UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

NORTHEAST QUARTER OF TURNERCREST 15' QUADRANGLE,

CAMPBELL COUNTY, WYOMING

BY

INTRASEARCH INC.

DENVER, COLORADO

OPEN FILE REPORT 79-074

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This report is preliminary, and has not been edited or reviewed for conformity with United States Geological Survey standards or stratigraphic nomenclature.

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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 per metric tons
acre feet	0.12335	hectare-meters
Btu/lb	2.326	kilojoules/kilogram (kJ/kg)
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 Northwest Quarter of Turnercrest 15' Quadrangle, Campbell County, Wyoming. This CRO and CDP map series (U. S. Geological Survey Open-File Report 79-074) includes 35 plates. The project is compiled by IntraSearch Inc., 1600 Ogden Street, Denver, Colorado, under KRCRA Northeastern 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 Areas (KRCRAs) in the western United States.

The Northeast Quarter of Turnercrest 15' Quadrangle is located in Campbell County, in northeastern Wyoming. It encompasses all or parts of Townships 42, 43 and 44 North, Ranges 72 and 73 West, and covers the area: 43° 37' 30" to 43° 45' north latitude; 105° 30' to 105° 37' 30" west longitude.

Main access to the Northeast Quarter of Turnercrest 15' Quadrangle is provided by Wyoming State Highway 387 which angles northeastward across the northern half of the study area. One maintained gravel road extends from Wyoming State Highway 387 to the northwestern corner of the quadrangle, and another traverses the southern half of the quadrangle. Minor roads and trails provide additional access to the study area. The closest railroad is the Burlington Northern trackage 6 miles (10 km) to the east near the Black Thunder coal mine.

Porcupine Creek flows southeastward across the southern half of the Northeast Quarter of Turnercrest 15' Quadrangle and drains into the Cheyenne River system. Hay Creek, a tributary of the Belle Fourche River, flows northeastward across the northeastern quadrant. The topography of the quadrangle attains heights of 5300 feet (1615 m) above sea level, 300 to 350 feet (91 to 107 m) above the valley floors.

The thirteen to fourteen inches (33 to 36 cm) of annual precipitation that falls in this semi-arid region accrues principally in the springtime. Summer and fall precipitation usually originates from thunderstorms, and infrequent snowfalls of six 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 Gillette, Wyoming, average wintertime minimums and summertime maximums approach +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. State and federal lands are 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 belongs to both fee and state owners.

The Coal Resource Occurrence and Coal Development Potential program is restricted to unleased federal coal and focuses upon: 1) the delineation of lignite, subbituminous coal, bituminous coal, and anthracite at the surface and in the subsurface on federal land; 2) subdivision of deposits into measured, indicated, and inferred reserve resource categories, and hypothetical resources; 3) the measurement of coal resources in place as well as recoverable reserves; and 4) the determination of the potential for surface or underground mining, and in-situ gasification of the coal beds. This report contains an evaluation of 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 3000 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 7.5 billion tons (6.8 billion metric tons) of unleased federal coal resources, and 3 million tons (3 million metric tons) of hypothetical coal resources in the Northeast Quarter of Turnercrest 15' Quadrangle.

The suite of maps that accompany this report portray the coal resource and reserve occurrence in detail. For the most part, this report supplements the cartographic information, with minimum duplication of the 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 3000 feet (914 m) of the Fort Union Formation, that includes 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 major coal resource occurrence in the Powder River Basin. The Tongue River Member is composed of very fine-grained sandstones, siltstones, claystones, shales, carbonaceous shales, and numerous coal beds. The Lebo Shale Member of the Fort Union Formation consists of light-to dark-gray very fine-grained to conglomeratic sandstone with interbedded siltstone, claystone, carbonaceous shale and thin coal beds. Thin bedded calcareous ironstone concretions interbedded with massive white sandstone and slightly bentonitic shale occur throughout the unit.

The Lebo Member is mapped at the surface northeast of Recluse, Wyoming, east of the principal coal outcrops and associated clinkers (McKay, 1974), and 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 working with subsurface data, principally geophysical logs, in the basin are trying to develop criteria for subsurface recognition of the Lebo-Tullock and Tongue River-Lebo contacts, no definitive guidelines are known to have been published. Hence, for subsurface mapping purposes, the Fort Union Formation is not divided into its members for this study.

