UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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1985

FEDERAL COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE SAN LUCAS DAM 7 1/2-MINUTE QUADRANGLE, McKINLEY COUNTY, NEW MEXICO

[Report includes 14 plates]

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SAN LUCAS DAM QUADRANGLE
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INTRODUCTION

Purpose

This text complements the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the San Lucas Dam 7½ minute quadrangle, McKinley County, New Mexico. These maps and report are part of an evaluation of fifty-six 7 ½ minute quadrangles in northwestern New Mexico which were completed under U. S. Geological Survey Contract No. 14-08-0001-17459 (see figs. 1 and 2).

The purpose of this Coal Resource Occurrence-Coal Development Potential program, which was conceived by Congress as part of its Federal Coal Leasing Amendments Act of 1976, is to obtain coal resource information and to determine the geographical extent of Federal coal deposits. In addition, the program is intended to provide information on the amount of coal recoverable by various mining methods and to serve as a guide for land-use planning.

The U. S. Geological Survey initiated the program by identifying areas underlain by coal resources. These areas were designated Known Recoverable Coal Resource Areas based on the presence of minable coal thicknesses, adequate areal extent of these coal deposits, and the potential for developing commercial quantities of coal at minable depths.

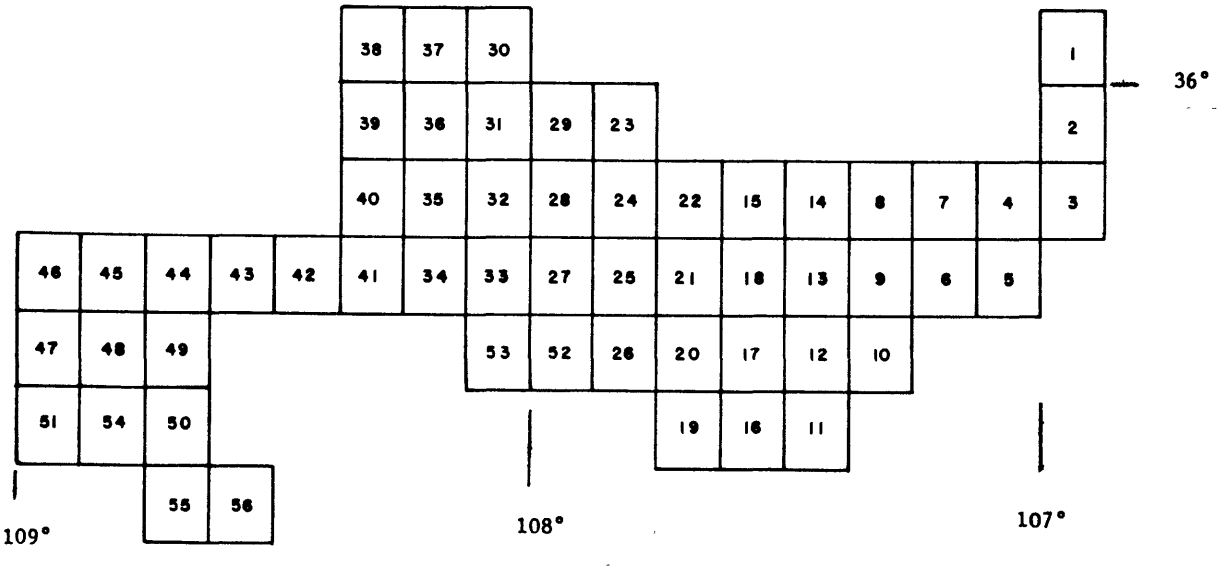
This report is limited to coal resources which are 3,000 ft (914 m) or less below ground surface. Published and unpublished public information was used as the data base for this study. No new drilling of field mapping was performed as part of this study, nor were any confidential data used.


LOCATION OF PROJECT AREA
PROJECT AREA
AREA OF THIS REPORT
COLORADO
ARIZONA
FARMINGTON
ALBUQUERQUE
Grants
Bloomfield
Aztec
Bernalillo
Window Rock
Estancia

FIGURE 1

FIGURE 2.--Index to USGS 7 1/2-minute quadrangles and coal resource occurrence/ coal development potential maps for the southern San Juan Basin area, New Mexico

