UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

Open-File Report 79-099

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE STACEY QUADRANGLE, POWDER RIVER COUNTY, MONTANA

[Report includes 25 plates]

By

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To convert	Multiply by	To obtain
feet	0.3048	meters (m)
miles	1.609	kilometers (km)
acres	0.40469	hectares (ha)
tons (short)	0.907	metric tons (t)
short tons/acre-ft	7.36	metric tons/hectare-meter (t/ha-m)
Btu/lb	2.326	kilojoules/kilogram (kJ/kg)

INTRODUCTION

Purpose

This text is for use in conjunction with the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Stacey quadrangle, Powder River County, Montana, (25 plates; U.S. Geological Survey Open-File Report 79-099). This set of maps was compiled to support the land planning work of the Bureau of Land Management in response to the Federal Coal Leasing Amendments Act of 1976, and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRAs) in the western United States. Coal beds considered in the resource inventory are only those beds 5 feet (1.5 m) or more thick and under less than 3,000 feet (914 m) of overburden.

Location

The Stacey 7 1/2-minute quadrangle is in northwestern Powder River County, Montana, about 44 miles (71 km) south-southwest of Miles City, a town in the Yellowstone River valley of eastern Montana. Miles City is on U.S. Interstate Highway 94 and the main east-west routes of the Burlington Northern Railroad and the Chicago, Milwaukee, St. Paul, and Pacific Railroad.

Accessibility

The quadrangle is accessible from Miles City, Montana, by going south on U.S. Highway 312 a distance of 51 miles (82 km) to the graveled Little Pumpkin Creek Road, and then west and southwest on this road 13 miles (21 km) to the eastern edge of the quadrangle. The Little Pumpkin Creek Road continues southwestward to intersect U.S. Highway 212 12 miles (19 km) southwest of the quadrangle. A number of unimproved roads and trails intersect the Little Pumpkin Creek Road to give access to the interior of the quadrangle. The nearest railroad is about 28 miles (45 km) west-northwest at the Big Sky coal mine in the

Colstrip SE quadrangle. A railroad spur connects the mine with the main line of the Burlington Northern Railroad about 35 miles (56 km) farther north.

Physiography

The Stacey quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The upland plateau surface, however, has been completely dissected. Little Pumpkin Creek and its tributaries drain all except the westernmost one to two tiers of sections, which are drained by tributaries of Beaver, Otter, and Liscom Creeks that flow westward into the Tongue River. Little Pumpkin Creek has a flood plain about 0.3 mile (0.5 km) wide. A few square miles near the northeast corner of the quadrangle have moderate relief. The remainder of the quadrangle's surface is rugged and mainly forested. Liscom Butte, in the northwestern part of the quadrangle, on the drainage divide between tributaries of the Tongue River and Little Pumpkin Creek is the highest point in the quadrangle with an elevation of 4,341 feet (1,323 m). Liscom Butte is an erosional remnant capped by reddish-colored, baked rock formed by the burning of a coal bed. Lower resistant clinker beds have produced a series of benches or great steps which are floored by the baked rock. Below each clinker rim or ledge is a steep slope, and below this a more gentle slope toward the next lower bench. The lowest elevation, about 3,250 feet (991 m), is on Little Pumpkin Creek at the eastern edge of the quadrangle. Topographic relief is about 1,090 feet (332 m).

Climate

The climate of Powder River County is characterized by pronounced variations in seasonal precipitation and temperature. Annual precipitation in the region varies from less than 12 inches (30 cm) to 16 inches (41 cm). The heaviest precipitation is from April to August. The largest average monthly precipitation is during June. Temperatures in eastern Montana range from as low as

-50°F (-46°C) to as high as 110°F (43°C). The highest temperatures occur in July and the lowest in January; the mean annual temperature is about 45°F (7°C) (Matson and Blumer, 1973, p. 6).

Land status

The Northern Powder River Basin Known Recoverable Coal Resource Area (KRCRA) covers the entire quadrangle except for a very small area near the northeast corner of the quadrangle. The Boundary and Coal Data Map (pl. 2) shows the location of the KRCRA tracts and the land ownership status. There were no outstanding Federal coal leases or prospecting permits recorded as of 1977.

