UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

Open-File Report 79-484

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE NORTHEAST QUARTER OF THE SCOFIELD 15-MINUTE QUADRANGLE, CARBON COUNTY, UTAH

(Report includes 16 plates)

By

AAA Engineering And Drafting, Inc.

CONTENTS

ILLUSTRATIONS

(Plates are in pocket)

Plates 1-16 Coal resource occurrence and coal development potential maps:

1. Coal data map
2. Boundary and coal data map
3. Coal data sheet
4. Isopach map of the Bob Wright coal bed
5. Structure contour map of the Bob Wright coal bed
6. Overburden isopach map of the Bob Wright coal bed
7. Areal distribution and identified resources map of the Bob Wright coal bed
8. Isopach map of the Castlegate "A" coal bed
9. Structure contour map of the Castlegate "A" coal bed
10. Overburden isopach map of the Castlegate "A" coal bed
11. Areal distribution and identified resources map of the Castlegate "A" coal bed
12. Isopach map of the Hiawatha coal bed
13. Structure contour map of the Hiawatha coal bed
14. Overburden isopach map of the Hiawatha coal bed
15. Areal distribution and identified resources map of the Hiawatha coal bed
16. Coal development potential map for subsurface mining methods.

TABLES

INTRODUCTION

Purpose

This report was compiled to support the land planning work of the Bureau of Land Management and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the Western United States. It supplements the land planning requirements of the Federal Coal Leasing Amendments Act of 1976 (Public Law 94-377) sec. (3)(B) which states, in part, that "Each land-use plan prepared by the Secretary [of the Interior] (or in the case of lands within the National Forest System, the Secretary of Agriculture pursuant to subparagraph (A)(i)) shall include an assessment of the amount of coal deposits in such land, identifying the amount of such coal which is recoverable by deep mining operations and the amount of such coal which is recoverable by surface mining operations."

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps (15 plates) and the Coal Development Potential (CDP) Map (1 plate) of the Northeast Quarter of the Scofield 15-minute quadrangle, Carbon County, Utah (U.S. Geoligical Survey Open-File Report 79-484).

Published and unpublished public information were used as data sources for this study. No new drilling nor field mapping were done to supplement this study. No confidential nor proprietary information was used.

Location

The Northeast Quarter of the Scofield 15-minute quadrangle is located at the north end of the Wasatch Plateau coal field, in Carbon County, Utah. The southeast corner of the quadrangle lies approximately 10 miles (16 km) northwest of Price, Utah, the county seat of Carbon County. The towns of Scofield and Clear Creek lie within two miles (3 km) of the west side of the quadrangle.

Accessibility

No paved highways nor railroads occur in the quadrangle and the only means of accessibility are by unimproved dirt roads and a graveled road, Utah Highway 139, which enters the southeast section of the quadrangle and continues several miles up the canyon of the North Fork of Gordon Creek. State Highway 139 runs eastward from the quadrangle where it joins U.S. Highway 50-6 near the city of Helper. Route 139 is a well-maintained gravel road over most of its length.

Physiography

The Wasatch Plateau is a high and deeply dissected tableland. The eastern margin forms a sweeping stretch of barren sandstone cliffs 80 miles (129 km) long. The rock strata dip at low angles and display the physiographic features of parallel ledges and cliffs typical of regions of flat-lying beds.

The terrain of the Northeast Quarter of the Scofield 15-minute quadrangle is rugged and mountainous. The southeast corner of the quadrangle consists of dissected lowland pediments which are locally called "benches." The principal streams in the quadrangle, the North Fork of Gordon Creek and Beaver Creek both drain into Price River. The lowest altitude in the southeast corner is about 6,700 ft (2,042 m), while the highest point in the quadrangle is a peak on the west side that reaches 9,585 feet (2,922 m) above sea level. Most of the quadrangle is characterized by rugged steep-walled canyons. The vegetation consists mainly of sparse native grasses, sagebrush, and juniper trees.

Climate

The annual precipitation ranges from less than 15 inches (38 cm) in the lowest southeast corner of the quadrangle to over 25 inches (64 cm)

in the high mountains to the west (U.S. Department of Commerce, (1964)). Occasional summer cloudburst storms sometimes cause flash floods which could damage unimproved roads.

Temperatures in the high areas of the Wasatch Plateau range from about 90 degrees F (32 degrees C) in the summer to -20 degrees F (-29 degrees C) in the winter. The temperature extremes in the lower foothill areas are about ten degrees F (5.6 degrees C) warmer than those at the higher elevations.