Map No.	Quadrangle	Open-file report
1	Cuba	79- 623
2	San Pablo	79- 624
3	La Ventana	79-1038
4	Headcut Reservoir	79-1043
5	San Luis	79-1044
6	Arroyo Empedrado	79-1045
7	Wolf Stand	79-1046
8	Tinian	79- 625
9	Canada Calladita	79- 626
10	Cerro Parido	79- 627
11	El Dado Mesa	79- 628
12	Mesa Cortada	79- 629
13	Mesita del Gavilan	79- 630
14	Rincon Marquez	79- 631
15	Whitehorse Rincon	79- 632
16	Mesita Americana	79- 633
17	El Dado	79- 634
18	Cerro Alesna	79- 635
19	San Lucas Dam	79- 636
20	Piedra de la Aguila	79-1039
21	Hospah	79- 637
22	Whitehorse	79-1040
23	Seven Lakes NE	79- 638
24	Kin Nahzin Ruins	79- 639
25	Orphan Annie Rock	79-1041
26	Mesa de los Toros	79-1122
27	Laguna Castillo	79- 640
28	Seven Lakes	79-1042
29	Seven Lakes NW	79-1123
30	Kin Klizhin Ruins	79-1047
31	Nose Rock	79- 641
32	Becenti Lake	79-1124
33	Heart Rock	79- 642
34	Crownpoint	79-1125
35	Antelope Lookout Mesa	79-1376
36	Milk Lake	79-1377
37	La Vida Mission	79-1378
38	The Pillar 3 SE	79-1379
39	Red Lake Well	79-1380
40	Standing Rock	79-1381
41	Dalton Pass	80- 026
42	Oak Spring	80- 027
43	Hard Ground Flats	80- 028
44	Big Rock Hill	80- 029
45	Twin Lakes	80- 030
46	Tse Bonita School	80- 031
47	Samson Lake	80- 032
48	Gallup West	80- 033
49	Gallup East	80- 034
50	Bread Springs	80- 035
51	Manuelito	80- 036
52	Borrego Pass	80- 037
53	Casamero Lake	80- 038
54	Twin Buttes	80- 039
55	Pinehaven	80- 040
56	Upper Nutria	80- 041



Location

The San Lucas Dam 7 1/2 minute quadrangle includes acreage in Tps. 13, 14, and 15 N., Rs. 7, 8, and 9 W. of the New Mexico Principal Meridian, McKinley County, northwestern New Mexico (see figs. 1 and 2).

Accessibility

No paved roads pass through the San Lucas Dam quadrangle. A light-duty private road provides access to the town of San Mateo, 3.5 mi (5.6 km) south of the quadrangle, and to the town of El Dado, 8.0 mi (12.0 km) northeast of the quadrangle. Unimproved dirt roads traverse most parts of the area. The Atchison, Topeka, and Santa Fe Railroad line passes about 22 mi (35 km) due south of the quadrangle (see fig. 1).

Physiography

The San Lucas Dam quadrangle is in the Navajo section of the southernmost part of the Colorado Plateau physiographic province (U. S. Geological Survey, 1965). The topography of the quadrangle is mesa-and-canyon. San Mateo Mesa is a broad topographic feature in the south and west central parts of the quadrangle.

No perennial streams are present in the quadrangle. Local drainage is provided by several intermittent arroyos. Elevations within the quadrangle range from less than 6,740 ft (2,054 m) in the northeast corner to 8,244 ft (2,513 m) on San Mateo Mesa.

Climate

The climate of this area is semiarid to arid. The following temperature and precipitation data were reported by the National Oceanic and Atmospheric Administration for the San Mateo Station. The San Lucas Dam quadrangle is about 3.5 mi (5.6 km) N. of the San Mateo Station. Average total annual precipitation for ten of the previous fifteen years is 8.37 in. (21.26 cm). Intense thunderstorms in July, August, and September account for the majority of precipitation. The area is susceptible to flash flooding associated with these thunderstorms. Mean annual temperature for four of the previous fifteen years is 48.8°F (9.3°C). The average daily temperatures in January and July are 28.3°F (-2.1°C) and 69.0°F (20.6°C), respectively.

Land status

The Federal Government holds coal rights to approximately 60 percent of the San Lucas Dam quadrangle. For the specific coal ownership boundaries, see plate 2. It is not within the scope of this report to provide detailed land-surface ownership. About 4,500 acres (1,821 ha) in the northeast portion of the quadrangle are within the Hospah Known Recoverable Coal Resource Area. About 1,000 acres (405 ha) in the northwest corner of the quadrangle are within the Crownpoint Known Recoverable Coal Resource Area. The Bartolome Fernandez Land Grant occupies the eastern one-fifth of the quadrangle. As of October 26, 1978, there were no Federal coal leases, coal preference right lease applications or coal exploration licenses within the San Lucas Dam quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include that of Gardner (1910) who measured a Gibson Coal Member outcrop in the quadrangle. Hunt (1936) measured several Gibson and Cleary Coal Member seams in the area. Santos (1966) mapped the geology of the area without regard to coal occurrences. Shomaker, Beaumont, and Kottlowski (1971) discussed Gibson and Dilco Coal Member beds and noted the only bed thicker than 3.0 ft (0.9 m) was dipping too steeply for surface mining. They made no reserve estimates in the area.

