Text to Accompany:

Open-File Report 79-822

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE YAMPA QUADRANGLE, ROUTT COUNTY, COLORADO

[Report includes 3 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

By

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This report has not been edited
for conformity with U.S. Geological
Survey editorial standards or
stratigraphic nomenclature.

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INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence and Coal Development Potential Maps of the Yampa quadrangle, Routt County, Colorado. This report was compiled to support the land planning work of the Bureau of Land Management (BLM) 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. This investigation was undertaken by Dames & Moore, Denver, Colorado, at the request of the U.S. Geological Survey under contract Number 14-08-001-15789. The resource information gathered for this report is in response to the Federal Coal Leasing Amendments Act of 1976 (P.L. 94-377). Published and unpublished public information available through April, 1978, was used as the data base for this study. No new drilling or field mapping was performed as part of this study, nor was any confidential data used.

Location

The Yampa quadrangle is located in southeastern Routt County in northwestern Colorado, approximately 24 miles (39 km) south-southwest of the town of Steamboat Springs via Colorado Highway 131. The towns of Yampa, in the southeastern part of the quadrangle, and Phippsburg, in the north-central part of the quadrangle, are located on Colorado Highway 131. Except for Yampa, Phippsburg, and several scattered ranches, the quadrangle is unpopulated.

Accessibility

Colorado Highway 131 crosses northwesterly along the Yampa River valley through the central part of the Yampa quadrangle. A paved medium-duty road following Hunt Creek and Watson Creek also connects the towns of Phippsburg and Yampa. Several improved light-duty roads and unimproved dirt roads provide access through the remainder of the quadrangle.

Railway service for the Yampa quadrangle is provided by the Denver & Rio Grande Western Railroad which parallels Colorado Highway 131. The rail line is the major transportation route for coal shipped eastward from northwestern Colorado (U.S. Bureau of Land Management, 1977).

Physiography

The Yampa quadrangle lies in the southern part of the Wyoming Basin physiographic province as defined by Howard and Williams (1972). The quadrangle is approximately 12 miles 832 km) southwest of the Continental Divide.

The landscape within the quadrangle is characterized by moderate to gentle slopes east of the Yampa River, and by steeper slopes and mesas cut by numerous streams, valleys, and gulches west of the river. The Yampa River forms a fairly broad, flat valley through the central part of the quadrangle.

Approximately 1,880 feet (573 m) of relief is present in the Yampa quadrangle. Altitudes range from approximately 9,240 feet (2,816 m) on the northeastern edge of the quadrangle, to less than 7,360 feet (2,243 m) along the Yampa River at the north-central edge of the quadrangle. Devils Grove Mesa rises approximately 520 feet (158 m) above Hunt Creek in the west-central part of the quadrangle.

The Yampa River, which provides the major drainage for the quadrangle, flows northward through the central part of the quadrangle. Hunt Creek and its tributaries drain the west-central part of the quadrangle, flowing northeasterly to join the Yampa River near Phippsburg. Numerous other northwestward- and northeastward-flowing creeks drain the remainder of the quadrangle into the Yampa River.

Climate and Vegetation

The climate of northwestern Colorado is semiarid. Clear, sunny days prevail in the Yampa area, with daily temperatures typically varying from 0° to 35°F (-18° to 2°C) in January and from 42° to 80°F (6° to

27°C) in July. Annual precipitation in the area averages approximately 16 inches (41 cm). Snowfall during the winter months accounts for the major part of the precipitation in the area, but rainfall from thundershowers during the summer months also contributes to the total. Winds, averaging 3 miles per hour (4.8 km per hour), are generally from the west, but wind directions and velocities vary greatly depending on the local terrain (U.S. Bureau of Land Management, 1977).

Sagebrush is the dominant vegetation in the Yampa quadrangle. Ridges west of Phippsburg and east of the Yampa River (between Phippsburg and Yampa) are grassland. Other vegetation within the quadrangle includes conifer forests in the northeastern part, and aspen at higher altitudes in the northwestern part of the quadrangle (U.S. Bureau of Land Management, 1977).

Land Status

The Yampa quadangle is in the southeastern part of the Yampa Known Recoverable Coal Resource Area (KRCRA). However, only a small part of the northwest corner of the quadrangle is within the KRCRA boundary. The Federal government owns the coal rights for approximately 75 percent of this area. One active coal lease, as shown on plate 2, accounts for the remaining 25 percent.

GENERAL GEOLOGY

Previous Work

The first geologic description of the general area in which the Yampa quadrangle is located was reported by Emmons (1877) as part of the Survey of the Fortieth Parallel. The decision to build a railroad into the region stimulated several investigations of coal between 1886 and 1905, including papers by Hewett (1889), Hills (1893), and Storrs (1902). Fenneman and Gale (1906) conducted geologic studies on the Yampa coal field, and included a description of the geology and coal occurrence in the northwestern part of the Yampa quadrangle in their report. The most comprehensive work on the area, including the northwestern part of the quadrangle, was conducted by Bass and others (1955).

In 1976, Tweto compiled a generalized regional geologic map which included this quadrangle.

Stratigraphy

The formations exposed in the Yampa quadrangle range in age from Jurassic to Miocene. These include the Late Cretaceous-age, coal-bearing Iles Formation of the Mesaverde Group; the underlying Late Cretaceous Mancos Shale; and the overlying Browns Park Formation of Miocene age. Only the Iles Formation is known to contain coal in this quadrangle.

The Mancos Shale is exposed in the western half and along the northeastern edge of the Yampa quadrangle (Tweto, 1976), and it consists of gray to dark-gray marine shale interbedded with light-gray to light-brown fine-grained sandstone beds (Kucera, 1962). According to Kucera, the Mancos ranges in thickness from about 2,900 to 3,800 feet (884 to 1,158 m) in the Yampa area, but its total thickness in this quadrangle is not known and only 1,150 feet (351 m) is shown in the composite columnar section on plate 3.

