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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE TENMILE SPRING QUADRANGLE, CARBON COUNTY, WYOMING

(Report includes 17 plates)

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INTRODUCTION

Purpose

This text is to be used along with the accompanying Coal Resource Occurrence (CRO) maps and the Coal Development Potential (CDP) map of the Tenmile Spring quadrangle, Carbon County, Wyoming (17 plates; U.S. Geol. Survey Open-File Report 78-050), prepared by Texas Instruments Incorporated under contract to the U.S. Geological Survey. This report was prepared to support the land planning work of the U.S. Bureau of Land Management's Energy Minerals Activities Recommendation System (EMARS's) program, and to contribute to a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA) in the western United States. The Coal Resource Occurrence maps and the Coal Development Potential map for this quadrangle cover part of the northwestern portion of the KRCRA of the Hanna coal field.

Acknowledgment

Texas Instruments Incorporated acknowledges the cooperation of the Rocky Mountain Energy Company, a wholly owned subsidiary of the Union Pacific Railroad Company, in supplying copies of survey sheets, drillers reports, electric logs, and coal analyses from the Union Pacific coal inventory program.

The Hanna and Carbon coal basins were studied as part of the inventory program and test drilling was conducted in 1970-1971. More than 650 Union Pacific coal drill holes have been evaluated as part of this contract study of 21 quadrangles in Carbon County, Wyoming, and the results and 230 coal analyses have been incorporated into these reports.

Location

The Tenmile Spring 7½-minute quadrangle is in the northeastern part of Carbon County, Wyoming. The center of the quadrangle is approximately 14 miles (23 km) northeast of Walcott and 8 miles (13 km) northwest of Hanna, Wyoming (Figure 1).

