UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

TRUMAN DRAW QUADRANGLE,

CAMPBELL COUNTY, WYOMING

BY

INTRASEARCH INC.

DENVER, COLORADO

OPEN FILE REPORT 79-029
1979

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

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CONVERSION TABLE

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

I. Introduction

This report and accompanying maps set forth the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) of coal beds within the Truman Draw Quadrangle, Campbell County, Wyoming. This CRO and CDP map series includes 75 plates (U. S. Geological Survey Open File Report 79-029). The project is compiled by IntraSearch Inc., 5351 South Roslyn Street, Englewood, Colorado, under KRCRA Northeastern Powder River Basin, Wyoming Contract Number 14-08-0001-17180. This contract is a part of a program to provide an inventory of unleased federal coal in Known Recoverable Coal Resource Areas (KRCRAs) in the western United States.

The Truman Draw Quadrangle is located in Campbell County, in northeastern Wyoming. It encompasses all or parts of Townships 52, 53 and 54 North, Ranges 74 and 75 West, and covers the area: 44°30' to 44°37'30" north latitude; 105°45' to 105°52'30° west longitude.

The main access to the Truman Draw Quadrangle is provided by a maintained gravel road which trends east-west across the northern portion of the study area. This maintained road joins U. S. Highway 14-16, 3.3 miles (5.3 km) east of the quadrangle boundary. Numerous minor roads and trails that branch from this maintained gravel road provide additional access to the area. The closest railroad is the Burlington Northern trackage 4 miles (6 km) to the west at Croton, Wyoming.

The major drainage is provided by the Middle Prong of Wild Horse Creek which flows northwestward through the northern portion of the quadrangle, eventually draining into the Powder River. A maximum elevation of 4697 feet (1432 m) above sea level occurs in the southeastern portion of the study area. Minimum elevations of 3980 feet (1213 m) above sea level are located in the valley floor of the Middle Prong of Wild Horse Creek at the western quadrangle boundary.

The 13 to 14 inches (33 to 36 cm) of annual precipitation falling in this semi-arid region accrue principally in the springtime. Summer and fall precipitation usually originates from thunderstorms, and infrequent snowfalls of 6 inches (15 cm) or less generally characterize winter precipitation. Although temperatures ranging from less than -25°F (-32°C) to more than 100°F (38°C) have been recorded near Arvada, Wyoming, average wintertime minimums and summertime maximums range from +5° to +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, as well as recoverable tons. These coal tonnages are then categorized in measured, indicated, and inferred reserves and resources, and hypothetical resources. Finally, recommendations are made regarding the potential for surface mining, underground mining, and in-situ gasification of the coal beds. This report evaluates the coal resources of all unleased federal coal beds in the quadrangle which are 5 feet (1.5 m) or greater in thickness and occur at depths down to 3000 feet (914 m). No resources or reserves are computed for leased federal coal, state coal, fee coal, or lands encompassed by coal prospecting permits and preference-right lease applications.

Surface and subsurface geological and engineering extrapolations drawn from the current data base suggest the occurrence of approximately 12.4 billion tons (11.2 billion metric tons) of total unleased federal coal-in-place in the Truman Draw Quadrangle.

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

II. Geology

Regional. The thick, economic coal deposits of the Powder River Basin in northeastern Wyoming occur mostly in the Tongue River Member of the Fort Union Formation and in the lower part of the Wasatch Formation. Approximately 3000 feet (914 m) of the Fort Union Formation, including the Tongue River, Lebo, and Tullock Members of Paleocene age, are unconformably overlain by approximately 700 feet (213 m) of the Wasatch Formation of Eocene age. These Tertiary formations lie in a structural basin flanked on the east by the Black Hills uplift, on the south by the Hartville and Casper Mountain uplifts, and on the west by the Casper Arch and the Big Horn Mountain uplift. The structural configuration of the Powder River Basin originated in Late Cretaceous time, with episodic uplift thereafter. The Cretaceous Cordillera was the dominant positive land form throughout the Rocky Mountain area at the close of Mesozoic time.

Outcrops of the Wasatch Formation and the Tongue River Member of the Fort Union Formation cover most of the areas of major coal resource occurrence in the Powder River Basin. The 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 contact through the use of subsurface data from geophysical logs, no definitive guidelines are known to have been published. Hence, for subsurface mapping purposes, the Fort Union Formation is not divided into its 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 sealevel 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 discrete balance between subsidence of the earth's crust and in-filling by tremendous volumes of organic debris. These conditions in concert with a favorable ground water table, non-oxidizing clear water, and a climate amenable to the luxuriant growth of vegetation produce a stabilized swamp critical to the deposition of coal beds.