GENERAL GEOLOGY

Previous work

Bass (1932) mapped the Stacey quadrangle as part of the Ashland coal field, Rosebud, Powder River, and Custer Counties, Montana. Gilmour and Williams (1969) mapped the northeast quarter of the quadrangle as part of the Foster Creek coal deposit. Matson and Blumer (1973) mapped most of the quadrangle as part of the Little Pumpkin Creek coal deposit in their summary of strippable coal, southeastern Montana.

Stratigraphy

A generalized columnar section of the coal-bearing rocks is shown on the Coal Data Sheet (pl. 3) of the CRO maps. The exposed bedrock units belong to the upper member of the Paleocene Fort Union Formation, the Tongue River Member.

The Tongue River Member is made up mainly of yellow sandstone, sandy shale, carbonaceous shale, and coal. Much coal has burned along outcrops, baking the overlying sandstone and shale and forming thick, reddish-colored clinker beds. The uppermost part of the Tongue River Member has been removed by erosion, but about 1,300 to 1,400 feet (396 to 427 m) remains.

Coal and other rocks comprising the Tongue River Member were deposited in a continental environment at elevations of perhaps a few tens of feet (a few meters) above sea level in a vast area of shifting flood plains, sloughs, swamps, and lakes that occupied the Northern Great Plains in Paleocene (early Tertiary) time.

Representative samples of the sedimentary rocks overlying and interbedded with minable coal beds in the eastern and northern Powder River Basin have been analyzed for the trace element content by the U.S. Geological Survey and the results summarized by the U.S. Department of Agriculture and others (1974) and by Swanson (in Mapel and others, 1977, pt. A, p. 42-44). The rocks contain no greater amounts of trace elements of environmental concern than do similar rock types found throughout other parts of the western United States.

Structure

The Stacey quadrangle is in the northeastern part of the Powder River structural basin. The strata in general dip southward or southwestward at an angle of less than 1 degree. In places the regional structure is modified by low-relief folds, as shown by the structure contour maps on top of the coal beds, (pls. 4, 7, 10, 14, 19, and 22). Some of the nonuniformity in structure may be due to differential compaction and to irregularities in deposition of the coals and other beds as a result of their continental origin.

COAL GEOLOGY

The coal beds in the Stacey quadrangle are shown in outcrop on the Coal Data Map (pl. 1) and in section on the Coal Data Sheet (pl. 3). All the coal beds belong to the Tongue River Member of the Fort Union Formation.

The lowermost of the beds is the Terret coal bed which lies 140 to 200 feet (43 to 61 m) above the base of the Tongue River Member. The Terret coal bed is

overlain by a noncoal interval of about 280 feet (85 m), the Knobloch coal bed, a noncoal interval of about 120 feet (37 m), the Lower Sawyer coal bed, a noncoal interval of about 15 to 40 feet (4.6 to 12 m), the Upper Sawyer coal bed, a noncoal interval of about 25 feet (7.6 m), a local coal bed, a noncoal interval of about 75 feet (23 m), the C coal bed, a noncoal interval of about 20 to 25 feet (6.1 to 7.6 m), the D coal bed, a noncoal interval of about 30 feet (9 m), a local coal bed, a noncoal interval of about 30 feet (9 m), the X coal bed, a noncoal interval of about 40 feet (12 m), a local coal bed, a noncoal interval of 15 to 40 feet (4.6 to 12 m), the E coal bed, a noncoal interval of about 50 feet (15 m), a local coal bed, a noncoal interval of about 190 feet (58 m), another local coal bed, a noncoal interval of about 90 feet (27 m), the Ferry coal bed, a noncoal interval of about 220 feet (67 m), and the Garfield clinker, formed by the burning of the Garfield coal bed.

The coal found along the eastern flank of the Powder River Basin in Montana increases in rank from lignite in the east to subbituminous in the deeper parts of the basin to the west. All coal analyses available at the present time from this and adjacent quadrangles were considered in our decision to assign a rank of subbituminous C to the coal in this quadrangle. The lignite-subbituminous boundary may fall somewhere within the eastern part of this quadrangle, but not enough data are presently known to allow our drawing that boundary line with certainty. Therefore, a rank of subbituminous C has been arbitrarily assigned by us to all of the coal in the entire quadrangle. Additional data to be obtained in the future may make a more precise determination of the location of this boundary line possible.

