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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE NORTH STACEY SCHOOL QUADRANGLE, CUSTER AND POWDER RIVER COUNTIES, MONTANA

[Report includes 22 plates]

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CONTENTS

ILLUSTRATIONS

[Plates are in pocket]

Plates 1-21. Coal resource occurrence maps:

1. Coal data map.
2. Boundary and coal data map.
3. Coal data sheet.
4. Isopach and structure contour map of the E coal bed.
5. Overburden isopach and mining-ratio map of the E coal bed.
6. Areal distribution and tonnage map of identified resources of the E coal bed.
7. Isopach and structure contour map of the C and D coal beds.
8. Overburden isopach and mining-ratio map of the C and D coal beds.
9. Areal distribution and tonnage map of identified resources of the C and D coal beds.
10. Isopach and structure contour map of the Sawyer coal bed and its splits.
11. Overburden isopach and mining-ratio map of the lower split of the Sawyer coal bed.
12. Areal distribution and tonnage map of identified resources of the lower split of the Sawyer coal bed.
13. Isopach and structure contour map of the Knobloch coal bed.
14. Overburden isopach and mining-ratio map of the Knobloch coal bed.

TABLES

Conversion table

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 North Stacey School quadrangle, Custer and Powder River Counties, Montana, (22 plates; U.S. Geological Survey Open-File Report 79-016). 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 North Stacey School 7 1/2-minute quadrangle is in southwestern Custer and northwestern Powder River Counties, Montana, about 38 miles (60.8 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 15 miles (24 km) to its intersection with local Highway 332 (Tongue River Road), and then southwest a distance

of 23 miles (36.8 km) to the Foster Creek road intersection, and then south and east on Foster Creek Road a distance of 11 miles (17.6 km) to the north border of the quadrangle. Foster Creek Road is an improved county road which crosses the northeast corner of the quadrangle. A number of unimproved roads provide access to the rest of the quadrangle.

Physiography

The North Stacey School quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The upland plateau surface, however, has been almost completely dissected by Pumpkin Creek and other tributaries of the Tongue River which flows northward to the Yellowstone River. In the north two-thirds of the quadrangle, Lay Creek, South Fork Foster Creek, and Foster Creek flow northwestward to the Tongue River; in the south third of the quadrangle, Cameron and Starvation Creeks flow eastward to Pumpkin Creek. The topography is rugged in the south half of the quadrangle, and some of the ridges between the creek valleys are capped with clinker, a result of the burning of coal beds. The highest elevation, 3,960 feet (1,207 m), is in the southwest quarter of the quadrangle. The lowest elevation, 2,900 feet (884 m), is just east of the northwest corner along Lay Creek. Topographic relief is 1,060 feet (323 m).

Climate

The climate of Custer and Powder River Counties 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 four small areas on the north and east borders. 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 North Stacey School quadrangle as part of the Ashland coal field, Rosebud, Powder River, and Custer Counties, Montana. Brown and others (1954) mapped most of the quadrangle as part of their Foster Creek Deposit, in a description of strippable coal in Custer and Powder River Counties, Montana. Gilmour and Williams (1969) mapped the north half of the quadrangle as part of the Foster Creek coal deposit. Matson and Blumer (1973) included a revision of the Gilmour and Williams work 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 Fort Union Formation (Paleocene). The Fort Union Formation is composed of three members: the upper Tongue River Member, the middle Lebo Shale Member, and the lower Tullock Member. Only the Tongue River Member is exposed in the North Stacey School quadrangle.

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. Originally as much as 1,600 feet (488 m) thick in this vicinity (Bass, 1932, p. 35), most of the Tongue River Member has been removed by erosion so that only about the lower 970 feet (296 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 their 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 North Stacey School quadrangle is in the north-central part of the Powder River structural basin. Regionally the strata dip southwestward about 40 feet per mile (7.6 m per km), but the coal beds exhibit diverse directions of dip (pls. 4, 7, 10, 13, 17, and 19) originating from basin subsidence and differential compaction of the sediments.