The Iles Formation conformably overlies the Mancos Shale and is exposed in the northwestern corner of the quadrangle. The formation consists of light-gray to light-brown fine- to medium-grained sandstone interbedded with light-gray to dark-gray carbonaceous shale and coals (Kucera, 1962). Although the formation is reported to be approximately 1,500 feet (457 m) thick in the Yampa district (Kucera, 1962), it is estimated that between 700 to 800 feet (213 to 244 m) of the lower part of the formation is present in this quadrangle. The Tow Creek Sandstone Member is the basal unit of the Iles Formation and consists of light-gray to light-brown, medium-grained massive sandstone, and is approximately 35 feet (11 m) thick where exposed a short distance west of Phippsburg (Kucera, 1962). A coal-bearing sequence beginning approximately 200 feet (61 m) above the base of the formation extends upward to the base of the Trout Creek Sandstone Member (removed by erosion in this quadrangle) and has been designated the Lower Coal Group of the Mesaverde by Fenneman and Gale (1906).

The Miocene-age Browns Park Formation rests unconformably on the Mancos Shale in the eastern half of the Yampa quadrangle and is primarily composed of pebble to boulder conglomerate and white coarse-grained sandstone interbedded with siltstone and claystone. The total thickness of the formation is not known, but Kucera (1962) indicates that at least 520 feet (158 m) of the formation is present in the vicinity of the town of Yampa.

Holocene deposits of alluvium cover the stream valleys of the Yampa River and its tributaries.

The Cretaceous-age rocks exposed in the Yampa quadrangle accumulated close to the western edge of a Late Cretaceous-age epeirogenic seaway which covered part of the western interior of North America. Several transgressive-regressive cycles caused the deposition of a series of marine, near-shore marine, and non-marine sediments in the Yampa area (Masters, 1959; Ryer, 1977).

The Mancos Shale was deposited in an offshore marine environment which existed east of the shifting strand line. Deposition of the Mancos Shale in the quadrangle area ended with the eastward migration of the shoreline and the subsequent deposition of the Iles Formation (Kucera, 1959).

The interbedded sandstone, shale, and coal of the Mesaverde Group were deposited as a result of minor changes in the position of the shoreline. During the deposition of the Iles Formation, near-shore marine, littoral, brackish tidal, brackish and fresh-water supratidal, and fluvial environments existed in the Yampa area. The sandstones of the Iles Formation were deposited in shallow marine and near-shore environments. The lenticular coal beds of the Lower Coal Group were generally deposited in environments associated with fluvial systems, such as back-levee and coastal plain swamps, interchannel basin areas, and abandoned channels. A large rise in sea level, resulting in a landward movement of the shoreline, ended the deposition of the near-shore and continental sediments of the Mesaverde Group (O'Boyle, 1955; Konishi, 1959).

The Miocene-age Browns Park Formation was deposited in the Yampa area after a long period of non-deposition and erosion. It is a continental deposit consisting of fluvial and eolian deposits, and much of its thickness has been removed as a result of late Cenozoic erosion.

Structure

The Yampa KRCRA lies in the southern extension of the Washakie/Sand Wash structural basin of south-central Wyoming. The basin is bordered on the east by the Park Range, approximately 13 miles (21 km) east of the Yampa quadrangle, and on the southwest by the Axial Basin anticline, approximately 35 miles (56 km) west of the quadrangle. Several northwest-trending faults and two northeast-trending faults offset the Cretaceous and Tertiary rocks in the central and northeastern parts of the quadrangle (Tweto, 1976). Local synclinal folding in the northwest corner of the quadrangle has resulted from more regional late Cenozic tectonic activity to the east.

COAL GEOLOGY

Several coal beds in the Lower Coal Group of the Mesaverde Group have been identified in the Yampa quadrangle. The Lower Coal Group includes all coal beds in the Iles Formation beginning about 200 feet (61 m) above the base of the formation and extending upward to the Trout Creek Sandstone Member. However, the Trout Creek Sandstone Member has been removed by erosion in this quadrangle. In general, coal beds in the Lower Coal Group tend to be lenticular and of limited areal extent.

Chemical analyses of coal.--Chemical analyses of coal in the Lower Coal Group are listed in table 1. Samples were taken from the Brazil-Hastings Mine in sec. 11, T. 3 N., R. 86 W., and the Gwynn Mine in SW 1/4 SE 1/4 sec. 12, T. 3 N., R. 86 W. The analyses indicate that the coal is high-volatile C bituminous in rank on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Lower Coal Group

Bass and others (1955) recognized three coal zones in the Lower Coal Group over most of the area they studied, but it appears that only the lower two zones occur in this quadrangle. Ordinarily, each zone contains numerous thin coal beds; however, only four have been identified throughout the Lower Coal Group in the northwest corner of the quadrangle; one coal bed in zone 1, another in zone 2, and two coal beds that cannot be placed accurately in either zone. None of the coal beds are formally named, but where the coal beds exceed Reserve Base thickess (5.0 feet or 1.5 meters) they have been given bracketed numbers for identification purposes in this quadrangle only.

Coal Zone 1

Zone 1 is located approximately 200 feet (61 m) above the base of the Iles Formation and is probably between 45 to 75 feet (14 to 23 m) in thickness (Bass and others, 1955). One coal bed exceeding Reserve Base thickness, the LG1[2] (Lower Group, zone 1, coal bed [2]), was identified in a drill hole at one location only and has been treated as an isolated data point (see Isolated Data Points section of this report).

Coal Zone 2

According to Bass and others (1955), zone 2 is located approximately 90 feet (27 m) stratigraphically above the top of zone 1 and ranges in thickness from about 40 to 110 feet (12 to 34 m). This zone probably contains other thin coal beds, but only the LG2[3] coal bed is mapped in the northwest corner of the Yampa quadrangle. The isopach map of this coal bed is shown in figure 1. (Figures are presented on pages 13 through 18.)

The LG2[3] coal bed has been identified in drill holes and measured sections and has been mined locally in the SW 1/4 sec. 12, T. 3 N., R. 86 W. This coal bed ranges in thickness from 5+ to 11.5 feet (1.5+ to

3.5 m), excluding a thin rock parting that varies from 0.1 to 2.5 feet (0.03 to 0.8 m) thick. As calculated from figure 5, the dips of the LG2[3] coal bed are quite variable, ranging from about 14° north to approximately 7° northeast and northwest.

Undifferentiated Coal Beds

Two coal beds in the Lower Coal Group were penetrated by a drill hole in the SW 1/4 NW 1/4 sec. 19, T. 3 N., R. 86 W., and cannot be located in the stratigraphic section with enough accuracy to place the coal beds in either zones 1 or 2. Only one of the coal beds, the LG[1], exceeds Reserve Base thickness and has been treated as an isolated data point.

