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COAL RESOURCE OCCURRENCE MAPS AND COAL DEVELOPMENT POTENTIAL MAPS OF THE SOUTHWEST QUARTER OF THE AZTEC 15-MINUTE QUADRANGLE, SAN JUAN COUNTY, NEW MEXICO

[Report includes 19 plates]

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INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps and Coal Development Potential (CDP) Map of the southwest quarter of the Aztec 15-minute quadrangle, San Juan County, New Mexico. These maps were compiled to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) of the western United States. The work was performed under contract with the Conservation Division of the U.S. Geological Survey (Contract No. 14-08-0001-17172).

The resource information gathered in this program is in response to the Federal Coal Leasing Amendments Act of 1976 and is a part of the U.S. Geological Survey's coal program. The information provides basic data on coal resources for land-use planning purposes by the Bureau of Land Management, state and local governments, and the public.

Location

The southwest quarter of the Aztec 15-minute quadrangle is in northeast San Juan County, New Mexico. The area is approximately 16 miles (26 km) northeast of Farmington; Aztec, New Mexico, is on the west-central border of the quadrangle.

Accessibility

The southwest quarter of the Aztec 15-minute quadrangle is accessible by New Mexico State Routes 550 and 44. Light-duty roads provide access to other parts of the quadrangle. The Atchison, Topeka, and Santa Fe Railway operates a route approximately 103 miles (166 km) south of the area which passes through Gallup, New Mexico.

Physiography

This quadrangle is in the northwestern portion of the Central Basin area (Kelley, 1950) of the structural depression known as the San Juan Basin. Elevations range from 5,640 ft (1,719 m) in the Animas River Valley to 6,788 ft (2,069 m) at Knickerbocker Peaks in the east. The Animas River flows southwest across the northwest corner of the area and is surrounded by low hills which are moderately dissected by canyons and arroyos.

Climate

The climate of the San Juan Basin is arid to semi-arid. Annual precipitation is usually less than about 10 inches (25 cm) but varies across the basin due to elevational differences. Rainfall is rare in the early summer or winter; most precipitation is received in July and August as intense afternoon thundershowers. Annual temperatures range from below 0°F (-18°C) to over 100°F (38°C) in the basin. Snowfall may occur from November to April.

Land Status

The quadrangle is in the north-central part of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 77 percent of the KRCRA land within the quadrangle as shown on Plate 2 of the Coal Resource Occurrence Maps. No Federal coal leases occur in the quadrangle.

GENERAL GEOLOGY

Previous Work

Reeside (1924) mapped the geology of the area on a scale of 1:250,000 as part of a study of the Upper Cretaceous and Tertiary formations of the San Juan Basin. A more recent publication by Fassett and Hinds (1971) includes subsurface interpretations of Fruitland Formation coal deposits throughout the San Juan Basin.

Geologic History

The San Juan Basin, an area of classic transgressive and regressive sedimentation, provided the ideal environment for formation of coals during Late Cretaceous time. At that time a shallow epeiric sea, which trended northwest-southeast, was northeast of the basin. The sea transgressed southwesterly into the basin area and regressed northeasterly numerous times;

consequently, sediments from varying environments were deposited across the basin. Noncarbonaceous terrestrial deposition predominated during Paleocene and Eocene time.

Depositional evidence of the final retreat of the Late Cretaceous sea is the nearshore regressive Pictured Cliffs Sandstone. Southwest (shoreward) of the beach deposits, swamps, which were dissected by streams, accumulated organic matter which became coals of the Fruitland Formation. Deposition of organic material was influenced by the strandline as shown by both the continuity of the coal beds parallel to the north-south strandline in this part of the basin and their discontinuity perpendicular to it to the east. The less continuous Fruitland coals appear to be noncorrelative, but are stratigraphically equivalent in terms of their relative position within the Fruitland Formation.