Stratigraphy

Within the San Juan Basin, the shoreline positions of the Cretaceous seaways changed innumerable times. The overall regional alignment of the shorelines trended N. 60^{o} W. - S. 60^{o} E. (Sears, Hunt, and Hendricks, 1941). The transgressive and regressive shoreline migrations are evidenced by the intertonguing relationships of continental and marine facies. Rates of trough (geosynclinal) subsidence and the availability of sediment supplies are the major factors that controlled the transgressive-regressive shoreline sequences.

Exposed rock units in the San Lucas Dam quadrangle include some of the sedimentary units of Upper Cretaceous age. Tertiary basalts cover portions of the quadrangle surface, and Quaternary alluvial and talus deposits are present in the area.

A major northeastward regression of the Cretaceous seaways resulted in the deposition of the Gallup Sandstone in a beach or littoral environment. The Gallup Sandstone is composed of pink to gray, fine-to medium-grained massive sandstone with interbedded gray shales, and ranges from 100 to 160 ft (30 to 49 m) thick locally. The Dilco Coal Member of the Crevasse Canyon Formation overlies the Gallup Sandstone and represents the continental deposits which formed inland from the beach area during deposition of the Gallup Sandstone. Medium to dark gray siltstone with interbedded medium-grained, tan sandstones, and coal beds comprise the lithologies of the Dilco Coal Member, which ranges from 100 to 130 ft (30 to 40 m) thick locally.

Increased rates of trough subsidence caused the regressive sequence to gradually slow, and finally stop. The seaways deepened and the shorelines advanced southwestward during the succeeding transgressive phase. The Mulatto Tongue of the Mancos Shale overlies the Dilco Coal Member and is composed of light gray to tan, silty shale with interbedded reddish-tan, very fine-grained sandstone. Thickness of the unit ranges from 370 to 420 ft (113 to 128 m) locally. A transitional contact of the Mulatto Tongue with the overlying Dalton Sandstone Member of the Crevasse Canyon Formation indicates the gradual reversal from transgressive to regressive depositional conditions.

The Dalton Sandstone Member is composed of yellowish-gray, very fine-grained, quartzose sandstone which formed in a nearshore environment, and ranges from 65 to 115 ft (20 to 35 m) thick locally. The Gibson Coal Member of the Crevasse Canyon Formation overlies the Dalton Sandstone Member and represents the continental deposits which formed inland from the beach area

during deposition of the Dalton Sandstone Member. Medium gray, carbonaceous siltstone with interbedded gray to tan sandstone, and coal beds comprise the lithologies of the Gibson Coal Member, which ranges from 240 to 285 ft (73 to 87 m) thick locally. Increased rates of trough subsidence resulted in the gradual reversal from regressive to transgressive conditions, and the nearshore Hosta Tongue of the Point Lookout Sandstone and the marine Satan Tongue of the Mancos Shale were deposited during the advancing shoreline sequence.

The Hosta Tongue overlies the Gibson Coal Member and is composed of light gray to reddish-brown, fine-to medium-grained sandstone with interbedded shales, and the Satan Tongue consists of light to dark gray, silty shale with interbedded tan to buff sandstone. The Satan Tongue pinches out near the central part of the San Lucas Dam quadrangle. Thickness of the Satan Tongue is up to 90 ft (27 m) near the northern quadrangle boundary. With the pinchout of the Satan Tongue, the Hosta Tongue and the overlying Point Lookout Sandstone merge into an expanded, undivided sandstone unit averaging 260 ft (79 m) thick.

The Point Lookout Sandstone represents nearshore or littoral deposits which formed during the most extensive northeastward retreat prior to the final withdrawal of the Cretaceous seaways in the San Juan Basin (Sears, Hunt, and Hendricks, 1941). Lithology of the Point Lookout Sandstone is similar to the Hosta Tongue. The continental sediments deposited inland from the beach area during deposition of the Point Lookout Sandstone compose the overlying Menefee Formation.

The Menefee Formation consists of dark gray to brown, carbonaceous to noncarbonaceous shales, light gray sandstones, and coal beds, and is

divisible into the basal Cleary Coal Member and upper Allison Member. A massive channel sandstone sequence defines the boundary between the two members. Erosion has completely eliminated the Allison Member and the upper portions of the Cleary Coal Member in this area. Maximum thickness of the Cleary Coal Member is about 150 ft (46 m) in the San Lucas Dam quadrangle.

Depositional environments

The Cretaceous System sedimentary units in the quadrangle represent transgressive and regressive depositional conditions. There were innumerable minor cycles of widely varying duration and extent within the major sedimentary sequences. The paucity of data in this quadrangle and the intended scope of this report permit only general interpretations of the depositional environments.

The Cretaceous coal deposits of the San Juan Basin are products of former coastal swamps and marshes. These swamps and marshes were supported by heavy precipitation and a climate conducive to rapid vegetal growth in moderately fresh water. Due to relatively low sulfur contents of the San Juan Basin coals, Shomaker and Whyte (1977) suggested the coals formed in fresh water environments.