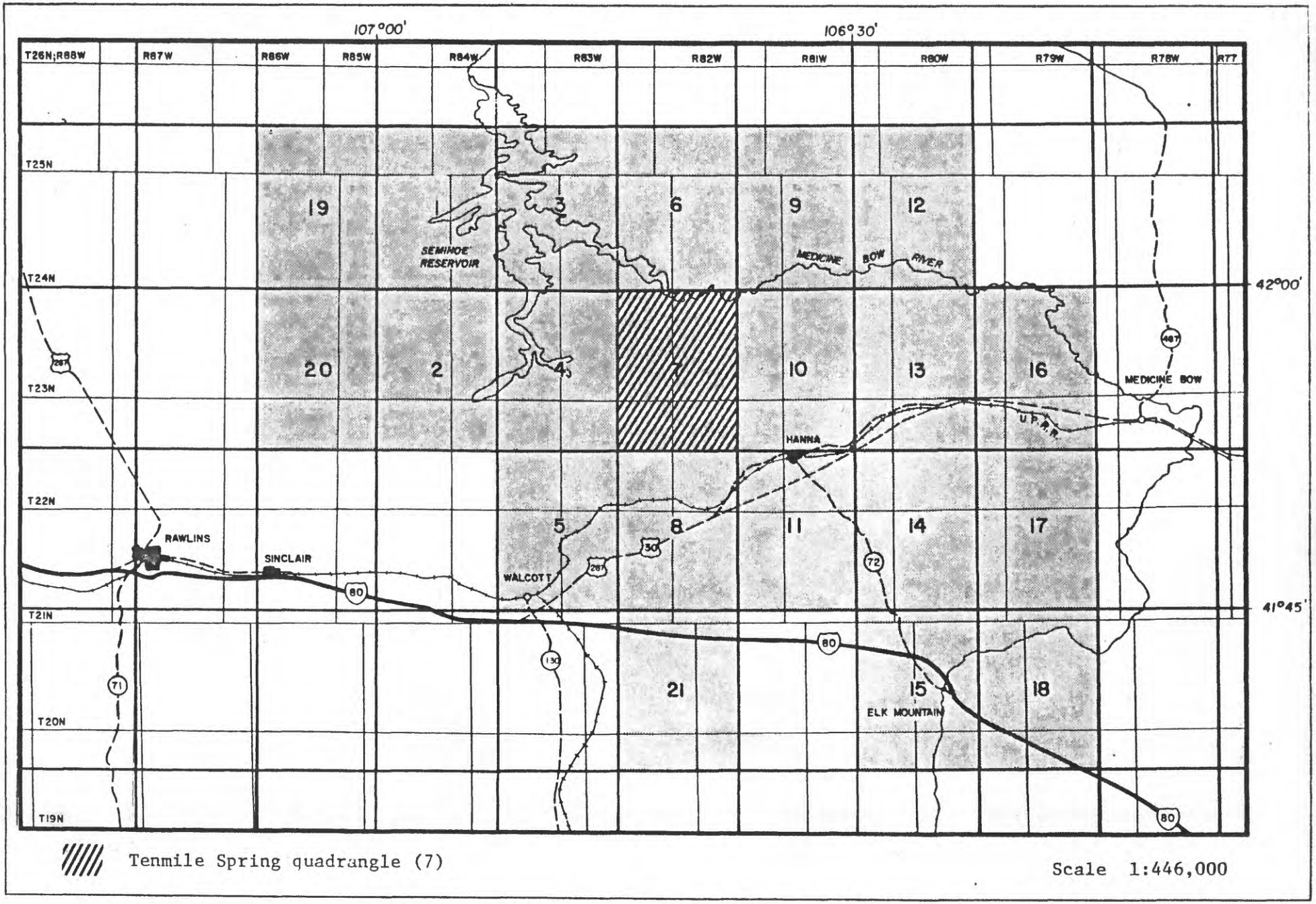

Figure 1. — Map of Hanna and Carbon Basins Study Area

Accessibility

Access within the quadrangle is provided by several short segments of light-duty roads and a number of unimproved dirt roads.

One light-duty road from Walcott enters the quadrangle in the northwest corner and proceeds east for 0.5 mile (0.8 km) where it connects with an unimproved dirt road. This dirt road crosses the northern part of the quadrangle in an approximate east-west direction along the crest of the ridge between the Medicine Bow River and North Ditch. Several unimproved dirt roads travel north from this east-west road and provide access to Seminoe Reservoir and to the Medicine Bow River. Unimproved dirt roads proceed south from this east-west road and connect with a second east-west unimproved dirt road which runs along the crest of Sand Ridge in the southern part of the quadrangle. Several unimproved dirt roads run south from this latter road to provide access to Big Ditch in the southwest corner. In the southeast corner of the quadrangle, several light-duty roads provide access from the town of Hanna to the mining operations of the area.

The main east-west track of the Union Pacific Railroad passes 9 miles south of the center of the quadrangle, through the towns of Hanna to the southeast and Sinclair to the southwest. A landing strip for light aircraft, in secs. 3 and 4, T. 22 N., R. 82 W., is shown on the 1:24,000 topographic map (1971 edition).

Physiography

The quadrangle is in the west-central part of the Hanna structural basin. The topography is typical of the high plains grasslands of southern Wyoming.

There are two notable topographic features in the quadrangle. In the north, Medicine Bow Breaks is an area of heavily dissected, north-facing, hill slopes overlooking the Medicine Bow River. Local relief in the area is about 450 feet (137 m). In the south, the assymmetric Sand Ridge trends west-northwest across the quadrangle. The southern side of the ridge has the steeper slopes but the local relief is less than 250 feet (76 m). Elevations within the quadrangle range from 6,358 feet (1,938 m) at Seminoe Reservoir to over 7,260 feet (2,212 m) on Sand Ridge.

The Medicine Bow River meanders in a westerly direction at the northern boundary of the quadrangle; a small part of the Seminoe Reservoir is located at the north-central boundary. North Ditch, Middle Ditch, and Big Ditch, three westerly flowing intermittent streams, drain the southern three quarters of the quadrangle.

Climate

Climate data for the Tenmile Spring quadrangle were obtained by evaluating and averaging the data recorded at two nearby weather stations. The Elk Mountain station is located 22 miles (35 km) southeast of the center of the quadrangle at an elevation of 7,270 feet (2,216 m); precipitation records are available for 65 years to 1970 and temperature records are available for 22 years to 1970. The Seminoe Dam station is located 19 miles (31 km) northwest of the center of the quadrangle at an elevation of 6,838 feet (2,084 m); precipitation and temperature records are available for 33 years to 1970.