During the Paleocene epoch, the Powder River Basin tropic to subtropic depositional environment included broad, inland flood basins with extensive swamps, marshes, freshwater lakes, and a sluggish but active northeastward discharging drainage system, 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 characteristic, 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 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 two 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 discrete balance between subsidence of the earth's crust and in-filling by tmememdous 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 in 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 draining this low land 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 Wasatch Formation of Eocene age crops out over most of the central part of the Powder River Basin and exhibits a disconformable contact with the underlying Fort Union Formation. The contact has been placed at various horizons by different workers; however, for the purpose of this report, the contact is positioned near the top of the Roland coal bed as mapped by Olive (1957) in northwestern Campbell County, Wyoming, and is considered to disconformably descend in the stratigraphic column to the top of the Wyodak-Anderson coal bed (Roland coal bed of Taff, 1909) along the eastern boundary of the coal measures. No attempt is made to differentiate the Wasatch and Fort Union Formations on geophysical logs or in the subsurface mapping program that is a part of this CRO-CDP project.

Although Wasatch and Fort Union lithologies are too similar to allow differentiation in some areas, most of the thicker coal beds occur in the Fort Union section on the east flank of the Powder River Basin. Furthermore, orogenic movements peripheral to the basin apparently increased in magnitude during Wasatch time causing the deposition of friable, coarse-grained to gritty arkosic sandstones, fine- to very fine-grained sandstones, siltstones, mudstones, claystones, brown-to-black carbonaceous shales and coal beds. These sediments are noticeably to imperceptibly coarser than the underlying Fort Union clastics.

The Northeast Quarter of Turnercrest 15' Quadrangle is located in an area where surface rocks are classified into the Wasatch Formation. Olive (1957) correlated coal beds in the Spotted Horse coal field with coal beds in the Sheridan coal field (Baker, 1929) and Gillette coal field (Dobbin and Barnett, 1927), Wyoming, 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 Felix coal bed was named by Stone and Lupton (1910). The Smith coal bed was named by Taff (1909). Baker (1929) assigned names to the Anderson and Canyon coal beds. The Cook coal bed was named by Bass (1932). The Pawnee coal bed was named by Warren (1959). IntraSearch's correlation of thick coal beds from the Spotted Horse coal field to Gillette points out that the Wyodak coal bed, named the "D" coal bed by Dobbin and Barnett (1927), is equivalent to the Anderson, Canyon and all or part of the Cook coal beds to the north and west of Gillette, Wyoming. Correlation of this suite of coal beds with the Wyodak coal bed south and southwest of Gillette suggests that the Anderson and Canyon coal beds equate with the upper ten to twenty-five percent of the thick Wyodak coal bed, and the Cook and Wall or Upper Wall coal beds are equivalent to the major part of the Wyodak coal bed. Due to problematic correlations outside of the Gillette area, the name Wyodak has been informally used by many previous authors to represent the coal beds in the area surrounding the Wyodak coal mine. The Wildcat and Moyer coal beds were informally named by IntraSearch (1978 and 1979).

Local. The Northeast Quarter of Turnercrest 15' Quadrangle lies on the eastern flank of the Powder River Basin, where the strata dip gently westward. The Wasatch Formation crops out over the entire area, and is comprised of friable, coarse-grained to gritty arkosic sandstones, fine- to very fine-grained sandstones, siltstones, mudstones, claystones, brown-to-black carbonaceous shales and coal beds. The Tongue River Member of the Fort Union Formation lies 750 to 1060 feet (229 to 323 m) beneath the surface and is composed of very fine-grained sandstones, siltstones, claystones, shales, carbonaceous shales, and numerous coal beds.

III. Data Sources

The principal source of data for the areal geology of the coal outcrop and associated clinker is the Preliminary Coal Resource Occurrence Map of the Turnercrest Northeast Quadrangle by Martin (1976). This information is supplemented by the reconaissance map by Schell and Mowat (1972).

The major source of subsurface control, particularly on deep coal beds, is the geophysical logs from oil and gas test bores and producing wells. 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 eighty percent of the logs include resistivity, conductivity, and self-potential curves. Occasionally the logs include gamma, density, and sonic curves. These logs are available from several commercial sources.

