UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

HOE RANCH QUADRANGLE,

JOHNSON COUNTY, WYOMING

BY

INTRASEARCH INC.

ENGLEWOOD, COLORADO

OPEN FILE REPORT 79-178

1980

This report was prepared under contract to the U.S. Geological Survey and has not been edited for conformity with Geological Survey standards and nomenclature. Opinions, and conclusions expressed herein do not necessarily represent those of the Geological Survey.

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CONVERSION TABLE

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

I. INTRODUCTION

This report and accompanying maps set forth the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) of coal beds within the Hoe Ranch Quadrangle, Johnson County, Wyoming. This CRO and CDP map series includes 39 plates (U. S. Geological Survey Open File Report 79-178). 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 Hoe Ranch Quadrangle is located in Johnson County, in northeastern Wyoming. It encompasses all or parts of Townships 45, 46, and 47 North, Ranges 77 and 78 West, and covers the area: 43°52'30" to 44°00' north latitude; 106°07'30" to 106°15' west longitude.

Main access to the Hoe Ranch Quadrangle is provided by two maintained roads which extend east to west across the central and extreme northern parts of the quadrangle. These two roads terminate on the west bank of the Powder River in the east-central and northeast portions of the area. U. S. Highway 87 is located approximately 32 miles (51 km) to the northwest of the study area. Minor roads and trails supply additional access to the more remote areas. The closest railroad is the Burlington Northern trackage approximately 36 miles (58 km) to the northeast near Echeta, Wyoming.

The primary drainage for the Hoe Ranch Quadrangle is provided by the northward-flowing Powder River which meanders through the eastern half of the study area. Eastward-flowing Ninemile Creek and westward-flowing Willow Creek empty into the Powder River and drain the southwest and southeast quarters of the quadrangle, respectively. Elevations attain maximum heights of 4620 feet (1408 m) above sea level along the west-central boundary of the quadrangle. These higher elevations rise about 400 feet (122 m) above the Powder River valley floor to the east. Topographic relief in the quadrangle is about 410 feet (125 m).

The 10 to 12 inches (25 to 30 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 identified reserves and resources, and hypothetical resources. Finally, recommendations are made regarding the potential for surface mining, underground mining, and in-situ gasification of the coal beds. This report evaluates the coal resources of all unleased federal coal beds in the quadrangle which are 5 feet (1.5 m) or greater in thickness and occur at depths down to 3,000 feet (914 m). No resources or reserves are computed for leased federal coal, state coal, fee coal, or lands encompassed by coal prospecting permits and preference-right lease applications.

Surface and subsurface geological and engineering extrapolations drawn from the current data base suggest the occurrence of approximately 5.1 billion tons (4.6 billion metric tons) of total, unleased federal coal-in-place in the Hoe Ranch Quadrangle.

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

II. GEOLOGY

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

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

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

The uplift of areas surrounding the Powder River Basin created a structural basin of asymmetric character, with the steep west flank located on the eastern edge of the Big Horn Mountains. The axis of the Powder River Basin is difficult to specifically define, but it is thought to be located in the western part of the Basin, and to display a north-south configuration some 15 to 20 miles (24 to 32 km) east of Sheridan, Wyoming. Thus, the sedimentary section described in this report lies on the east flank of the Powder River Basin, with gentle dips of 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 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 Hoe Ranch 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 400 to 500 feet (122 to 152 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 Smith coal bed was named by Taff (1909), and Baker (1929) assigned the name to the Wall coal bed. The Pawnee coal bed was named by Warren (1959). IntraSearch informally named the Wildcat and Oedekoven coal beds (1978b, 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. 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 10 to 25 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 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 Hoe Ranch 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

No significant coal outcrops or associated clinker are mapped in any publications known to IntraSearch at the time of this report. It is presumed and highly possible that no significant coal outcrops exist at the surface in the Hoe Ranch Quadrangle.

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 Hoe Ranch Quadrangle is published by the U. S. Geological Survey, compilation date 1953. 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 Hoe Ranch Quadrangle include, in descending stratigraphic order: the Smith, Local, Upper Wyodak, Middle Wyodak, Lower Wyodak, Wall, Pawnee, Wildcat and Oedekoven coal beds. The Upper Wyodak coal beds are mapped as a coal zone. 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 and coal zones.