Most of the coal-bearing units were deposited in coastal plain environments. The majority of the peat deposits formed in a transition zone between lower and upper deltaic sediments during periods of relative shoreline stability. Coals also formed in lake margin swamps inland from the coastal area. Shoreline oscillations and the subsequent influx of continental or marine debris upon the peat accumulations produced the vertical

buildup or "stacking" of peat deposits. This sediment debris is represented by variable ash contents, rock partings, and splits within the coal seams.

The peat accumulated in lenses or pods which were generally parallel to the ancient shorelines. The coals in the lower portions of the coal-bearing units represent regressive depositional conditions (Sears, Hunt, and Hendricks, 1941). The coals in the upper portions of these units are relatively sporadic in occurrence.

Structure

The San Lucas Dam quadrangle is in the Chaco Slope and Acoma Sag (Baltz, 1967) structural divisions in the southern portion of the structural depression known as the San Juan Basin (Kelley, 1950). The eroded San Mateo Dome is the dominant structural feature in the quadrangle. The rock units dip from 1^{o} N. to NE. on the crest of the dome, to about 11^{o} E. to NE. on the eastern flank. Hunt (1936) mapped several low displacement normal faults in the quadrangle.

COAL GEOLOGY

In this quadrangle, the authors identified three coal beds and three coal zones in oil and gas well logs and Hunt's (1936) surface mapping. The beds and zones are here informally called the Crevasse Canyon Dilco coal zone, Crevasse Canyon Gibson coal zone, Crevasse Canyon Gibson No. 2 coal bed, the Menefee Cleary No. 1 and No. 2 coal beds, and the Menefee Cleary coal zone.

Stratigraphically, the Crevasse Canyon Dilco coal zone contains the lowest identified coals in the San Lucas Dam quadrangle. The Crevasse Canyon Dilco coal zone contains several zone beds which occur from 6 to 63 ft (2 to 19 m) above the Gallup Sandstone. These beds may be correlated for limited distances in portions of the area but they lack sufficient continuity with poorly defined stratigraphic position and cannot be designated as persistent coal beds.

The Crevasse Canyon Gibson coal zone contains up to eight beds which occur from 7 to 280 ft (2 to 85 m) below the Hosta Tongue of the Point Lookout Sandstone. The Crevasse Canyon Gibson No. 2 coal bed was identified in two outcrops mapped by Hunt (1936) as being from 85 to 87 ft (26 to 27 m) below the Hosta Tongue of the Point Lookout Sandstone.

The Menefee Cleary No. 1 coal bed is the first identified coal bed above the Point Lookout Sandstone. It occurs 4 ft (1 m) above the Point Lookout Sandstone in this quadrangle, although in nearby quadrangles it is up to 15 ft (5 m) above the Point Lookout Sandstone. The bed is probably not continuous throughout the quadrangle since it was measured at only one outcrop.

The Menefee Cleary No. 2 coal bed occurs 8 ft (2 m) above the Point Lookout Sandstone in the San Lucas Dam quadrangle. It was identified in the same outcrop measurement where the Menefee Cleary No. 1 coal bed was observed. The Menefee Cleary coal zone contains the youngest identified coals in this quadrangle. Up to three beds comprise the zone which occur from 100 to 148 ft (30 to 45 m) above the Point Lookout Sandstone.

There are no published coal quality analyses for coal beds from the San Lucas Dam quadrangle. An analysis of a core sample of Cleary Coal

Member beds taken about 12 mi (19 km) northwest of the San Lucas Dam quadrangle has been reported by Shomaker, Beaumont, and Kottlowski (1971) and is shown in table 1. The Cleary Coal Member beds analyzed are probably similar in quality to the Cleary Coal Member beds in this quadrangle. Rank of the Cleary Coal Member seams is probably subbituminous A in this area.

A coal quality analysis for Gibson Coal Member beds from the Boone Mine about 11.5 mi (18.5 km) south of the quadrangle has been reported by the U. S. Bureau of Mines (1936) and is shown in table 2. The Gibson Coal Member beds analyzed are probably similar in quality to the Gibson Coal Member beds in this quadrangle. Rank of the Gibson Coal Member seams is probably high volatile C bituminous in this area.

Table 1. - Analysis of a coal sample from the Cleary Coal Member of the Menefee Formation.

(Core sample from sec. 36, T. 17 N., R. 10 W.)