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

In some parts of the Powder River Basin, additional subsurface control is available from U. S. Geological Survey open-file reports that include geophysical and lithologic logs of shallow holes drilled specifically for coal exploration. A sparse scattering of subsurface data points are shown on unpublished CRO-CDP maps compiled by the U. S. Geological Survey, and where these data are utilized, the rock-coal intervals are shown on the Coal Data Map (Plate 1). Inasmuch as these drill holes have no identifier headings, they are not set forth on the Coal Data Sheet (Plate 3). The geophysical logs of these drill holes were not available to IntraSearch to ascertain the accuracy of horizontal location, topographic elevation, and downhole data interpretation.

The reliability of correlations, set forth by IntraSearch in this report, vary depending on: the density and quality of lithologic and geophysical logs; the detail, 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 Turnercrest 15' Quadrangle is published by the U. S. Geological Survey, compilation date, 1960. Expansion of the topographic base of the Turnercrest 15' Quadrangle (scale 1:62,500) into seven and one-half minute quadrangle maps (scale 1:24,000) was performed by the U. S. Geological Survey for Coal Resource Occurrence/ Coal Development Potential mapping purposes. 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

Wasatch and Fort Union coal beds that are present in all or part of the Northeast Quarter of the Turnercrest 15' Quadrangle include, in descending stratigraphic order, the Upper Felix, Lower Felix, Smith, Upper Wyodak, local, Middle Wyodak, Lower Wyodak, Pawnee, Wildcat, and Moyer coal beds. A complete suite of maps (structure, isopach, mining ratio, overburden, identified resources, and areal distribution of identified resources) is prepared for the Felix coal zone, the Smith and upper Wyodak coal beds, the Middle and Lower Wyodak coal zone, the Pawnee coal bed, and the Wildcat-Moyer coal zone. In addition, interburden maps presented with the overburden isopach maps, are prepared for the Felix coal bed and the Middle and Lower Wyodak coal zone. Insufficient areal extent precludes detailed mapping of the local coal bed.

No physical and chemical analyses are known to have been published regarding the coal beds in the Northeast Quarter of Turnercrest 15' Quadrangle. However, the general "as received" basis proximate analyses for central and southern Campbell County coal beds are as follows:

COAL BED NAME			ASH %	FIXED CARBON %	MOISTURE %	VOLATILES %	SULFUR %	BTU/LB
Felix	(U)	Hole 7324	6.993	35.200	25.010	37.798	0.629	8544
Smith	(U)	Hole 7312C	6.167	33.340	29.610	30.883	1.068	8215
Upper Wyodak	(U)	Hole 7544	4.501	32.688	24.337	38.450	0.201	8953
Middle & Lower Wyodak	(U)	757	6.024	32.831	26.907	34.237	0.336	8366
Pawnee	(U)	Hole 7424C	7.880	31.029	31.910	29.183	0.386	7344
Wildcat	(*)	Hole 11447	4.3	29.4	27.8	29.4	0.27	8410

(U) - U. S. Geological Survey & Montana Bureau of Mines & Geology - 1974 and 1976.

(*) - Winchester, 1912

The Coal Data Sheet, Plate 3, shows the downhole identification of coal beds within the quadrangle as interpreted from geophysical logs of oil and gas test bores and producing sites. A datum coal bed is utilized to position columnar sections on Plate 3. 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 Middle Wyodak coal bed underlies the entire quadrangle, it is designated as datum for the correlation diagram.

The Felix coal zone is comprised of one Upper and two Lower Felix coal beds. The Upper Felix coal bed is equivalent to the "A" coal bed of Dobbin and Barnett (1928), the local coal bed of Schell and Mowat (1972), and the "F_1" coal bed of Martin (1976). The Upper Felix coal bed is eroded from approximately fifty percent of the quadrangle. The Lower Felix coal beds are eroded from approximately twenty percent of the study area. A single outcrop is shown representing both Lower Felix coal beds due to the minimal separation between the two coal beds at the map scale of 1:24,000. The split line which angles across the upper third of the quadrangle indicates the separation of the Upper Felix coal bed from the Lower Felix coal bed to the south. The total coal thickness for the Felix coal zone ranges from less than 15 feet (5 m) in the southwestern quadrant to 32 feet (10 m) in the northeastern quadrant. The Felix coal zone mining ratio map, combined with the coal isopach map, is drawn using the Upper Felix coal thickness where it is greater than 5 feet (1.5 m) thick plus the Lower Felix coal thickness. In the areas where the Upper Felix coal bed is less than 5 feet (1.5 m) thick, the mining ratio map is drawn only on the Lower Felix coal bed. In computing mining ratio control points, the non-coal interval between the two coal beds is added to the Upper Felix overburden and then divided by ninety-five percent of the combined coal thickness. The total non-coal interburden within the Felix coal zone varies in thickness from 3 to 138 feet (0.9 to 42 m). The primary structural feature of the Felix coal zone is a broad northwest plunging anticline in the western half of the quadrangle. A smaller northwest plunging anticline, separated from the major anticline by a narrow synclinal trough, occurs in the northeastern quadrant. At maximum, the Felix coal bed lies approximately 350 feet (107 m) beneath the surface.