Isolated Data Points

In instances where single or isolated measurements of coal beds thicker than 5.0 feet (1.5 m) are encountered, the standard criteria for construction of isopach, structure contour, mining ratio, and overburden isopach maps are not available. The lack of data concerning these beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other, better known beds. For this reason, isolated data points are included in a separate figure for non-isopached coal beds (figure 5).

COAL RESOURCES

Data from drill holes, mine measured sections, and outcrops were used to construct outcrop, isopach, and structure contour maps of the LG2[3] coal bed in the Yampa quadrangle. The source of each indexed data point shown on plate 1 is listed in table 4.

Coal resources for Federal Land of the LG2[3] coal bed were calculated using data obtained from the coal isopach map (figure 1) and the areal distribution and identified resources map (figure 4). The coal-bed acreage (measured by planimeter) multiplied by the average thickness of the coal bed, and by a conversion factor of 1,800 short tons of coal per acre-foot (13,238 metric tons per hectare-meter) for bituminous coal, yields the coal resources in short tons. Coal beds thicker than 5 feet (1.5 m) that lies less than 3,000 feet (914 m) below the ground surface are included. These criteria differ from those stated in U.S. Geological Survey Bulletin 1450-B which call for a minimum thickness of 28 inches (70 cm) and a maximum depth of 1,000 feet (305 m) for bitumonous coal.

Reserve Base and Reserve tonnages for the LG2[3] coal bed are shown in figure 4 and are rounded to the nearest 10,000 short tons (9,072 metric tons). Only Reserve Base tonnages (designated as inferred resources) are calculated for areas influnced by isolated data points. Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 3.38 million short tons (3.07 million metric tons) for the entire quadrangle, including tonnages in the isolated data points. Reserve Base tonnages from the various development potential categories for surface and subsurface mining methods are shown in tables 2 and 3.

Dames & Moore has not made any determination of economic recoverability for any of the coal beds described in this report.

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn to coincide with the boundaries of the smallest legal land subdivisions shown on plate 2. In sections or parts of sections where no land subdivisions have been surveyed by the BLM, approximate 40-acre (16-ha) parcels have been used to show the limits of the high, moderate, or low development potentials. A constraint imposed by the BLM specifies that the highest development potential affecting any part of a 40-acre (16-ha) lot, tract, or parcel be applied to that entire lot, tract, or parcel. For example, if 5 acres (2 ha) within a parcel meet criteria for a high development potential; 25 acres (10 ha), a moderate development potential; and 10 acres (4 ha), a low development potential; then the entire 40 acres (16 ha) are assigned a high development potential.

Development Potential for Surface Mining Methods

Areas where the coal beds of Reserve Base thickness are overlain by 200 feet (61 m) or less of overburden are considered to have potential for surface mining 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 ratios for surface mining of coal is as follows:

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

where MR = mining ratio

t_o = thickness of overburden in feet

t_c = thickness of coal in feet

rf = recovery factor (85 percent for this quadrangle)

cf = conversion factor to yield MR value in terms of cubic yards of overburden per short tons of recoverable coal:
0.911 for subbituminous coal
0.896 for bituminous coal

Note: To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply MR by 0.8428.

Areas of high, moderate, and low development potential for surface mining methods are defined as areas underlain by coal beds having respective mining-ratio values of 0 to 10, 10 to 15, and greater than 15. 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.

Areas where the coal data is absent or extremely limited between the 200-foot (61-m) overburden line and outcrop are assigned unknown development potential for surface mining methods. This applies to areas where coal beds 5.0 feet (1.5 m) or more thick are not known, but may occur, and to those areas influenced by isolated data points. Limited knowledge pertaining to the areal distribution, thickness, depth and attitude of the coals in these areas prevents accurate evaluation of development potential in the high, moderate, or low categories. The areas influenced by isolated data points in this quadrangle contain approximately 1.13 million short tons of coal available for surface mining.

The coal development potential for surface mining methods is shown in figure 6. All of the Federal land areas having a known development potential for surface mining are rated high. The remaining Federal lands within the KRCRA boundary are classified as having unknown development potential for surface mining methods.

