UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

DEAD HORSE LAKE QUADRANGLE

CAMPBELL COUNTY, WYOMING

REVISED TEXT, OCTOBER 1980

BY

INTRASEARCH INC.

ENGLEWOOD, COLORADO

OPEN-FILE REPORT 78-066

1978

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CONVERSION TABLE

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

I. INTRODUCTION

This report and accompanying maps set forth the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) of coal beds within the Dead Horse Lake Quadrangle, Campbell County, Wyoming. This CRO and CDP map series includes 40 plates (U. S. Geological Survey Open-File Report 78-066). 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 Dead Horse Lake Quadrangle is located on the Wyoming-Montana border in Campbell County, Wyoming, Townships 57 and 58 North, Ranges 74 and 75 West, and covers the area: 44°52'30" to 45°00' north latitude; 105°45' to 105°52'30" west longitude.

The principal access into the Dead Horse Lake Quadrangle is via the gravel road on Bitter Creek. This gravel road joins a paved road north of Recluse, Wyoming, southeast of the quadrangle. The gravel road joins a major gravel road along the Powder River, northwest of the quadrangle in Montana, and that extends northward to Broadus, Montana. The remainder of the quadrangle is accessible by minor roads and trails that branch from the Bitter Creek Road. Many of the minor roads are "four-wheel drive" roads.

The principal drainages in the Dead Horse Lake Quadrangle flow northwestward. Bitter Creek is the major ephemeral stream in the project area, and is paralleled by Dead Horse Creek and Dry Creek. Stream flow on these drainages occurs principally in the spring or during and shortly after rainfall. The lowest elevations in the quadrangle are near the Montana border on Bitter Creek where the terrain is less than 3,500 feet (1,607 m) above sea level. Elevations slightly in excess of 4,100 feet (1,250 m) are common to the inter-drainage areas between Dead Horse, Bitter, and Dry Creek. The somber grays, yellows and browns of outcropping shales and siltstones contrast strikingly with the brilliant reds, oranges, and purples of "clinker", and deep greens of the juniper and pine tree growth.

The 13 to 14 inches (33 to 36 cm) of annual precipitation falling in this semi-arid region accrue principally in the springtime. Summer and fall precipitation usually originates from thunderstorms, and infrequent snowfalls of 6 inches (15 cm) or less generally characterize winter precipitation. Although temperatures ranging from less than -25°F (-32°C) to more than 100°F (38°C) have been recorded near Arvada, Wyoming, average wintertime minimums and summertime maximums range from +5° to +15°F (-15° 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 (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 4.1 billion tons (3.7 billion metric tons) of total, unleased federal coal-in-place in the Dead Horse Lake Quadrangle.

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

II. GEOLOGY

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

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

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

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

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

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

The 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 Dead Horse Lake Quadrangle is located in an area where surface rocks are classified into the Tongue River Member of the Fort Union Formation. Although the Tongue River Member is reportedly

1,200 to 1,300 feet (366 to 396 m) thick (Olive, 1957), only 500 to 600 feet (152 to 183 m) are exposed in this area. Olive (1957) correlated coal beds in the Spotted Horse coal field with coal beds in the northward extension of the Sheridan coal field, Montana (Baker, 1929), and Gillette coal field, Wyoming (Dobbin and Barnett, 1927), and with coal beds in the Ashland coal field (Bass, 1932) in southeastern Montana. This report utilizes, where possible, the coal bed nomenclature used in previous reports. Baker (1929) assigned names to the Anderson, Canyon, and Wall coal beds. The Cook coal bed was named by Bass (1932), and the Pawnee coal bed was named by Warren (1959). The Cache coal bed was named by Warren (1959), and IntraSearch (1978) informally named the Oedekoven coal bed.

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

Multiple coal bed occurrences characterize the Fort Union Formation in the Dead Horse Lake Quadrangle. The coal beds dip gently westward at approximately 60 feet (18 m) per mile. Gentle structure is superimposed on the regional dip, and the strongest structural feature reflected through most of the coal beds is a closed synclinal low that occurs in the central and southcentral parts of the quadrangle. Faults of mappable displacement are restricted to the extreme southeast part of the quadrangle. These faults trend approximately east-west and extend beyond the quadrangle boundary onto the Corral Creek Quadrangle to the east, and are depicted as mapped by Olive (1957).