The trace element content of coals in this quadrangle has not been determined; however, coals in the Northern Great Plains, including those in the Fort

Union Formation in Montana, have been found to contain, in general, appreciably lesser amounts of most elements of environmental concern than coals in other areas of the United States (Hatch and Swanson, 1977, p. 147).

Terret coal bed

The Terret coal bed was described by Bass (1932, p. 51) from a small mine on the Terret Ranch in the Ashland coal field in the Cook Creek Reservoir quadrangle which is about 6 miles (9.6 km) to the west of the Stacey quadrangle. The Terret coal bed lies 140 to 200 feet (43 to 61 m) above the base of the Tongue River Member. The coal bed does not crop out within the quadrangle and has not been penetrated in drill holes. The Terret coal bed has been projected into the northern part of the quadrangle based on our mapping in the adjacent quadrangles. As shown by the isopach and structure contour map (pl. 22) the Terret coal bed is believed to range from less than 4 feet (1.2 m) to more than 8 feet (2.4 m) in thickness and to dip southeastward at an angle of less than 1 degree. Overburden on the Terret coal bed (pl. 23) ranges in thickness from about 500 to about 1,300 feet (152 to 396 m) where the bed is more than 5 feet (1.5 m) thick.

A chemical analysis of the Terret coal from depths of 197 to 208 feet (60 to 63.4 m) in drill hole FC-28 (sec. 21, T. 1 N., R. 47 E.) in the North Stacey School quadrangle, about 5 miles (8 km) north of the Stacey quadrangle shows ash 6.25 percent, sulfur 0.24 percent, and a heating value of 7,860 Btu per pound (18,280 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 86). This heating value converts to a heating value of about 8,380 Btu per pound (19,490 kJ/kg) on a moist, mineral-matter-free basis, indicating that the coal is subbituminous C in rank. Because this location is close to the Stacey quadrangle and has a similar position in the basin, it is assumed that the Terret coal in the Stacey quadrangle is similar and is likewise subbituminous C in rank.

Flowers-Goodale coal bed

The Flowers-Goodale coal bed was described by Bass (1932, p. 53) from two small coal mines in the Brandenberg quadrangle about 9 miles (15 km) northwest of the Stacey quadrangle. Normally this bed lies 50 to 100 feet (15 to 30 m) above the Terret coal bed. However, the Flowers-Goodale coal bed does not crop out in the Stacey quadrangle, nor has it been recognized in drill holes. The coal bed has been measured in quadrangles to the west and north; a regional isopach map indicates that if it is present in the Stacey quadrangle it is probably less than 5 feet (1.5 m) thick. Because of the lack of data and the inferred thinness of the Flowers-Goodale coal bed, it has not been mapped in the Stacey quadrangle.

Knobloch coal bed

The Knobloch coal bed was named by Bass (1924). The name of the coal bed was taken from the Knobloch Ranch and coal mine in the Birney Day School quadrangle about 20 miles (32 km) southwest of the Stacey quadrangle. The Knobloch coal bed in the vicinity of this quadrangle lies about 280 feet (85 m) above the Terret coal bed. The Knobloch coal bed crops out only in the extreme northeast corner of the Stacey quadrangle, but it has been penetrated in drill holes. The isopach and structure contour map (pl. 19) indicates that the Knobloch coal bed ranges in thickness from about 12 to about 46 feet (3.7 to 14 m), generally increasing in thickness southwestward and has a dip of less than 1 degree southward interrupted by broad, gentle, southward-plunging folds. Overburden on the Knobloch coal bed ranges in thickness from zero at the outcrop in the northeast corner of the quadrangle to almost 1,000 feet (305 m).

There is no publicly available chemical analysis of the Knobloch coal in the Stacey quadrangle. The closest analyzed coal is from drill hole SH-7080, sec. 34, T. 1 S., R. 46 E., in the Beaver Creek School quadrangle, about 2 miles

(3.2 km) west of the Stacey quadrangle. An analysis of the Knobloch coal from a depth of 85 to 95 feet (26 to 29 m) in this drill hole shows ash 7.501 percent, sulfur 0.016 percent, and a heating value of 7,933 Btu per pound (18,452 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 121). This heating value converts to 8,576 Btu per pound (19,948 kJ/kg) on a moist, mineral-matter-free basis, indicating that the coal at this location is subbituminous C in rank. Because of the proximity of this location to the Stacey quadrangle, it is assumed that the Knobloch coal in the Stacey quadrangle is similar and is also subbituminous C in rank.