COAL GEOLOGY

Eight coal beds, all in the Tongue River Member of the Fort Union Formation, were mapped on the surface in this quadrangle (pl. 1) and are shown in section on plate 3. The lowest of these is an unnamed local bed which may be equivalent to the Burley coal (Bass, 1932, pl. 11), about 70 feet (21 m) above the base of the Tongue River Member. As it is thin and discontinuous, no economic resources have been attributed to it. It is overlain successively by a 70-foot (21.3-m)-thick noncoal interval, the Terret coal bed, a 70-foot (21.3-m)-thick noncoal interval, the Flowers-Goodale coal bed, a 50-foot (15-m)-thick noncoal interval, the Lay Creek coal bed, a 40-foot (12-m)-thick noncoal interval, the Knobloch coal bed, a 200-foot (61-m)-thick noncoal interval, the Sawyer coal bed, a 100-foot (30-m)-thick noncoal interval, the C and D coal beds, a 150-foot (46-m)-thick noncoal interval, and the E coal bed.

The coal found along the eastern flank of the Powder River Basin in Montana increases in rank from lignite, located along the outcrop areas in the east, to subbituminous located in the deeper parts of the basin to the west. All coal analyses data 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 the North Stacey School 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 (Cook Creek Reservoir quadrangle) in the Ashland coal field about 10 miles (16 km) to the southwest of this quadrangle. The Terret bed lies about 140 feet (43 m) above the base of the Tongue River Member, and crops out around the valleys of Lay Creek, South Fork Foster Creek, and Widow Creek, near the north border of the quadrangle (pl. 1). The coal bed lies beneath the surface in the remainder of the quadrangle. Along most of the outcrops much coal has burned, leaving broad areas of clinker. In a number of places, the clinker has been removed by surface

erosion, exposing the coal bed. Based on these coal outcrops, and on drill hole data, the Terret coal bed ranges from 4 to 15 feet (1.2 to 4.6 m) in thickness (pl. 19). Structure contours on top of the Terret coal bed show a south dip of about 40 feet per mile (7.6 m/km) modified by a synclinal trough north-south through the middle of the quadrangle (pl. 19). Overburden on the Terret coal bed ranges from zero to more than 800 feet (244 m) in thickness, as shown on plate 20. Other coal beds lie within this overburden interval. The Montana Bureau of Mines and Geology cored the Terret coal in drill hole FC-28 (sec. 21, T. 1 N., R. 47 E.) in the northeast quarter of the North Stacey School quadrangle. A chemical analysis of coal from depths of 197 to 208 feet (60 to 63.4 m) shows a heating value of 7,860 Btu per pound (18,280 kJ/kg), ash 6.25 percent, and sulfur 0.24 percent, on an as-received basis (Matson and Blumer, 1973, p. 86). This heating value converts to 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.

Flowers-Goodale coal bed

The Flowers-Goodale coal bed was described by Bass (1932, p. 53) from two small coal mines located in the Brandenberg quadrangle, about 10 miles (16 km) west of the North Stacey School quadrangle. The Flowers-Goodale coal bed lies about 220 feet (67 m) above the base of the Tongue River Member and crops out on the divides separating the valleys of Widow Creek, South Fork Foster Creek, and Lay Creek in the north half of the quadrangle. It underlies the entire south half of the quadrangle (pls. 1 and 16). Except for minor interruptions near the outcrop, the Flowers-Goodale

coal bed dips gently northward at about 30 feet per mile (5.7 m/km), and ranges from 4 to 13 feet (1.2 to 4 m) in thickness (pl. 16). The overburden on the Flowers-Goodale coal bed increases southward from zero at the outcrops to over 500 feet (152 m) in thickness, as shown on plate 17.

The Montana Bureau of Mines and Geology cored the Flowers-Goodale coal in drill hole FC-28 (sec. 21, T. 1 N., R. 47 E.) in the North Stacey School quadrangle. A chemical analysis of coal from depths of 74 to 87 feet (22.6 to 26.5 m) shows a heating value of 7,570 Btu per pound (17,610 kJ/kg), ash 9.02 percent, and sulfur 0.77 percent, on an as-received basis (Matson and Blumer, 1973, p. 86). This heating value converts to about 8,320 Btu per pound (19,350 kJ/kg) on a moist, mineral-matter-free basis, and indicates that the coal is subbituminous C in rank. The Montana Bureau of Mines and Geology cored the Flowers-Goodale coal in a second drill hole (FC-11) in the southeast quarter of the North Stacey School quadrangle (sec. 3, T. 1 S., R. 47 E.). An analysis of this coal shows a heating value of 7,550 Btu (17,560 kJ/kg), ash 7.28 percent, and sulfur 0.4 percent, on an as-received basis (Matson and Blumer, 1973, p. 86). This heating value converts to about 8,150 Btu per pound (18,957 kJ/kg) on a moist, mineral-matter-free basis, indicating that this Flowers-Goodale coal is lignite A in rank. In order to be consistent, however, all the Flowers-Goodale coal in the North Stacey School quadrangle is considered to be of the same rank (subbituminous C).