Development Potential for Subsurface and In-Situ Mining Methods

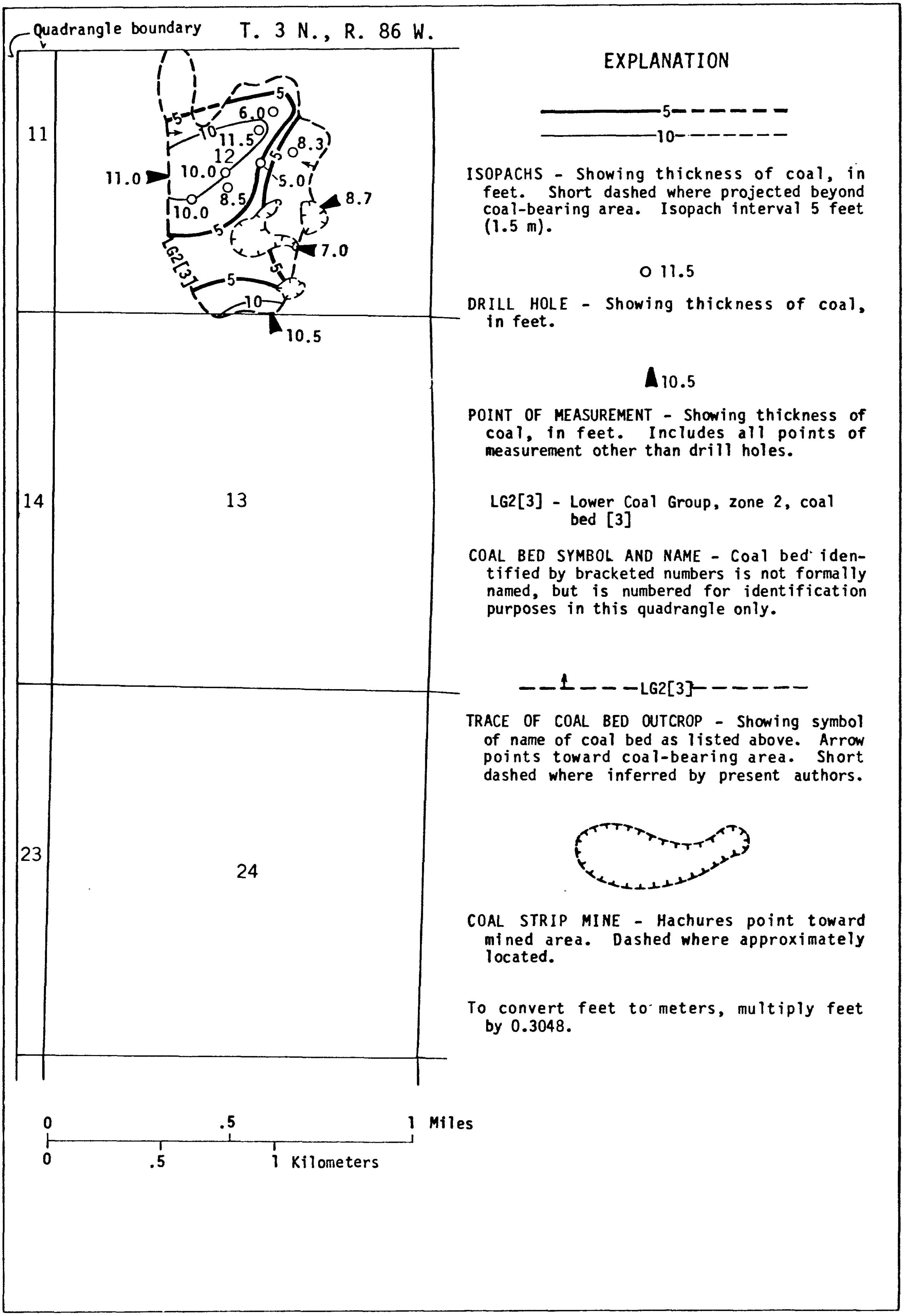
Areas considered to have a development potential for conventional subsurface mining methods are those areas where the coal beds of Reserve Base thickness are between 200 and 3,000 feet (61 and 914 m) below the ground surface and have dips of 15° or less. Unfaulted coal beds lying between 200 and 3,000 feet (61 and 914 m) below the ground surface, dipping greater than 15°, are considered to have a development potential for in-situ mining methods.

Areas of high, moderate, and low development potential for conventional subsurface mining methods are defined as areas underlain by coal beds at depths ranging from 200 to 1,000 feet (61 to 305 m), 1,000 to 2,000 feet (305 to 610 m), and 2,000 to 3,000 feet (610 to 914 m), respectively.

Areas where the coal data is absent or extremely limited between 200 and 3,000 feet (61 and 914 m) below the ground surface are assigned unknown development potentials. This applies to areas where coal beds of Reserve Base thickness are not known, but may occur, and to those areas influenced by isolated data points. The areas influenced by isolated data points in this quadrangle contain approximately 1.02 million short tons (0.93 million metric tons) of coal available for conventional subsurface mining.

Since the Federal lands within the KRCRA boundary in this quadrangle are not known to contain coal beds of Reserve Base thickness at depths between 200 and 3,000 feet (61 and 914 m), except for the area influenced by the isolated data point, all of these Federal lands have been classified as having unknown development potential for conventional subsurface mining methods.

Because the coal beds in this quadrangle have dips less than 15°, all Federal land areas within the KRCRA boundary have been rated as having unknown development potential for in-situ mining methods.



EXPLANATION

ISOPACHS - Showing thickness of coal, in feet. Short dashed where projected beyond coal-bearing area. Isopach interval 5 feet (1.5 m).

DRILL HOLE - Showing thickness of coal, in feet.

POINT OF MEASUREMENT - Showing thickness of coal, in feet. Includes all points of measurement other than drill holes.

LG2[3] - Lower Coal Group, zone 2, coal bed [3]

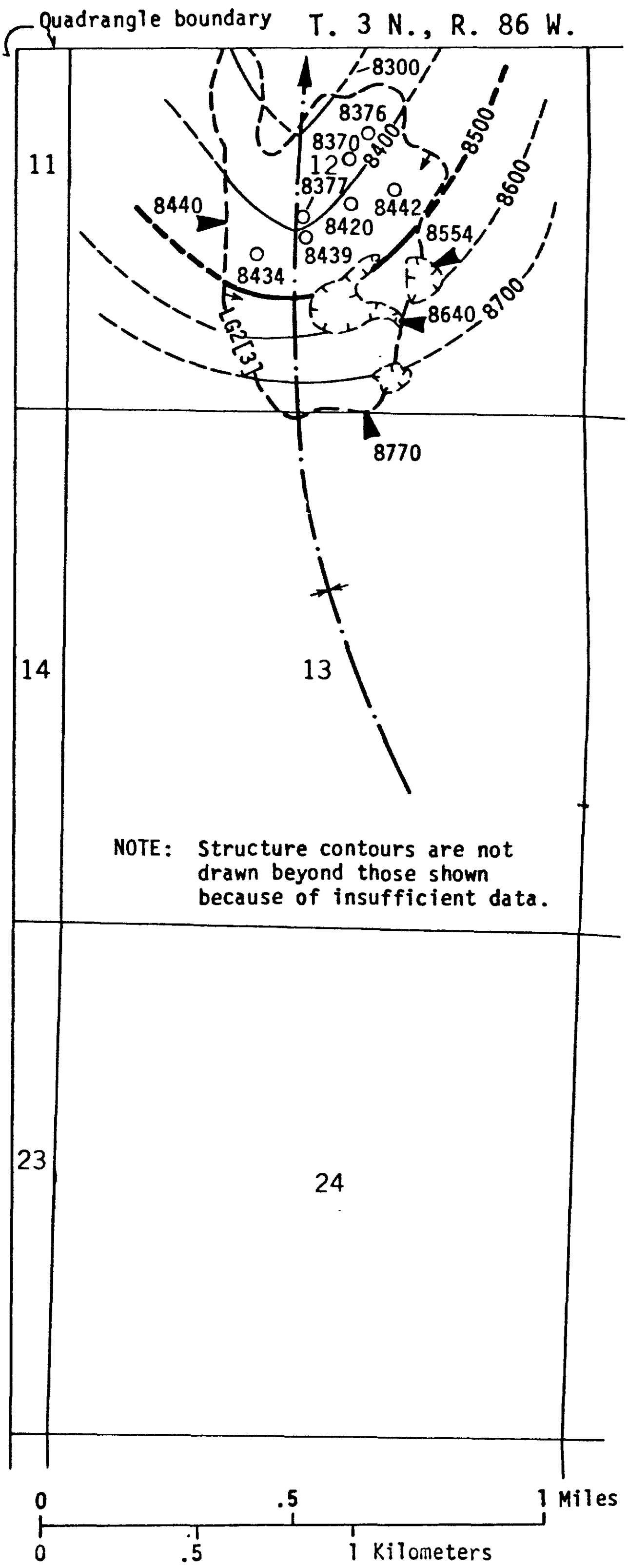
COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Short dashed where inferred by present authors.