The brackish-water swamp environment of the Fruitland moved northeast of the quadrangle as the regression continued in that direction. Terrestrial freshwater sediments then covered the area as indicated by the lacustrine, channel, and floodplain deposits of the Kirtland Shale. This sequence of events is evidenced by both an upward decrease in occurrence and thickness of Fruitland coals and a gradational change to noncarbonaceous deposits of the Kirtland. Continuous deposition during Late Cretaceous time ended with the Kirtland. The sea then retreated beyond the limits of the quadrangle area, and modern basin structure began to develop. An erosional unconformity developed in a relatively short time as part of the Cretaceous Kirtland Shale was removed.

Terrestrial deposition resumed in the Paleocene as represented by the Ojo Alamo Sandstone and the overlying Nacimiento Formation. Alluvial plain and floodplain deposits of the Ojo Alamo were followed by the thick, lithologically varied deposits of the Nacimiento during continuous nonmarine deposition. The Nacimiento was later exposed to erosion.

The Eocene San Jose Formation was subsequently deposited over the Nacimiento erosional surface, reflecting various nonmarine environments which developed across the basin. Deposition and structural deformation of the basin then ceased, and the warped strata of the San Juan Basin have been exposed to the present time.

Stratigraphy

The formations studied in this quadrangle range from Late Cretaceous to Eocene in age. They are, in order from oldest to youngest: the Pictured Cliffs Sandstone, Fruitland Formation, Kirtland Shale, Ojo Alamo Sandstone, Nacimiento Formation, and the San Jose Formation. A composite columnar section on CRO Plate 3 illustrates the stratigraphic relationships of these formations and is accompanied by lithologic descriptions of the individual formations.

The Pictured Cliffs Sandstone averages 125 ft (38 m) thick. Because the unit is present throughout most of the San Juan Basin and easily recognized on geophysical logs, the top was picked as the datum (CRO Plate 3) for Fruitland coal correlations. The formation consists of a light gray, calcareous, argillaceous sandstone and interbedded gray, micaceous, fissile shale. Intertonguing with the overlying Fruitland Formation occurs throughout the entire basin, and, consequently, minor Fruitland coal beds are commonly present in the upper portion of the Pictured Cliffs.

The major coal-bearing unit in the quadrangle is the Fruitland Formation. Wide variations in the reported thickness of the Fruitland are common due to an indistinct upper contact with the Kirtland Shale, but the average is about 370 ft (113 m) in this quadrangle. Many authors have utilized various criteria for establishing the upper contact, but, in general, for this study the uppermost coal was chosen (after Fassett and Hinds, 1971). The formation consists primarily of gray, carbonaceous shale with plant fossils and local siderite nodules, interbedded light gray, calcareous sandstone and siltstone, and lenticular coal beds.

The Upper Cretaceous Kirtland Shale conformably overlies the Fruitland Formation and averages 890 ft (271 m) in thickness in this area. It consists predominantly of freshwater, gray to gray-green siltstone with plant fossils and sandy stringers, interbedded buff to light gray-green, slightly calcareous sandstone, and minor beds of the many variations between shale and sandstone. The formation has previously been divided into several members by various authors; however, for the purposes of this report it was not necessary to distinguish between the individual members.

The Paleocene Ojo Alamo Sandstone, which unconformably overlies the Kirtland Shale, is a buff to gray, medium-grained to conglomeratic, micaceous sandstone with angular to subangular grains, and interbedded thin, gray, silty, micaceous shale. It averages 120 ft (37 m) in thickness in this area.

Approximately 1,180 ft (360 m) of the Paleocene Nacimiento Formation overlie the Ojo Alamo Sandstone. These rocks are exposed across most of the quadrangle where they consist of buff to gray, fine-grained to conglomeratic, locally calcareous sandstone and interbedded gray to gray-green, locally silty, micaceous shale.

The San Jose Formation of Eocene age unconformably overlies the Nacimiento Formation and crops out in the east-central part of the quadrangle area. It is predominantly yellow-brown to gray claystone and interbedded sandstone and shale.

Structure

The southwest quarter of the Aztec 15-minute quadrangle is in the Central Basin area (Kelley, 1950) of the San Juan Basin. The axis of the basin is about 3 miles (5 km) northeast of the quadrangle area and trends in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). Reeside (1924) has stated that rocks in this area are "nearly horizontal."