Sawyer coal bed

The Sawyer coal bed was described by Dobbin (1930, p. 28) after exposures in the foothills of the Little Wolf Mountains in the Forsyth coal field (Rough Draw and Black Spring quadrangles) about 37 miles (59 km) west of the Stacey quadrangle. Throughout the Stacey quadrangle the Sawyer coal is split into two beds that are 30 to 40 feet (9.1 to 12.2 m) apart. These beds crop out along Little Pumpkin Creek and its tributaries in the northeastern part of the quadrangle and underlie the remainder of the quadrangle. As shown by the isopach map (pl. 13) the Upper Sawyer coal bed ranges from about 4 feet to 22 feet (1.2 to 6.7 m) in thickness, and the Lower Sawyer coal bed ranges from about 2 to 31 feet (0.6 to 9.4 m) in thickness. The structure contour map of the Sawyer coal beds (pl. 14) shows that the beds dip southward at an angle of less than 1 degree, although this regional dip is modified by minor folds. Overburden on the Upper Sawyer coal bed (pl. 15) ranges in thickness from zero at the outcrops to about 800 feet (244 m).

There is no known publicly available chemical analysis of the Sawyer coal in the Stacey quadrangle. An analysis of the Sawyer coal in drill hole SH-7064, sec. 8, T. 3 S., R. 46 E., in the Coleman Draw quadrangle, about 5 miles (8 km)

southwest of the Stacey quadrangle shows ash 4.026 percent, sulfur 0.352 percent, and heating value of 7,965 Btu per pound (18,527 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 73). This heating value converts to about 8,300 Btu per pound (19,306 kJ/kg) on a moist, mineral-matter-free basis, indicating that the coal at this location is on the borderline between lignite A and subbituminous C in rank. For purposes of calculating reserves, the Sawyer coal has been assigned a rank of subbituminous C in this quadrangle.

C and D coal beds

The C and D coal beds were first described by Bass (1932, p. 55) after exposures in the Ashland coal field, possibly in the Cook Creek Reservoir or Beaver Creek School quadrangles, just west of the Stacey quadrangle, although a type locality was not given. In most places the two closely spaced beds have been represented on maps as a single line. The D coal bed makes up the bulk of the coal mapped as the combined C and D coal beds as it is the thickest and most widespread of the two. According to Bass (1932, p. 55), the underlying C coal bed is of little economic importance because it contains an abundance of silicified, partly carbonized tree stumps and fragments of logs that destroy the value of the bed. The C and D beds crop out in the northeastern part of the quadrangle and along its western border. As shown by the isopach and structure contour map (pl. 10) the coal beds range in thickness from about 3 to about 17 feet (0.9 to 5.2 m) projected from thicknesses in the Beaver Creek School quadrangle to the west, and dip southwestward or southward at an angle of less than 1 degree. Overburden on the C and D beds (pl. 11) ranges in thickness from zero at the outcrops to about 800 feet (244 m).

There are no known, publicly available, chemical analyses of the C and D coal beds. For purposes of calculating reserves the C and D beds have been assigned a rank of subbituminous C in accordance with the rank of closely associated coal beds in this quadrangle.

X coal bed

The X coal bed was first described by Bass (1932, p. 55) from exposures in the Ashland coal field, probably in the Beaver Creek School quadrangle, just west of the Stacey quadrangle, where it is well exposed. The X coal bed occurs about 60 feet (18 m) above the D coal bed and crops out in the central and east-central parts of the Stacey quadrangle (pl. 1). The X coal bed was measured in only two places where it was 2.8 and 4 feet (0.85 and 1.2 m) thick (pls. 1 and 3). Because of its thinness, economic coal resources have not been assigned to the X coal bed in this quadrangle.

E coal bed

The E coal bed was first described by Bass (1932, p. 5) from exposures in the Ashland coal field. A type locality was not given. The E coal bed occurs 55 to 80 feet (17 to 24 m) above the X coal bed. The coal crops out on the east and west sides of the high country in the western and southern parts of the quadrangle (pl. 1). The E coal bed increases in thickness from about 5 feet (1.5 m) in the southwestern part of the quadrangle to 19.6 feet (6.0 m) in the northwestern part and is almost flat, as shown by the isopach and structure contour map (pl. 7). Overburden on the E coal bed (pl. 8) ranges in thickness from zero at the outcrops to about 600 feet (183 m), but practically all of the coal is below the arbitrarily assigned stripping limit of 500 feet (152 m).