Deposition of the unusually thick coal beds of the Powder River Basin may be partially attributable to short-distance water transportation of organic detritus into areas of crustal subsidence. Variations 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 that is a part of the CRO-CDP project.

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

The Truman Draw Quadrangle is located in an area where surface rocks are classified within the Wasatch Formation. Although the Wasatch

Formation is reportedly 700 to 800 feet (213 to 244 m) thick (Olive, 1957), only 600 to 700 feet (183 to 213 m) are exposed in the quadrangle. Olive (1957) correlated coal beds in the Spotted Horse coal field with coal beds in the Sheridan coal field (Baker, 1929) and Gillette coal field (Dobbin and Barnett, 1927), Wyoming, and with coal beds in the Ashland coal field (Bass, 1932) in southeastern Montana. This report utilizes, where possible, the coal bed nomenclature used in previous reports. The Truman and Parnell coal beds were named by Haddock and others (1976). The Scott coal bed was named by Olive (1957), and McLaughlin and Hayes (1973) named the Daly coal bed. The Felix coal bed was named by Stone and Lupton (1910). Kent (1976) named the Norfolk coal bed, and the Smith coal bed was named by Taff (1909). The Swartz coal bed was designated by McKay and Mapel (1973), and Baker (1929) assigned names to the Anderson, Canyon and Wall coal beds. The Cook coal bed was named by Bass (1932), and the Pawnee and Cache coal beds were named by Warren (1959). The Wildcat, Moyer, and Oedekoven coal beds were informally named by IntraSearch (1978b, 1979 and 1978a).

Local. The Truman 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 comprised of friable, coarse-grained to gritty, arkosic sandstones, fine- to very fine-grained sandstones, siltstones, mudstones, claystones, brown-to-black carbonaceous shales, and coal beds.

A branching, northeast-trending fault located in the northwestern portion of the quadrangle vertically displaces strata approximately 5 feet (1.5 m). The western branch of this fault is downthrown to the east, and the eastern branch is downthrown to the southeast. An east-northeast-trending fault in the west-central region vertically displaces strata approximately 10 feet (3 m). This fault is downthrown to the southeast. In the central portion of the study area a third northeast-trending fault, downthrown to the northwest, vertically displaces strata approximately 5 feet (1.5 m). Three northwest-southeast trending faults are located in the southwestern sector and another northwest-trending fault occurs in the northeastern portion of the quadrangle. These faults are downthrown to the southwest and vertically displace strata approximately 5 feet (1.5 m). Another northwest-trending fault is present in the southeastern sector of the study area. This fault vertically displaces strata 5 feet (1.5 m) and is downthrown to the northeast.

III. Data Sources

Areal geology of the coal outcrops and associated clinker is derived from Kent and others (1977).

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

All geophysical logs available in the quadrangle are scanned to select those with data applicable to Coal Resource Occurrence mapping.

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

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 allows continued improvement in the understanding of coal bed occurrences in the eastern Powder River Basin.

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

IV. Coal Bed Occurrence

Wasatch and Fort Union Formation coal beds that are present in all or part of the Truman Draw Quadrangle include, in descending stratigraphic order: The Truman, Parnell, Scott, Daly, Felix, Norfolk, Smith, Swartz, Anderson, Canyon, Cook, Wall, Pawnee, Cache, Wildcat, Moyer, and Oedekoven coal beds. The Truman and Parnell coal beds, and the Wildcat, Moyer and Oedekoven coal beds are mapped as coal zones. A suite of maps comprised of coal isopach, mining ratio, where appropriate, structure, overburden isopach, areal distribution of identified resources, identified resources, and hypothetical resources, where applicable, was prepared for each of these coal beds or coal zones. Mining ratios are presented on the isopach maps of the Truman-Parnell coal zone, and the Scott, Daly, Felix, Norfolk, Smith, Swartz, and Anderson coal beds. Interburden contours are presented on the overburden isopach maps of the Canyon and Pawnee coal beds.