COAL GEOLOGY

Four coal beds (Fruitland 1, Fruitland 2, Fruitland 3, Fruitland 4) and a coal zone (Fruitland) were identified in the subsurface of this quadrangle (CRO Plate 1). The Fruitland 1 (Fr 1) coal bed is defined by the authors as the lowermost coal of the Fruitland Formation; it is generally directly above the Pictured Cliffs Sandstone. The Fruitland 2 (Fr 2) coal bed is above the Fruitland 1; they are separated by a rock interval of 46 to 120 ft (14.0-36.6 m). The Fruitland 3 (Fr 3) coal bed overlies the Fruitland 2, and they are separated by a rock interval of 20 to 57 ft (6.1-17.4 m). The Fruitland 4 (Fr 4) coal bed is separated from the overlying Fruitland 3 by a rock interval of 12 to 70 ft (3.7-21.3 m). Noncorrelative and discontinuous coal beds in the Fruitland Formation or Pictured Cliffs Sandstone (due to intertonguing of the two formations) are designated as local (L) coals (CRO Plate 3). Although the Fruitland 1, Fruitland 2, Fruitland 3, and Fruitland 4 coal beds have been correlated and mapped as consistent horizons, each may actually be several different coal beds that are lithostratigraphically equivalent but not laterally continuous.

The remaining coals in the upper portion of the Fruitland Formation are designated as the Fruitland coal zone (Fr zone). These coals are generally noncorrelative and less than reserve base thickness (5 ft [1.5 m]); an exception is a 5-ft (1.5-m) coal bed in drill hole 28. Due to these characteristics, derivative maps were not constructed.

Fruitland Formation coals in the central part of the San Juan Basin are considered high volatile A bituminous in rank. The rank has been determined on a moist, mineral-matter-free basis with calorific values averaging 14,833 Btu's per pound (34,502 kj/kg) (Amer. Soc. for Testing and Materials, 1977). The coal is hard, brittle, and black with a bright luster. The coal readily slakes with exposure to weather; however, it stocks fairly well when protected. The "as received" analyses indicate moisture content varying from 1.4 to 2.6 percent, ash content ranging from 9.8 to 20.4 percent, sulfur content of 0.5 to 2.2 percent, and heating values on the order of 12,358 Btu's per pound (28,745 kj/kg). Analyses of several Fruitland Formation coals are given in Table 1 (Bauer and Reeside, 1921; Dane, 1936; Fassett and Hinds, 1971).

TABLE 1

Analyses of coal samples from the Fruitland Formation

(Form of analysis: A, as received; B, moisture free; C, moisture and ash free)

U.S. Bureau Mines Lab No.	Well or Other Source	Location Section	T.N.	R.W.	Approx. Depth Interval of Sample (ft.)	Form of Analysis	Proximate, percent Moisture	Volatile matter	Fixed Carbon	Ash	Sulfur	Heating Value (Btu)	Remarks
H-13061	Aztec Oil & Gas	SW¼ 17	28	9	1,985-1,990	A	1.4	36.1	42.1	20.4	0.8	11,670	
	Reid No. 23-D					B	---	36.6	42.7	20.7	0.8	11,830	
						C	---	46.2	53.8	---	1.0	14,920	
H-5472	Aztec Oil & Gas	NW¼ 16	28	10	1,842-1,853	A	1.6	38.4	40.7	19.3	0.6	11,760	
	Caine No. 13					B	---	39.0	41.4	19.6	0.6	11,950	
						C	---	48.5	51.5	---	0.8	14,870	
H-12704	Redfern & Herd	SW¼ 10	28	11	1,490-1,500	A	2.1	39.8	43.4	14.7	0.6	12,190	
	Redfern & Herd No. 5					B	---	40.7	44.3	15.0	0.6	12,460	
						C	---	47.9	52.1	---	0.7	14,670	
H-16310	Aztec Oil & Gas	SW¼ 30	29	9	1,985-2,005	A	1.6	41.1	46.6	10.7	0.7	13,310	
	Cain No. 16-D					B	---	41.7	47.5	10.8	0.7	13,520	
						C	---	46.8	53.2	---	0.7	15,160	
H-27541	Aztec Oil & Gas	SW¼ 5	29	10	2,065-2,080	A	2.3	39.1	42.1	16.5	1.9	12,020	
	Grenier "B" No. 3					B	---	40.0	43.1	16.9	2.0	12,300	
						C	---	48.1	51.9	---	2.4	14,800	
H-27540	Aztec Oil & Gas	SW¼ 5	29	10	2,150-2,160	A	2.0	40.6	47.6	9.8	0.5	13,300	
	Grenier "B" No. 3					B	---	41.4	48.6	10.0	0.5	13,560	
						C	---	46.0	54.0	---	0.6	15,070	
H-3028	International Oil	NW¼ 9	29	11	1,905-1,910	A	1.8	39.9	43.9	14.4	0.7	12,360	
	Fogeleon No. 1-9					B	---	40.6	44.8	14.6	0.7	12,590	
						C	---	47.6	52.4	---	0.8	14,750	
H-13060	Tidewater	SE¼ 12	29	11	2,065-2,070	A	2.1	38.7	47.9	11.3	0.6	12,830	
	N.M.-Fed. No. 12-E					B	---	39.5	48.9	11.6	0.6	13,100	
						C	---	44.7	55.3	---	0.7	14,820	