The Smith coal bed occurs between 341 and 469 feet (104 and 143 m) below the Felix coal zone. The Smith coal bed attains a maximum thickness of over 15 feet (5 m) along the northern quadrangle boundary, and a minimum thickness of less than 5 feet (1.5 m) in the southwestern quadrant. Structure contours drawn on top of the Smith coal bed define a northwest plunging syncline extending from the east-central portion of the quadrangle to the northwestern corner. This syncline is bordered by anticlines to the east and west. The Smith coal bed occurs at depths from less than 300 feet (91 m) to more than 750 feet (229 m) beneath the surface. Less than 500 feet (152 m) of overburden covers the Smith coal bed over approximately sixty percent of the Northeast Quarter of Turnercrest 15' Quadrangle.

A non-coal interval 117 to 234 feet (36 to 71 m) thick separates the Upper Wyodak coal bed from the overlying Smith coal bed. The thickness of the Upper Wyodak coal bed ranges from 6 feet (1.8 m) in the northeastern quadrant to over 25 feet (8 m) in the extreme northwestern corner. Similar to the structure contour map of the Smith coal bed, the structure contour map of the Upper Wyodak coal bed shows a northwest plunging syncline bounded by two anticlines. The Upper Wyodak coal bed occurs less than 500 feet (152 m) below the surface throughout approximately fifteen percent of the study area.

The Middle and Lower Wyodak coal zone lies 38 to 357 feet (12 to 109 m) below the Upper Wyodak coal bed. The total thickness of coal in the Middle and Lower Wyodak coal zone varies from less than 30 feet (9 m) to 159 feet (48 m). Minimum thicknesses occur in the southwestern quadrant where the Middle Wyodak coal bed is pinched out, and maximum thicknesses occur in the northwestern quadrant. The split line of the Middle and Lower Wyodak coal beds trends southeastward from the northwest corner to the north-central part of the quadrangle. The non-coal interburden between the Middle and Lower Wyodak coal beds attains a maximum value of over 200 feet (61 m) in the extreme southwestern corner of the quadrangle. The structure contour map is drawn on top of the Lower Wyodak coal bed in the west-central region of the quadrangle where the Middle Wyodak coal bed is absent. Contours are drawn on top of the Middle Wyodak coal bed throughout the remainder of the study area. The structure contours indicate a structurally low area trending east-west through the east-central portion of the area, and numerous minor folds. The Middle and Lower Wyodak coal zone lies at depths greater than 500 feet (152 m) beneath the surface throughout the Northeast Quarter of Turnercrest 15' Quadrangle.

The Pawnee coal bed occurs 236 to 242 feet (72 to 75 m) beneath the Middle and Lower Wyodak coal zone. The Pawnee coal bed is absent from approximately seventy-five percent of the quadrangle. The thickness varies from 0 to more than 15 feet (0 to 5 m) with the maximum thickness located in the northeast corner of the area. The westward-dipping Pawnee coal bed lies greater than 1000 feet (305 m) beneath the surface throughout the entire quadrangle. (Plate 26).

The Wildcat-Moyer coal zone lies almost 600 feet (183 m) below the Pawnee coal bed. The Wildcat and Moyer coal beds are very lenticular in this quadrangle. The Wildcat-Moyer coal zone is pinched out over approximately fifty percent of the study area. The maximum total thickness of coal in the Wildcat-Moyer coal zone, over 20 feet (6 m), is located in the southeastern corner of the quadrangle. The westward-dipping Wildcat-Moyer coal zone occurs at depths greater than 1500 feet (457 m) below the surface throughout the entire quadrangle. (Plate 31).