Kent and others (1977) published the following physical and chemical analyses for the Truman coal bed in the Truman Draw Quadrangle. No physical or chemical analyses are known to have been published regarding the other coal beds in the Truman Draw Quadrangle. However, the proximate analyses performed on a general "as received" basis for northern Campbell County coal beds are as follows:

COAL BED NAME		ASH%	FIXED CARBON%	MOISTURE%	VOLATILES%	SULPHUR%	BTU/LB
Truman*	Coal Sec. 0-134	5.7	26.9	37.1	30.3	0.7	6520
Felix (U)	Hole 7345	5.223	34.181	30.280	30.316	0.338	8111
Smith (P)		6.440	31.390	35.370	26.800	0.450	7125
Swartz (U)	Hole 7334	6.442	34.001	29.260	30.297	0.707	7738
Anderson (U)	Hole 7406	6.317	31.113	32.583	29.986	0.327	7498
Wall (U)	Hole 7426	9.542	29.322	32.150	28.985	0.500	7279
Pawnee (U)	Hole 7424	7.880	31.029	31.910	29.183	0.386	7344
Cache (U)	Hole 741	9.481	30.517	31.420	28.582	0.488	7271

* Kent and others (1977).
(P) Proprietary Data
(U) U. S. Geological Survey & Montana Bureau of Mines & Geology - 1974 and 1976a.

The Coal Data Sheet, Plate 3, shows the downhole 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 Anderson coal bed underlies the entire quadrangle, it is designated as datum for the correlation diagram. The Smith, Anderson, Canyon, Cook, Wall, and Pawnee coal beds show the thickest coal bed occurrences throughout the study area. The Truman, Parnell, Scott, Daly, Felix, Norfolk, Swartz, Cache, Wildcat, Moyer and Oedekoven coal beds are relatively thin throughout the Truman Draw Quadrangle.

The Truman and Parnell coal beds have been eroded from approximately 90 percent of the quadrangle and are present mainly in the southeast quadrant. Mapped together as a zone, the Truman and Parnell coal beds have a composite range of thickness from 9.6 to 25 feet (2.9 to 8 m), with the thickest coal in the southeast quadrant and thinnest coal in outliers along the northern and western borders of the quadrangle. Interburden between the two coal beds is approximately 20 to 25 feet (6 to 8 m) thick. Structure contours drawn on the top of the Truman coal bed suggest a gentle, northwest dip. The coal zone is less than 200 feet (61 m) from the surface in the Truman Draw Quadrangle.

Occurring from 60 to 83 feet (18 to 25 m) below the Parnell coal bed, the Scott coal bed crops out throughout the quadrangle, and averages 6 feet (1.8 m) thick. Ranging from less than 4 to more than 8 feet (1.2 to 2.4 m) in thickness, the Scott coal bed attains maximum thickness in the northwestern quarter of the quadrangle (Plate 9). The Scott coal bed dips gently westward (Plate 10), and lies less than 300 feet (91 m) beneath the surface throughout the Truman Draw Quadrangle (Plate 11).

From 80 to 87 feet (24 to 27 m) of clastic sediment separates the Daly coal bed from the overlying Scott coal bed. The Daly coal bed crops out throughout the study area, and averages 5 feet (1.5 m) thick. Thicknesses for the Daly coal bed vary from less than 4 to more than 6 feet (1.2 to 1.8 m) (Plate 14). Structural contours drawn on top of the Daly coal bed indicate a structurally low area in the northwestern portion of the quadrangle and a predominantly westward dip of less than one degree (Plate 15). The Daly coal bed lies from 0 to less than 400 feet (0 to 122 m) below the surface throughout the study area (Plate 16).

Occurring 54 to 108 feet (16 to 33 m) beneath the Daly coal bed is the Felix coal bed, which crops out throughout the study area. The Felix coal bed thickness averages 20 feet (6 m) and ranges from less than 14 to more than 32 feet (4 to 10 m). The maximum thickness of more than 32 feet (10 m) occurs in the southeastern portion of the quadrangle (Plate 19). The Felix coal bed thins to 14 feet (4 m) thick in the east-central sector, and contains non-coal intervals from 4 to 7 feet (1.2 to 2.1 m) thick in the northeastern portion of the study area. Structural contours drawn on top of the Felix coal bed define a westward-plunging syncline in the northwestern part of the quadrangle, and a westward dip of less than one degree (Plate 20). The Felix coal bed occurs at depths ranging from 0 to less than 500 feet (0 to 152 m) below the surface (Plate 21).