TABLE 1 (Continued)

Analyses of coal samples from the Fruitland Formation

(Form of analysis: A, as received; B, moisture free; C, moisture and ash free)

U.S. Bureau Mines Lab No.	Well or Other Source	Location			Approx. Depth Interval of Sample (ft.)	Form of Analysis	Proximate, percent					Heating Value (Btu)	Remarks
		Section	T.N.	R.W.			Moisture	Volatile matter	Fixed Carbon	Ash	Sulfur		
H-35925	El Paso Nat. Gas Turner No. 3	SE¼ 28	30	9	2,385-2,390	A	1.5	39.9	45.5	13.1	2.2	12,960	
						B	---	40.5	46.2	13.3	2.2	13,150	
						C	---	46.7	53.3	----	2.5	15,170	
H-19882	El Paso Nat. Gas Ludwick No. 20	SW¼ 29	30	10	2,340-2,360	A	2.3	33.1	39.9	24.7	0.7	10,800	
						B	---	33.9	40.9	25.2	0.7	11,060	
						C	---	45.3	54.7	----	0.9	14,790	
H-19883	El Paso Nat. Gas Ludwick No. 20	SW¼ 29	30	10	2,505-2,515	A	2.6	41.7	44.5	11.2	0.6	13,080	
						B	---	42.9	45.6	11.5	0.6	13,420	
						C	---	48.4	51.6	----	0.7	15,160	
H-13062	Aztec Oil & Gas Ruby Jones No. 1	NE¼ 7	30	11	2,020-2,030	A	1.4	37.2	44.1	17.3	0.6	12,010	
						B	---	37.7	44.8	17.5	0.6	12,180	
						C	---	45.7	54.3	----	0.7	14,770	

To convert Btu's/lb by kj/kg, multiply Btu's/lb by 2.326.
To convert feet to meters, multiply feet by 0.3048.

Fruitland 1 Coal Bed

The coal bed has been mapped only in areas with less than 3,000 ft (914 m) of overburden (the study limit). As indicated by the structure contour map (CRO Plate 5), the coal bed dips less than 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 6) varies from less than 2,000 ft (610 m) in the extreme southwest in Bloomfield Canyon and in the area of the Animas River to greater than 3,000 ft (914 m) in the vicinity of Knickerbocker Peaks in the eastern part of the quadrangle. The isopach map (CRO Plate 4) illustrates that the coal bed has a thickness of greater than 20 ft (6.1 m) in the northwest and, in general, decreases in thickness in all directions. The coal is absent in portions of the central and eastern parts of the quadrangle.

Chemical Analyses of the Fruitland 1 Coal Bed - Analyses of several coals of the Fruitland Formation from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 2 Coal Bed

The coal bed has been mapped only in areas with less than 3,000 ft (914 m) of overburden (the study limit). As indicated by the structure contour map (CRO Plate 9), the coal bed dips less than 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 10) varies from less than 2,000 ft (610 m) in the southwest at Bloomfield Canyon and in the Animas River area to greater than 3,000 ft (914 m) in the Knickerbocker Peaks region. The isopach map (CRO Plate 8) illustrates that the coal bed has a thickness of greater than 5 ft (1.5 m) in the southwest of the quadrangle. In general, the coal bed decreases in thickness in all directions, and the coal is absent in parts of the north-northwest, east-central, and southeast, and in small areas in the extreme southwest and northeast.

