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Environmental Impact Assessment Guidelines

For New Source Surface Coal Mines

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ENVIRONMENTAL IMPACT ASSESSMENT GUIDELINES FOR NEW SOURCE SURFACE COAL MINES

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Preface

This document is one of a series of industry specific Environmental Impact Assessment Guidelines being developed by the Office of Environmental Review for use in EPA's Environmental Impact Statement preparation program on New Source NPDES permits. It is intended to be used in conjunction with Environmental Impact Assessment Guidelines for Selected New Source Industries, on OER publication that includes a description of impacts common to most industrial new sources.

The requirement for federal agencies to assess the environmental impacts of their proposed actions is included in Section 102 of the National Environmental Policy Act of 1969 (NEPA), as amended. The stipulation that EPA's issuance of a New Source NPDES permit is an action subject to NEPA is in Section 511(c)(1) of the Clean Water Act of 1977. EPA's regulations for preparation of Environmental Impact Statements are in Part 6 of Title 40 of the Code of Federal Regulations, NEPA procedures for the New Source NPDES Program are described in Subpart F of Part 6.

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INTRODUCTION

The Clean Water Act requires that EPA establish standards of performance for categories of new source industrial wastewater dischargers. Before the discharge of any pollutant to the navigable waters of the United States from a new source in an industrial category for which performance standards have been proposed, a new source National Pollutant Discharge Elimination System (NPDES) permit must be obtained from either EPA or the State (whichever is the administering authority for the State in which the discharge is proposed). The Clean Water Act also requires that the issuance of a permit by EPA for a new source discharge be subject to the National Environmental Policy Act (NEPA), which may require preparation of an Environmental Impact Statement (EIS) on the new source. The procedure established by EPA regulations (40 CFR 6 Subpart F) for applying NEPA to the issuance of new source NPDES permits may require preparation of an Environmental Information Document (EID) by the permit applicant. Each EID is submitted to EPA and reviewed to determine if there are potentially significant effects on the quality of the human environment resulting from construction and operation of the new source. If there are, EPA publishes an EIS on the action of issuing the permit.

The purpose of these guidelines is to provide industry specific guidance to EPA personnel responsible for determining the scope and content of EID's and for reviewing them after submission to EPA. It is to serve as supplementary information to EPA's previously published document, Environmental Impact Assessment Guidelines for Selected New Source Industries, which includes the general format for an EID and those impact assessment considerations common to all or most industries. Both that document and these guidelines should be used for development of an EID for a new source surface coal mine.

These guidelines provide the reader with an indication of the nature of the potential impacts on the environment and the surrounding region from construction and operation of a surface coal mine. In this capacity, the volume is intended to assist EPA personnel in the identification of those impact areas that should be addressed in an EID. In addition, the guidelines present (in Chapter I) a description of the industry, principal mining areas and methods, environmental problems, and recent trends in location, raw materials, mining methods, pollution control, and demand for industry output. This "Overview of the Industry" is included to familiarize EPA staff with existing conditions in the industry.

Although this document may be transmitted to an applicant for informational purposes, it should not be construed as representing the procedural requirements for obtaining an NPDES permit, for complying with Office of Surface Mining (DOI) regulations, or as representing the applicant's total responsibilities relating to the new source EIS program. In addition, the content of an EID for a specific new source application is determined by EPA in accordance with Section 6.604(b) Title 40 of the Code of Federal Regulations and this document does not supersede any directive received by the applicant from EPA's official responsible for implementing that regulation.

The appendix is divided into six sections. Chapter I is the "Overview of the Industry," described above. Chapter II, "Impact Identification," discusses mining related wastes and the impacts that may occur during construction and operation of the mine. Chapter III, "Pollution Control," describes the technology for controlling environmental impacts. Chapter IV discusses other impacts that can be mitigated through design considerations and proper site and mine planning. Chapter V, "Evaluation of Alternatives," discusses the consideration and impact assessment of possible alternatives to the proposed action. Chapter VI describes regulations other than pollution control that apply to the coal mining industry.

I. OVERVIEW OF THE INDUSTRY

I.A. BACKGROUND

I.A.1. US Environmental Protection Agency NPDES Program Procedures

The Clean Water Act (33 USC *et seq*.) establishes a National goal to eliminate pollution of the surface waters of the United States. Section 402 of the Clean Water Act authorizes US-EPA either to directly administer NPDES permits to various industries that discharge to waters of the United States, or to delegate the permitting authority to State or interstate agencies that have the authority adequate to implement and enforce their own wastewater permit programs. As of 1 October 1978, 13 States which contain minable coal reserves had either not elected or not been qualified by US-EPA to issue NPDES permits. In the States listed below NPDES permits are processed by the appropriate regional offices of US-EPA.