Land Status

The Northeast Quarter of the Scofield 15-minute quadrangle is located in the northeast corner of the Wasatch Plateau Known Recoverable Coal Resource Area (KRCRA). The quadrangle covers approximately 36,900 acres of which nearly 23,400 acres are designated KRCRA lands. The areas and boundaries of Federal coal leases, non-Federal lands, unleased Federal coal lands, and the Wasatch Plateau and Book Cliffs KRCRA's in the quadrangle are shown on plate 2. Approximately 20 percent of the KRCRA lands in the quadrangle are non-Federal lands, 6 percent are Federal coal-leased lands, and the remaining 74 percent are unleased Federal coal lands.

GENERAL GEOLOGY

Previous Work

Spieker (1931) mapped the Wasatch Plateau and his work is the most detailed original published work presently available. The stratigraphy of the area is further described by Katich (1954). Doelling (1972) has summarized the geology and updated the coal data. Clark (1928) mapped the geology and coal outcrops in the adjoining quadrangles to the east.

Stratigraphy

The coal beds of economic importance in the Wasatch Plateau field are Upper Cretaceous in age, and are confined to the Blackhawk Formation of the Mesaverde Group. The Mesaverde consists of four formations which are, in ascending order, the Star Point Sandstone, Blackhawk Formation, Castlegate Sandstone, and Price River Formation. The Upper Cretaceous Mancos Shale underlies the Mesaverde Group and consists of three shale members, the Tunuk at the base, the Blue Gate, and the Masuk. Two sandstone members, the Ferron and Emery separate the shale members.

The Tertiary strata overlying the Price River Formation consist of the Wasatch Group which includes the North Horn Formation, Flagstaff Limestone, and Colton Formation. Only the North Horn Formation (Upper Cretaceous and Paleocene age) occurs on some of the higher peaks on the north side of the quadrangle.

The oldest formation exposed in the quadrangle is the Mancos Shale, which is present in the south half. The gray marine shale of the Masuk Member overlies the massive yellowish-gray to white sandstone of the Emery Sandstone Member.

The coal-bearing Blackhawk Formation consists of alternating littoral and lagoonal sediments, consisting of interlayered sandstone, shale, and coal beds. The unit is at least 1,000 feet (305 m) thick, but all important coal seams are in the lower 400 feet (122 m).

The massive Castlegate Sandstone overlies the Blackhawk Formation and consists of up to 500 feet (150 m) of white to gray, coarse-grained, and conglomeratic, brown-weathering sandstone. It is overlain by the less resistant Price River Formation which is composed of up to 1,000 feet (305 m) of sandstone interbedded with minor gray shale layers.

The northeast corner and some of the peaks in the north part of the quadrangle contain some areas underlain by the North Horn Formation which consists of variegated shale, sandstone, and thin-bedded limestone.

Structure

The most important structural feature in the quadrangle is the North Gordon fault zone. The coal-bearing rocks are broken by the network of faults in a zone which crosses the canyon of the North Fork of Gordon Creek and is about 5 miles wide. Between the eastern border of the area and Trail Canyon there are at least 33 faults, 10 of which have displacements greater than 100 feet (30 m) (Spieker, 1931). Most of the larger faults trend nearly north, but many others extend in diverse directions, forming an irregular network within which the positions of the coal beds are complicated.

To the north the faulting is less complex, and in the northwest corner of the quadrangle there are three important faults about one-half mile (.8 km) apart. The displacements along these faults are large and may be as much as 1,000 feet (305 m) in places. Four north-south trending faults occur within a half mile near the mouth of Bob Wright Canyon with displacements between 50 and 150 feet (15 and 46 m).

The strata in the center of the quadrangle dip about 2 degrees north, while those to the south are approximately horizontal. Dips ranging up to 4 degrees occur in the north part of the quadrangle. The dips of some strata may be larger in local areas near the faults.

COAL GEOLOGY

Coal outcrop measured sections are concentrated in three areas: (1) the southwest part of the quadrangle in Bob Wright Canyon, (2) the central area, and (3) the western extension of the Spring Canyon area on the east

side of the quadrangle. The three coal beds which reach Reserve Base thickness in the quadrangle are the Hiawatha, Castlegate "A", and Bob Wright. The lowest of these is the Hiawatha coal bed which lies at the base of the Blackhawk Formation which rests on top of the Star Point Sandstone. In the central quadrangle area the Gordon coal bed lies from 60 to 100 ft (18 to 30 m) above the Hiawatha bed. Doelling (1972) suggests that the Gordon bed may correlate with the Union Pacific bed in Pleasant Valley to the west.