COAL STRIP MINE - Hachures point toward mined area. Dashed where approximately located.

To convert feet to meters, multiply feet by 0.3048.

FIGURE 1. — Isopach map of the Lower Coal Group, zone 2, coal bed [3].



NOTE: Structure contours are not drawn beyond those shown because of insufficient data.

EXPLANATION

———— 8500 – – – – –
———— 8400 – – – – –

STRUCTURE CONTOURS - Drawn on top of coal bed. Solid where vertical accuracy within 40 feet; Short dashed where projected above ground surface. Contour interval is 100 feet (31 m). Datum is mean sea level.

o 8376

DRILL HOLE - Showing altitude of top of coal bed, in feet.

▲ 8440

POINT OF MEASUREMENT - Showing altitude of top of coal bed, in feet.

LG2[3] - Lower Coal Group, zone 2, coal bed [3]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

– – –↑– – – – –LG2[3]– – – – – – – –

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Short dashed where inferred by present authors.

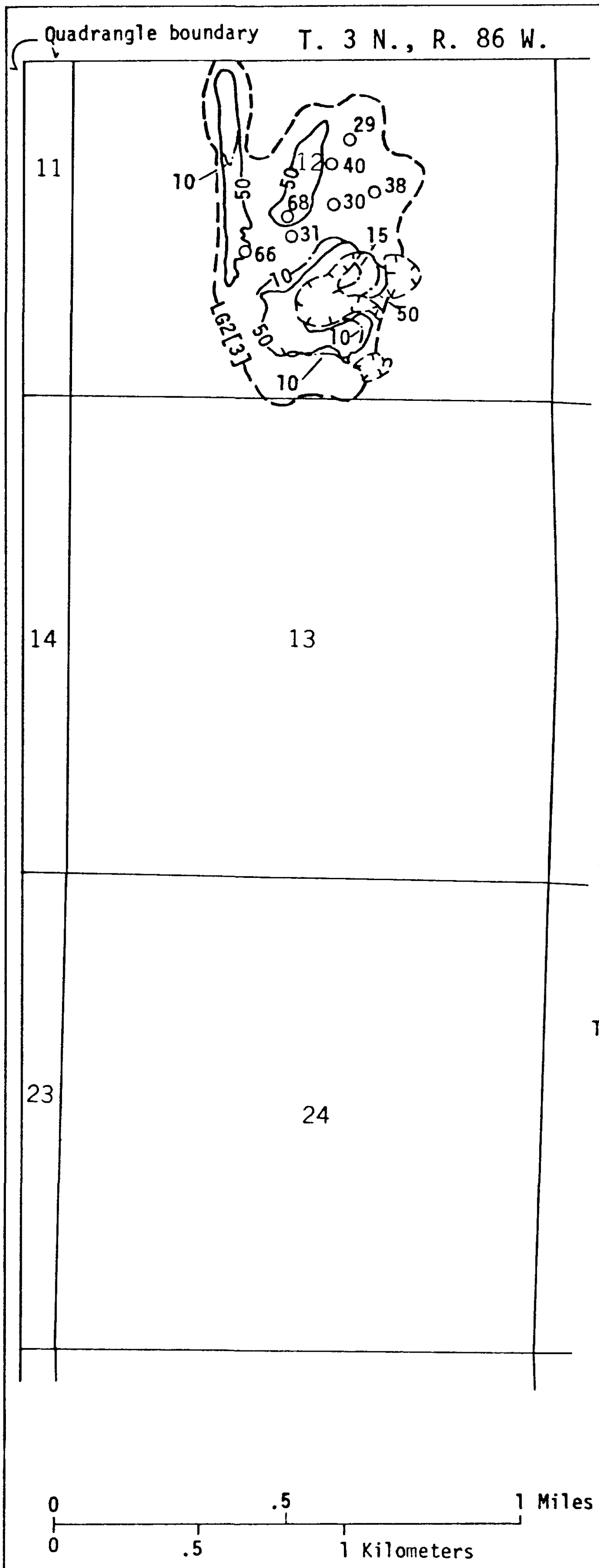
←——·—┼—·———·——

SYNCLINE - Showing trace of axial plane and direction of plunge.

COAL STRIP MINE - Hachures point toward mined area. Dashed where approximately located.

To convert feet to meters, multiply feet by 0.3048.

FIGURE 2. — Structure contour map of the Lower Coal Group, zone 2, coal bed [3].



EXPLANATION

——————50——————

OVERBURDEN ISOPACHS - Showing thickness of overburden, in feet, from surface to top of coal bed. Isopach interval is 50 feet (15 m).

○ 29

DRILL HOLE - Showing thickness of overburden, in feet, from surface to top of coal bed.

———·———15———·———

MINING-RATIO CONTOUR - Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown in areas underlain by coal within the stripping-limit (in this quadrangle, the 200-foot-overburden isopach). To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply mining ratio by 0.8428.

LG2[3] - Lower Coal Group, zone 2, coal bed [3]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

--------LG2[3]--------

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Short dashed where inferred by present authors.

COAL STRIP MINE - Hachures point toward mined area. Dashed where approximately located.

To convert feet to meters, multiply feet by 0.3048.

FIGURE 3. — Overburden isopach and mining ratio map of the Lower Coal Group, zone 2, coal bed [3].