Lay Creek coal bed

The Lay Creek coal bed was described by Bass (1932, p. 54) after outcrops near the headwaters of Lay Creek in the Hayes Point quadrangle.

about 2 miles (3.2 km) west of the North Stacey School quadrangle. The bed is thin (everywhere less than 4.1 feet or 1.2 m thick) and of irregular quality (Bass, 1932, p. 54) in the North Stacey School quadrangle. Maps have not been made for the coal bed, nor have resources been estimated.

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 located about 30 miles (48 km) southwest of the North Stacey School quadrangle.

The Knobloch coal bed lies about 300 feet (91 m) above the base of the Tongue River Member and crops out around the headquarters of Lay, Foster, Widow, and South Fork Foster Creeks. It underlies most of the south half of the North Stacey School quadrangle, where it is almost flat, showing only a slight dip to the northwest (pl. 13). The bed thickens from about 5 to 22 feet (1.5 to 6.7 m) southeastward (pl. 13). Overburden overlying the Knobloch coal bed reaches 600 feet (182 m) in thickness just east of the southwest corner of the quadrangle (pl. 14).

The Montana Bureau of Mines and Geology cored the Knobloch coal in drill hole FC-11 (sec. 3, T. 1 S., R. 47 E.) in the southeast quarter of the North Stacey School quadrangle. A chemical analysis of coal from depths of 84 to 100 feet (25.6 to 30.5 m), shows a heating value of 7,500 Btu per pound (17,445 kJ/kg), ash 8.36 percent, and sulfur 0.32 percent, on an as-received basis (Matson and Blumer, 1973, p. 86). This heating value converts to about 8,190 Btu per pound (19,050 kJ/kg) on a moist, mineral-matter-free basis, indicating that the coal is lignite A in rank. However,

the Montana Bureau of Mines and Geology cored the Knobloch coal in another drill hole (FC-29 located in sec. 21, T. 1 N., R. 46 E.) 1 mile (1.6 km) west of the North Stacey School quadrangle in the northeast quarter of the Hayes Point quadrangle. An analysis of the Knobloch coal from this drill hole shows a heating value of 7,840 Btu per pound (18,236 kJ/kg), ash 8.65%, and sulfur 1.61 percent, on an as-received basis (Matson and Blumer, 1973, p. 86). This heating value converts to about 8,580 Btu per pound (19,960 kJ/kg) on a moist, mineral-matter-free basis, which is well within the range of the subbituminous C rank. Conforming to the rank of other coal beds in the North Stacey School quadrangle, the Knobloch coal is considered to be subbituminous C in rank for calculation of resources.

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 40 miles (64 km) west of the North Stacey School quadrangle.

The Sawyer coal bed lies about 200 feet (61 m) above the Knobloch coal bed and crops out around the higher elevations in the extreme southern part of the North Stacey School quadrangle (pls. 1 and 10). The Sawyer is actually two coal beds with as much as 100 feet (30 m) of separation. The Upper Sawyer (Sa_1) attains a thickness of 6 feet (1.8 m) plus, and the Lower Sawyer (Sa_2) as much as 6.8 feet (2.1 m). In their small area of exposure, the beds appear to dip gently southward (pl. 10).

The Upper Sawyer is of minable thickness in only a relatively small area along the central part of the southern border of the quadrangle (pl. 10). Because this area falls on non-Federal coal lands no maps were made showing the overburden isopachs or tonnage of identified resources for the upper split of the Sawyer coal bed. In this small area, it overlies Lower Sawyer of minable thickness. The overburden on the Lower Sawyer coal bed, which includes the minable Upper Sawyer bed, reaches 200 feet (61 m) in thickness, as is shown on plate 11.