The Castlegate "A" coal bed occurs approximately 200 ft (61 m) above the Hiawatha bed, and lies on top of the Aberdeen Sandstone Member of the Blackhawk Formation. The bed is well developed in the Pleasant Valley area on the west side of the quadrangle. Beds above the Castlegate "A" are more lenticular and more difficult to correlate. Some of these are grouped in the Bob Wright coal zone which is well developed in the southwest corner of the quadrangle in Bob Wright Canyon. The lowest beds of this zone occur 75 to 105 ft (23 to 32 m) above the Castlegate "A". The zone may be divided into a lower, main, and upper part, each separated by noncoal intervals 3 to 25 ft (1 to 7.5 m) thick. A thin coal bed which may correlate with the Royal Blue coal bed in the Standardville and Helper quadrangles occurs between the Castlegate "A" bed and the lower Bob Wright bed.

The stratigraphic positions of these coal beds within the Blackhawk Formation are shown in the composite columnar section on plate 3. The coal data includes drill hole information and surface- and mine-measured sections.

Intervals reported as "bony coal," "bone," "shaly coal," or other similar terms in the data sources are shown as "rock" intervals in this report on plates 1 and 3. These intervals were not included in the coal thicknesses used to construct the coal isopach maps.

Chemical Analyses of the Coal

Doelling (1972) has summarized the analyses of 48 coal samples taken from the quadrangle in the following table. All but seven samples came from the Hiawatha coal bed.

Table 1. Average coal analyses, Northeast Quarter of the Scofield 15-Minute Quadrangle

	No. Analyses	As received (percent) Average	Range
	Hiawatha Bed		
Moisture	40	7.2	3.2-12.6
Volatile matter	25	41.3	37.3-44.4
Fixed carbon	35	44.6	39.7-49.1
Ash	38	6.5	2.9-11.5
Sulfur	28	0.56	0.4-0.87
Btu/lb*	38	12,114	10,550-13,078
	Castlegate "A" Bed		
Moisture	7	5.4	4.1-6.1
Volatile matter	5	43.7	42.2-44.2
Fixed carbon	5	44.9	43.9-45.9
Ash	7	5.9	4.7-7.0
Sulfur	7	0.45	0.39-0.60
Btu/lb*	5	12,686	12,330-12,840

* To convert Btu/lb to Kj/kg multiply by 2.326

Based on the above analyses, the coal is low sulfur and high-volatile bituminous B rank in both the Hiawatha and the Castlegate "A" beds. Details of these analyses, plus sulfur-type determinations and carbonization product yields are also reported by Doelling (1972). No analyses of coal samples from other beds were available.

Hiawatha Coal Bed

Spieker (1931) mapped the Hiawatha coal bed trace across the quadrangle. However, the bed is thin and undeveloped in and around Bob Wright Canyon but

it thickens to the northeast and reaches a thickness of over 10 ft (3 m) in the central part of the quadrangle. The coal isopach map (plate 12) shows that the bed exhibits an irregular lenticular thickening with the longest dimension of the lens oriented east-west. The bed is cut by numerous faults oriented north-south and northwest-southeast. There are very few rock or shale splits in the coal which is the most important bed in the quadrangle.

Castlegate "A" Coal Bed

The coal isopach map (plate 8) shows two areas where the Castlegate "A" bed is of Reserve Base thickness. In the southwest corner of the quadrangle the bed reaches a thickness of 10 ft (3 m) and in the central parts of the quadrangle it is up to 8 ft (2.4 m) thick.

The Castlegate "A" bed is the most valuable coal bed in the Pleasant Valley area in the adjoining 7½-minute quadrangle to the west where it ranges from less than 6 ft (1.8 m) to 19 ft (5.8 m) thick. East of Beaver Creek the bed is probably too thin to mine profitably (Doelling, 1972).

Bob Wright Coal Bed

The Bob Wright bed, or more rightly, beds of the Bob Wright coal zone, attain Reserve Base thickness in the southwest part of the quadrangle where the coal isopach map (plate 4) shows a maximum thickness of 17.8 ft (5.4 m). This represents the total coal in the zone and not a single bed. The zone generally consists of three coal beds with two noncoal intervals from 3 to 25 ft (1-7.5 m) separating them. The three coal beds occur approximately 45, 75, and 100 ft (14, 23, and 30 m) above the Castlegate "A" coal bed. The lower two beds are generally thicker than the upper one.