III. Data Sources

Areal geology of the coal outcrops and associated clinker for the Dead Horse Lake Quadrangle is derived from the Spotted Horse coal field publication (Olive, 1957). Coal bed correlations between Olive's publication and the Moorhead, Montana coal field publicaton (Bryson and Bass, 1973) are difficult due to the paucity of subsurface control and the difference in coal bed nomenclature between publications. The following table sets forth the coal bed nomenclature of the Dead Horse Lake, Wyoming Quadrangle that relates to Olive's work, and the Moorhead, Montana Quadrangle that relates to Bryson and Bass' publication.

Dead Horse Lake Quadrangle	Moorhead Quadrangle
Anderson	Dietz
Upper Canyon	Canyon east of Bitter Creek
	Upper Cook west of Bitter Creek
Lower Canyon	Upper Cook east of Bitter Creek
	Lower Cook west of Bitter Creek
Cook	Lower Cook and #5 east of Bitter Creek
	#5 west of Bitter Creek
No equivalent	#5A
Wall	Pawnee
Pawnee	Cache
Cache	No equivalent

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

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

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

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

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

IV. Coal Bed Occurrence

Fort Union Formation coal beds that are present in all or part of the Dead Horse Lake Quadrangle include, in descending stratigraphic order: the Anderson, Upper Canyon, Lower Canyon, Cook, Wall, Pawnee, Cache and Oedekoven. 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 all the coal beds. The limited areal extent of the Oedekoven coal bed precludes its inclusion in this mapping program.

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

COAL BED NAME		DATA SOURCE IDENTIFICATION	AS RECEIVED BASIS						MOIST, M-M-F BTU/LB	COAL RANK
			ASH %	FIXED CARBON %	MOISTURE %	VOLATILES %	SULFUR %	BTU/LB		
Smith	(U)	Hole 7340	3.5	38.0	30.0	28.5	0.31	8371	8700	Subbtm. C
Anderson	(U)	Hole 746	6.3	31.1	32.6	30.0	0.33	7498	8045	Lignite A
Canyon	(U)	Hole 744	4.3	32.9	35.1	27.8	0.31	7298	7650	Lignite A
Cook	(**)	Hole SH-64	4.6	34.4	33.6	27.3	0.25	7766	8173	Lignite A
Wall	(U)	Hole 7426	9.5	29.3	32.2	29.0	0.50	7279	8112	Lignite A
Pawnee	(U)	Hole 7424	7.9	31.0	31.9	29.2	0.39	7344	8025	Lignite A
Cache	(U)	Hole 741	9.5	30.5	31.4	28.6	0.49	7271	8097	Lignite A

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

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

(U) U. S. Geological Survey and Montana Bureau of Mines and Geology (1974 and 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 Dead Horse Lake 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 Cook coal bed underlies a large percentage of the quadrangle, it is designated as datum for the correlation diagrams. The Coal Data Sheets show thicknesses for all coal beds from the Anderson to the Oedekoven coal beds.

The limited occurrence of the Smith coal bed in the high inter-drainage areas coupled with the lack of subsurface coal thickness control prevents inclusion of the Smith coal bed in the CRO mapping program for this quadrangle. Coal beds beneath the Smith coal bed are extensively eroded and burned along the flanks of Bitter Creek. Limited erosion and burning of the Cook coal bed is mapped in the extreme north-central part of the Dead Horse Lake Quadrangle. A deeply buried, thin coal bed occurs within part of this quadrangle more than 500 feet (152 m) beneath the Cache coal bed and in excess of 600 feet (183 m) beneath the Pawnee coal bed. Subsurface control on this bed is scattered and precludes its mapping in the CRO series. This coal bed is thought to correlate with the informally named Oedekoven coal bed (IntraSearch, 1978), of the Recluse, Wyoming area. Although the Dietz No. 1 coal bed is mapped by Olive (1957), the subsurface data existent throughout the quadrangle do not indicate the occurrence of a mappable subsurface coal bed at shallow depth beneath the Anderson coal bed.