The climate is semiarid with a mean annual temperature of 42°F (6°C) and extremes ranging from 98° to -42°F (37° to -41°C). July is the warmest month with a mean monthly temperature of 66°F (19°C) and January is the coldest month with 22°F (-6°C). For seven months of the year, April to October, the mean monthly temperature exceeds 32°F (0°C). Average annual precipitation is 14 inches (36 cm) with 53 percent of this total falling in the five months of March to July. Part of the precipitation in March, April, and May is in the form of snow. Average annual snowfall is 102 inches (259 cm) with 63 percent falling in the four months of January to April. Snow rarely falls in July and August but an inch or more of snow may fall in any other month. March is the month of maximum snowfall (18 inches, or 46 cm).

High winds are common throughout most of the year. The prevailing wind direction, as recorded at four weather stations around the perimeter of the Hanna and Carbon Basins, is westerly for all twelve months of the year. The growing season is restricted to less than 100 days between late May and early September, which are the average times of the last killing spring frost and the first killing fall frost, respectively.

Land Status

The Tenmile Spring quadrangle is located in the center of the KRCRA of the Hanna coal field. The Federal Government owns 50 percent of the coal rights in the quadrangle; the other 50 percent is privately owned. Approximately 60 percent of the area of the quadrangle is included in the KRCRA, and within the KRCRA, 45 percent of the land is federally owned. About 60 percent of the Federal land in the KRCRA is presently leased for coal. Plate 2 shows the ownership status of the land in the quadrangle and the boundary of the KRCRA.

There are six coal mines, two active and four abandoned, located in the quadrangle, all of them owned by Energy Development Company. The two active mines are Vanguard No. 3 underground mine, which is producing from coal bed 65 near the west boundary of sec. 7, T. 22 N., R. 82 W., and the portion of Section 18 open-pit mine on the right bank of Big Ditch. The four abandoned mines are the Rimrock No. 1, Rimrock No. 2, and Rimrock No. 3 open-pit mines in the north part of T. 22 N., R. 82 W., and the Vanguard No. 1 underground mine in sec. 8, T. 22 N., R. 82 W. On the 1:24,000 topographic map (1971 edition) a strip mine is shown in the southeastern part of sec. 8, T. 22 N., R. 82 W. but the Energy Development Company states that this is the location of a second entry to, or the eastern portal of, the Vanguard No. 1 mine (personal communication, P. Wyckoff).

GENERAL GEOLOGY

Previous Work

Dobbin, Bowen, and Hoots (1929) mapped the Tenmile Spring quadrangle as part of their study of the geology and coal and oil resources of the Hanna and Carbon Basins. Weitz and Love (1952) compiled a geological map of Carbon County which incorporates available data, published and unpublished, to that date. Gill, Merewether, and Cobban (1970) provide a detailed description and discussion of the stratigraphic units exposed in this quadrangle. The geology of the quadrangles adjoining on the west and northwest has been mapped more recently by Blanchard and Comstock (1976), and Blanchard and Jones (1976), respectively.

Stratigraphy

Rock units exposed in the quadrangle range in age from Late Cretaceous to Quaternary. Coal beds occur in the Ferris Formation of Late Cretaceous-Paleocene age, and in the Hanna Formation of Paleocene age.

The oldest formation is the Ferris Formation which is exposed across the southern quarter of the quadrangle. It is about 6,500 feet (1,981 m) thick at the type locality near the old Ferris Ranch on the North Platte River, 10 miles (16 km) west of the center of this quadrangle. The formation consists of a thick sequence of continental rocks that can be divided into two parts: a lower unit of Late Cretaceous age which is about 1,100 feet (335 m) thick, and an upper unit of Paleocene age which is about 5,400 feet (1,646 m) thick. The basal 300 feet (91 m) of the lower unit consists of dark-gray shales and buff to yellow coarse-grained friable massive sandstones with irregular thin beds of conglomerate. The overlying 800 foot (244 m) section of the lower unit is made up largely of conglomerate which occurs as pockets, lenses, and thin beds irregularly distributed throughout the sandstone. This lower unit of the Ferris Formation is not exposed at the surface, but it is identified in the subsurface in drill hole 34 in sec. 4, T. 22 N., R. 82 W. The stratigraphic log of this drill hole shows an apparent thickness of the Ferris Formation of 8,914 feet (2,717 m). The upper unit is conformable with the lower unit and consists of gray, brown, and yellow sandstones interstratified with numerous thick beds of coal. The upper 2,700 feet (823 m) of the unit is exposed in the Tenmile Spring quadrangle.