STATE	US-EPA REGION	STATE	US-EPA REGION
Alabama	IV	New Mexico	VI
Alaska	X	Oklahoma	VI
Arizona	IX	Texas	VI
Arkansas	VI	Utah	VIII
Idaho	X	West Virginia	III
Kentucky	IV	S. Dakota	VIII
Louisiana	VI		

Sections 301 and 304 of the Clean Water Act require that US-EPA develop effluent standards for specific industries, which include surface coal mines, and that effluent standards be established both for existing sources (operating surface coal mines) and new sources (surface coal mines either not yet in operation on the date final regulations are issued, or that meet specific EPA criteria qualifying them as new sources). New source regulations were published on 12 January 1979 (40 CFR Part 434; 44 FR 2589. Operations of mines that began operation after January 12, 1979 will have to acquire a new source NPDES permit prior to initial mine development and start-up operations.

In accordance with Section 511(c) of the Clean Water Act, Federal permits for new sources are subject to the provisions of the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et. seq.; 83 Stat. 852 et seq.; PL 91-190). NEPA requires identification of and environmental impact statements on "major Federal actions significantly affecting the quality of the human environment." (Section 102(2)(c)). (State-administered NPDES permits are not subject to NEPA.)

Regulations governing the application of NEPA to new source permits in general were promulgated in 40 CFR Part 6, Subpart F. These regulations provide for environmental review by EPA of all new source NPDES permit applications. After the proposed facility (in this case a surface coal mining operation) is designated a "new source", EPA usually reviews an environmental information document (EID) submitted by the permit applicant. Upon completion of this review, EPA may issue either a finding of no significant impact or require the preparation of an environmental impact statement (EIS) as a basis for more extensive review.

I.A.2. US Department of Interior, Office of Surface Mining Reclamation and Enforcement

The US Department of Interior Office of Surface Mining Reclamation and Enforcement (OSM) was established under Title II of the Surface Mining Control and Reclamation Act of 1977 (SMCRA; 30 USC 1201 et seq.). The responsibilities of OSM broadly include:

- The promulgation of performance standards for surface mine operations and surface operations of underground mines
- Approving and monitoring State-administered programs to regulate the surface coal mining industry
- Administering various programs to repair the legacy of previous mining, and advancing the technology of surface mining and reclamation

Sections 506, 510, 515, and 516 of SMCRA require that OSM regulate all aspects of surface coal mining that may affect water quality and quantity, including those aspects not regulated by EPA under the Clean Water Act, such as:

- Nonpoint source discharges
- Discharges to groundwater
- Discharges to surface waters not regulated by EPA
- Impacts of mining on water quantity
- Discharges to surface waters during reclamation

Final regulations for OSM's permanent regulatory program were published on 13 March 1979 (44 FR 50:15311-15463). These regulations focus primarily on the prevention or mitigation of potentially adverse effects of surface coal mining on the hydrologic balance.

Environmentally sensitive hydrologic resources are protected through the use of in-process and end-of-process controls to reduce or eliminate the discharge of pollutant loads to the hydrologic regime. Other parts of the regulations contain performance standards for special surface mining techniques (i.e., mountaintop removal) and for mining in certain areas (i.e., steep slopes, prime farmland, and the State of Wyoming). Also included are criteria for determining the appropriate post mining land use to which a surface-mined area must be reclaimed.

Of the twelve subchapters promulgated, two bear directly on the scope and extent of information to be furnished in an applicant's EID:

- Subchapter G: Permits for surface coal mining and reclamation operations

- Subchapter K: Permanent program performance standards

I.A.3. <u>Relationship Between Permits Granted Under NPDES and SMCRA</u>

OSM's responsibilities for regulating the surface mining industry are partly coincident with EPA's mandate to regulate water and air pollution under the Clean Water Act and the Clean Air Act (42 U.S.C. 7401 <u>et seg</u>). Both agencies have the power either to grant permits directly or to oversee the granting of permits to operators of surface coal mines. Both agencies are constrained to avoid duplicative effort--EPA under Section 101.(f) of the Clean Water Act, and OSM under Section 201,(c)(12) of SMCRA.