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

COAL BED NAME	DATA SOURCE IDENTIFICATION	AS RECEIVED BASIS						MOIST, M-M-F BTU/LB	COAL RANK
		ASH %	FIXED CARBON %	MOISTURE %	VOLATILES %	SULFUR %	BTU/LB		
Smith (**)	Lab.No. 6460	4.7	34.0	28.8	32.5	0.46	7862	8280	Lignite A
Upper Wyodak (U)	Hole 7310	5.852	33.938	29.060	31.150	0.435	8172	8722	Subbtm. C
Middle-Lower Wyodak (U)	Hole 755	4.438	35.522	27.405	32.719	0.207	8568	8999	Subbtm. C
Pawnee (U)	Hole 7424	7.880	31.029	31.910	29.183	0.386	7344	8025	Lignite A
"Wildcat" (1)	Lab.No. 11447	4.3	29.4	27.8	29.4	0.27	8410	8819	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 Hoe Ranch 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 Middle Wyodak coal bed underlies the entire quadrangle, it is designated as datum for the correlation diagram. The Middle and Lower Wyodak coal beds show a moderately thick coal bed occurrence throughout the study area. The remaining coal beds are relatively thin throughout the Hoe Ranch Quadrangle.

The Smith coal bed occurs approximately 675 to 1,075 feet (206 to 238 m) beneath the surface of the quadrangle. The coal bed thickness ranges from 0 to 6 feet (0 to 1.8 m), with maximum thicknesses occurring in the northeast corner and the southeast quarter of the study area. The coal bed thins to the west and is absent from 50 percent of the quadrangle, primarily in the western half. Structure contours drawn on top of the Smith coal bed indicate a gentle dip to the west with a west-plunging syncline along the extreme northern edge of the quadrangle.

The Upper Wyodak coal zone lies approximately 200 to 300 feet (61 to 91 m) below the overlying Smith coal bed. The coal zone is comprised of two, thin, uniform coal beds overlying as many as three lenticular coal beds. The total coal zone thickness ranges from less than 5 feet (1.5 m) to a maximum of 42 feet (13 m). Maximum thicknesses occur along the eastern boundary of the quadrangle, and the coal beds thin to the west. Thinning of the coal zone in the western half of the quadrangle is attributed to the absence of the lower coal beds. The clastic interval within the coal zone varies from 30 to 275 feet (9 to 84 m). The dominant structural feature is a broad, westward-plunging anticline present in the southeast quarter, and a westward-plunging syncline near the northern edge of the quadrangle. The remaining area dips gently to the west. The Upper Wyodak coal zone occurs between 850 and 1,450 feet (259 and 442 m) beneath the surface of the entire quadrangle.

The Middle Wyodak coal bed lies between 50 and 250 feet (15 to 76 m) below the overlying Upper Wyodak coal zone. The coal bed thickness ranges from 20 to 55 feet (6 to 17 m). Maximum thicknesses occur in the northeastern and southeastern parts of the quadrangle, and it thins westward. Structure contours drawn on top of the Middle Wyodak coal bed depict a gentle dip to the west throughout the study area. The Middle Wyodak coal bed occurs between 1,100 and 1,800 feet (335 and 549 m) beneath the surface of the quadrangle.

The Lower Wyodak coal beds lie approximately 50 to 150 feet (15 to 46 m) below the Middle Wyodak coal bed. The combined thickness of the coal beds varies from 20 to 50 feet (6 to 15 m) with maximum thicknesses located in the northeast quarter of the quadrangle. The coal beds thin to the southwest. The Lower Wyodak coal beds occur as a single coal bed in the eastern third of the quadrangle and as two coal beds throughout the remainder of the area. The clastic interval separating the two coal beds varies from 0 to 110 feet (0 to 34 m). Minor clastic partings further separate both the upper and lower coal beds. Structure contours drawn on top of the Lower Wyodak coal beds indicate a broad, westward-plunging anticline extending across the central part of the study area. The Lower Wyodak coal beds lie between 1,200 and 1,850 feet (366 and 564 m) beneath the surface of the quadrangle.