The Hanna Formation crops out over the northern three-quarters of the quadrangle. This formation lies unconformably on the Ferris Formation, is of continental origin, and consists of light tan to dark orangish-brown very fine to coarse-grained thin- to massive-bedded sandstones, gray mudstones, dark-brown carbonaceous shales, and coal. The sandstones are conglomeratic near the base of the formation but are progressively finer grained up the stratigraphic section. The Hanna Formation is at least 7,000 feet (2,134 m) thick and may be as much as 13,500 feet (4,115 m) thick in parts of the Hanna Basin, according to Gill, Merewether, and Cobban (1970, p. 47). Approximately 8,200 feet (2,499 m) of the Hanna Formation is exposed in the

Tenmile Spring quadrangle. Drill hole 34 in sec. 4, T. 22 N., R. 82 W. reports over 316 feet (96 m) of Hanna Formation before intersecting the underlying Ferris Formation.

Quaternary alluvium is confined to scattered deposits along most of the major drainage channels.

Structure

The Tenmile Spring quadrangle is in the west-central part of the intermontane Hanna Basin. This structural basin is comparatively small in areal extent, 40 miles (64 km) east-west and 25 miles (40 km) north-south, but very deep. Exploratory drilling for oil shows that, at the center of the basin in the southeast part of T. 24 N., R. 82 W., about 8 miles (13 km) northeast of the center of this quadrangle, there are 30,000 to 35,000 feet (9,140 to 10,670 m) of sediments overlying Precambrian crystalline basement.

The principal deformation defining the present structural basin occurred during the Laramide Orogeny. The bordering highlands were raised and deformed, and the sediments accumulated rapidly in the basin; consequently, the present Hanna Basin has complexly folded and faulted borders, with mild deformation within the basin expressed by a few broad folds and normal faults.

The Tenmile Spring quadrangle reflects the simple structure within the Hanna Basin itself, as compared to the complexity of structure at the periphery. The structure in this quadrangle is basically monoclinal, with the Ferris and Hanna Formations dipping to the north-northeast at angles of 6° to 16°. Strike of the beds is almost uniformly west-northwest. One exception to this is along the west boundary of the quadrangle in T. 23 N., R. 83 W.; in the southern part of the township the beds dip about 10° to the northeast, and in the northern part, about 10° east and southeast, forming a broad, shallow syncline that occupies the area north of Middle Ditch. This simple structure is affected immediately to the west, in the Pats Bottom quadrangle, by many local small normal faults which have a general northwesterly trend.

Faulting in the Tenmile Spring quadrangle is of minor significance. There are a few northwest-trending normal faults with small displacements

that may be traced at the surface, in the Hanna Formation, in T. 22 and 23 N., R. 83 W. An additional normal fault and a reverse fault displace both the Ferris and Hanna Formations in T. 22 N., R. 82 W. Again, these are minor northwest-trending faults with small displacements, down on the northeast sides.

COAL GEOLOGY

Previous Work

The coal deposits of the Hanna and Carbon Basins have been studied by Veatch (1907), Dobbin, Bowen, and Hoots (1929), Beryhill and others (1950), and Glass (1972 and 1975).

Twenty-six coal analyses have been published since 1913 for coal beds of the Mesaverde Group and the Medicine Bow, Ferris, and Hanna Formations within the Hanna and Carbon Basins (Appendices 1 and 2). Samples collected and analyzed prior to 1913 have not been considered in this report (American Society for Testing and Materials, 1977, p. 218). An average analysis of coal beds in each of these four stratigraphic units has also been calculated for the 230 analyses from the Union Pacific coal inventory program (Appendices 1 and 2). An apparent rank has been calculated from the average analysis for coal in each of the four stratigraphic units. A standard rank determination (ASTM, 1977, p. 216, sec. 6.2.2) cannot be made because: (a) some of the published analyses are from weathered coal samples, and (b) the procedure and quality of sampling for the Union Pacific coal evaluation program are not known.

Glass (1975) and U.S. Department of Interior (1975) published not only proximate coal analyses for 17 samples collected in the Hanna Basin but also assays for 10 major and minor oxides, 12 major and minor elements, and up to 32 trace elements. Glass (1975, p. 1) stresses that his assay data are insufficient to characterize the chemical and physical properties of any individual coal beds but that this will be possible at a later date as the study continues. Assay results of the 17 Hanna Basin samples show that these coals contain no significantly greater amounts of trace elements of environmental concern than are found in the 42 samples collected in six other Wyoming coal fields.