To insure that duplicative regulatory activity is minimized, interagency task groups have been convened to draft a memoranda of understanding between EPA and OSM. In final form, these memoranda will provide for a joint application process, joint permiting, and joint inspection activity. OSM's mandate to control mining pollution under SMCRA extends beyond EPA's mandate to regulate the active mining phase covered under NPDES, A major part of this combined permitting process, therefore, will fall outside the purview of EPA's responsibility to regulate surface coal mining.

I.B. SUBCATEGORIZATION OF THE INDUSTRY

For the purpose of studying waste treatment and effluent limitations, the coal mine point source category initially was subcategorized by the established Standard Industrial Classification (SIC) groups applicable to the coal mining industry. These SIC groups then were further subdivided by: (1) geographic location of the mine, (2) type of mine (surface or underground), and (3) size of mine (annual tonnage); all based on anticipated variations in raw wastewater. After evaluation of statistical analyses of the data obtained during the study, it was determined that based on waste treatment the coal mining point source category should be divided into four discrete subcategories based on the origin of the wastewater, i.e., wastewater from the mining activities and wastewater from the coal preparation activities, or mining services activities.

Wastewater from the mining activities was further subdivided by the characteristics of the raw mine drainage. Mining services activities (coal preparation) were subdivided on the basis of characteristics of wastewaters from preparation plants, coal storage areas, refuse storage areas, and the ancillary areas associated with coal preparation plants.

Thus, the coal mining point source category has been subdivided for the purpose of EPA's effluent guidelines and standards (40 CFR 434) as follows:

Subpart A - Coal Preparation Plant. The provisions of this subpart are applicable to discharges resulting from the cleaning or beneficiation of coal of any rank including but not limited to lignite, bituminous, and anthracite.

Subpart B - Coal Storage, Refuse Storage, and the Coal Preparation Plant Ancillary Area. The provisions of this subpart are applicable to discharges which are pumped, siphoned, or drained from coal storage, refuse storage, and coal preparation plant ancillary areas related to the cleaning or beneficiation of coal of any rank including but not limited to bituminous, lignite, and anthracite.

Subpart C - Acid or Ferruginous Mine Drainage. The provisions of this subpart are applicable to acid or ferruginous mine drainage resulting from the mining of coal of any rank, including but not limited to bituminous, lignite, and anthracite.

Subpart D - Alkaline Mine Drainage. The provisions of this subpart are applicable to alkaline mine drainage resulting from the mining of coal of any rank including but not limited to bituminous, lignite, and anthracite.

In order to maximize the utility of this environmental impact assessment guidance material, this particular document focuses on surface coal mining operations and associated environmental impacts and pollution control methods. Specifically, the document considers rank of coal, geographic location of coal, and mining and reclamation methods as the primary determinants of environmental impact. This approach was taken to isolate those areas of concern that are unique to surface coal mining activities and to establish a workable methodology to assess the magnitude and significance of potential impacts in the EID. Although a distinction has been made between surface coal mining activities and other coal mining operations (e.g., underground mining, coal preparation facilities, coal storage facilities, etc.), it should be noted that these other coal mining methods and related activities will be the subjects of separate guideline documents to be prepared by EPA.

I.C. COAL FORMATION AND GEOGRAPHICAL DISTRIBUTION

I.C.1. Types of Coal

Coal is formed by the accumulation and compaction of organic material, which when buried by sediments is altered from complex organic compounds to carbon. The organic material that forms today's coal was derived from the accumulation and partial decay of plants and animals in ancient marine and freshwater marshes. Paleoenvironmental analyses suggest that these remains accumulated in lowland areas associated with floodplains, in estuarine marshes associated with ancient barrier islands, and in marshes associated with the non-marine and marine parts of ancient deltas.

Coals that occur in the United States were deposited mostly during the Pennsylvanian (345-280 million years before present) and Cretaceous Periods (136-65 million years before present). The type of coal that formed during and since these periods of deposition is dependent on its degree of compaction, not on its age. Coals that were subject to greater burial or mountain building stresses were changed more or have a higher "rank" than those that were subjected to less stress. Coal normally is ranked on the basis of its percentages of fixed carbon, natural moisture, and volatile matter (Table 1). Lignite, subbituminous coal, bituminous coal, and anthracite comprise the major classes of coal, within which there are groups. As rank increases (lignite to anthracite) the percentage of fixed carbon increases, the percentage of volatile matter decreases, and heating value increases. Based solely on heating value, the market value of coal can be expected to increase with rank. Because sulfur content and other end-use specifications and requirements can influence significantly the demand for coal, the heating value is only one of several criteria that determine the actual market value of coal deposits.