[Form of analysis: A, as received; B, moisture free; C, moisture and ash free]

from Shomaker, Beaumont, and Kottlowski, 1971

Form of analysis	Proximate analysis (percent)				Sulfur	Heating value (Btu/lb)
	Moisture	Volatile Matter	Fixed Carbon	Ash		
A	16.5	33.4	40.4	9.7	0.6	10,070
B	----	40.0	48.3	11.7	0.7	12,060
C	----	45.3	54.7	----	0.8	13,650

Remarks:

A moist, mineral-matter-free (MMMF) calculation using the Parr formula (American Society for Testing and Materials, 1973) yields a heating value of 11,256 Btu/lb (26,181 kJ/kg). The free-swelling index of the analysis shows the sample to be nonagglomerating.

Table 2. - Analysis of a coal sample from the Gibson Coal Member of the Crevasse Canyon Formation (Mine sample from sec. 6, T. 11 N., R. 8 W.)

[Form of analysis: A, as received; B, moisture free]

from U. S. Bureau of Mines, 1936

Form of analysis	Proximate analysis (percent)				Sulfur	Heating value (Btu/lb)
	Moisture	Volatile Matter	Fixed Carbon	Ash		
A	13.5	37.9	42.9	5.7	0.6	11,400
B	----	43.8	49.6	6.6	0.7	13,170

Remarks:

A moist, mineral-matter-free (MMMF) calculation using the Parr formula (American Society for Testing and Materials, 1973) yields a heating value of 12,159 Btu/lb (28,282 kJ/kg). No agglomerating characteristics were included with the analysis.

Menefee Cleary No. 2 coal bed

The Menefee Cleary No. 2 coal bed was identified by Hunt (1936) in a single outcrop with 3.7 ft (1.1 m) of coal. This outcrop occurs near the eastern quadrangle boundary within the unsurveyed Bartolome Fernandez land grant. The 0, 3, and 5 ft (0, 0.9, and 1.5 m) isopachs (plate 4) along the northern quadrangle boundary are inferred from Menefee Cleary No. 2 coal data from the northern adjacent Piedra de la Aguila quadrangle. Existence and character of the Menefee Cleary No. 2 bed are unknown in most of the quadrangle because of insufficient data.

Crevasse Canyon Gibson coal zone

The Crevasse Canyon Gibson coal zone was identified in two drill holes and numerous measured sections by Hunt (1936). The zone crops out over most of the quadrangle, and contains from one to eight individual beds with up to 22.0 ft (6.7 m) of coal. Most of the individual coals are less than 4.0 ft (1.2 m) thick. Isopach values (plate 7) were derived by totaling the individual coal thicknesses at each data point. The structural datum (plate 8) is the base of the Hosta Tongue of the Point Lookout Sandstone. Existence and character of the Crevasse Canyon Gibson zone are unknown in the northwest part of the quadrangle because of insufficient data.

Crevasse Canyon Gibson No. 2 coal bed

The Crevasse Canyon Gibson No. 2 bed was measured at two isolated outcrops by Hunt (1936) in the central eastern part of the quadrangle. Thickness of the bed ranges from 0 to 5.0 ft (0 to 1.5 m). Because of limited data, the bed is interpreted to occur as lenticular pods with limited areal extent. Existence and character of the Crevasse Canyon Gibson No. 2 coal bed are unknown in most of the quadrangle because of insufficient data.

COAL RESOURCES

The U. S. Geological Survey requested resource evaluations of the Menefee Cleary No. 2 and Crevasse Canyon Gibson No. 2 coal beds, where the beds are 3.0 ft (0.9 m) or more thick. The evaluation is restricted to Federal coal lands.

The following procedures were prescribed by the U. S. Geological Survey for the calculation of reserve base. Criteria established in U. S. Geological Survey Bulletin 1450-B were used to areally divide the bed into measured, indicated, and inferred reserve base categories. Reserve base was calculated for each category by section, using data from the isopach (plate 4 and 10) and overburden maps (plates 6 and 12). The acreage in each category (measured by planimeter) multiplied by the average coal bed thickness and a bituminous coal conversion factor (1,800 tons of coal per acre-ft) yields the reserve base for that category. Coal beds with 3.0 ft (0.9 m) minimum thickness are included in reserve base and reserve data

rather than the 28 in. (71 cm) minimum thickness prescribed in U. S. Geological Survey Bulletin 1450-B. Reserve figures are derived from reserve base totals by applying recovery factors of 85 percent and 50 percent for coal beds 0 to 200 ft (0 to 61 m) and 200 to 3,000 ft (61 to 914 m) deep, respectively. All reserve base and reserve values are rounded to the nearest 10,000 short tons (9,072 t).

Total reserve base data for the Menefee Cleary No. 2 and Crevasse Canyon Gibson No. 2 coal beds, which include all reserve base categories, are shown by section on plate 2. Because of the limited areal extent of the Menefee Cleary No. 2 and Crevasse Canyon Gibson No. 2 coal beds, both beds are mapped on the same areal distribution and identified resources map (plate 13).