General Features

In this quadrangle, 42 coal beds and 19 local coal lenses in the Ferris and Hanna Formations have been mapped by Dobbin, Bowen, and Hoots (1929) or have been identified in the subsurface (Plates 1, 3, and 3A). Of the 61 coal beds and local coal lenses identified, coal beds 50, 64, and 65 of the Ferris Formation and coal bed BB (Brooks Bed) of the Hanna Formation were selected for coal resource evaluation.

Several coal beds in the Ferris and Hanna Formations have been worked by the mines located in the quadrangle. The Ferris coal bed 56 is most probably the coal bed worked in the right bank of Big Ditch at the Section 18 open pit. The Vanguard No. 1 underground mine worked coal bed 65; the new Vanguard No. 3 underground mine is now working the same coal bed. The Hanna coal bed BB (Brooks Bed) was mined at the three abandoned Rimrock open-pit mines.

Analyses of samples collected during the Union Pacific coal inventory program and published analyses are shown in Appendix 3. In this quadrangle, analyses are available for 14 coal samples collected in the Ferris Formation, and 4 coal samples collected in the Hanna Formation.

Ferris Coal Beds

In the south part of the quadrangle, 28 coal beds are exposed at the surface and 15 local coal lenses are identified in the subsurface (Plates 1, 3, and 3A). Dips vary from 9° to 17° to the north and northeast. Coal bed thicknesses vary from 0.4 to 12.0 feet (0.1 to 3.7 m). The selected coal bed, 50, which occurs in the middle of the formation, crops out in secs. 14 and 15 of T. 22 N., R. 83 W., and is also intersected in the subsurface by drill hole 9. Dip of the coal bed is north to northeast at approximately 15°. Thickness of coal in bed 50 averages about 7.0 feet (2.1 m) with a maximum coal thickness of 8.6 feet (2.6 m) measured at the surface. A sample of coal bed 50 from drill hole 9 was analyzed and the results are shown in Appendix 3.

Coal bed 64 occurs in the upper part of the formation. This coal bed crops out in secs. 3, 10, and 11 of T. 22 N., R. 83 W. and is also intersected in the subsurface by drill holes 4, 7, 11, and 12. Dip of the coal

bed is north to northeast at angles of 9° to 11°. Coal thicknesses range from 3.2 to 9 feet (1.0 to 2.7 m) with the maximum thickness intersected in drill hole 4. Thickness of coal in bed 64 increases to the northwest. Analyses for two samples of coal bed 64 appear in Appendix 3.

Coal bed 65 also occurs in the upper part of the formation. This coal bed is exposed at the surface and may be traced continuously across the entire south part of the quadrangle. Dip of the coal bed is north to northeast at angles of 9° to 11°. In the subsurface, coal bed 65 is identified in seven drill holes. Coal thickness ranges from 3.8 to 12.0 feet (1.2 to 3.7 m) with the maximum thickness measured at the surface in sec. 7 of T. 22 N., R. 82 W. Analyses for six samples of coal bed 65 appear in Appendix 3.

Hanna Coal Beds

Exposures of 14 coal beds occur in the south and west sections of the quadrangle (Plate 1). Also, 4 additional local coal lenses are identified in the subsurface (Plate 3 and 3A). Dips vary from 6° to 10°, north and east toward the center of the Hanna Basin. Coal beds range in thickness from 0.8 to 8.0 feet (0.2 to 2.4 m).

Coal bed BB (Brooks Bed), which is equivalent to coal beds 67, 68, and 69 (Dobbin and others, 1929), occurs in the lower part of the formation. This coal bed crops out in the southeast part of the quadrangle, and is identified in the subsurface in drill holes 19, 25, 28, and 34. Dip of the coal bed BB is 6° to the north, and coal thickness ranges from 1 to 6.7 feet (0.3 to 2.0 m). The maximum coal thickness was measured at the surface in sec. 4 of T. 22 N., R. 82 W., but the area has since been mined by the Rimrock Strip Pit No. 1. Analyses for three samples of coal bed BB appear in Appendix 3.

COAL RESOURCES

Previous Work

Coal reserves of the Hanna and Carbon Basins have been estimated or calculated by Dobbin, Bowen, and Hoots (1929), Berryhill and others (1950), and Glass (1972).