The initial compaction of coal-forming material results in the formation of peat. Compaction of peat results in formation of lignite, the lowest-ranked coal type. Lignite is characterized by contents of about 30% fixed carbon, about 25% volatile materials, 45% moisture, and an average thermal content of about 6,590 BTU's per pound. Compaction of lignite results in the formation of subbituminous coal, characterized by average contents of about 42% fixed carbon, about 34% volatile materials, 23% moisture, and about 9,700 BTU's. Subbituminous coal is subcategorized on the basis of heat content into 3 groups (Table 1).

Bituminous coal results from compaction of organic material under pressures higher than those associated with lignite or subbituminous coal. Five groups of bituminous coal are recognized (Table 1), and the average characteristics of these coals include contents of 47 to 86% fixed carbon, more than 14% volatile matter, 3 to 12% moisture, and 11,000 to 15,000 BTU's.

Table 1. Classification of coal by rank.

CLASS	GROUP	LIMITS[1]
Anthracite	Metaanthracite	FC 98 - 100%
	Anthracite	FC 92 - 98% VM 2 - 8%
	Semianthracite	FC 96 - 92% VM 8 - 14%
Bituminous	Low volatile Bituminous	FC 78 - 86% VM 14 - 22%
	Medium volatile Bituminous	FC 69 - 78% VM 22 - 31%
	High volatile A Bituminous	FC $<$ 69% VM $>$ 31% BTU 13,000 - 14,000
	High volatile B Bituminous	FC $<$ 69% VM $>$ 31% BTU 11,000 - 13,000
	High volatile Bituminous	FC $<$ 68% BTU 11,000 - 13,000
Subbituminous	Subbituminous A coal	FC $<$ 69% VM $<$ 31% BTU 11,000 - 13,000
	Subbituminous B coal	FC $<$ 69% VM $<$ 31% BTU 9,500 - 11,000
	Subbituminous C coal	FC $<$ 69% VM $<$ 31% BTU 8,300 - 9,500
Lignite	Lignite	FC $<$ 69% VM $<$ 31% BTU $<$ 8,300

1 FC - percent by dry weight of fixed carbon
VM - percent by volume of volatile matter
BTU - British thermal units per pound of naturally moist coal

Source: American Society for Testing and Materials. 1978. Specification for class of coal by rank. D388. Philadelphia PA.

Anthracite coal is ranked highest, and its formation requires extraordinary pressures and temperatures generally not associated with simple burial and compaction. Distribution of anthracite is limited, therefore, to local or regional areas which have undergone intense folding or are near to igneous intrusions. Average characteristics of anthracite coals include contents of greater than 86% fixed carbons, less than 3% moisture, less than 14% volatile matter, and 12,000 to 15,000 BTU's. Three groups of anthracite coals are distinguished on the basis of fixed carbon content (Table 1).

I.C.1.a. Coal Reserves. The reserves in the 31 States believed to have significant amounts of coal were determined to be 438,332 million tons as of January 1976 (USBM 1977). About 32% (141,361 million tons) are considered to be surface minable and are distributed among 6 coal provinces (Figure 1). The reserves include those coal deposits which occur in relatively thick beds at depths which do not prohibit extraction by conventional surface recovery methods. Anthracite and bituminous coal deposits in the reserve base are at least 28 inches thick and are within 1,000 feet of the surface. Subbituminous and lignite reserves base are within 1,000 feet and 200 feet of the surface, respectively, and are at least 60 inches thick. Additional coal deposits, which do not meet these criteria, were included in the reserve base if such deposits are mined currently, or if, in the opinion of the US Bureau of Mines, such deposits are commercially minable at the present time. Table 2 is a summary of the distribution of surface minable coal.

Generally, about 50% of the reserves are recoverable, based on current mining techniques and environmental restrictions (USBM 1977). Approximately 28.7% of the surface minable reserve tonnage is located east of the Mississippi River. The remaining 71.3% is located in Alaska and in the conterminous States west of the Mississippi River. Most of this coal is located within the lignite and subbituminous coal fields of Montana, Wyoming, and North Dakota. Table 3 summarizes coal distribution by rank east and west of the Mississippi River.

I.C.1.b. Composition of Coals. Sulfur is the most abundant trace element in coal, and it reduces the value of those coals in which it is found. Sulfur occurs both as an inorganic constituent mineral (mostly pyrite) in coal itself and as part of organic complexes associated with coal. Sulfur contributes to air pollution, reduces coking quality, and (when exposed to oxygen and water) forms acid mine drainage.