Gordon Coal Bed

The Gordon coal bed occurs in measured sections and drill holes in the central part of the quadrangle where it is generally less than 5 ft

(1.5 m) thick. However, a hole drilled in the SE¼ of Section 7, T. 13 S., R. 8 E. (index no. 48) encountered an 11.0 ft (3.4 m) thick coal bed that has been called the Gordon bed. An isolated data map was made for this bed for file purposes only. The Reserve Base tonnages for the bed are included in those shown on plate 2. Doelling (1972) has suggested that the Gordon bed may correlate with the Union Pacific bed in Pleasant Valley to the west of the quadrangle.

Local Coal Beds

Several lenticular coal beds of apparent limited extent occur in the quadrangle area. In most of the measured sections where they occur, the beds are less than 5 ft (1.5 m) thick and have not been correlated with any of the more persistent correlatable beds. See plates 1 and 3. However, there are three occurrences of local coal beds over 5 ft (1.5 m) thick on unleased Federal land. At index no. 13 a 6 ft (1.8 m) bed occurs approximately 50 ft (15 m) above the Bob Wright bed. At index no. 26 a 6.1 ft (1.9 m) bed occurs approximately 200 feet above the Castlegate "A" bed and at index no. 44 a 7.0 ft (2 m) bed occurs approximately 45 ft (13.7 m) above the Hiawatha bed. Isolated data maps of these three coal beds have been made for file purposes, but the Reserve Bases have been calculated for them to the extent of the "measured" category and included in the Reserve Base tonnages shown on plate 2.

MINING OPERATIONS

At least nine mines have been opened in the Gordon Creek area in the central part of the quadrangle, and mining in the adjacent quadrangle to the west has been extended into the southwest corner of the Northeast Quarter of the Scofield 15-minute quadrangle. The earliest mining began in 1925 and continued until the mid 1940's. In 1967 the Swisher Coal

Company reactivated the area and is now (1979) the only company actively mining in the quadrangle. Most of the coal mined in the quadrangle came from the Hiawatha and Castlegate "A" beds where a 35 to 40 percent recovery ability was experienced because of complex faulting (Doelling, 1972). Total production from the Gordon Creek area is between 5.3 and 5.5 million tons (1972).

Coal mine maps covering the Gordon Creek area were not available and therefore the mined-out areas are not shown on plate 1. However, Doelling (1972, p. 216) reports that "Most of the mining has taken place between the east edge of the North Gordon fault zone and the line between R. 7 and 8 E. and between the outcrops on the south and the first tier of sections in T. 13 S., R. 8 E. to the north."

In the southwest corner of the quadrangle at the head of Bob Wright Canyon, the Castlegate "A" coal bed was extensivley produced in the Clear Creek mines as shown on plate 1. The main entry ways to this mining area are at Clear Creek through the Pleasant Valley fault zone in the adjoining quadrangle to the west. The Clear Creek mines were operated by Utah Fuel Company, Pleasant Valley Coal Company, Independent Coal and Coke Company, and North American Coal Corporation. The mines were opened in 1899 and remained active until 1967.

Mining has also taken place on the east side of the quadrangle where it progressed from the Spring Canyon area of the Book Cliffs coal field in the adjoining Standardville quadrangle (Northwest Quarter of the Castle Gate 15-minute quadrangle). The extent of mining into the Northeast Quarter of the Scofield 15-minute quadrangle is unknown because of a lack of mine maps. The Spring Canyon Sub 2 coal bed was mined into the western parts of sections 11 and 14, T. 13 S., R. 8 E. It is not known if mining progressed farther than those two sections.

COAL RESOURCES

The principal sources of data for the construction of the isopach maps, structure contour maps and for the coal data map were Spieker (1931) and Doelling (1972). The logs of six coal test holes drilled by the U.S. Geological Survey and two coal companies were also utilized. All other recent drilling in the area is proprietary information and was not available to the present authors.