Method of Calculating Resources

Data from Dobbin, Bowen, and Hoots (1929), oil and gas well logs, and coal drill holes (written communication, Rocky Mountain Energy Company, 1977) were used to construct the coal data map (Plate 1) and coal data sheets (Plates 3 and 3A). U.S. Geological Survey reviewed these three plates and on the basis of Reserve Base criteria, selected four coal beds (50, 64, 65, and BB) for the calculation of coal resources in the Tenmile Spring quadrangle. In addition, calculation of coal resources was requested for isolated or noncorrelatable data points.

The coal data map and coal data sheets were used to construct structure contour, coal isopach, and overburden isopach maps of the selected coal beds (Plates 4-15). For single coal beds, the maps were drawn using, as control points, thicknesses measured at outcrop and subsurface data from drill hole information. Where coal beds are split, cumulative coal thicknesses were used, excluding non-coal partings.

Plates 4-15 provide the data for calculating the coal resources within the KRCRA boundary of the quadrangle, in accordance with the classification system given in U.S. Geological Survey Bulletin 1450-B and the instructions provided by U.S. Geological Survey on approval of these 12 plates. Calculation of coal resources is in accordance with certain criteria, including:

- All coal deeper than 3,000 feet (914 m) is excluded.
- Coal resources are calculated for unleased Federal land within the KRCRA boundary (Plate 2). Information pertaining to leased or fee acreage and to private land is considered proprietary and not for publication.
- Coal resources from isolated or noncorrelatable data points are calculated for a single coal bed at least 5 feet (1.5 m) thick or for an aggregate thickness of multiple coal beds each at least 5 feet (1.5 m) thick. The single coal bed, or the stratigraphically highest bed in an aggregate of coal beds, is locally projected up dip to the surface to establish an inferred outcrop. Strippable coal resources for the projected bed or beds are considered to occur from surface to a depth of 200 feet (61 m); nonstrippable coal resources are considered to occur from surface to a depth of 3,000 feet (914 m). Only the coal resources underlying unleased Federal land within 0.5 miles (804 m) of a drill hole or a measured surface outcrop are considered, and they are assigned to the inferred category of reliability.

Results

Evaluation of Plates 4-15 and Plate 2, the boundary and coal data map, showed that all coal resources of the selected coal beds, which meet Reserve Base criteria are located beneath leased or private land within the KRCRA. Consequently, no coal Reserve Base tonnages exist for the selected coal beds 50, 64, 65, and BB.

One isolated data point, a 5-foot (1.5 m) thick local coal lens in drill hole 29, yielded nonstrippable coal resources when projected down dip to the northeast. A small area in the southwest corner of sec. 34, T. 22 N., R. 82 W., within 0.5 mile (804 m) of the drill hole, is underlain by coal below the stripping limit but at less than 3,000-foot (914 m) depth. This area was measured by planimeter and the acreage was multiplied by the coal bed thickness, times the conversion factor for subbituminous coal, 1,770 short tons (1,606 t) per acre-foot. The result is 0.90 million short tons (0.82 million t).

Therefore, the total Reserve Base for all coal beds thicker than 5 feet (1.5 m), that lie less than 3,000 feet (914 m) below the ground surface of unleased Federal land within the KRCRA in the Tenmile Spring quadrangle, is 0.9 million short tons (0.82 million t) assigned to the inferred resource category.

COAL DEVELOPMENT POTENTIAL

Method of Calculating Development Potential

Following the calculation of coal Reserve Base values, the coal resources within the KRCRA of the Tenmile Spring quadrangle, except those coal resources determined from isolated or noncorrelatable data points, are evaluated for their development potential in each of two mining-method categories, surface and subsurface.

No surface development potential was determined for the selected coal beds because the areas between coal bed outcrops and the stripping limits, 200 feet (61 m) of overburden for single coal beds and 500 feet (152 m) of overburden and interburden for multiple coal beds, are on leased or private land within the KRCRA of the quadrangle.

Nonstrippable Resources

Nonstrippable resources are assigned to one of four development potential categories (high, moderate, low, and unknown) according to the following criteria:

- If the overburden is between 0 and 1,000 feet (0 and 305 m), resources have high development potential; if the overburden is between 1,000 and 2,000 feet (305 and 610 m), resources have moderate development potential; if the overburden is between 2,000 and 3,000 feet (610 and 914 m), resources have low development potential.

- If insufficient data prevents the construction of coal isopachs or overburden isopachs, or if the selected coal bed in the area is located completely above the stripping limit, the resources are assigned to the unknown development potential category, provided that there is reasonable assurance the selected coal bed is present in the area.