The sulfur content of United States coals ranges from 0.2 to about 7.0% by weight. The percentage of sulfur in coal generally is greatest in the bituminous coals of the Interior and Eastern coal fields. The sulfur content of coal generally is less than 1% in the Northern Great Plains and Rocky Mountain Provinces for subbituminous coal and lignite. Thus, more than 90,000 million tons (64%) of the total surface-minable reserves are low-sulfur (<1% sulfur) and occur in the western United States.

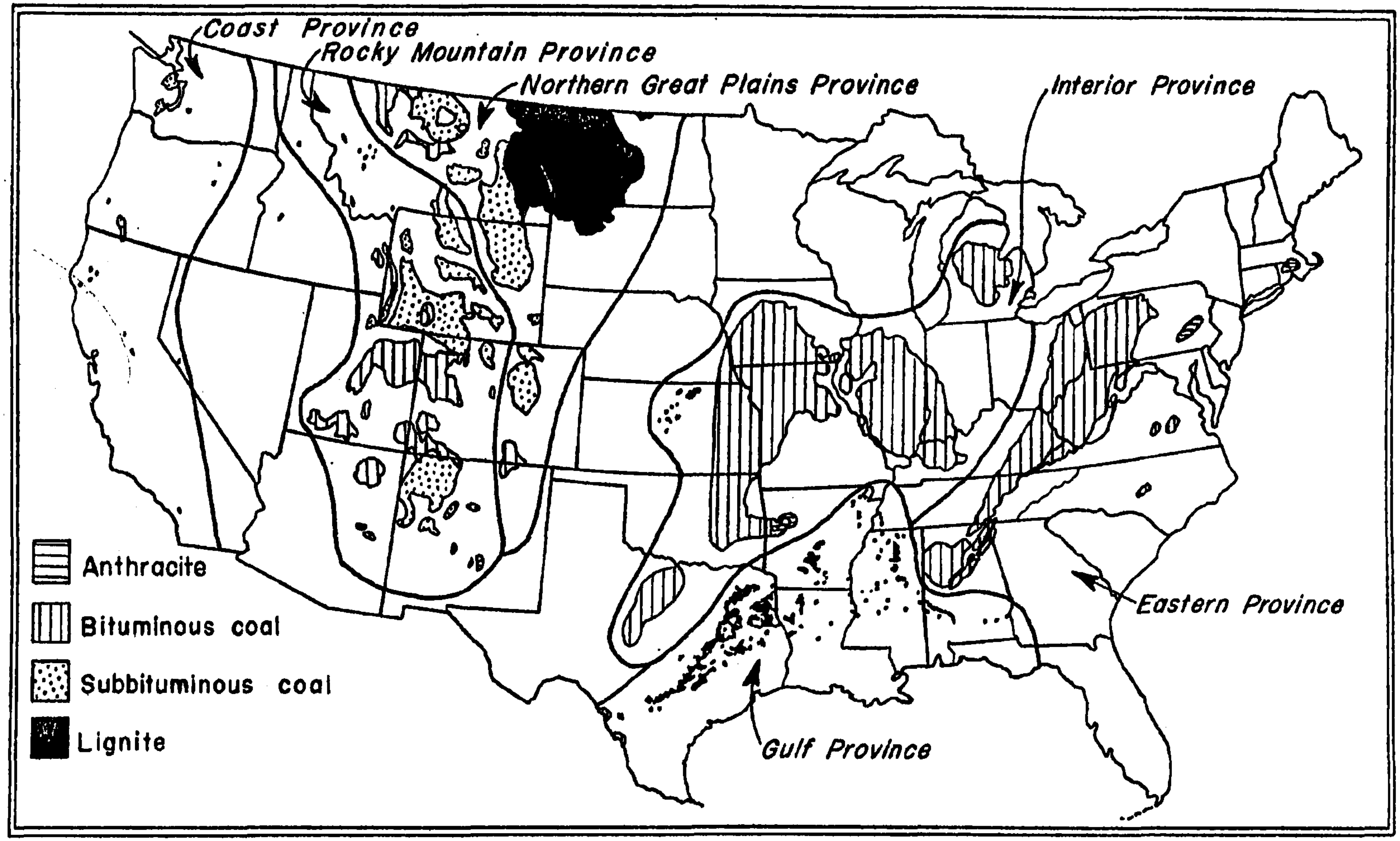


Figure 1. Coal provinces of the United States.