There is no known publicly available chemical analysis of the E coal bed in the Stacey quadrangle. It is assumed that the E coal bed is similar to closely associated coals in the Stacey quadrangle and is subbituminous C in rank.

Ferry coal bed

The Ferry coal bed was first described by Warren (1959, p. 573) from exposures in the central and southwestern parts of the Birney-Broadus coal field. A type locality was not given. We are here applying the name Ferry to the coal

bed which Bass (1932) called the F coal bed in his report on the Ashland coal field, which includes this quadrangle. We feel that Ferry is a better name for this coal bed of regional extent. In the Stacey quadrangle, the Ferry coal bed is present at high elevations in the western and southern parts of the quadrangle (pl. 1). However, the coal has been extensively burned, and there are no thickness measurements of the Ferry coal bed in this quadrangle. There appears to be a limited area of unburned Ferry coal in the southwestern part of the quadrangle and a very small patch in the northwestern part of the quadrangle. The thickness of this unburned coal is believed to range from about 7 to about 17 feet (2.1 to 5.2 m), and the bed appears to be nearly horizontal, as shown by the isopach and structure contour map (pl. 4). The isopachs have been projected into the quadrangle from the south and east. Overburden on the Ferry coal bed (pl. 5) ranges from zero at the outcrops to slightly more than 100 feet (30.5 m) in thickness.

There is no known publicly available chemical analysis of the Ferry coal bed. For calculation of coal resources, the Ferry coal has been assigned a rank of subbituminous C in accordance with the rank of other closely associated coals in this quadrangle.

Local coal beds

The local coal beds shown on plates 1 and 3 are thin and of very limited areal extent, and consequently have not been assigned economic coal resources.

COAL RESOURCES

Data from all publicly available drill holes and from surface mapping by others (see list of references) were used to construct outcrop, isopach, and structure contour maps of the coal beds in this quadrangle.

Coal resource tonnages shown in this report are the Reserve Base (RB) part of the Identified Resources and the Hypothetical (HYP) part of the Undiscovered Resources, as discussed in U.S. Geological Survey Bulletin 1450-B.

The Reserve Base for subbituminous coal is coal that is 5 feet (1.5 m) or more thick, under 3,000 feet (914 m) or less of overburden, and located within 3 miles (4.8 km) of a point of coal-bed measurement. Reserve Base is further subdivided into reliability categories according to their nearness to a measurement of the coal bed. Measured coal is coal within 0.25 mile (0.4 km) of a measurement, Indicated coal extends 0.5 mile (0.8 km) beyond Measured coal to a distance of 0.75 mile (1.2 km) from the measurement point, and Inferred coal extends 2.25 miles (3.6 km) beyond Indicated coal to a distance of 3 miles (4.8 km) from the measurement point.

Hypothetical Resources are undiscovered coal resources in beds that may reasonably be expected to exist in known mining districts under known geologic conditions. In general, Hypothetical Resources are located in broad areas of coal fields where no points of observation are present, and the evidence of the coal's existence is from distant outcrops, drill holes, or wells that are more than 3 miles (4.8 km) away. Hypothetical Resources are located beyond the outer boundary of the Inferred part of Identified Resources in areas where the assumption of continuity of the coal bed is supported only by extrapolation of geologic evidence. For purposes of this report, tonnages were calculated for only those Hypothetical coal resources in beds that are estimated to be 5 feet (1.5 m) or more thick and to be under less than 3,000 feet (914 m) of overburden.

Reserves are the recoverable part of the Reserve Base coal. For surface-minable coal in this quadrangle, the coal reserves are considered to be 85 percent (the recovery factor for this area) of that part of the Reserve Base that

is beneath 500 feet (152 m) or less of overburden, the stripping limit of multiple, thin (5 to 40 feet or 1.5 to 12 m thick) beds of subbituminous coal in this area.

