UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

JUNIPER DRAW QUADRANGLE,

JOHNSON COUNTY, WYOMING

BY

INTRASEARCH INC.

ENGLEWOOD, COLORADO

OPEN FILE REPORT 79-174
1980

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MAPS

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 Juniper Draw Quadrangle, Johnson County, Wyoming. This CRO and CDP map series includes 40 plates (U. S. Geological Survey Open-File Report 79-174). 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 Juniper Draw Quadrangle is located in Johnson County, in northeastern Wyoming. It encompasses all or parts of Townships 48 and 49 North, Ranges 77 and 78 West, and covers the area: 44°07'30" to 44°15' north latitude; 106°07'30" to 106°15' west longitude.

Main access to the Juniper Draw Quadrangle is provided by Interstate Highway 90, which extends east-to-west across the northern portion of the study area. A maintained gravel road (Schoonover Road) traverses east-to-west across the southern part of the quadrangle. Minor roads and trails branch from these maintained roads providing access to the more remote area. The closest railroad is the Burlington Northern trackage approximately 18 miles (29 km) to the northeast near Echeta, Wyoming.

The most significant drainage is provided by the Powder River which meanders northward throughout the eastern one-third of the quadrangle. Indian Creek flows eastward into the Powder River providing drainage for the southern half of Juniper Draw Quadrangle. Juniper Draw, Burger Draw, and Dry Creek flow eastward into the Powder River and drain the northern half of the quadrangle. The terrain attains elevations of 4,643 feet (1,414 m) above sea level in the west-central portion of the quadrangle, where hills rise 700 to 750 feet (213 to 229 m) above the valley floor.

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° 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 Johnson County Courthouse in Buffalo, 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 parts of identified 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 9.6 billion tons (8.8 billion metric tons) of total, unleased federal coal-in-place resources in the Juniper Draw 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 overlying 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 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 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 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 noticably to imperceptibly coarser than the underlying Fort Union clastics.

The Juniper Draw Quadrangle is located in an area where surface rocks are classified within the Wasatch Formation. Although the Wasatch Formation is reportedly up to 1,800 feet (549 m) thick (Denson and Horn, 1975), Olive (1957) mapped 700 to 800 feet (213 to 244 m). Only 700 to 750 feet (213 to 229 m) of Wasatch Formation are exposed in the quadrangle. 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 Dry Creek coal bed was named by Gale and Wegemann (1910). The Felix coal bed was named by Stone and Lupton (1910). Taff (1909) named the Smith coal bed, and the Wall coal bed was named by Baker (1929). The Pawnee coal bed was named by Warren (1959). IntraSearch informally assigned names to the Wildcat and Oedekoven coal beds (1978b, 1978a).

IntraSearch's correlation of the 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 and Canyon coal beds (Baker, 1929), and all, or part, of the Cook coal bed (Bass, 1932) and the Wall coal bed 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 previous authors to represent coal beds in the area surrounding the Wyodak coal mine. The Wyodak coal zone occurring in the Juniper Draw Quadrangle correlates with the Anderson, Canyon, and Cook coal beds to the north. The Wall coal bed in Juniper Draw Quadrangle is equivalent to the Lower Wall coal bed to the east in Laskie Draw Quadrangle, and to the Wall coal bed to the north in Somerville Flats West Quadrangle.

The Fort Union Formation directly underlies the Wasatch Formation, and is composed of very fine-grained sandstones, siltstones, claystones, shales, carbonaceous shales, and numerous coal beds.

The dominant structural feature present within the quadrangle is a westward-plunging anticline extending across the central portion of the study area. This anticlinal feature is usually associated with synclinal features to the north and south.

Local. The Juniper Draw 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 quadrangle and is composed 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.

III. Data Sources

Within the Juniper Draw Quadrangle, no significant coal outcrops or associated clinker are mentioned in any known publications at the time of this report. It is presumed and highly possible that no significant coal outcrops exist at the surface in this area. The Buffalo coal field report (Gale and Wegemann, 1910) maps the Dry Creek coal bed in the northwest quarter of the quadrangle and two thin, coal beds. Insufficient thickness and areal extent preclude detailed mapping of these coal beds.