The Anderson coal bed constitutes the youngest and highest coal bed occurring within the Dead Horse Lake Quadrangle that includes extensive recoverable reserves. A major portion of the reserves are in place along the divide area between Bitter Creek and Dead Horse Creek. The Anderson coal bed varies from 15 to more than 35 feet (5 to 11 m) in thickness. Structural control for the mapping of the top of the Anderson coal bed is somewhat scattered, but generally establishes the presence of regional west-to-southwestward dip varying from 30 to 60 feet per mile (6 to 11 m/km) in magnitude. The Anderson coal bed is a maximum of 300 feet (91 m) beneath the surface.

The Upper Canyon coal bed lies from 62 to 139 feet (19 to 42 m) beneath the Anderson coal bed, and coal bed thickness varies from 0 in the central and extreme southeastern parts of the quadrangle, to a maximum of 22 feet (7 m) in the southeast quarter of Section 3, T. 57 N., R. 75 W. Structural configurations drawn on the top of the Upper Canyon coal bed are similar to contouring on the top of the Anderson coal bed and reflect a gentle, westward dip with minor structural variations. The Upper Canyon coal bed is from 0 to 490 feet (0 to 149 m) below the surface.

A coal bed, mapped as a local coal bed by Olive (1957), is informally named the Lower Canyon coal bed by IntraSearch for use in this CRO/CDP mapping program. This nomenclature is suggested because, as the coal bed is mapped southeastward into the Recluse area, its equivalent is mapped as the Canyon coal bed in the White Tail Butte Quadrangle by Landis and Hayes (1973). The Lower Canyon coal bed varies from 82 feet to 199 feet (25 to 61 m) beneath the Upper Canyon coal bed. Coal bed thickness varies from a maximum of 18 feet (5 m) in the east-central part of the quadrangle to 3 feet (0.9 m) in the west-central part of the area. Structural configurations drawn on the coal bed top are similar to contours on the overlying Upper Canyon coal bed; however, a distinct, closed synclinal area develops in the south-central part of the quadrangle. The Lower Canyon coal bed attains a maximum depth of slightly more than 600 feet (183 m).

The Cook coal bed is one of the major coal occurrences in the Dead Horse Lake Quadrangle, and is separated from the overlying Lower Canyon coal bed by 28 to 145 feet (9 to 44 m) of fine-grained clastic debris. The Cook coal bed varies from a minimum of approximately 9 feet (2.7 m) in the northwestern part of the quadrangle to a maximum of 36 feet (11 m) in thickness in the central part of the area. A gentle, westward dip is reflected by contours drawn on the top of this coal bed and, similar to the overlying Lower Canyon coal bed, a closed synclinal low is located in the south-central part of the quadrangle. The Cook coal bed is from 0 to 780 feet (0 to 238 m) below the surface.

The Wall coal bed is separated from the overlying Cook coal bed by fine-grained sediments that vary in thickness from a minimum of 41 feet (12 m) to a maximum of 114 feet (35 m). This coal bed thickness varies from 5 feet (1.5 m) in the northern part of the area to a maximum of 26 feet (8 m) in the extreme southeast part of the quadrangle. Structural contours drawn on the top of the Wall coal bed show a similarity to overlying structural configurations as gentle, westward dip is interrupted by minor tectonic adjustment that culminates in a major closed synclinal low in the south-central part of the area. The Wall coal bed varies in depth from approximately 60 to 850 feet (18 to 259 m) within the Dead Horse Lake Quadrangle.

The Pawnee coal bed is represented by a coal interval that lies from 43 to 106 feet (13 to 32 m) beneath the Wall coal bed. Total coal thickness of the coal bed ranges from 4 feet (1.2 m) in the east-central part of the quadrangle to more than 20 feet (6 m) in the southwestern part of the area. The non-coal split within the Pawnee coal bed varies from 0 to 28 feet (0 to 9 m) in magnitude. Structural contours drawn on the Pawnee coal bed top show a similar configuration to the structure on the overlying coal beds with a well developed, closed synclinal low in the south-central part of the quadrangle. The Pawnee coal bed lies between approximately 150 to 880 feet (46 to 268 m) beneath the surface.

