UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

WILDCAT QUADRANGLE,

CAMPBELL COUNTY, WYOMING

BY

INTRASEARCH INC.

DENVER, COLORADO

OPEN FILE REPORT 79-030
1979

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

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

MAPS | PLATES

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 Wildcat Quadrangle, Campbell County, Wyoming. This CRO and CDP map series (U. S. Geological Survey Open-File Report 79-030) includes 76 plates. 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 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 Wildcat Quadrangle is located in Campbell County, in northeastern Wyoming. It encompasses all or parts of Townships 52, 53, and 54 North, Ranges 73 and 74 West, and covers the area: 44°30' to 44°37'30" north latitude; 105°37'30" to 105°45' west longitude.

The main access to the Wildcat Quadrangle is provided by U. S. Highway 14-16 which traverses northwest-southeast across the eastern portion of the study area. Four maintained gravel roads branch westward from U. S. Highway 14-16, providing access to the western portion of the quadrangle. Several minor roads and trails which branch from these maintained roads provide additional access to the area. The closest railroad is the Burlington Northern trackage approximately 6 miles (10 km) to the southwest at Echeta, Wyoming.

Drainage patterns generate from high, fairly rugged terrain located in the western half of the quadrangle. A maximum elevation of 4662 feet (1421 m) above sea level occurs in the extreme southwest portion of the study area. The North Fork of Wildcat Creek flows intermittently eastward through the east-central part of the quadrangle, and Horse Creek flows northeastward through the extreme northwestern portion of the area.

Both of these creeks drain northeastward into the Little Powder River. Minimum elevations of 3960 feet (1207 m) above sealevel are located in the valley floor of the North Fork of Wildcat Creek at the eastern quadrangle boundary.

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 +°15F (-15° to -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, as well as recoverable tons. These coal tonnages are then categorized into units of measured, indicated, and inferred 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 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 9.0 billion tons (8.2 billion metric tons) of unleased federal coal resources in the Wildcat Quadrangle.

The suite of maps that accompany 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 3000 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 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 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 (Denson and Horn, 1975). The Lebo Member is mapped at the surface northeast of Recluse, Wyoming. Here, 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 the 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 members 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 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 delicate balance between subsidence of the earth's crust and in-filling 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 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 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 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. It is considered to descend disconformably 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 was made to differentiate the Wasatch and Fort Union Formations on geophysical logs or in the subsurface mapping program for this 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 Wildcat Quadrangle is located in an area where surface rocks are classified into the Fort Union Formation and the Wasatch Formation. Approximately 200 to 250 feet (61 to 76 m) of the Fort Union Formation and 400 to 500 feet (122 to 152 m) of the Wasatch Formation crop out in this quadrangle. 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 Scott coal bed was named by Olive (1957), and the Felix coal bed was named by Stone and Lupton (1910). Kent (1976a) named the Norfolk coal bed, and the Smith coal bed was named by Taff (1909). The Swartz coal bed was designated by McKay and Mapel (1973), and 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 Wildcat, Moyer, and Oedekoven coal beds were informally named by Intra-Search (1978b, 1979, 1978a).

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. 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.

Local. The Wildcat Quadrangle lies on the eastern flank of the Powder River Basin, where the strata dip gently westward. The Wasatch Formation covers approximately 50 percent of the quadrangle, 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 Fort Union Formation crops out over the remaining area. The Fort Union Formation is composed of very fine-grained sandstones, siltstones, claystones, shales carbonaceous shales, and numerous coal beds.

Two northeast-southwest trending faults are located in the east-central portion of the study area. These faults vertically displace strata approximately 10 to 30 feet (3 to 9 m). The northern fault is downthrown to the south. It was extended from the northern fault mapped by Kent (1976b) in order to be consistent with subsurface data and to match the elevation of the Norfolk coal bed on the hillside north of the fault with the elevation of the Norfolk coal bed in the valley south of the fault. The southern fault is downthrown to the north, and it is approximately 700 feet (213 m) in length.

An east-west trending fault is present in the southeastern portion of the quadrangle. This fault is downthrown to the north approximately 10 to 30 feet (3 to 9 m).

III. Data Sources

Areal geology of the coal outcrops and associated clinker is derived from Kent (1976b).