Coal resource tonnages were calculated for measured, indicated, and inferred categories in unleased areas of Federal coal land within the KRCRA boundary. Data obtained from the coal isopach maps (plates 4, 8, and 12) and plate 1 were used to calculate the Reserve Base values. The coal-bed acreage (measured by planimeter) where the coal bed is 5.0 ft (1.5 m) or more thick multiplied by the average isopached thickness of the coal bed times a conversion factor of 1,800 short tons of coal per acre-foot of bituminous coal yields the coal resources in short tons of coal for each isopached coal bed. Reserve Base and Reserve values for the Bob Wright, Castlegate "A", and Hiawatha beds are shown on plates 7, 11, and 15, and are rounded to the nearest tenth of a million short tons. The "reserve" values are based on a subsurface mining recoverability factor of 50 percent.

"Measured resources are computed from dimensions revealed in outcrops, trenches, mine workings, and drill holes. The points of observation and measurement are so closely spaced and the thickness and extent of coals are so well defined that the tonnage is judged to be accurate within 20 percent of true tonnage. Although the spacing of the points of observation necessary to demonstrate continuity of the coal differs from region to region according to the character of the coal beds, the points of observation are no greater

than ½ mile (0.8 km) apart. Measured coal is projected to extend as a ¼ mile (0.4 km) wide belt from the outcrop or points of observation or measurement.

"Indicated resources are computed partly from specified measurements and partly from projection of visible data for a reasonable distance on the basis of geologic evidence. The points of observation are 1/2 (0.8 km) to 1 1/2 miles (2.4 km) apart. Indicated coal is projected to extend as a 1/2-mile (0.8 km) wide belt that lies more than 1/4 mile (0.4 km) from the outcrop or points of observation or measurement.

"Inferred quantitative estimates are based largely on broad knowledge of the geologic character of the bed or region and where few measurements of bed thickness are available. The estimates are based primarily on an assumed continuation from Demonstrated coal for which there is geologic evidence. The points of observation are 1/2 (2.4 km) to 6 miles (9.6 km) apart. Inferred coal is projected to extend as a 2 1/4-mile (3.6 km) wide belt that lies more than 3/4 mile (1.2 km) from the outcrop or points of observation or measurement." (U.S. Bureau of Mines and U.S. Geological Survey, 1976).

Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 104.81 million short tons (95.08 million metric tons) for the unleased Federal coal lands within the KRCRA boundary in the quadrangle.

Reserve Base tonnages for four coal beds of limited areal extent were also calculated. These are the Gordon coal bed (index number 48 on plate 1) and three local coal beds (index numbers 13, 20, and 44 on plate 1). Isopach maps were not prepared for these beds and in table

2 below they are referred to collectively as non-isopached coal beds. The Reserve Base tonnages (in short tons) for each of these beds are:

Gordon bed: 6,900,000 short tons

Local bed (index number 13): 600,000 short tons

Local bed (index number 20): 400,000 short tons

Local bed (index number 44): 1,000,000 short tons

The Reserve Base tonnages shown in table 2 pertain to unleased Federal coal lands which lie within the KRCRA in the quadrangle.

AAA Engineering and Drafting, Inc. has not made any determination of economic mineability for any of the coal beds described in this report.

Table 2. Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Northeast Quarter of the Scofield 15-minute quadrangle, Carbon County, Utah.

(To convert short tons to metric tons, multiply by 0.9072)

Coal Bed Name	High development potential	Moderate development potential	Low development potential	Total
Bob Wright	51,800,000	10,000	0	51,810,000
Castlegate "A"	6,200,000	0	0	6,200,000
Hiawatha	31,100,000	6,800,000	0	37,900,000
Non-isopached Coal beds	8,100,000	800,000	0	8,900,000
Total	97,200,000	7,610,000	0	104,810,000

COAL DEVELOPMENT POTENTIAL

Development Potential for Surface Mining Methods

No development potential for surface mining methods exists in the area of this quadrangle because of the rugged topography, steep-sided

canyons, extreme relief, and thick overburden. There may be very small areas where some rim stripping could be done, but in general the area is not conducive to surface mining methods.

Development Potential for Subsurface Mining and In Situ Gasification

Areas of high, moderate, and unknown coal-development potential are shown on plate 16. Areas of high development potential are those which contain coal in beds 5 ft (1.5 m) or more thick at depths of 1,000 ft (305 m) or less. Areas where such beds are overlain by 1,000-2,000 ft (305-610 m) and 2,000-3,000 ft (610-914 m) of overburden are rated as having a moderate and a low development potential respectively. Areas of unknown coal development potential are those containing no known coal beds 5 ft (1.5 m) or more thick, but coal-bearing units are present in the area at depths of less than 3,000 ft (914 m). Areas where no coal beds are known to occur or where coal beds are present at depths greater than 3,000 ft (914 m) have no coal development potential. There are no areas of unleased Federal coal land within the KRCRA in the quadrangle that are known to fall within the "low" development potential classification.