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 Juniper Draw Quadrangle is published by the U. S. Geological Survey, compilation date 1972. 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

The Wasatch Formation and Fort Union Formation coal beds that are present in all or part of the Juniper Draw Quadrangle include, in descending stratigraphic order: the Local, Dry Dreek, Local, Felix, Smith, Wyodak, Wall, Pawnee, Wildcat, Oedekoven, Local 1 and Local 2 coal beds. The Smith coal beds, the Wyodak coal beds, and the Pawnee coal beds are mapped as coal zones. The Wildcat and Oedekoven coal beds, and the Local 1 and Local 2 coal beds were combined and mapped as coal bed composites. 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 or coal zones. Mining ratios are presented on the isopach maps of the Felix and Smith coal beds. Interburden isopachs are presented on the overburden isopach maps of the Wyodak coal zone. Insufficient thickness and areal extent preclude any detailed mapping of the Dry Creek or Local coal beds. The Local 1 and Local 2 coal beds are mapped as a coal bed composite.

No physical or chemical analyses are known to have been published regarding coal beds in the Juniper Draw Quadrangle. For Campbell County and northeastern Johnson County coal beds, the Btu value computed on a moist, mineral-matter-free basis;* and the coal rank are as follows:

COAL BED NAME		DATA SOURCE IDENTIFICATION	AS RECEIVED BASIS ASH %	FIXED CARBON %	MOISTURE %	VOLATILES %	SULFUR %	BTU/LB	MOIST, M-M-F BTU/LB	COAL RANK
Felix	(**)	Lab.No. 6432	5.6	35.7	25.8	32.9	0.39	8465	9010	Subbtm. C
Smith	(**)	Lab.No. 6460	4.7	34.0	28.8	32.5	0.46	7862	8280	Lignite A
Wyodak	(U)	Hole 7310	5.9	33.9	29.1	31.2	0.44	8172	8722	Subbtm. C
Wall	(U)	Hole 7334	5.1	34.9	29.4	30.5	0.29	8329	8814	Subbtm. C
Pawnee	(U)	Hole 7424	7.9	31.0	31.9	29.2	0.39	7344	8025	Lignite A
"Wildcat"	(1)	Lab.No. 11447	4.3	29.4	27.8	29.4	0.27	8410	8818	Subbtm. C

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

** Stone and Lupton (1910).

(1) Winchester (1912).

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

The proximate analyses presented above are from core hole or outcrop locations in excess of 20 miles (32 km) from this quadrangle. For the simplification of tonnage computations all coal beds in the Juniper Draw Quadrangle are tentatively classified as subbituminous C rank.

The Coal Data sheet, plate 3, shows 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 Oedekoven coal bed underlies the entire quadrangle, it is designated as datum for the correlation diagram. The Wyodak coal zone shows the thickest coal bed occurrences throughout the study area. The Felix, Smith, Wall, Pawnee, Wildcat, Oedekoven, Local 1, and Local 2 coal beds are relatively thin throughout the Juniper Draw Quadrangle.

The Felix coal bed, relatively thin (0 to 7 feet) (0 to 2.1 m) in the western two-thirds of Juniper Draw Quadrangle, is absent to the east. Maximum thicknesses occur in the northwest quadrant. Structure contours drawn on the Felix coal bed top define a broad, west-plunging anticline in the central portion of the quadrangle with companion synclines to the north and south. The Felix coal bed is positioned approximately 50 to 750 feet (15 to 229 m) beneath the surface.

The Smith coal zone lies approximately 450 to 610 feet (137 to 186 m) beneath the Felix coal bed. The total coal zone thickness ranges from 5 to 32 feet (1.5 to 10 m) in the northwest quarter. The Smith coal zone is composed locally of four separate, thin, coal beds. The non-coal interval separating the coal beds ranges from 0 to

103 feet (0 to 31 m) in thickness. The lower two coal beds are not present in the southern half of the quadrangle. The main structural configuration on this coal zone is a west-plunging anticline in the central portion of the quadrangle. Two west-plunging synclines are present in the south-central and northwest portion of the quadrangle. The Smith coal zone occurs between 480 to 1,350 feet (146 to 411 m) beneath the surface.