The Norfolk coal bed lies 243 to 327 feet (74 to 100 m) beneath the Felix coal bed and averages 6 feet (1.8 m) thick. Absent from the central and southwestern portions of the quadrangle, the Norfolk coal bed varies from 0 to more than 12 feet (0 to 4 m) in thickness (Plate 24). Structural contours drawn on top of the Norfolk coal bed indicate a westward dip of less than one degree (Plate 25). The Norfolk coal bed lies 0 to less than 800 feet (244 m) below the surface throughout the study area (Plate 26).

From 53 to 150 feet (16 to 46 m) of sediment separates the Smith coal bed from the overlying Norfolk coal bed. The Smith coal bed ranges from 24 to 45 feet (7 to 14 m) thick, and averages 32 feet (10 m) in thickness (Plate 29). Although the Smith coal bed is undivided in Section 31, T. 54 N., R. 74 W., non-coal intervals from 2 to 24 feet

(0.6 to 7 m) thick are present throughout the remainder of the quadrangle. Structural contours drawn on top of the Smith coal bed portray a broad, westward-plunging syncline in the northwestern portion of the study area, and a westward dip of approximately one degree (Plate 30). The Smith coal bed occurs at depths varying from less than 200 feet to more than 750 feet (61 to 229 m) beneath the surface throughout the quadrangle (Plate 31).

The Swartz coal bed occurs 11 to 192 feet (3 to 59 m) below the Smith coal bed, and averages 8 feet (2.4 m) thick. Absent from the western portion of the study area, the Swartz coal bed varies from 0 to more than 10 feet (0 to 3 m) thick (Plate 34). The Swartz coal bed dips approximately one degree to the west. Structural contours drawn on top of the Swartz coal bed define a southwest-plunging anticline in the southeastern portion of the quadrangle (Plate 35). The Swartz coal bed lies less than 500 feet (152 m) to more than 1000 feet (305 m) beneath the surface.

Occurring 99 to 250 feet (30 to 76 m) below the Swartz coal bed, the Anderson coal bed averages approximately 35 feet (11 m) thick. Thicknesses for the Anderson coal bed range from less than 19 to more than 60 feet (6 to 18 m), with maximum thicknesses in the western portion of the study area (Plate 39). The Anderson coal bed contains non-coal intervals from 0 to 12 feet (0 to 4 m) thick. Structural contours drawn on top of the Anderson coal bed indicate a bifurcating, westward-plunging syncline in the western sector of the quadrangle and a westward dip of less than one degree (Plate 40). The Anderson coal bed lies at depths ranging from less than 500 feet (152 m) to more than 1000 feet (305 m) beneath the surface (Plate 41).

The Canyon coal bed lies 0 to 117 feet (0 to 36 m) beneath the Anderson coal bed, and averages 20 feet (6 m) thick. The Canyon coal bed consists of two separate coal beds in the northern portion of the study area, and the upper unit is absent from the remainder of the quadrangle. Thicknesses for the Canyon coal bed range from 9 to 40 feet (2.7 to 12 m) with the maximum thickness located in the southwestern sector of the study area (Plate 44). The Anderson and Canyon coal beds merge in one drill hole in Section 20, T. 53 N., R. 74 W., and the thickness and structural elevation for each coal bed are derived by examining isopach and structural trends in the area surrounding this drill hole. Where the Canyon coal bed is mapped as two units, non-coal intervals vary from 59 to 73 feet (18 to 22 m) thick. South of this area, non-coal intervals range from 2 to 9 feet (0.6 to 2.7 m) in thickness. Structural contours drawn on top of the Canyon coal bed define a broad, westward-plunging syncline in the western part of the quadrangle, and a westward dip of less than one degree (Plate 45). The Canyon coal bed lies at depths varying from less than 750 feet (229 m) to more than 1250 feet (381 m) (Plate 46).

From 147 to 352 feet (45 to 107 m) of clastic sediment separates the Cook coal bed from the overlying Canyon coal bed. The Cook coal bed varies from 0 to 35 feet (0 to 11 m) thick, averages 23 feet (7 m) in thickness (Plate 49), and contains non-coal intervals from 2 to 4 feet (0.6 to 1.2 m) thick. Structural contours drawn on top of the Cook coal bed portray a westward dip of less than one degree, and a northwest-plunging syncline in the western sector, and a southwest-plunging anticline in the southern portion of the quadrangle (Plate 50). The Cook coal bed occurs at depths ranging from less than 750 feet (229 m) to more than 1500 feet (457 m)(Plate 51).