The designation of a coal development potential classification is based on the occurrence of the highest-rated coal-bearing area that may occur within any fractional part of a 40-acre BLM land grid area or lot area of unleased Federal coal land. For example, a certain 40-acre area is totally underlain by a coal bed with a "moderate" development potential. If a small corner of the same 40-acre area is also underlain by another coal bed with a "high" development potential, the entire 40-acre area is given a "high" development potential rating even though most of the area is rated "moderate" by the lower coal bed. Another possibility is a 40-acre area devoid of any coal

except a small corner where a 5-ft (1.5 m) coal bed crops out. In this case the 40-acre area will have a "high" development potential rating.

The in situ coal gasification methods of development potential classification are based on the dip and depth of coal beds having a minimum thickness of 5 ft (1.5 m). There are only two development potential classifications--moderate and low. The criteria for in situ classification include coal bed dips of 15 to 90 degrees and coal bed depths of 200-3,000 ft (61-914 m). Inasmuch as the coal beds dip less than 15 degrees in the Northeast Quarter of the Scofield 15-minute quadrangle, the in situ coal gasification methods of development potential classification do no apply.

The following table summarizes and correlates the sources of data shown by index number on plates 1 and 3.

Table 3. Sources of data used on plate 1.

Source	Plate 1 Index Number	Data: Drill Hole or Measured Section No.	Data: Page or Plate No.
Doelling, H.H., 1972	1	11	214
	2	1, 2, 21	214
	3	15, 28, and 55	214 and 215
	4	22	214
	5	13, 24, and 84	214
	6	14 and 26	214
	7	27 and 54	214 and 215
	8	16 and 29	214
	9	17, 30, and 56	214 and 215
	10	31	214
	11	18	214
	12	19	214
	13	8, 20, and 70	214 and 215
	14	32, 48, and 58	214 and 215
	15	33	214
	16	2, 34, and 60	214 and 215
	17	71	215
	18	4	214
	19	5	214
	20	6, 35, and 61	214 and 215
	21	7, 36, and 62	214 and 215
	22	37	214
	23	63	215
	24	65	215
	25	64	215
	26	39 and 66	214 and 215
	27	67	215
	28	68	215
	29	69	215
	30	73	215
	31	72	215
	32	75	215
	33	76	215
	34	9, 40, and 74	214 and 215
	35	77	215
	36	41 and 49	214
	37	42	214
	38	51	214
	39	49 and 79	214 and 215
	40	43, 50, and 78	214 and 215
	41	80	215
	42	45 and 81	214 and 215
	43	46 and 82	214 and 215
	44	52 and 83	214 and 215
	45	85	215

Source	Plate 1 Index Number	Data Base: Drill Hole or Measured Section No.	Page or Plate No.
U.S. Geological Survey	46	Drill Hole W-BC-2-S	
	47	Drill Hole W-BC-3-S	
	50	Drill Hole W-BC-4-S	
	51	Drill Hole W-BC-5-S	
LMC Resources	48	Drill Hole LMC No. 1	
Blue Blaze Coal Co.	49	Drill Hole No. 3	

REFERENCES

American Society of Testing and Materials, 1977, Standard Specifications for classification of coals by rank, in Gaseous fuels, coal, and coke; atmospheric analysis: ASTM Publication D 388-77.

Clark, F. R., 1928, Economic geology of Castlegate, Wellington, and Sunnyside quadrangles, Carbon County, Utah: U.S. Geol. Survey Bull. 793.

Doelling, H. H., 1972, Wasatch Plateau coal field, in Doelling, H. H., Central Utah coal fields: Utah Geol. and Min. Survey Mon. Ser. No. 3.

Katich, P. J., Jr., 1954, Cretaceous and early Tertiary stratigraphy of central and south-central Utah with emphasis on the Wasatch Plateau area: Intermtn. Association of Petroleum Geologists Guidebook, 5th Ann. Field Conf.

Spieker, E. M., 1931, The Wasatch Plateau coal field, Utah: U.S. Geol. Survey Bull. 819.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geol. Survey Bull. 1450-B.

U.S. Department of Commerce, (1964), Normal annual precipitation in inches 1931-1960, State of Utah: U.S. Dept. of Commerce Weather Bureau Map WR-1210-A.