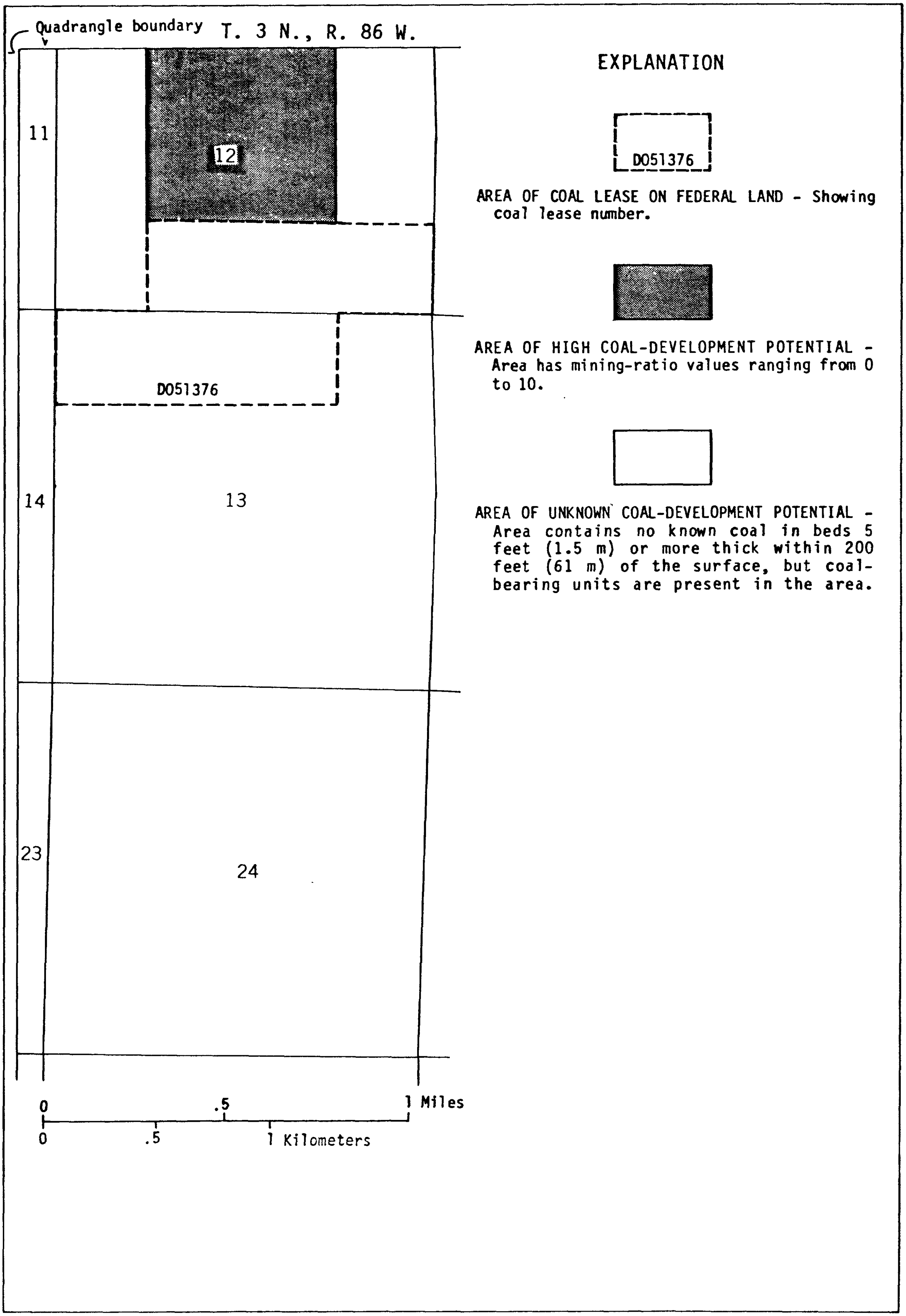


FIGURE 6. — Coal development potential map for surface mining methods.

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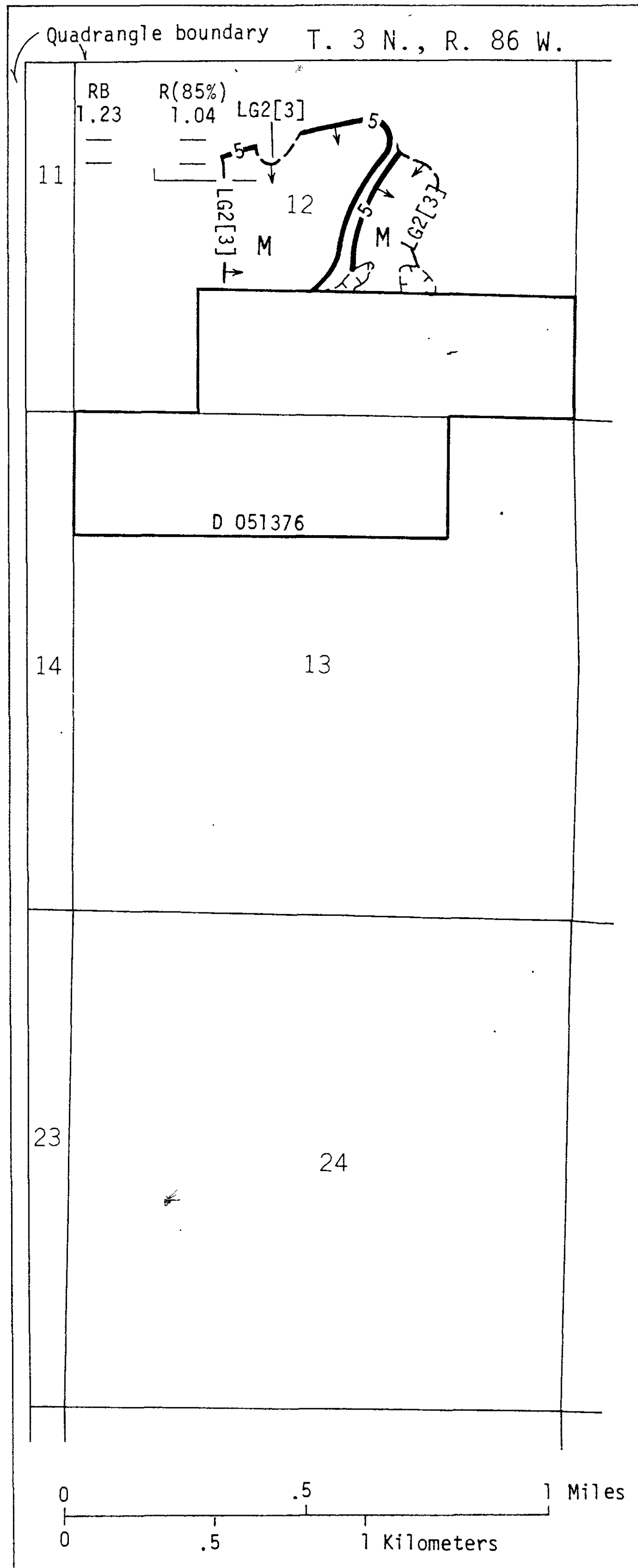


EXPLANATION

D 051376

AREA OF COAL LEASE ON FEDERAL LAND - Showing coal lease number.