The U. S. Geological Survey also requested a resource evaluation of the Crevasse Canyon Gibson coal zone. Total identified resources for the Crevasse Canyon Gibson coal zone in the San Lucas Dam quadrangle are 73.34 million short tons (66.53 million t), where the total coal thickness is 5.0 ft (1.5 m) or greater.

COAL DEVELOPMENT POTENTIAL

The factors used to determine the development potential are the presence of a potentially coal-bearing formation, and thickness and overburden of correlative coal beds. The U. S. Geological Survey supplied the criteria to evaluate the coal development potential for Federal lands in this quadrangle. These criteria are based on current industry practice, U. S. Geological Survey Bulletin 1450-B, and anticipated technological advances. All available data were utilized for the surface and subsurface coal development potential evaluations.

Any area underlain by a potentially coal-bearing formation with 200 ft (61 m) or less of overburden has potential for surface mining. The U. S. Geological Survey designated the 200 ft (61 m) maximum depth as the stripping limit. Areas where a potentially coal-bearing formation is overlain by more than 200 ft (61 m) of overburden have no potential for surface mining. Areas with no correlative coal bed or a coal bed less than 3.0 ft (0.9 m) in thickness and overlain by 200 ft (61 m) or less of overburden have unknown surface mining potential. Areas which have a correlative coal bed 3.0 ft (0.9 m) or more thick with surface mining potential are assigned a high, moderate or low development potential based on the mining ratio (cubic yards of overburden per short ton of recoverable coal). The formula used to calculate mining ratios is:

$$MR = \frac{t_o\ (C)}{t_c\ (Rf)}$$

Where MR = Mining ratio

t_o = Thickness of overburden in feet

t_c = Thickness of coal in feet

Rf = Recovery factor

C = Volume-weight conversion factor

(.896 yd^3/short ton for bituminous coal)

(.911 yd^3/short ton for subbituminous coal)

High, moderate, and low development potential areas are underlain by a coal bed 3.0 ft (0.9 m) or more thick and have respective surface mining ratio values of 0 to 10, 10 to 15, and greater than 15.

Any area underlain by a potentially coal-bearing formation with 200 to 3,000 ft (61 to 914 m) of overburden has potential for subsurface mining. Areas where a potentially coal-bearing formation is overlain by more than 3,000 ft (914 m) of overburden have no subsurface mining potential. Development potential for subsurface mining is unknown where a potentially coal-bearing formation within 200 to 3,000 ft (61 to 914 m) of the surface contains no identified correlative coal bed or a correlative coal bed less than 3.0 ft (0.9 m) thick. High, moderate, and low development potential areas have respective overburden values of 200 to 1,000 ft (61 to 305 m), 1,000 to 2,000 ft (305 to 610 m), and 2,000 to 3,000 ft (610 to 914 m). The no and unknown development potential boundaries for surface mining methods (plate 14) are defined at the contacts of the coal-bearing Dilco and Gibson Coal Members of the Crevasse Canyon Formation and Menefee Formation with the underlying noncoal-bearing Gallup Sandstone, Dalton Sandstone Member of the Crevasse Canyon Formation, and Point Lookout Sandstone. These contacts are approximated due to the inaccuracies of adjusting old geologic maps to modern topographic bases.

Boundaries of coal development potential areas coincide with the boundaries of the smallest legal land subdivision (40 acre lot). When a lands subdivision contains areas with different development potentials, the potential shown on the map is that of the areally largest component area. Where an area is underlain by more than one bed, the potential shown on the map is that of the bed with the highest potential.

Reserve base (in short tons) in the various development potential categories for surface and subsurface mining methods are shown in tables 3 and 4, respectively.

The coal development potential maps are subject to revision. Map boundary lines and reserve base values are based on coal resource occurrence map isopachs, overburden isopachs, and coal bed correlations that are interpretive and subject to change as additional coal information becomes available.

Development potential for surface mining methods

The coal development potential for surface mining methods in the San Lucas Dam quadrangle is shown on plate 14. The Menefee Cleary No. 2 coal bed has reserves in the low surface development potential category and the Crevasse Canyon Gibson No. 2 coal bed has reserves in the high, moderate, and low surface development potential categories. Refer to table 5 for reserves and planimetered acreage, by section, for Federal coal lands with development potential for surface mining methods. Because the high and moderate surface development potential areas for the Crevasse Canyon Gibson No. 2 coal bed encompass less than 50 percent of the smallest legal land-subdivisions, they are not shown on plate 14. The remainder of the Federal coal land in the San Lucas Dam quadrangle has either no or unknown development potential for surface mining methods.