Estimated coal resources in this quadrangle were calculated using data obtained from the coal isopach maps (pls. 4, 7, 10, 13, 19, and 22). The coalbed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed times a conversion factor of 1,770 short tons of coal per acre-foot (13,027 metric tons per hectare-meter) for subbituminous coal yields the coal resources in short tons of coal for each isopached coal bed. Reserve Base and Reserve tonnage values of federally owned coal beds considered to have resources in this quadrangle are shown on plates 6, 9, 16, 18, 21, and 24 and are rounded to the nearest one-hundredth of a million short tons.

The Reserve Base tonnage and Hypothetical tonnage of federally owned coal in this quadrangle are shown in the northwest corner of each section on CRO plate 2 and by development-potential category in tables 1 and 2. Table 1 shows the total estimated tonnage of surface-minable federally owned Reserve Base coal to be 882.12 million short tons (800.08 million t) and the total Hypothetical surface-minable coal to be 46.15 million short tons (41.86 million t). Table 2 shows a total of 658.96 million short tons (597.67 million t) of underground-minable Reserve Base coal, and 26.29 million short tons (23.85 million t) of underground-minable Hypothetical coal. All numbers are rounded to the nearest one-hundredth of a million short tons. About 2 percent of the estimated surface-minable Reserve Base tonnage is classed as Measured, 15 percent as Indicated, and 83 percent as Inferred. The same percentages apply to the estimated underground-minable Reserve Base tonnage.

COAL DEVELOPMENT POTENTIAL

Areas where coal beds are 5 feet (1.5 m) or more thick and are overlain by 500 feet (152 m) or less of overburden are considered to have potential for surface mining and were 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-ratio values for subbituminous coal is as follows:

$$MR = \frac{t_o\ (0.911)}{t_c\ (rf)}$$

where MR = mining ratio
t_o = thickness of overburden
t_c = thickness of coal
rf = recovery factor = 0.85
0.911 = conversion factor (cu. yds./ton)

Areas of high, moderate, and low development potential for surface mining of coal are here defined as areas underlain by coal beds having less than 500 feet (152 m) of overburden and having respective mining-ratio values of zero to 10, 10 to 15, and greater than 15, as shown on CRO maps, plates 5, 8, 12, 15, 17, 20, and 23 for the Ferry, E, C and D, Upper Sawyer, Lower Sawyer, Knobloch, and Terret coal beds, respectively. These mining-ratio values for each development-potential category are based on economic and technological criteria and were provided by the U.S. Geological Survey. Estimated tonnages in each development-potential category (high, moderate, and low), of both Reserve Base and Hypothetical coal, for surface mining are shown in table 1. Estimated tonnages for underground mining are shown in a like manner in table 2.

Development potential for surface-mining methods

The Coal Development Potential (CDP) map included in this series of maps pertains only to surface mining. It depicts the highest coal development-potential category which occurs within each smallest legal subdivision of land

(normally about 40 acres or 16.2 ha). If such a 40-acre (16.2-ha) tract of land contains areas of high, moderate, and low development potential, the entire tract is assigned to the high development-potential category for CDP mapping purposes, etc.

In areas of moderate to high topographic relief, the area of moderate-development potential for surface mining of a coal bed (areas having mining-ratio values of 10 to 15) is often restricted to a narrow band between the high and low development potential areas. In fact, due to the 40-acre (16.2-ha) minmum size of coal development-potential increments, the narrow strip of moderate development-potential area is often absorbed into the 40-acre (16.2-ha) tracts of high development-potential category. The Coal Development Potential (CDP) map then shows areas of low development potential abutting against areas of high development potential.

The coal-development potential for surface-mining methods is shown on the Coal Development Potential map (pl. 25). Because several coal beds contain surface-minable coal with high development potential, most of the Federal coal lands in the quadrangle have a high development potential for surface mining. The coal beds, in ascending order, are the Terret, Knobloch, Lower Sawyer, Upper Sawyer, C, D, E, and Ferry.

The Terret coal bed (pl. 23) has practically no development potential for surface mining as the thickness of the overburden in general is greater than 500 feet (152 m), the arbitrarily assigned stripping limit.

The Knobloch coal bed (pl. 20) has a wide area of high development potential (mining-ratio values 0 to 10) in the bottoms of Little Pumpkin Creek, Stacey Creek, and Gaskill Creek valleys in the northeastern part of the quadrangle. However, the amount of Federal coal land here is quite limited.