Geophysical logs from oil and gas test bores and producing wells comprise 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 are scanned to select those with data applicable to Coal Resource Occurrence mapping. Paper copies of the logs are obtained and interpreted, and coal intervals are 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, varies 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 Wildcat 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

Wasatch and Fort Union coal beds or coal zones that are present in all or part of the Wildcat Quadrangle include, in descending stratigraphic order, the Ulm, Scott, Daly, Felix, an unamed local, the Norfolk, Upper Smith, Lower Smith, Swartz, Anderson, Canyon, Cook, Wall, Pawnee, Cache, another local, the Wildcat, a third unnamed local, the Moyer, Oedekoven, and another unnamed local coal bed. A suite of maps comprised of coal isopach, mining ratio, where appropriate, structure, overburden isopach, areal distribution of identified resources, and identified resources was prepared for each of these coal beds or coal zones except the Ulm, Daly, and local coal beds, which are not mapped due to insufficient areal extent. Interburden as well as overburden thicknesses are mapped for the Lower Smith-Swartz coal zone and the Pawnee coal bed. Mining ratio maps presented with the isopachs, are prepared for the Scott, Felix, Norfolk, Upper Smith, Lower Smith-Swartz, Anderson, Canyon, Cook, and Wall coal beds.

No physical and chemical analyses are know to have been published regarding the coal beds in the Wildcat Quadrangle. However, the general proximate analyses performed on an "as received" basis for northern Campbell County coal beds are as follows:

COAL BED NAME			ASH %	FIXED CARBON %	MOISTURE %	VOLATILES %	SULFUR %	BTU/LB
Felix	(U)	Hole 7322	9.526	31.410	25.952	33.112	1.075	8170
Lower Smith	(U)	Hole 7312C	6.167	33.340	29.610	30.883	1.068	8215
Swartz	(U)	Hole 7336	5.224	33.326	33.242	28.029	0.999	7712
Anderson	(U)	Hole 738	4.546	34.783	31.540	29.131	0.250	7770
Pawnee	(U)	Hole 7424	7.880	31.029	31.910	29.183	0.386	7344

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

The Coal Data Sheet, Plates 3a and 3b, shows the down hole identification of coal beds within the quadrangle as interpreted from geophysical logs from oil and gas test bores and producing sites. Inasmuch as the Cook coal bed underlies the entire quadrangle, it is designated as datum for the correlation diagram. The Lower Smith, Cook and Pawnee coal beds show the thickest single coal bed occurrences throughout the quadrangle.

The Scott coal bed has been eroded from approximately 98 percent of the quadrangle, present only along the western border and in scattered outliers in the western half. Map data, taken from outcrop information, indicate a thickness range for the Scott coal bed of approximately 4 to 10 feet (1.2 to 3 m). Structural configuration based on the limited data suggests a rolling surface dipping gently westward. The Scott coal bed is less than 150 feet (46 m) deep in the quadrangle.

The Felix coal bed crops out over about 20 percent of the study area along the western boundary of the quadrangle. In less than one percent of the area of outcrop the Felix coal bed has been burned. The minimum thickness of less than 10 feet (3 m) is attained in the west-central portion of the quadrangle. Maximum thicknesses of over 22 feet (7 m) occur in the northwest quadrant and are projected along the eastern edge. Structural contours drawn on top of the Felix coal bed define a northwest-southeast trending syncline. The Felix coal bed lies less than 350 feet (107 m) below the surface throughout the Wildcat Quadrangle.

The Norfolk coal bed, located about 300 feet (91 m) below the Felix coal bed, crops out over approximately 80 percent of the Wildcat Quadrangle. Burned in approximately 5 percent of the area of outcrop, the Norfolk coal bed varies in thickness from a maximum of 18 feet (5 m) in the central portion of the quadrangle to a minimum of less than 2 feet (0.6 m) in the southwestern corner of the quadrangle. In addition to the faults which displace strata throughout the sequence in the Wildcat Quadrangle, three major features dominate the structure of the Norfolk coal bed. These are an east-west trending anticline located in the northeastern quadrant, a north-south trending anticline in the southeastern quadrant, and a depression along the west-central region of the quadrangle. The Norfolk coal bed occurs at depths from 0 to over 500 feet (0 to 152 m) beneath the surface. The Norfolk coal bed lies less than 500 feet (152 m) beneath the surface throughout approximately 98 percent of the Wildcat Quadrangle.

From 33 to 160 feet (10 to 49 m) beneath the Norfolk coal bed, the Upper Smith coal bed crops out over approximately 95 percent of the Wildcat Quadrangle. Both the maximum thickness, 33 feet (10 m), and the minimum thickness, 10 feet (3 m), of the Upper Smith coal bed are attained in the southwestern quadrant. The structural contours drawn on top of the Upper Smith coal bed indicate numerous minor flexures superimposed on the regional westward dip. The overburden of the Upper Smith coal bed ranges from 0 to over 750 feet (0 to 229 m) in thickness. The Upper Smith coal bed lies less than 500 feet (152 m) below the surface throughout approximately 90 percent of the Wildcat Quadrangle.