The Wall coal bed lies 9 to 306 feet (2.7 to 93 m) below the overlying Cook coal bed. Thicknesses for the Wall coal bed range from 0 to 44 feet (0 to 13 m), and average 32 feet (10 m) (Plate 54). The Wall and Upper Pawnee coal beds merge in two drill holes in Section 33, T. 54 N., R. 74 W. Thicknesses and structural elevations for each coal bed are derived by examining isopach and structural trends in areas surrounding these drill holes. The Wall coal bed contains non-coal intervals totalling as much as 30 feet (9 m) thick. Structural contours drawn on top of the Wall coal bed (Plate 55) indicate the same features previously discussed for the Cook coal bed. The Wall coal bed lies approximately 1100 to 1600 feet (335 to 488 m) beneath the surface throughout the Truman Draw Quadrangle (Plate 56).

Occurring 0 to 227 feet (0 to 69 m) below the Wall coal bed is the Pawnee coal bed. Thicknesses for the Pawnee coal bed range from 0 to 40 feet (0 to 12 m), and average 26 feet (8 m) (Plate 59). The Pawnee coal bed is undivided in the western portion of the quadrangle, and separates into two coal beds over the remainder of the study area. Non-coal intervals between the Upper and Lower Pawnee coal beds vary from 2 to 118 feet (0.6 to 36 m) thick. The Pawnee coal bed dips gently westward (Plate 60), and lies approximately 1100 to 1700 feet (335 to 518 m) beneath the surface throughout the study area (Plate 61).

From 19 to 178 feet (6 to 54 m) of clastic sediment separates the Cache coal bed from the overlying Pawnee coal bed. The Cache coal bed averages 10 feet (3 m) thick, and varies from 3 to 18 feet (0.9 to 5 m) in thickness (Plate 64). Structural contours drawn on top of the Cache coal bed define a westward dip of less than one degree (Plate 65). The Cache coal bed lies less than 1250 to more than 1750 feet (381 to 533 m) beneath the surface (Plate 66).

The Wildcat-Moyer-Oedekoven coal zone lies 17 to 142 feet (5 to 43 m) below the Cache coal bed. Aggregate thicknesses for the Wildcat-Moyer-Oedekoven coal zone (Plate 69) range from 4 to 35 feet (1.2 to 11 m), and average 16 feet (5 m). Structural contours are positioned on top of the Wildcat coal bed except in the northeastern portion of the quadrangle where the Wildcat coal bed is absent (Plate 70). In this area, structural contours are constructed on top of the Moyer coal bed. The Wildcat-Moyer-Oedekoven coal zone dips gently westward and lies 1400 to 2100 feet (427 to 640 m) beneath the surface throughout the Truman Draw Quadrangle (Plate 71).

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 Truman Draw 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 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.

Coal tonnage calculations involve the planimetering of areas of measured, indicated, inferred reserves and resources, and hypothetical resources to determine their areal extent in acres. An 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 1750, or 1770--the number of tons of lignite A or subbituminous C coal per acre-foot, respectively (12,874 or 13,018 metric tons per hectare-meter, respectively), to determine total tons in place. Recoverable tonnage is calculated at

95 percent of the total tons in place. Where tonnages are computed for the CRO-CDP map series, resources and reserves are expressed in millions of tons. Frequently the planimetering of coal resources on a sectionized basis involves complexly curvilinear lines (coal bed outcrop and 500-foot stripping limit designations) in relationship with linear section boundaries and circular resource category boundaries. Where these relationships occur, generalizations of complex curvilinear lines are discretely utilized, and resources and/or reserves are calculated within an estimated two to three percent, plus or minus, accuracy.

VI. Coal Development Potential

Strippable Coal Development Potential. Areas where coal beds are 5 feet (1.5 m) or more in thickness and are overlain by 500 feet (152 m) or less of overburden are considered to have potential for surface mining and are assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios 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 potential map (Plate 69) 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 is utilized for coal beds greater than 40 feet (12 m) thick:

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

The surface mining development potential is high for approximately 80 percent of the quadrangle. These high development potential areas result from mining ratios of less than 10:1 for the Truman-Parnell coal zone and for the Scott, Daly, and Felix coal beds. The high development potential areas are located primarily in the northeastern, northwestern, and southwestern regions of the quadrangle. Mining ratios of the thick Felix coal bed are less than 5:1 over approximately 50 percent of the study area. Moderate and low development potential areas cover the remaining 20 percent of the Truman Draw Quadrangle. The areas of moderate development potential occur mainly in the southeastern quarter of the quadrangle, and the areas of low development potential occur in the east-central portion of the quadrangle. Moderate development potential areas relate to mining ratios between 10:1 and 15:1 for the

Scott, Daly, and Felix coal beds. Areas of low development potential are due to mining ratios greater than 15:1 for the Scott, Daly, and Felix coal beds. Table 1 sets forth the estimated strippable reserve base tonnages per coal bed for quadrangle.