Development potential for subsurface mining methods and in situ gasification

The Crevasse Canyon Gibson No. 2 coal bed has reserves in the high development potential category for subsurface mining methods in this

quadrangle. The reserves are in a 4 acre (2 ha) area in sec. 23, T. 14 N., R. 8 W., and total 10,000 short tons (9,072 t). Since the 4 acre high potential area does not encompass more than 50 percent of the smallest legal land subdivision, no subsurface coal development potential map was constructed. All remaining Federal coal lands have unknown development potential for subsurface mining methods.

In situ gasification of coal has not been done on a commercial scale in the United States and criteria for rating the development potential of this method are unknown.

Table 3. - Reserve base data (in short tons) for surface mining methods for Federal coal lands in the San Lucas Dam quadrangle, McKinley County, New Mexico.

[Development potentials are based on mining ratios (cubic yards of overburden/ton of underlying coal). To convert short tons to metric tonnes, multiply by 0.9072; to convert mining ratios in yds^3/ton coal to m^3/t, multiply by 0.842].

Coal Bed	High Development Potential (0-10 mining ratio)	Moderate Development Potential (10-15 mining ratio)	Low Development Potential (greater than 15 mining ratio)	Total
Menefee Cleary No. 2	---	---	2,140,000	2,140,000
Crevasse Canyon Gibson No. 2	10,000	30,000	90,000	130,000
Total	10,000	30,000	2,230,000	2,270,000

Table 4. - Reserve base data (in short tons) for subsurface mining methods for Federal coal lands in the San Lucas Dam quadrangle, McKinley County, New Mexico.

[Development potentials are based on thickness of overburden. To convert short tons to metric tonnes, multiply by 0.9072].

Coal Bed	High Development Potential (200'-1,000' overburden)	Moderate Development Potential (1,000'-2,000' overburden)	Low Development Potential (2,000'-3,000' overburden)	Total
Crevasse Canyon Gibson No. 2	20,000	---	---	20,000
Total	20,000	---	---	20,000

Table 5. - Reserves and planimetered acreage, by section, for Federal coal lands in the San Lucas Dam quadrangle with surface mining potential.

[To convert acres to hectares, divide acres by 2.471; to convert short tons to metric tonnes, multiply short tons by 0.9072].

Potential category	Coal bed	Sec.	T. N.	R. W.	Acres (planimetered)	Reserves (in short tons)
High	Crevasse Canyon Gibson No. 2	23	14	8	1.0	less than 10,000
Moderate	Crevasse Canyon Gibson No. 2	23	14	8	3.5	20,000
Low	Crevasse Canyon Gibson No. 2	23	14	8	13.0	60,000
	Menefee Cleary No. 2	26	15	8	251.6	1,810,000

SELECTED REFERENCES
(SAN LUCAS DAM QUADRANGLE)

American Society for Testing and Materials, 1973, Standard specification for classification of coals by rank, in American Society for Testing and Materials Standards for coal and coke: Designation D388-66, p. 54-57.

Baltz, E. H., 1967, Stratigraphy and regional tectonic implications of part of Upper Cretaceous and Tertiary rocks, east-central San Juan Basin, New Mexico: U.S. Geological Survey Professional Paper 552, 101 p.

Gardner, J. H., 1910, The coal field between San Mateo and Cuba, New Mexico, in Coal fields in Colorado and New Mexico: U.S. Geological Survey Bulletin 381-C, p. 461-473.

Hunt, C. B., 1936, The Mount Taylor coal field, part 2 of Geology and fuel resources of the southern part of the San Juan Basin, New Mexico: U.S. Geological Survey Bulletin 860-B, p. 31-80.

Kelley, V. C., 1950, Regional structure of the San Juan Basin, in New Mexico Geological Society Guidebook of the San Juan Basin, New Mexico and Colorado, 1st Field Conference, 1950: p. 101-108.

Keroher, G. C., and others, 1966, Lexicon of geologic names of the United States for 1936-60: U.S. Geological Survey Bulletin 1200, 4341 p.

National Oceanic and Atmospheric Administration, 1964-78, Climatological data, New Mexico: National Climatic Center, Asheville, N. C., v. 68-82.

Petroleum Information Well Log Library: Denver, Colo.

Rocky Mountain Well Log Service, 1974, Catalog of electrical, radioactivity and hydrocarbon surveys: Electrical Log Services, 1974, 819 p.

Santos, E. S. 1966, Geologic map of the San Lucas Dam quadrangle, McKinley County, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-516, scale 1:24,000.

Sears, J. D., Hunt, C. B., and Hendricks, T. A., 1941, Transgressive and regressive Cretaceous deposits in southern San Juan Basin, New Mexico: U.S. Geological Survey Professional Paper 193-F, p. 101-121.

Shomaker, J. W., Beaumont, E. C., and Kottlowski, F. E., 1971, Strippable low-sulfur coal resources of the San Juan Basin in New Mexico and Colorado: New Mexico Bureau of Mines and Mineral Resources Memoir 25, 189 p.