V. Geological and Engineering Mapping Parameters

The correct horizontal location and elevation of drill holes utilized in subsurface mapping are critical to map accuracy. Intra-Search Inc., plots the horizontal location of the drill hole as described on the geophysical log heading. Occasionally this location is superimposed 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 Inc., 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 Northeast Quarter of Turnercrest 15' 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 surface measured sections where there is sparse subsurface control. Where isopach contours do not honor surface measured sections, the surface thicknesses are thought to be attenuated by oxidation and/or erosion, hence 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 to a particular coal bed under study. Mining ratio maps for this quadrangle are constructed utilizing a ninety-five 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 at the intersections of coal bed and overburden isopach contours 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), 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, inferred reserves and resources, and hypothetical resources to determine their areal extent in acres. An <u>Insufficient Data Line</u> 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 1750, or 1770 (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 tonnage is calculated at ninety-five 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 complexly curvilinear lines are discretely utilized, and resources and/or reserves are calculated within an estimated two to three 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 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 potential map (Plate 34) is prepared utilizing the following mining ratio criteria for coal beds 5 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 following mining ratio criteria is utilized for coal beds greater than 40 feet (12 m) thick:

1. Low development potential = 7:1 and greater ratio.
2. Moderate development potential = 5:1 to 7:1 ratio.
3. High development potential = 0 to 5:1 ratio.

Approximately seventy-five percent of the Northeast Quarter of Turnercrest 15' Quadrangle shows high development potential for surface mining. In areas of Felix coal bed occurrence, low mining ratios for the Felix coal bed produce high potential areas. Moderate development potential areas encompass approximately ten percent of the Northeast Quarter of Turnercrest 15' Quadrangle and can be attributed to the higher ratio values of the Felix coal bed. These moderate potential areas are located in small portions of the western half of the quadrangle.

Low surface mining development potential areas cover approximately fifteen percent of the quadrangle, and result from high overburden to coal ratios for coals below the Felix coal bed. Table 1 sets forth the estimated strippable reserve base tonnages per coal bed for the quadrangle.

Underground Mining Coal Development Potential. Subsurface coal mining potential throughout the Northeast Quarter of Turnercrest 15' 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 potential relates to the occurrence of coal beds more than 5 feet (1.5 m) thick buried from 500 to 3000 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 500 feet (152 m) to 3000 feet (914 m) beneath the surface, or 2) coal beds 5 feet (1.5 m) or more in thickness that lie 500 feet (152 m) to 1000 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 1000 to 3000 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 1000 to 3000 feet (305 to 914 m).

The coal development potential for in-situ gasification is low for approximately eighty-five percent of the Northeast quarter of Turnercrest 15' Quadrangle. The resource tonnage for in-situ gasification with low development potential totals approximately 5 billion tons (4.5 billion metric tons) (Table 3). The remaining fifteen percent of the quadrangle is considered to have moderate development potential with coal resource tonnages totalling approximately 1.2 billion tons (1.1 billion metric tons) (Table 3). None of the coal beds in the Northeast Quarter of Turnercrest 15' Quadrangle qualify for a high development potential rating.

Table 1.--Strippable Coal Reserve Base Data (in short tons) for Federal Coal Lands in the Northeast Quarter of Turnercrest 15' 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
Felix	634,190,000	160,030,000	22,410,000	816,630,000
Smith	-----	-----	274,570,000	274,570,000
Upper Wyodak	-----	-----	62,520,000	62,520,000
TOTAL	634,190,000	160,030,000	359,500,000	1,153,720,000

Table 2.--Coal Resource Base Data (in short tons) for Underground Mining Methods for Federal Coal Lands in the Northeast Quarter of Turnercrest 15' Quadrangle, Campbell County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Smith	-----	-----	293,600,000	293,600,000
Upper Wyodak	-----	-----	673,660,000	673,660,000
Middle and Lower Wyodak	----	-----	4,942,090,000	4,942,090,000
Pawnee	-----	-----	89,870,000	89,870,000
Wildcat-Moyer	-----	-----	254,710,000	254,710,000
TOTAL	-----	-----	6,253,930,000	6,253,930,000

Table 3.--Coal Resource Base Data (in short tons) for In-Situ Gasification for Federal Coal Lands in the Northeast Quarter of Turnercrest 15' Quadrangle, Campbell County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
	-----	1,244,690,000	5,009,240,000	6,253,930,000
TOTAL	-----	1,244,690,000	5,009,240,000	6,253,930,000

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