5

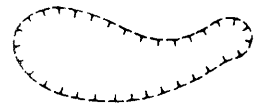
ISOPACH - Showing thickness of coal, in feet. Arrow points toward area where coal bed is 5 feet or more thick.

LG2[3] - Lower Coal Group, zone 2, coal bed [3]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

LG2[3]

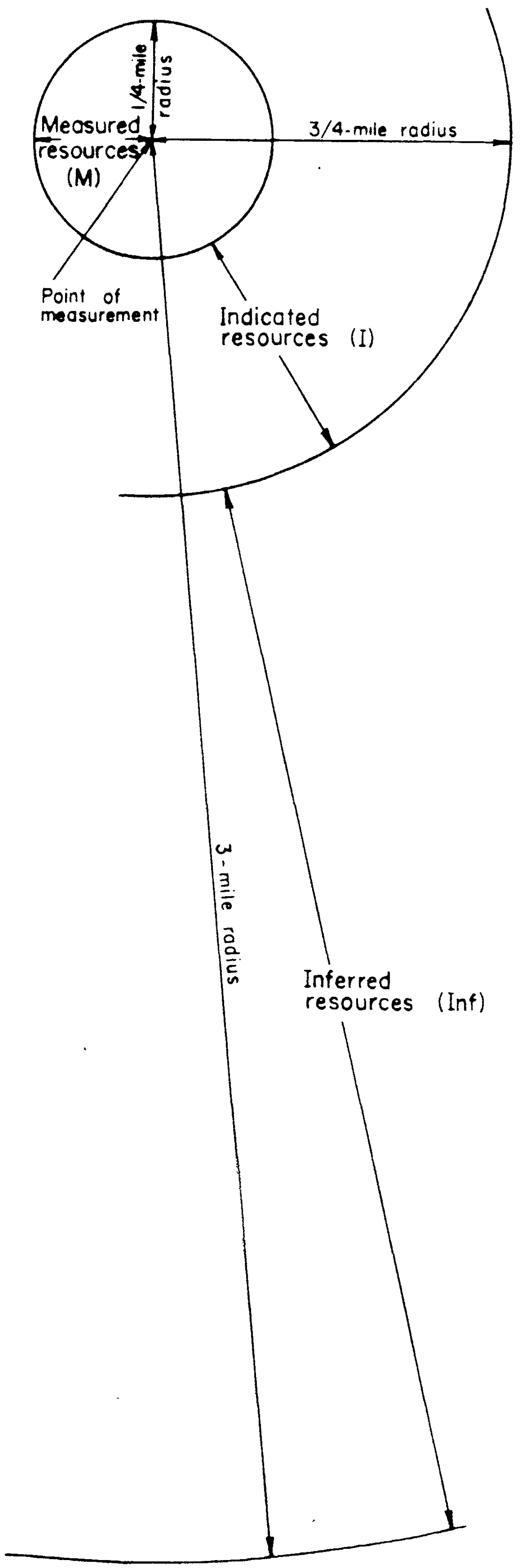
TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Short dashed where inferred by present authors.



COAL STRIP MINE - Hachures point toward mined area. Dashed where approximately located.

RB	R(85%)	
1.23	1.04	(Measured)
—	—	(Indicated)
—	—	(Inferred)

IDENTIFIED COAL RESOURCES - Showing totals for Reserve Base (RB) and Reserves (R), in millions of short tons, for each section or part of section of non-leased Federal coal land, both within and beyond the stripping-limit line. Reserve (R) tonnage is calculated by multiplying the Reserve Base (RB) tonnage by the appropriate recovery factor. Dash indicates no resource in that category.



BOUNDARY LINES - Enclosing areas of measured (M), indicated (I), and inferred (Inf) coal resources.

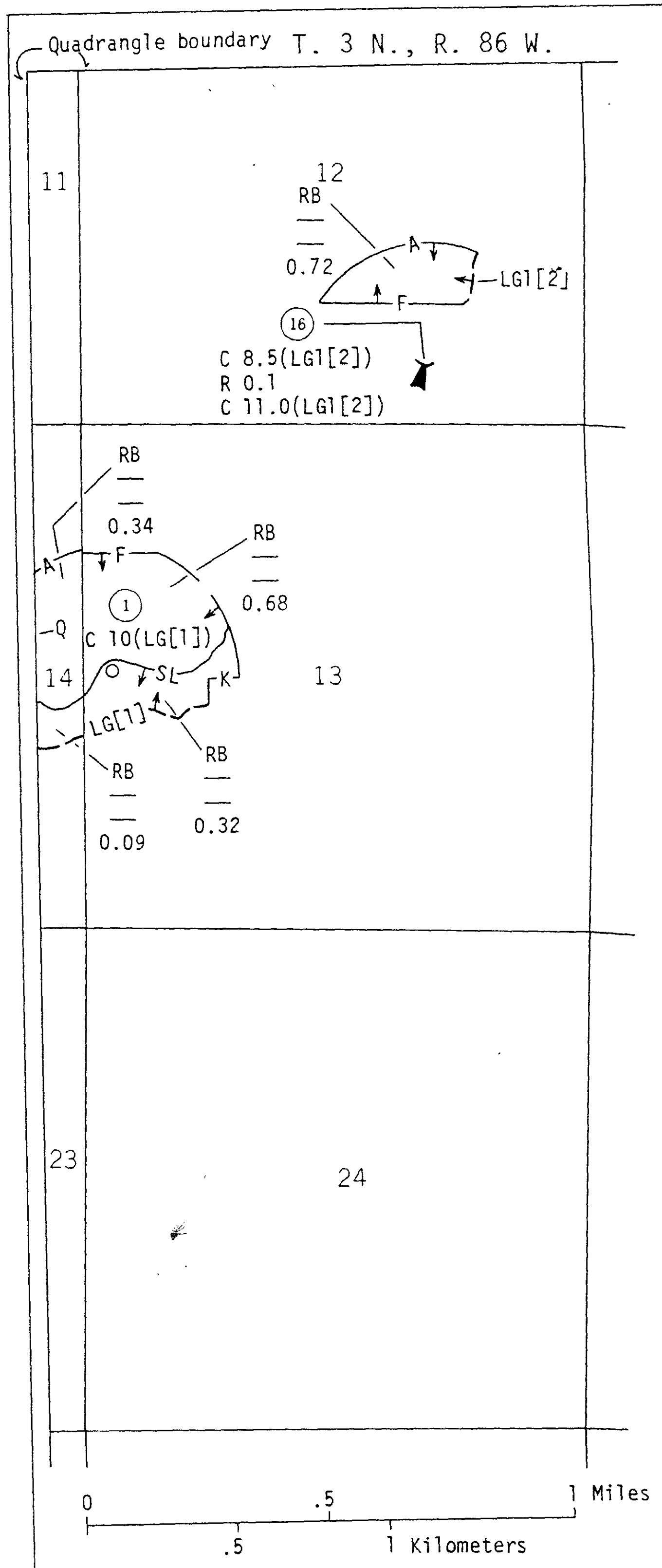
To convert feet to meters, multiply feet by 0.3048.