When evaluating the selected coal beds 50, 64, and 65, the overburden isopachs to 400, 500, and 600 feet (122, 152, and 183 m), respectively, were constructed with reasonable geologic assurance. However, the coal resources developed for these selected coal beds all lie beneath leased or private land. The overburden isopachs for coal bed BB (Brooks Bed) are shown on Plate 15, constructed to 400 feet (122 m) with reasonable geologic assurance. These coal resources lie beneath unleased Federal land in sec. 32 and the western part of sec. 34, T. 23 N., R. 82 W.; therefore, as shown on Plate 16, subsurface development potential acreage is blocked out for coal bed BB in these areas.

Development Potential for Strippable and Nonstrippable Resource

Development potential for nonstrippable coal resources within unleased Federal land in the KRCRA of the Tenmile Spring quadrangle, is shown on Plate 16. These coal resources are assigned to the unknown development potential category.

Of the 4,080 acres (1,651 ha) of unleased Federal land, there are 450 acres (182 ha) or 11 percent of the total, which are classifiable as of unknown surface mining potential on the basis of both (a) the presence of outcrops of non-correlatable coal beds of unknown thickness and (b) data gaps on beds selected for coal resource evaluation.

Of the 4,080 acres (1,651 ha) of unleased Federal land, there are 1,990 acres (805 ha) or 49 percent of the total, which are classifiable as of unknown subsurface mining potential on the basis of both (a) the presence of outcrops of non-correlatable coal beds of unknown thickness and (b) data gaps on beds selected for coal resource evaluation.

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Appendix 1. — Average analyses of coal samples from the Hanna and Carbon Basins

Source of Data	Number of samples (1)	Total footage Ft	in	Average analyses – as-received basis, Percent: Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb	Calorific Value, Btu/lb: Moist, mineral-matter-free basis (2)	Apparent rank of coal (3)
Published analyses	26	318	6	12.5	7.1	36.2	44.2	0.6	10,553	11,438	sub A or hvCb
Union Pacific coal inventory program	230	1,605	10	12.48	8.74	35.12	43.68	0.82	10,398	11,494	sub A or hvCb

Notes:

(1) Published data from USBM (1931, p. 40-45, sample nos. 2623, 2624, 22800, 22972, 93486, 93488, 93541, A14123, A14124); Glass (1975, p. 16-19, sample nos. 74-23 to 74-34, inclusive); Dept. of Interior (1975, p. 38, sample nos. D169597-99, D169607-08). Union Pacific coal inventory program data from company files, Rocky Mountain Energy Company (1977).

(2) Moist, mineral-matter-free Btu/lb calculated from average analyses, as-received basis, using Parr formula (ASTM, 1977, p. 216, sec. 8.2).

(3) Sub A – subbituminous A; hvCb – high volatile C bituminous (ASTM, 1977, p. 215, sec 4.2, and p. 217).

[To convert feet and inches to meters, multiply feet by 0.3048 and inches by 0.0254. To convert Btu/lb to kilojoule/kilogram, multiply by 2.326].

Appendix 2. — Average analyses of coal grouped by coal-bearing formations in the Hanna and Carbon Basins

Source of data	Formation or Group	Number of samples (1)	Total footage		Average analyses — as-received basis						Calorific Value, Btu/lb	Apparent rank of coal (3)
					Percent						Moist, mineral-matter-free basis (2)	
			Ft	in	Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb		
Published analyses	Mesaverde	1	4	0	14.1	7.8	36.5	41.6	1.1	10,290	11,251	sub A or hvCb
	Medicine Bow	2	10	1	12.8	3.8	33.3	50.2	0.8	11,050	11,534	hvCb
	Ferris	10	93	1	.13.0	8.3	34.3	44.3	0.4	9,970	10,956	sub A or hvCb
	Hanna	13	211	4	12.0	6.6	38.1	43.3	0.7	11,946	11,797	hvCb
Union Pacific coal inventory program	Mesaverde	13	70	5	9.45	8.41	35.42	46.72	0.77	11,112	12,237	hvCb
	Medicine Bow	16	93	4	13.09	4.03	35.46	47.42	0.80	10,927	11,446	sub A or hvCb
	Ferris	114	863	1	12.69	7.96	34.39	44.97	0.44	10,331	11,309	sub A or hvCb
	Hanna	87	579	0	12.51	10.67	35.96	40.85	1.33	10,280	11,640	hvCb

Notes:

(1) Published data from USBM (1931, p. 40-45, sample nos. 2623, 2624, 22800, 22972, 93486, 93488, 93541, A14123, A14124); Glass (1975, p. 16-19, sample nos. 74-23 to 74-34, inclusive); Dept. of Interior (1975, p. 38, sample nos. D169597-99, D169607-08). Union Pacific coal inventory program data from company files, Rocky Mountain Energy Company (1977).

