle. The Anderson coal bed is encountered at higher elevations and is less than 500 feet (152 m) from the surface over the entire quadrangle.

Table 1 sets forth the estimated strippable reserve base tonnages per coal bed for this quadrangle.

Underground Mining Coal Development Potential. Subsurface coal mining development potential throughout the Corral Creek Quadrangle is considered low. Inasmuch as recovery factors have not been established for the underground development of coal beds in this quadrangle, reserves are not calculated for coal beds that occur more than 500 feet (152 m) beneath the surface. Table 2 sets forth the estimated coal resources in tons per coal bed.

In-Situ Gasification Coal Development Potential. The evaluation of subsurface coal deposits for in-situ gasification development potential relates to the occurrence of coal beds more than 5 feet (1.5 m) thick buried from 500 to 3,000 feet (152 to 914 m) beneath the surface. This categorization is as follows:

1. Low development potential relates to: 1) a total coal section less than 100 feet (30 m) thick that lies 1,000 feet (305 m) to 3,000 feet (914 m) beneath the surface, or 2) a coal bed or coal zone 5 feet (1.5 m) or more in thickness that lies 500 feet (152 m) to 1,000 feet (305 m) beneath the surface.
2. Moderate development potential is assigned to a total coal section from 100 to 200 feet (30 to 61 m) thick and buried from 1,000 to 3,000 feet (305 to 914 m) beneath the surface.

3. High development potential involves 200 feet (61 m) or more of total coal thickness buried from 1,000 to 3,000 feet (305 to 914 m).

The coal development potential for "in-situ" gasification on the Corral Creek Quadrangle is low, hence no CDP map is generated for this map series. The resource tonnage for "in-situ" gasification with low development potential totals 593 million tons (538 million metric tons) (table 3). None of the coal beds in the Corral Creek Quadrangle qualifies for a moderate or high development potential rating for "in-situ" gasification.

Table 1.--Strippable Coal Reserve Base and Hypothetical Resource Data (in short tons) for Federal Coal Lands in the Corral Creek Quadrangle, Campbell County, Wyoming.

Development potentials are based on mining ratios (cubic yards of overburden/ton of recoverable coal).

Coal Bed	High Development Potential (0-10:1 Mining Ratio)	Moderate Development Potential (10:1-15:1 Mining Ratio)	Low Development Potential (>15:1 Mining Ratio)	Total
Reserve Base				
Anderson	228,590,000	520,000	-	229,110,000
Upper Canyon	294,840,000	81,530,000	57,280,000	433,650,000
Lower Canyon	249,100,000	82,690,000	121,960,000	453,750,000
Cook	336,860,000	402,340,000	340,410,000	1,079,610,000
Wall	22,020,000	151,900,000	407,290,000	581,210,000
Pawnee	-	-	115,400,000	115,400,000
Cache	-	-	13,250,000	13,250,000
Total	1,131,410,000	718,980,000	1,055,590,000	2,905,980,000
Hypothetical Resources				
Anderson	-	-	5,800,000	5,800,000
Total	-	-	5,800,000	5,800,000
GRAND TOTAL	1,131,410,000	718,980,000	1,061,390,000	2,911,780,000

Table 2.--Coal Reserve Base Data (in short tons) for Underground Mining Methods for Federal Coal Lands in the Corral Creek Quadrangle, Campbell County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Cook	-	-	39,290,000	39,290,000
Wall	-	-	134,430,000	134,430,000
Pawnee	-	-	149,590,000	149,590,000
Cache	-	-	269,310,000	269,310,000
TOTAL	-	-	592,620,000	592,620,000

Table 3.--Coal Reserve Base Data (in short tons) for In-Situ Gasification for Federal Coal Lands in the Corral Creek Quadrangle, Campbell County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Cook	-	-	39,290,000	39,290,000
Wall	-	-	134,430,000	134,430,000
Pawnee	-	-	149,590,000	149,590,000
Cache	-	-	269,310,000	269,310,000
TOTAL	-	-	592,620,000	592,620,000

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