The Lower Smith-Swartz coal zone occurs from 7 to 112 feet (2.1 to 34 m) below the Upper Smith coal bed, and it crops out over approximately 95 percent of the Wildcat Quadrangle. The two coal beds that comprise the Lower Smith-Swartz coal zone are separated by from 7 to 178 feet (2.1 to 54 m) of interburden. The Lower Smith coal bed pinches out along the southern boundary of the quadrangle. The Swartz coal bed pinches out in the northern and southeastern regions of the study area. The composite thickness varies from a maximum of 36 feet (11 m) in the southwestern quadrant to a minimum of 8 feet (2.4 m) in the northwestern quadrant. The structure contour map is drawn on top of the Lower Smith coal bed where it is present and on top of the Swartz coal bed where the Lower Smith coal bed is absent. The major feature of the structure contour map is a basin located in the west-central portion of the quadrangle. The overburden above the Lower Smith-Swartz coal zones varies in thickness from less than 100 to over 750 feet (30 to 229 m). The Lower Smith-Swartz coal bed lies less than 500 feet (152 m) beneath the surface of approximately 80 percent of the Wildcat Quadrangle.

The Anderson coal bed is separated from the overlying Lower Smith-Swartz coal zone by a non-coal interval from 3 to 149 feet (0.9 to 45 m) thick. Pinched out in the central portion of the study area, the Anderson coal bed attains a maximum thickness of over 40 feet (12 m) in the southeastern corner. The structure contours drawn on top of the Anderson coal bed define several local flexures superimposed on the regional westward dip. The Anderson coal bed lies from less than 100 feet (30 m) to more than 750 feet (229 m) below the surface. The Anderson coal bed lies less than 500 feet (152 m) beneath the surface throughout approximately 60 percent of the Wildcat Quadrangle.

The Canyon coal bed lies 24 to 280 feet (7 to 85 m) below the Anderson coal bed. It varies in thickness from a minimum of less than 5 feet (1.5 m) in the center of the quadrangle to a maximum of over 40 feet (12 m) in the southeastern corner. A structural dome occurs in the eastern quadrant and a northeast-southwest trending syncline extends across the southern half of the quadrangle, paralleling the principal fault. The overburden above the Canyon coal bed ranges in thickness from less than 200 feet (61 m) to over 1000 feet (305 m). Over 500 feet (152 m) covers the Canyon coal bed throughout approximately 50 percent of the Wildcat Quadrangle.

From 0 to 244 feet (0 to 74 m) below the Canyon coal bed, the Cook coal bed ranges from over 50 feet (15 m) thick in the southeastern corner to less than 20 feet (6 m) thick in the southwestern corner of the quadrangle. The structure contour map drawn on top of the Cook coal bed shows minor flexures superimposed on the regional dip of one to two degrees westward. The thickness of overburden above the Cook coal bed varies from less than 300 feet (91 m) to more than 1250 feet (381 m). The Cook coal bed lies less than 500 feet (152 m) below the surface throughout approximately 15 percent of the Wildcat Quadrangle.

The Wall coal bed occurs from approximately 31 to 235 feet (9 to 72 m) below the Cook coal bed. Areas where the Wall coal bed is pinched out are located along the eastern boundary of the Wildcat Quadrangle, in the center of the quadrangle, and in the northwestern quadrant. The maximum thickness of the Wall coal bed, over 20 feet (6 m), is attained along the western boundary of the quadrangle. The Wall coal bed dips approximately one to two degrees to the west. A structurally low area located in the southeastern quadrant parallels the major fault. The Wall coal bed lies at depths ranging from less than 500 feet (152 m) to more than 1250 feet (381 m) beneath the surface. Throughout approximately 98 percent of the Wildcat Quadrangle the Wall coal bed occurs at depths greater than 500 feet (152 m).

The Pawnee coal bed lies approximately 133 to 248 feet (41 to 76 m) below the Wall coal bed. The Pawnee coal divides into two to three units in the western and northern portions of the quadrangle. These units are separated by a maximum total interburden thickness of over 150 feet (46 m). The maximum thickness of the undivided Pawnee coal bed, over 44 feet (13 m), occurs in the southwestern quadrant. The combined thickness of the separate units attains a maximum of 45 feet (14 m) in the northwestern quadrant. The Pawnee coal bed dips one to two degrees to the west. A northeast-southwest trending syncline crosses the southern half of the quadrangle, paralleling the major fault in the east-central region. The thickness of overburden above the Pawnee coal bed varies from less than 750 feet (229 m) to more than 1500 feet (457 m).

A non-coal interval of approximately 44 to 142 feet (13 to 43 m) separates the Cache coal bed from the overlying Pawnee coal bed. The Cache coal bed pinches out in the northeastern and southeastern corners of the quadrangle. The maximum thickness of over 10 feet (3 m) is attained in the east-central portion and along the western boundary of the quadrangle. The structure contours drawn on top of the Cache coal bed indicate a structurally low area in the southeastern quadrant parallel to the principal fault, and a gentle westward dip of one to two degrees. The Cache coal bed occurs at depths which range from less than 750 feet (229 m) to more than 1750 feet (533 m) below the surface.