(2) Moist, mineral-matter-free Btu/lb calculated from average analyses, as-received basis, using Parr formula (ASTM, 1977, p. 216, sec. 8.2).

(3) Sub A — subbituminous A; hvCb — high volatile C bituminous (ASTM, 1977, p. 215, sec. 4.2, and p. 217).

[To convert feet and inches to meters, multiply feet by 0.3048 and inches by 0.0254. To convert Btu/lb to kilojoule/kilogram, multiply by 2.326].

Appendix 3. — Coal analyses, Tenmile Spring quadrangle

Drill hole	Location			Coal bed	Sample interval				Sample width		Analyses — as-received basis					
					From		To				Percent					
	Sec.	Twp.	Rge.		Ft	in	Ft	in	Ft	in	Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb
28	3	22N	82W	BB	115	1	120	7	5	6	13.34	4.62	33.62	48.42	.57	10,861
29	3	22N	82W	L	262	5	268	11	6	6	11.12	5.89	32.74	50.25	.35	10,983
25	5	22N	82W	BB	31	0	37	0	6	0	13.67	5.03	33.32	47.98	.35	10,395
18	7	22N	82W	65	274	0	279	0	5	0	12.61	6.18	34.32	46.89	.45	10,843
7	3	22N	83W	65	62	6	68	0	5	6	13.02	4.55	33.62	48.81	.33	10,765
7	3	22N	83W	64	184	0	190	7	6	7	10.45	9.89	35.35	44.51	.38	10,397
6	3	22N	83W	65	456	0	462	0	6	0	11.75	5.99	34.21	48.05	.29	10,826
4	3	22N	83W	65	70	3	82	0	11	9	13.31	7.11	33.58	46.00	.39	10,417
4	3	22N	83W	64	157	11	166	6	8	7	11.48	9.20	34.80	44.52	.33	10,430
12	11	22N	83W	65	315	9	322	2	6	5	13.09	5.61	34.49	46.81	.41	10,727
9	15	22N	83W	50	474	6	480	8	6	2	11.29	7.29	33.05	48.37	.28	10,694
5	15	22N	83W	37	263	2	267	8	4	6	12.04	6.86	34.95	46.15	.36	10,758
5	15	22N	83W	31	628	4	638	9	10	5	11.53	10.40	34.40	43.67	.23	10,215
5	15	22N	83W	29	686	6	692	9	6	3	11.96	5.82	33.53	48.69	.18	10,910

Data from Rocky Mountain Energy Company, 1977.

[To convert feet and inches to meters, multiply feet by 0.3048 and inches by 0.0254.
To convert Btu/pound to kilojoules/kilogram (kJ/kg), multiply by 2.326].

Appendix 3. — Coal analyses, Tenmile Spring quadrangle

Sample number	Location			Coal bed	Sample interval				Sample width		Analyses — as-received basis					
					From		To				Percent					
	Sec.	Twp.	Rge.		Ft	in	Ft	in	Ft	in	Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb
74-27	9	22N	82W	BB	-	-	-	-	7	6	12.3	7.0	33.5	47.2	0.5	10,820
74-28	8	22N	82W	65	-	-	-	-	6	8	10.1	6.3	37.2	46.4	0.6	11,150
D169607	12	23N	83W	unnamed	77	4	82	8	5	5	12.6	5.4	36.7	45.3	0.6	10,820
D169608	12	23N	83W	unnamed	104	11	111	6	6	7	11.2	13.1	30.9	44.8	0.3	9,840

Published data from Glass (1975, p. 16-17, samples 74-27 and 74-28) and Dept. of Interior (1975, p. 38, samples D169607 and D169608)

[To convert feet and inches to meters, multiply feet by 0.3048 and inches by 0.0254. To convert Btu/pound to kilojoues/kilogram (kJ/kg), multiply by 2.326].