There are no publicly available analyses for the Sawyer coal in the North Stacey School quadrangle. The Montana Bureau of Mines and Geology cored the Sawyer coal in several drill holes in the Ashland coal field (Coleman Draw and Cook Creek Reservoir quadrangles) about 12 miles (19 km) southwest of the North Stacey School quadrangle. In the analyses of Sawyer coal from these cores, the heating value ranges from about 8,200 to 8,400 Btu per pound (19,070 to 19,540 kJ/kg) on a moist, mineral-matter-free basis, and are not conclusive as to whether the coal is lignite A or subbituminous C in rank (Matson and Blumer, 1973, p. 96). In order to be consistent with the other coal beds in the North Stacey School quadrangle, the rank of the Sawyer coal is assumed to be subbituminous C for calculation of resources.

C and D coal beds

The C and D coal beds were described by Bass (1932, p. 55) without designating a type locality. In most localities both beds were mapped with a single boundary (1932, pl. 3). The C and D coal beds lie about 100 feet (30

m) above the Sawyer coal bed, and crop out around the high elevations near the southwest corner of North Stacey School quadrangle (pl. 1). The coal beds, mapped as a single unit on plate 7, are shown to dip southwest about 30 feet per mile (5.7 m/km), and increase from 3 feet to 12 feet (0.9 to 3.7 m) in thickness southwestward across the same area. Overburden on the coal beds exceeds 200 feet (61 m) in thickness in small areas (pl. 8). There are no publicly available chemical analyses for the C and D coal beds. To be consistent with the other coal beds in the quadrangle in calculating resources, it is assumed that the rank of the coal is subbituminous C.

E coal bed

The E coal bed was described by Bass (1932, p. 55) after exposures in the Ashland coal field without designation of a type locality. The E coal bed lies about 100 feet (31 m) above the C and D coal beds, and is present only beneath the highest divides just east of the southwest corner of the North Stacey School quadrangle (pls. 1 and 4). Within its small area of occurrence the bed appears nearly flat, and thickens northwestward from 10 to 16.8 feet (3 to 5 m). Maximum overburden on the E coal bed is about 200 feet (61 m) thick on the crests of the divides (pl. 5). There are no publicly available analyses for the E coal in the North Stacey School quadrangle or nearby. For purposes of consistency in estimating tonnages it is assumed that the E bed coal is similar in rank to the coal beds beneath it, and is subbituminous C.

COAL RESOURCES

Data from drill holes as well as from all publicly available 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 derived 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 for 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 geologic projection. 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. This depth of overburden is the stripping limit for multiple, relatively 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, 16, and 19). The coal-bed acreage multiplied by the average isopached thickness of the coal bed, times a conversion factor of 1,770 short tons of coal per acre-foot (13,028 metric tons per hectare-meter) for subbituminous coal yields the coal resources in short tons of coal for each isopached coal bed. The total Reserve Base tonnage of federally owned coal for the six coal beds considered to have resources in this quadrangle are shown on plates 6, 9, 12, 15, 18, and 21, rounded to the nearest one-hundredth of a million short tons.

The total Reserve Base tonnage of federally owned surface-minable and underground-minable coal in this quadrangle is estimated to be 525.33

million short tons (476.47 million t). The Reserve Base tonnage totals per section 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 471.69 million short tons (427.82 million t) of Reserve Base tonnage and 2.09 million short tons (1.90 million t) of Hypothetical Resources of surface-minable coal; and table 2 shows 53.64 million short tons (48.65 million t) of Reserve Base tonnage and 7.03 million short tons (6.38 million t) of Hypothetical Resources for underground-minable coal. All numbers are rounded to the nearest one-hundredth of a million short tons. About 8 percent of the Reserve Base tonnage is classed as Measured, 37 percent as Indicated, and 55 percent as Inferred.

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 in this quadrangle and are assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining-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 are here defined as areas underlain by coal beds having respective mining-ratio values of 0 to 10,

10 to 15, and greater than 15, as shown on CRO plates 5, 8, 11, 14, 17, and 20. 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 each coal bed for surface mining are shown in table 1.

Development potential for surface-mining methods

The Coal Development Potential (CDP) map, plate 22 in this series of maps, depicts the highest coal development-potential category which occurs within each smallest legal subdivision of Federal coal 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.