Underground Mining Coal Development Potential. Subsurface coal mining potential throughout the Truman 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 potential relates to the occurrence of coal beds more than 5 feet (1.5 m) thick buried from 500 to 3000 feet (152 to 914 m) beneath the surface. This categorization is as follows:

1. Low development potential relates to: 1) a total coal section less than 100 feet (30 m) thick that lies 500 feet (152 m) to 3000 feet (914 m) beneath the surface, or 2) a coal bed or coal zone 5 feet (1.5 m) or more in thickness that lies 500 feet (152 m) to 1000 feet (305 m) beneath the surface.
2. Moderate development potential is assigned to a total coal section from 100 to 200 feet (30 to 61 m) thick and buried from 1000 to 3000 feet (305 to 914 m) beneath the surface.

3. High development potential involves 200 feet (61 m) or more of total coal thickness buried from 1000 to 3000 feet (305 to 914 m).

The coal development potential for in-situ gasification (Plate 75) on the Truman Draw Quadrangle is: 1) high for approximately 20.5 million tons (18.60 million metric tons) of coal that underlies less than five percent of the quandrangle; 2) moderate for ± 5.5 billion tons (± 5.0 billion metric tons) of coal beneath approximately 70 percent of the study area; and 3) low for 5.0 billion tons (4.5 billion metric tons) of coal below approximately 25 percent of the quadrangle (Table 3). The high development potential areas occur in the northeastern quarter of the quadrangle. The areas of low development potential are located along the northern and eastern quadrangle boundaries, and in the southwestern quarter of the quadrangle. Moderate development potential areas cover the remainder of the quadrangle. The two, small, high potential areas result from a total coal thickness greater than 200 feet (61 m) thick beneath more than 1000 feet (305 m) of overburden. Moderate potential areas are due to high terrain and aggregate coal thicknesses ranging from 101 to 165 feet (31 to 50 m). Areas of low development potential relate to total coal thicknesses of 81 to 88 feet (25 to 27 m) buried beneath more than 500 feet (152 m) of overburden.

Table 1.--Strippable Coal Reserve Base and Hypothetical Resource Data (in short tons) for Federal Coal Lands in the Truman Draw 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
RESERVE BASE TONNAGE				
Truman-Parnell	136,910,000	--	--	136,910,000
Scott	49,170,000	9,860,000	7,320,000	66,350,000
Daly	48,310,000	32,920,000	2,940,000	84,170,000
Felix	784,110,000	202,740,000	13,740,000	1,000,320,000
Norfolk	10,450,000	11,030,000	34,200,000	55,680,000
Smith	125,530,000	211,510,000	142,630,000	479,670,000
Swartz	--	--	10,950,000	10,950,000
Anderson	--	--	6,800,000	6,800,000
TOTAL	1,154,480,000	467,790,000	218,580,000	1,840,850,000
HYPOTHETICAL RESOURCES TONNAGE				
Truman-Parnell	--	--	730,000	730,000
Felix	--	--	7,860,000	7,860,000
TOTAL	--	--	8,590,000	8,590,000
GRAND TOTAL	1,154,480,000	467,790,000	227,170,000	1,849,440,000

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

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Norfolk	--	--	36,370,000	36,370,000
Smith	--	--	1,355,150,000	1,355,150,000
Swartz	--	--	217,660,000	217,660,000
Anderson	--	--	2,145,370,000	2,145,370,000
Canyon	--	--	1,179,980,000	1,179,980,000
Cook	--	--	1,158,700,000	1,158,700,000
Wall	--	--	1,705,980,000	1,705,980,000
Pawnee	--	--	1,129,220,000	1,129,220,000
Cache	--	--	542,210,000	542,210,000
Wildcat-Moyer-Oedekoven	--	--	945,420,000	945,420,000
TOTAL			10,416,060,000	10,416,060,000

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

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
	20,450,000	5,428,760,000	4,966,850,000	10,416,060,000
TOTAL	20,450,000	5,428,760,000	4,966,850,000	10,416,060,000

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