To convert short tons to metric tons, multiply short tons by 0.9072.

To convert miles to kilometers, multiply miles by 1.6093.

FIGURE 4. — Areal distribution and identified resources map of the Lower Coal Group, zone 2, coal bed [3].

79-822



EXPLANATION

○ ①
C 10(LG[1])

DRILL HOLE - Showing thickness of coal, in feet. Index number refers to hole on plate 1 of CRO map or in table of text. Letters designate name of coal bed as listed below. Bracketed number identifies coal bed named on plates 1 or 3.

▲ ⑯
C 8.5(LGl[2])
R 0.1
C 11.0(LGl[2])

POINT OF MEASUREMENT - Showing thickness of coal, in feet. Includes all points of measurement other than drill holes. Index number refers to hole on plate 1 of CRO map or in table of text. Letters designate name of coal bed as listed below. Bracketed number identifies coal bed named on plates 1 or 3.

LGl[2] - Lower Coal Group, zone 1, coal bed [2]
LG[1] - Lower Coal Group, coal bed [1]

COAL BED SYMBOLS AND NAMES - Coal beds identified by bracketed numbers are not formally named, but are numbered for identification purposes in this quadrangle only.

– – – ⊥ – – LG[1] – – – – –

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Short dashed where inferred by present authors.

———————SL———————

STRIPPING-LIMIT LINE - Boundary for surface mining (in this quadrangle, the 200-foot-overburden isopach). Arrow points toward area suitable for surface mining.

———↑———A———————

BOUNDARY OF IDENTIFIED RESERVE BASE COAL - Drawn along the coal bed outcrop, an arc (A) drawn 0.25 miles from the nearest point of Reserve Base coal bed measurement, the KRCRA boundary (K), the Federal coal lease boundary (F), and the quadrangle boundary (Q). Arrow points toward area of identified Reserve Base coal.

RB
— (Measured)
— (Indicated)
0.72 (Inferred)

IDENTIFIED COAL RESOURCES - Showing totals for Reserve Base (RB), in millions of short tons, for each section or part(s) of section of non-leased Federal coal land, either within or beyond the stripping-limit. Dash indicates no resources in that category.

To convert short tons to metric tons, multiply short tons by 0.9072.

To convert feet to meters, multiply feet by 0.3048.

To convert miles to kilometers, multiply miles by 1.6093.

SCALE - 1:24,000 (1 inch = 2,000 feet)

FIGURE 5. — Areal distribution and identified resources map of non-isopached coal beds.

Table 1. -- Chemical analyses of coals in the Yampa quadrangle, Routt County, Colorado.

Location	COAL BED NAME	Form of Analysis	Proximate				Ultimate					Heating Value	
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu/Lb
Sec. 11, T. 3 N., R. 86 W., Brazil-Hastings Mine (George and others, 1937)	Iles Formation, Lower Coal Group No. 2	A	8.9	36.5	48.5	6.1	0.7	-	-	-	-	6,667	12,000
		C	-	40.1	53.2	6.7	0.8	-	-	-	-	7,322	13,180
SW¼, SE¼, sec. 12, T. 3 N., R. 86 W., Gwynn Mine (George and others, 1937)	Iles Formation Lower Coal Group No. 2	A	9.9	37.6	49.1	3.4	0.6	-	-	-	-	6,739	12,130
		C	-	41.8	54.5	3.7	0.6	-	-	-	-	7,478	13,460

Form of Analysis: A, as received
C, moisture free

Note: To convert Btu/pound to kilojoules/kilogram, multiply by 2.326

Table 2. -- Coal Reserve Base data for surface mining methods for Federal coal lands (in short tons) in the Yampa quadrangle, Routt County, Colorado.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
LG2 {3}	1,200,000	30,000	-	-	1,230,000
Isolated Data Points	-	-	-	1,130,000	1,130,000
Totals	1,200,000	30,000	-	1,130,000	2,360,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 3. -- Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Yampa quadrangle, Routt County, Colorado.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Isolated Data Points	-	-	-	1,020,000	1,020,000
Totals	-	-	-	1,020,000	1,020,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 4. -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	U.S. Geological Survey, 1957, Inactive Coal Prospecting Permit No. Colorado 023207, Edna Coal Co.	Drill hole No. 3
2	↓	Drill hole No. 6
3		Drill hole No. 19
4		Drill hole No. 33
5		Drill hole No. 18
6		Drill hole No. 23
7		Drill hole No. 20
8		Drill hole No. 28
9		Drill hole No. 21
10		Drill hole No. 26
11		Drill hole No. 27
12	U.S. Geological Survey, 1936, Inactive Coal Prospecting Permit No. Denver-032589, H. I. Smith	Mine Measured Section
13	Bass, N. W., and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 22	Measured Section No. 39
14	↓	Measured Section No. 40
15		Measured Section No. 41
16		Measured Section No. 42
17		Measured Section No. 43

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