The Wyodak coal zone occurs 100 to 430 feet (30 to 131 m) beneath the Smith coal zone. Total coal thickness ranges from 50 to 203 feet (15 to 62 m) with maximum thicknesses occurring in the northwest corner and the southeast quarter of the quadrangle. The Wyodak coal zone thins to 50 feet (15 m) in the north-central portion of the Juniper Draw Quadrangle. The Wyodak coal zone splits into four coal beds with the total non-coal interval ranging from 0 to 372 feet (0 to 113 m) in thickness. The four coal beds composing the Wyodak coal zone combine into a single bed in the northeast quarter of Juniper Draw Quadrangle. Structure contours drawn on the top of the Wyodak coal zone indicate a narrow, east-plunging anticline in the central portion of the quadrangle. A broad, synclinal feature dominates structures in the southern half of the quadrangle, and a narrow, closed syncline occurs in the extreme northwest corner of the quadrangle. The Wyodak coal bed lies from less than 900 feet (274 m) to more than 1,600 feet (488 m) beneath the surface.

Approximately 220 to 415 feet (67 to 126 m) of clastic sediments separate the overlying Wyodak coal zone from the Wall coal bed. The

Wall coal bed ranges in thickness from 0 to 8 feet (0 to 2.4 m) with maximum thicknesses occurring in the central portion of the quadrangle. The Wall coal bed is absent in the northwest quadrant and the extreme western and southern edges of the study area. A broad, west-plunging anticline is present in the central portion of the quadrangle. A broad, southwest-plunging syncline is located in the southern half of the quadrangle. The Wall coal bed lies from less than 1,250 feet (381 m) to greater than 2,200 feet (671 m) beneath the surface.

The Pawnee coal zone occurs 60 to 480 feet (18 to 146 m) beneath the Wall coal bed, or 430 to 975 feet (131 to 297 m) beneath the Wyodak coal zone where the Wall coal bed is absent. The total coal zone thickness ranges from 0 to 30 feet (0 to 9 m) with maximum thicknesses in the extreme northeast corner of the quadrangle. The Pawnee coal zone is absent in the southwest quadrant and thins to 4 feet (1.2 m) in the north-central portion of the quadrangle. The Pawnee coal zone is composed of at least four separate coal beds that merge to form a single coal bed in the southern one-third of the quadrangle. The non-coal interval, separating the coal beds of the Pawnee coal zone, ranges from 0 to 107 feet (0 to 33 m) in thickness, Structure contours drawn on top of the Pawnee coal zone indicate a west-plunging anticline in the southern half and a broad, west-plunging syncline in the northern half of Juniper Draw Quadrangle. The Pawnee coal zone lies between 1,600 and 2,400 feet (488 and 732 m) beneath the surface.

The Wildcat-Oedekoven coal bed composite lies approximately

240 to 375 feet (73 to 114 m) beneath the Pawnee coal zone. The Wildcat coal bed is absent from the western two-thirds of the quadrangle except for an isolated occurrence of the coal bed in the northwest corner of the quadrangle. Where the Wildcat coal bed is absent, the Oedekoven coal bed is separated from the overlying Pawnee coal zone by approximately 495 to 660 feet (151 to 201 m) of clastic sediments. The coal bed composite thickness ranges from 5 feet (1.5 m) along the northern edge of the quadrangle, to 25 feet (8 m) along the extreme eastern border, and in the south-central part of the northwest quarter. The thickness of the clastic interval separating the Wildcat coal bed from the Oedekoven coal bed ranges from 155 to 233 feet (47 to 71 m). Structure contours drawn on top of the Wildcat coal bed and on the top of the Oedekoven coal bed, where the Wildcat coal bed is absent, indicate a gentle westward dip. The Wildcat coal bed lies from less than 2,000 feet (610 m) to more than 2,950 feet (899 m) beneath the surface. The Oedekoven coal bed occurs from less than 2,250 feet (686 m) to more than 3,250 feet (991 m) beneath the surface.