Chemical Analyses of the Fruitland 2 Coal Bed - Analyses of several coals of the Fruitland Formation from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 3 Coal Bed

The coal bed has been mapped only in areas with less than 3,000 ft (914 m) of overburden (the study limit). As indicated by the structure contour map (CRO Plate 13), the coal bed dips less than 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 14) varies from less than 2,000 ft (610 m) in the southwest in Bloomfield Canyon and in the Animas River Valley to greater than 3,000 ft (914 m) at Knickerbocker Peaks and in the eastern part of the quadrangle. The isopach map (CRO Plate 12) illustrates that the coal bed has a thickness of greater than 5 ft (1.5 m) in the east and in a small area in the southwest. The coal bed decreases in thickness in all directions, and the coal is absent in parts of the north, west, and south of the quadrangle area.

Chemical Analyses of the Fruitland 3 Coal Bed - Analyses of several coals of the Fruitland Formation from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 4 Coal Bed

The coal bed has been mapped only in areas with less than 3,000 ft (914 m) of overburden (the study limit). As indicated by the structure contour map (CRO Plate 17), the coal bed dips less than 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 18) varies from less than 1,900 ft (579 m) in Bloomfield Canyon and the Animas River Valley to greater than 3,000 ft (914 m) at Knickerbocker Peaks and a small area in the east. The isopach map (CRO Plate 16) illustrates that the coal bed has a thickness of greater than 15 ft (4.6 m) in the east-central part of the quadrangle and decreases in thickness to the west. The coal is absent in the northwest and in several small areas throughout the quadrangle.

Chemical Analyses of the Fruitland 4 Coal Bed - Analyses of several coals of the Fruitland Formation from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

COAL RESOURCES

Coal resource data from oil and gas wells and pertinent publications were utilized in the construction of isopach and structure contour maps of coals in this quadrangle. All of the coals studied in the southwest quarter of the Aztec 15-minute quadrangle are more than 200 ft (61 m) below the ground surface and, thus, have no outcrop or surface development potential.

The U.S. Geological Survey designated the Fruitland 1, Fruitland 2, Fruitland 3, and Fruitland 4 coal beds for the determination of coal resources in this quadrangle. Coals of the Fruitland zone were not evaluated because they are discontinuous, noncorrelative, and generally less than the reserve base thickness (5 ft [1.5 m]).

For Reserve Base and Reserve calculations, each coal bed was areally divided into measured, indicated, and inferred resource categories (CRO Plates 7, 11, and 15) according to criteria established in U.S. Geological Survey Bulletin 1450-B. Data for calculation of Reserve Base and Reserves for each category were obtained from the respective coal isopach (CRO Plates 4, 8, 12, and 16) and areal distribution maps (CRO Plates 7, 11, and 15) for each coal bed. The surface area of each isopached bed was measured by planimeter, in acres, for each category, then multiplied by both the average isopached thickness of the coal bed and 1,800 short tons of coal per acre-foot (13,239 tons/hectare-meter), the conversion factor for bituminous coal. This yields the Reserve Base coal, in short tons, for each coal bed.

In order to calculate Reserves, a recovery factor of 50 percent was applied to the Reserve Base tonnages for underground coal. However, in areas of underground coal exceeding 12 ft (3.7 m) in thickness, the Reserves (mineable coal) were calculated on the basis of a maximum coal bed thickness of 12 ft (3.7 m), which represents the maximum economically mineable thickness for a single coal bed in this area by current underground mining technology.

Reserve Base and Reserve values for measured, indicated, and inferred categories of coal for the Fruitland 1, Fruitland 2 and Fruitland 4, and Fruitland 3 beds are shown on CRO Plates 7, 11, and 15, respectively, and are rounded to the nearest hundredth of a million short tons. The total coal Reserve Base, by section, is shown on CRO Plate 2 and totals approximately 374 million short tons (339 million metric tons).