The Pawnee coal bed occurs approximately 425 to 500 feet (130 to 152 m) below the overlying Lower Wyodak coal bed. The coal bed thickness ranges from 0 to 17 feet (0 to 5 m) with maximum thicknesses occurring in the northeast quarter of the quadrangle. The coal bed thins to the southwest and is absent from approximately 25 percent of the study area, primarily in the southwest quarter. A clastic interval, ranging from 0 to 21 feet (0 to 6 m), locally separates the Pawnee coal bed into two units. The Pawnee coal bed dips gently westward and lies between 1,700 and 2,550 feet (564 and 777 m) beneath the surface of the quadrangle.

The Wildcat coal bed is a thin coal bed occurring approximately 250 to 300 feet (76 to 91 m) below the overlying Pawnee coal bed. The coal bed thickness ranges from 0 to 10 feet (0 to 3 m). Maximum thicknesses occur in the extreme northeast corner of the quadrangle, and the coal bed thins significantly to the south and west. The 10-foot isopach line relates to subsurface control from adjacent quadrangles. The Wildcat coal bed, that dips gently to the west at less than 1 degree, lies between 2,100 and 2,600 feet (640 and 792 m) beneath the surface.

The Oedekoven coal beds lies approximately 225 to 275 feet (69 to 84 m) below the Wildcat coal bed. The coal bed thickness ranges from 0 to 15 feet (0 to 5 m) with maximum thicknesses occurring along the northeastern boundary of the study area. The coal bed thins to the south and west and is absent from approximately 20 percent of the study area in the southwest and southeast quarters. A minor, non-coal interval ranging from 0 to 43 feet (0 to 13 m) locally separates the two Oedekoven coal beds. The Oedekoven coal bed dips gently westward with minor structural features superimposed on the regional dip. The Oedekoven coal beds lie between 2,350 and 2,900 feet (716 and 884 m) in depth.

V. Geological and Engineering Mapping Parameters

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

Subsurface mapping is based on geologic data within, and adjacent to, the Hoe Ranch Quadrangle area. Data from geophysical logs are used to correlate coal beds and control contour lines for the coal thickness, structure, and overburden maps. Structure contour maps are constructed on the tops of the main coal beds.

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 <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 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, when applicable, is 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 coal beds present within the study area occur at depths that exceed the 500 foot (152 m) strippable limit. For this reason, no surface mining development potential map was generated.

Underground Mining Coal Development Potential. Subsurface coal mining development potential throughout the Hoe Ranch 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 1 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 39) on the Hoe Ranch Quadrangle is moderate to low for the entire study area. The moderate potential rating covers approximately 20 percent of the area, and occurs in the eastern half of the quadrangle. It is attributed to the moderate coal bed thickness of the Middle Wyodak coal bed. The Upper Wyodak coal zone supplements the total thickness with moderate coal thicknesses throughout the eastern half of the study area. The low potential rating covers the western 75 percent of the quadrangle and results from the thinning of the coal beds to the west. The remaining area is classified as non-federal land, and therefore, it is not evaluated in this study.

Table 1.--Coal Reserve Base and Hypothetical Resource Data (in short tons) for Underground Mining Methods for Federal Coal Lands in the Hoe Ranch Quadrangle, Johnson County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Reserve Base				
Smith	-	-	8,230,000	8,230,000
Upper Wyodak	-	-	935,670,000	935,670,000
Middle Wyodak	-	-	1,700,160,000	1,700,160,000
Lower Wyodak	-	-	1,871,440,000	1,871,440,000
Pawnee	-	-	241,850,000	241,850,000
Wildcat	-	-	29,250,000	29,250,000
Oedekoven	-	-	254,320,000	254,320,000
Total	-	-	5,040,920,000	5,040,920,000
Hypothetical Resources				
Upper Wyodak	-	-	2,510,000	2,510,000
Middle Wyodak	-	-	6,130,000	6,130,000
Lower Wyodak	-	-	9,160,000	9,160,000
Total	-	-	17,800,000	17,800,000
Grand Total	-	-	5,058,720,000	5,058,720,000

Table 2.--Coal Reserve Base and Hypothetical Resource Data (in short tons) for In-Situ Gasification for Federal Coal Lands in the Hoe Ranch Quadrangle, Johnson County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
RESERVE BASE	-	1,776,160,000	3,264,760,000	5,040,920,000
HYPOTHETICAL RESOURCES				
	-	-	17,800,000	17,800,000
Grand Total	-	1,776,160,000	3,282,560,000	5,058,720,000

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