The Cache coal bed is absent in the northeast, west, and southwest parts of the Dead Horse Lake Quadrangle. The coal bed thickness varies from a pinchout to a maximum of 14 feet (4 m) in the east-central quadrangle area. From 16 to 96 feet (5 to 29 m) of Fort Union sediments separate the Cache coal bed from the overlying Pawnee coal bed. To a minor extent, structural configurations drawn on the top of the Cache coal bed differ from overlying coal beds in that a minor structural high is shown in the northern part of the quadrangle. To the south, a closed structural low is mapped, in partial agreement with structural configurations on overlying coal beds. The Cache coal bed is 200 to

1,000 feet (61 to 305 m) below the surface.

Scattered local coal beds occur beneath the Cache or Pawnee coal beds; however, they do not develop a large enough geographic extent nor coal bed thickness to warrant mapping in the CRO program.

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

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

Coal tonnage calculations involve the planimetering of areas of measured, indicated, and inferred parts of identified resources, and hypothetical resources to determine their areal extent in acres. An <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 (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 high surface mining potential on the Dead Horse Lake Quadrangle results from an interesting ralationship between the multiple coal bed occurrence and 500 to 600 feet (152 m to 183 m) of topographic relief. In deeply eroded areas, such as the Bitter Creek drainage, the thick Cook, Wall, and Pawnee coal beds lie less than 500 feet (152 m) beneath the surface. As elevations on valley flanks increase away from the valley floor, additional coal beds greater than 5 feet (1.5 m) in thickness are encountered. These thick coal beds, the Anderson, Upper Canyon, and Lower Canyon, underlie the higher terrain at less than 500 feet (152 m) resulting in a high surface mining potential in these areas. Table 1 sets forth the strippable reserve base tonnages per coal bed for this quadrangle.

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

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

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

2. Moderate development potential is assigned to a total coal section from 100 to 200 feet (30 to 61 m) thick and buried from 1,000 to 3,000 feet (305 to 914 m) beneath the surface.

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

The coal development potential for "in-situ" gasification on the Dead Horse Lake Quadrangle is low, hence no CDP map is generated for this map series. The resource tonnage for "in-situ" gasification with low development potential totals approximately 1.5 billion tons (1.4 billion metric tons) (Table 3). None of the coal beds in the Dead Horse Lake Quadrangle qualifies for a moderate or high development potential rating.

Table 1.--Strippable Coal Reserve Base (in short tons) for Federal Coal Lands in the Dead Horse Lake 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
Anderson	414,470,000	1,880,000	-	416,350,000
Upper Canyon	231,270,000	74,230,000	99,410,000	404,910,000
Lower Canyon	76,360,000	88,470,000	220,500,000	385,330,000
Cook	154,090,000	172,150,000	431,420,000	757,660,000
Wall	38,240,000	78,160,000	283,620,000	400,020,000
Pawnee	-	1,610,000	121,530,000	123,140,000
Cache	-	-	49,700,000	49,700,000
TOTAL	914,430,000	416,500,000	1,206,180,000	2,537,110,000

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

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Lower Canyon	-	-	29,200,000	29,200,000
Cook	-	-	326,700,000	326,700,000
Wall	-	-	560,440,000	560,440,000
Pawnee	-	-	453,310,000	453,310,000
Cache	-	-	99,720,000	99,720,000
TOTAL	-	-	1,469,370,000	1,469,370,000

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

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Lower Canyon	-	-	29,200,000	29,200,000
Cook	-	-	326,700,000	326,700,000
Wall	-	-	560,440,000	560,440,000
Pawnee	-	-	453,310,000	453,310,000
Cache	-	-	99,720,000	99,720,000
TOTAL	-	-	1,469,370,000	1,469,370,000

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