The coal development potential for each bed was calculated in a manner similar to the Reserve Base, from planimetered measurements, in acres, for areas of high, moderate, and low potential for subsurface mining methods. The southwest quarter of the Aztec 15-minute quadrangle has development potential for subsurface mining methods only (CDP Plate 19).

COAL DEVELOPMENT POTENTIAL

Coal beds of 5 ft (1.5 m) or more in thickness which are overlain by 200 to 3,000 ft (61-914 m) of overburden are considered to have potential for underground mining and are designated as having high, moderate, or low development potential according to the overburden thickness: 200 to 1,000 ft (61-305 m), high; 1,000 to 2,000 ft (305-610 m), moderate; and 2,000 to 3,000 ft (610-914 m), low. Table 2 summarizes the coal development potential, in short tons, for underground coal of the Fruitland 1, Fruitland 2, Fruitland 3, and Fruitland 4 coal beds.

Development Potential for Surface Mining Methods

All coals studied in the southwest quarter of the Aztec 15-minute quadrangle occur more than 200 ft (61 m) below the ground surface and, thus, they have no coal development potential for surface mining methods.

Development Potential for Subsurface Mining Methods

Underground coal of the Fruitland 1, Fruitland 2, and Fruitland 3 coal beds has moderate development potential in the southwestern part of the

TABLE 2

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS (in short tons) IN THE SOUTHWEST QUARTER OF THE AZTEC 15-MINUTE QUADRANGLE, SAN JUAN COUNTY, NEW MEXICO

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

Coal Bed	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Fruitland 4	--	--	46,820,000	46,820,000
Fruitland 3	--	80,000	77,970,000	78,050,000
Fruitland 2	--	2,400,000	3,520,000	5,920,000
Fruitland 1	--	530,000	242,770,000	243,300,000
TOTAL	--	3,010,000	371,080,000	374,090,000

quadrangle (CDP Plate 19) where the coal bed thicknesses are 5 to 10 ft (1.5-3.0 m) for the Fruitland 1 (CRO Plate 4) and 5 ft (1.5 m) for the Fruitland 2 and Fruitland 3 (CRO Plates 8 and 12), and overburden thickness values are 2,000 ft (610 m) for the Fruitland 1 (CRO Plate 6), 1,940 to nearly 2,000 ft (591-610 m) for the Fruitland 2 (CRO Plate 10), and 1,900 ft (579 m) for the Fruitland 3 (CRO Plate 14).

The Fruitland 1, Fruitland 2, Fruitland 3, and Fruitland 4 coal beds each have low development potential in the quadrangle area. The Fruitland 1 has low potential in the northern part of the quadrangle as well as in the southwest and southeast. The coal bed thickness in these areas varies from 5 ft (1.5 m) to more than 20 ft (6.1 m) in the northwest (CRO Plate 4), and the overburden thickness increases from 2,000 ft (610 m) in the southwest to 3,000 ft (914 m) in the northeast (CRO Plate 6). Coal of the Fruitland 2 with low development potential is limited to one small area in the northeast (refer to CRO Plate 11) where the coal is approximately 5 ft (1.5 m) thick (CRO Plate 8), and the overburden ranges from 2,575 ft (785 m) to about 2,730 ft (832 m) thick (CRO Plate 10).

The Fruitland 3 and Fruitland 4 coal beds have low development potential in the eastern part of the quadrangle area. The thickness of the Fruitland 3 varies from 5 to 9 ft (1.5-2.7 m) (CRO Plate 12) and that of the Fruitland 4 ranges from 5 to 15 ft (1.5-4.6 m) (CRO Plate 16) in the low potential areas; overburden thicknesses are 2,000 to 3,000 ft (610-914 m) (CRO Plate 14) and 2,400 to 3,000 ft (732-914 m) (CRO Plate 18), respectively.

The central and south-central parts of the quadrangle have unknown development potential and include areas where the thickness of the individual coal beds is less than 5 ft (1.5 m) and areas outside the 3,000-foot (914-m) overburden study limit of each coal bed.

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