The Upper Sawyer and Lower Sawyer coal beds (pls. 15 and 17) have wide areas of high development potential where the mining-ratio values are less than 10 in the eastern part of the quadrangle. Above these areas are narrow areas of moderate development potential where the mining-ratio values range from 10 to 15, and wide areas of low development potential extending from the 15 mining-ratio contour to the 500-foot overburden isopach, which is the arbitrarily assigned stripping limit. The Upper Sawyer coal bed also has narrow areas of high and moderate development potential and broader areas of low development potential along the western border of the quadrangle.

The C and D coal beds (pl. 12) have rather narrow bands of high development potential in the upper parts of stream valleys in the north-central part of the quadrangle and along its western border.

The E coal bed (pl. 8) has moderately wide bands of high development potential (mining-ratio values 0 to 10) above the outcrops east and west of the high country in the western and southern parts of the quadrangle.

The Ferry coal bed (pl. 5) has limited areas of high development potential (mining-ratio values 0 to 10) above the outcrops in the high country in the southwestern part of the quadrangle.

About 77 percent of the Federal coal lands in the quadrangle have a high development potential for surface mining, 13 percent have a moderate development potential, and 10 percent have a low development potential.

Development potential for underground mining and in-situ gasification

Coal beds 5 feet (1.5 m) or more in thickness lying more than 500 feet (152 m) but less than 3,000 feet (914 m) below the surface of this quadrangle are considered to have development potential for underground mining. Estimates of the

tonnage of underground-minable coal are listed in table 2 by development-potential category for each coal bed. Coal is not currently being mined by underground methods in the Northern Powder River Basin because these methods are not profitable at this time. Therefore, the coal development potential for underground mining of these resources is rated as low, and a Coal Development Potential map for underground mining was not made.

In-situ gasification of coal on a commercial scale has not been done in the United States. Therefore, the development potential for in-situ gasification of coal found below the surface-mining limit in this area is rated as low.

Table 1.--Surface-minable coal resource tonnage (in short tons) by development-potential category for Federal coal lands in the Stacey quadrangle, Powder River County, Montana

[Development potentials are based on mining ratios (cubic yards of overburden/short ton of recoverable coal). To convert short tons to metric tons, multiply by 0.9072]

Coal bed	High development potential (0-10 mining ratio)	Moderate development potential (10-15 mining ratio)	Low development potential (>15 mining ratio)	Total
Reserve Base tonnage				
E	54,750,000	27,910,000	86,690,000	169,350,000
C and D	11,610,000	13,340,000	91,820,000	116,770,000
Sawyer and Upper Sawyer	10,200,000	11,180,000	173,930,000	195,310,000
Lower Sawyer	30,840,000	8,480,000	99,220,000	138,540,000
Knobloch	20,120,000	45,070,000	196,960,000	262,150,000
Total	127,520,000	105,980,000	648,620,000	882,120,000
Hypothetical Resource tonnage				
Ferry	11,660,000	640,000	20,000	12,320,000
Lower Sawyer	140,000	1,370,000	25,300,000	26,810,000
Knobloch	0	0	6,960,000	6,960,000
Terret	0	0	60,000	60,000
Total	11,800,000	2,010,000	32,340,000	46,150,000
Grand Total	139,320,000	107,990,000	680,690,000	928,270,000

Table 2.--Underground-minable coal resource tonnage (in short tons) by development-potential category for Federal coal lands in the Stacey quadrangle, Powder River County, Montana

[To convert short tons to metric tons, multiply by 0.9072]

Coal bed	High Development potential	Moderate development potential	Low development potential	Total
Reserve Base tonnage				
E	0	0	170,000	170,000
C and D	0	0	11,190,000	11,190,000
Sawyer and Upper Split	0	0	95,500,000	95,500,000
Lower Sawyer	0	0	52,450,000	52,450,000
Knobloch	0	0	495,930,000	495,930,000
Terret	0	0	3,720,000	3,720,000
Total	0	0	658,960,000	658,960,000
Hypothetical Resource tonnage				
Lower Sawyer	0	0	8,180,000	8,180,000
Knobloch	0	0	6,200,000	6,200,000
Terret	0	0	11,910,000	11,910,000
Total	0	0	26,290,000	26,290,000
Grand Total	0	0	685,250,000	685,250,000

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