The Local 1 - Local 2 coal zone occurs approximately 200 to 250 feet (61 to 76 m) beneath the Oedekoven coal bed. Subsurface control for mapping of the Local 1 - Local 2 is derived from data to the north in the Somerville Flats West Quadrangle, and to the east in Laskie Draw Quadrangle. Total coal zone thickness ranges from 0 to 20 feet (0 to 6 m) with the maximum thickness in the northeast quadrant. The Local 1 - Local 2 coal beds are absent from 70 percent of the quadrangle, and are present in the northeast portion of the study area. Structure contours drawn on top of the Local 1 - Local 2 coal zone indicate a gentle, south-westward dip. The Local 1 - Local 2 coal zone lies from less than 2,400 feet (732 m) to greater than 3,000 feet (914 m) beneath the surface.

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. 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 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 development potential is low for approximately 25 percent of the quadrangle. This low development potential area is located primarily in the southwest quadrant and in the extreme northwest corner of the study area. Scattered areas of low development potential exist in the east-central part of the quadrangle. The low development potential results from high overburden-to-coal ratios for the Felix coal bed and the Smith coal bed. The older coal beds occur greater than 500 feet (152 m) beneath the surface. Seventy-five percent of Juniper Draw Quadrangle either has no potential for surface mining development, or involves non-federal coal land. Table 1 sets forth the estimated strippable reserve base tonnages per coal bed for Juniper Draw Quadrangle.

Underground Mining Coal Development Potential. Subsurface coal mining development potential throughout the Juniper Draw 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 (plate 40) on the Juniper Draw Quadrangle is moderate over approximately 50 percent of the quadrangle. This classification relates to the thick Wyodak coal zone occurring greater than 1,000 feet (305 m) beneath the surface. The moderate potential rating covers primarily the southwest corner and the west-central portion of the quadrangle. Approximately 25 percent of the study area is high development potential. This potential, located mainly in the southeast quarter and the northwest quadrant, relates to thickening of the Wyodak coal zone and the Pawnee coal zone. A low development potential rating covers approximately 20 percent of Juniper Draw Quadrangle. This area lies mainly in the northeast quadrant where the Wyodak coal zone is less than 1,000 feet deep, and the underlying coal beds are thin. The remaining 5 percent of the study area is classified as non-federal coal land. The coal resource tonnage totals for in-situ gasification are set forth on table 3.

Table 1.--Strippable Coal Reserve Base Data (in short tons) for Federal Coal Lands in the Juniper Draw Quadrangle, Johnson 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 Resources				
Felix	-	-	66,520,000	66,520,000
Smith	-	-	6,890,000	6,890,000
TOTAL	-	-	73,410,000	73,410,000

Table 2.-- Coal Reserve Base and Hypothetical Resource Data (in short tons) for Underground Mining Methods for Federal Coal Lands in the Juniper Draw Quadrangle, Johnson County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Reserve Base Resources				
Felix	-	-	54,590,000	54,590,000
Smith	-	-	815,720,000	815,720,000
Wyodak	-	-	7,058,110,000	7,058,110,000
Wall	-	-	56,210,000	56,210,000
Pawnee	-		807,470,000	807,470,000
Wildcat-Oedekoven	-	-	707,860,000	707,860,000
Local 1-Local 2	-	-	65,800,000	65,800,000
Total	-	-	9,565,760,000	9,565,760,000
Hypothetical Resources				
Local 1-Local 2	-	-	3,860,000	3,860,000
Total	-	-	3,860,000	3,860,000
GRAND TOTAL	-	-	9,569,620,000	9,569,620,000

Table 3.--Coal Reserve Base and Hypothetical Resource Data (in short tons) for In-Situ Gasification for Federal Coal Lands in the Juniper Draw Quadrangle, Johnson County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Reserve Base Resources	2,821,040,000	5,299,070,000	1,445,650,000	9,565,760,000
Hypothetical Resources	-	-	3,860,000	3,860,000
TOTAL	2,821,040,000	5,299,070,000	1,449,510,000	9,569,620,000

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