The Wildcat coal bed lies about 80 to 182 feet (24 to 55 m) beneath the Cache coal bed. The Wildcat coal bed varies in thickness from less than 5 feet (1.5 m) along the northern and eastern boundaries of the quadrangle to 16 feet (5 m) in the west-central region of the quadrangle. The structure contours drawn on top of the Wildcat coal bed define a pattern typical of coal beds in the Wildcat Quadrangle: a gentle westward dip of one to two degrees and a structural depression surrounding the major fault in the east-central region of the study area. The thickness of overburden above the Wildcat coal bed ranges from less than 1000 feet (305 m) to more than 1750 feet (533 m).

The Moyer coal bed lies between 127 and 201 feet (39 and 61 m) below the Wildcat coal bed. With a minimum thickness of less than 5 feet (1.5m) in the northeastern quadrant, the Moyer coal bed attains a maximum thickness of over 16 feet (5 m) in the southeastern corner of the quadrangle. The Moyer coal bed dips one to two degrees to the west. The Moyer coal bed occurs at depths varying from less than 1250 feet (381 m) to more than 2000 feet (610 m).

A non-coal interval from 55 to 205 feet (17 to 62 m) thick separates the Oedekoven coal bed from the overlying Moyer coal bed. Pinched out along the northern quadrangle boundary and throughout most of the northwestern quadrant, the Oedekoven coal bed attains a maximum thickness of 21 feet (6 m) in the southeastern quadrant. Non-coal interburden within the Oedekoven coal bed attains a maximum thickness of 38 feet (12 m) in Township 53 North, Range 73 West, Section 20. Structure contours drawn on top of the Oedekoven coal bed indicate a syncline associated with the large southwest trending fault in the east-central portion of the quadrangle. The thickness of overburden above the Oedekoven coal bed ranges from less than 1250 feet (381 m) to more than 2000 feet (610 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 Inc., 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 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 Wildcat 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, 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 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 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 complexly 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 74) was 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 are 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.

The surface mining potential is high for most of the Wildcat Quadrangle due to the presence of numerous coal beds at relatively shallow depths and the high relief in the area. Small areas of low and moderate surface-mining potential occur in the western half of the study area and along the southern quadrangle boundary. 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 Wildcat 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 1000 feet (305 m) to 3000 feet (914 m) beneath the surface, or 2) a coal bed or coal zone 5 feet (1.5 m) or more in thickness which lies 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 in-situ gasification potential is moderate for approximately 10 percent of the Wildcat Quadrangle. The areas of moderate potential occur along the western boundary of the quadrangle where the Wall and Pawnee coal beds lie between 1000 and 3000 feet (305 to 914 m) beneath the surface and attain their maximum thicknesses. The remainder of the quadrangle is considered to have low in-situ gasification potential.

Table 1.--Strippable Coal Reserve Base Data (in short tons) for Federal Coal Lands in the Wildcat 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
Scott	10,530,000	-----	-----	10,530,000
Felix	165,900,000	29,790,000	3,720,000	199,410,000
Norfolk	185,610,000	74,120,000	98,210,000	357,940,000
Upper Smith	406,080,000	155,150,000	162,540,000	723,770,000
Lower Smith-Swartz	219,770,000	247,150,000	224,620,000	691,540,000
Anderson	58,350,000	82,870,000	105,200,000	246,420,000
Canyon	50,710,000	188,780,000	229,330,000	468,820,000
Cook	3,200,000	211,280,000	57,880,000	272,360,000
Wall	-----	-----	1,810,000	1,810,000
TOTAL	1,100,150,000	989,140,000	883,310,000	2,972,600,000

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

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Norfolk	-----	-----	14,880,000	14,880,000
Upper Smith	-----	-----	104,130,000	104,130,000
Lower Smith-Swartz	-----	-----	281,050,000	281,050,000
Anderson	-----	-----	299,870,000	299,870,000
Canyon	-----	-----	357,590,000	357,590,000
Cook	-----	-----	1,273,210,000	1,273,210,000
Wall	-----	-----	394,780,000	394,780,000
Pawnee	-----	-----	1,553,440,000	1,553,440,000
Cache	-----	-----	265,820,000	265,820,000
Wildcat	-----	-----	489,620,000	489,620,000
Moyer	-----	-----	455,410,000	455,410,000
Oedekoven	-----	-----	411,910,000	411,910,000
TOTAL	-----	-----	5,901,710,000	5,901,710,000

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

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
	-----	980,860,000	4,920,850,000	5,901,710,000
TOTAL	-----	980,860,000	4,920,850,000	5,901,710,000

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