Shomaker, J. W., and Whyte, M. R., 1977, Geologic appraisal of deep coals, San Juan Basin, New Mexico: New Mexico Bureau of Mines and Mineral Resources Circular 155, 39 p.

U.S. Bureau of Mines, 1936, Analyses of New Mexico coals: U.S. Bureau of Mines Technical Paper 569, 112 p.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-B, 7 p.

U.S. Geological Survey, 1965, Mineral and water resources of New Mexico: New Mexico Bureau of Mines and Mineral Resources Bulletin 87, 437 p.

coal bed--A stratified sequence of coal, composed of relatively homogeneous material, exhibiting some degree of lithologic unity and separated from the rocks above and below by physically rather well defined boundary planes.

coal bed separation line--A line on a map plate separating areas where different coal beds or zones are mapped.

coal bench--One of two or more divisions of a coal bed separated by rock.

coal conversion factor--A factor used to convert acre-feet of coal into short tons of coal; bituminous coal is 1800 tons/acre-ft; subbituminous coal is 1770 tons/acre-ft.

coal development potential--A subjective determination of the comparative potential of Federal coal lands for development of a commercially viable coal mining operation.

coal exploration license--An area of Federal coal lands in which the licensee is granted the right, after outlining the area and the probable methods of exploration, to investigate the coal resources. An exploration license has a term not to exceed 2 years and does not confer rights to a lease.

coal lease--An area of Federal coal lands in which the Federal Government has entered into a contractual agreement for development of the coal deposits.

coal split--A coal bed resulting from the occurrence of a noncoal parting within the parent coal bed which divides the single coal bed into two or more coal beds.

coal zone--A distinctive stratigraphic interval containing a sequence of alternating coal and noncoal layers in which the coal beds may so lack lateral persistence that correlating individual beds in the zone is not feasible.

Federal coal land--Land for which the Federal Government holds title to the coal mineral rights, without regard to surface ownership.

hypothetical resources--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 in broad areas of coal fields where points of observation are absent and evidence is from distant outcrops, drill holes or wells. Exploration that confirms their presence and reveals quantity and quality will permit their reclassification as a Reserve or Identified Subeconomic Resource.

identified resources--Specific bodies of coal whose location, rank, quality, and quantity are known from geologic evidence supported by engineering measurements.

indicated--Coal for which estimates for the rank, quality, and quantity have been computed partly from sample analyses and measurements and partly from reasonable geologic projections.

inferred--Coal in unexplored extensions of demonstrated resources for which estimates of the quality and quantity are based on geologic evidence and projections.

isopach--A line joining points of equal bed thickness.

Known Recoverable Coal Resource Area (KRCRA)--Formerly called Known Coal Leasing Area (KCLA). Area in which the Federal coal land is classified (1) as subject to the coal leasing provisions of the Mineral Leasing Act of 1920, as amended, and (2) by virtue of the available data being sufficient to permit evaluation as to extent, location, and potential for developing commercial quantities of coal.

measured--Coal for which estimates for rank, quality, and quantity can be computed, within a margin of error of less than 20 percent, from sample analyses and measurements from closely spaced and geologically well known sample sites.

mining ratio--A numerical ratio equating the in-place volumes, in cubic yards, of rocks that must be removed in order to recover 1 short ton of coal by surface mining.

overburden--A stratigraphic interval (composed of noncoal beds and coal beds) lying between the ground surface and the top of a coal bed. For coal zones, overburden is the stratigraphic interval lying between the ground surface and the structural datum used to map the zone.

parting--A noncoal layer occurring along a bedding plane within a coal bed.

Preference Right Lease Application (PRLA)--An area of Federal coal lands for which an application for a noncompetitive coal lease has been made as a result of exploration done under a coal prospecting permit. PRLA's are no longer obtainable.

quality or grade--Refers to measurements such as heat value; fixed carbon; moisture; ash; sulfur; phosphorus; major, minor, and trace elements; coking properties; petrologic properties; and particular organic constituents.

rank--The classification of coal relative to other coals, according to degree of metamorphism, or progressive alteration, in the natural series from lignite to anthracite (Classification of coals by rank, 1973, American Society for Testing and Materials, ASTM Designation D-388-66).

recovery factor--The percentage of total tons of coal estimated to be recoverable from a given area in relation to the total tonnage estimated to be in the Reserve Base in the ground.

reserve--That part of identified coal resource that can be economically mined at the time of determination. The reserve is derived by applying a recovery factor to that component of the identified coal resource designated as the reserve base.

reserve base--That part of identified coal resource from which Reserves are calculated.

stripping limit--A vertical depth, in feet, measured from the surface, reflecting the probable maximum, practical depth to which surface mining may be technologically feasible in the forseeable future. The rock interval, expressed in feet, above the stripping limit is the "strippable interval."

structure contour--A line joining points of equal elevation on a stratum or bed.