The coal development potential for surface-mining methods (less than 500 feet or 152 m of overburden) is shown on the Coal Development Potential map (pl. 22). Because several coal beds contain surface-minable coal, most of the Federal coal lands in the quadrangle have a high development potential for surface mining. The superimposed coal beds, in ascending order, are the Terret, Flowers-Goodale, Knobloch, Lower Sawyer, C and D, and E.

The Terret coal bed has a high development potential (mining-ratio values of 0 to 10) in a moderately wide band extending eastward across the north third of the quadrangle (pl. 20). Directly south of that band is a narrow band of moderate development potential, between the 10 and 15 mining-ratio contours.

South of that is a wide band of low development potential extending to the arbitrary stripping limit, 500 feet (152 m) of overburden, just south of the center of the quadrangle.

The Flowers-Goodale coal bed (pl. 17) has a high development potential in a wide, irregular band extending easterly across the central part of the quadrangle. South of that band the coal bed has a moderately wide band of moderate development potential. That band is succeeded to the south by a wide band of low development potential extending across the south-central part of the quadrangle to the stripping limit (the 500-foot or 152-m overburden isopach) or to the limit of minable-coal thickness (5 ft or 1.5 m).

The Knobloch coal bed (pl. 14) has a high development potential in an irregular band extending easterly across the central third and southeast quarter of the quadrangle. Just south and west of that band is a narrow band of moderate development potential. Southwest of that band a wide band having low development potential extends to the arbitrarily assigned stripping limit (500-foot or 152-m overburden isopach).

The Lower Sawyer coal bed (pl. 11) and the C and D coal beds (pl. 8) are of minable thickness near the south border of the quadrangle where they have small areas of high, moderate, and low development potential.

The E coal bed (pl. 5) is surface minable only in a small area in the southwest quarter of the quadrangle. The coal there has a high development potential in a narrow band circling a steep-sided ridge, which encompasses even narrower bands of moderate and low development potential.

About 77 percent of the Federal coal lands in the quadrangle have a high development potential for surface mining, 7 percent have a moderate development potential, 9 percent have a low development potential, and 7 percent have no development potential for surface mining.

Development potential for underground mining and in-situ gasification

Coal beds of economic thickness (5 feet or 1.5 m, or more), lying more than 500 feet (152 m) but less than 3,000 feet (914 m) below the surface in this quadrangle, are considered to have a development potential for underground mining. Tonnage estimates of such underground-minable coal are listed in table 2 by coal bed and by coal development-potential category. Coal is not currently being mined by underground methods in the Northern Powder River Basin because of poor economics. For this reason the coal development potential for all the underground-minable coal resource tonnnage listed in table 2 is classified as low, and consequently, 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 stripping limit in this area is rated as low.

Table 1.--Surface-minable coal resource tonnage by development-potential category for Federal coal lands (in short tons) in the North Stacey School quadrangle, Custer and Powder River Counties, 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	8,640,000	1,010,000	490,000	10,140,000
C and D	0	220,000	660,000	880,000
Lower Sawyer	8,440,000	320,000	140,000	8,900,000
Knobloch	88,220,000	26,250,000	63,960,000	178,430,000
Flowers-Goodale	40,680,000	20,510,000	51,230,000	112,420,000
Terret	46,880,000	15,380,000	98,660,000	160,920,000
Total	192,860,000	63,690,000	215,140,000	471,690,000
Hypothetical Resource tonnage				
Terret	0	0	2,090,000	2,090,000
Total	0	0	2,090,000	2,090,000
Grand Total	192,860,000	63,690,000	217,230,000	473,780,000

Table 2.--Underground-minable coal resource tonnage by development-potential category for Federal coal lands (in short tons) in the North Stacey School quadrangle, Custer and Powder River Counties, 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				
Knobloch	0	0	7,960,000	7,960,000
Flowers-Goodale	0	0	6,200,000	6,200,000
Terret	0	0	39,480,000	39,480,000
Total	0	0	53,640,000	53,640,000
Hypothetical Resource tonnage				
Terret	0	0	7,030,000	7,030,000
Total	0	0	7,030,000	7,030,000
Grand total	0	0	60,670,000	60,670,000

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