Source: University of Oklahoma. 1975. Energy Alternatives: A comparative analysis. Prepared for CEQ, ERDA, FEA, FPC, DOI, and NSF. USGPO. OY1-011-00025-Y.

Table 2. Demonstrated coal reserve base of surface minable coal. Values are expressed in millions of short tons.

STATE	COAL RANK				COAL PROVINCE						TOTAL
	Anthracite	Bituminous	Subbituminous	Lignite	Pacific	Rocky Mountain	Great Plains	Interior	Gulf	Eastern	
Alabama		284.4		1,083.0					1,367.4		1,367.4
Alaska		80.5	640.7	14.0	735.2						735.2
Arizona		325.5				325.5					325.5
Arkansas	7.8	107.0		25.7				140.5			140.5
Colorado		676.2	149.2	2,965.7			3,791.0[a]				3,791.0
Georgia		0.4								0.4	0.4
Illinois		14,841.2						14,841.2			14,841.2
Indiana		1,774.5						1,774.5			1,774.5
Iowa		465.4						465.4			465.4
Kansas		998.2						998.2			998.2
Kentucky		8,418.0						3,950.4		4,467.6	8,418.0
Louisiana				b					b		b
Maryland		134.5								134.5	134.5
Michigan		1.6						1.6			1.6
Mississippi				b					b		b
Missouri		3,596.0						3,596.0			3,596.0
Montana			33,843.2	15,766.8			49,610.1[a]				49,610.1
New Mexico		601.1	1,846.8			2,447.9					2,447.9
North Carolina		0.4								0.4	0.4
North Dakota				10,145.3			10,145.3				10,145.3
Ohio		6,139.8								6,139.8	6,139.8
Oklahoma		425.2						425.2			425.2
Oregon			2.9		2.9						2.9
Pennsylvania	142.7	1,391.8								1,534.4	1,534.4
South Dakota				426.1			426.1				426.1
Tennessee		337.9								337.9[a]	337.9
Texas		b						b	3,181.9		3,181.9
Utah		267.9				267.9					267.9
Virginia		888.5								888.5	888.5
Washington			481.5	8.1	489.5						489.5
West Virginia		5,149.1								5,149.1	5,149.1
Wyoming			23,724.7				23,724.7[a]				23,724.7
Totals	150.5	46,905.0	60,688.9	33,616.6	1,227.6	39,708.7	49,134.3	28,088.5	4,718.2	18,483.6	141,361

[a] Combined reserve base of surface minable coal in two provinces.

[b] No reliable data on the reserve base of surface minable coal.

Source: US Bureau of Mines. August 1977. Demonstrated coal reserve base of the United States on January 1, 1976.

Table 3. Distribution of surface minable coal, by rank, east and west of the Mississippi River.

	Million Short Tons				
	Anthracite	Bituminous	Subbituminous	Lignite	Total
East of the Mississippi River	142.7	39,362.1	--	1,083.0	40,587.8
West of the Mississippi River	7.8	7,542.9	60,688.9	32,533.6	100,773.2
Total	150.5	46,905.0	60,588.9	33,616.6	141,361.0

Source: US Bureau of Mines. August 1977. Demonstrated coal reserve base of the United States on January 1, 1976.

Coal contains traces of virtually all elements, but insufficient data on their occurrence and concentration is known to classify coals according to trace element content. When coal is burned, most of these elements are concentrated in the coal ash, but a few are volatilized and can be emitted to the atmosphere. Trace elements are of interest because generally they are more concentrated in coal than in the earth's crust. They also are potential pollutants. Arsenic, barium, beryllium, bismuth, boron, cobalt, copper, fluorine, gallium, germanium, lanthanum, lead, lithium, mercury, molybdenum, nickel, scandium, selenium, silver, strontium, tin, vanadium, uranium, yttrium, zinc, and zirconium occur in some coals in concentrations that are greater than their average abundance in the crust of the earth. The occurrence of an element at concentrations above average for ordinary crustal rocks, however, does not mean that its concentration necessarily is at a level toxic to humans or other biota, nor that it is in a form that readily permits its release to the environment. The possible elevated concentration of some trace elements in selected coal beds probably will receive greater attention in the future.

I.C.2. Coal Provinces

The six coal province boundaries (Figure 1) generally coincide with boundaries of major physiographic provinces, although more than one physiographic province may be contained within a single coal province, and parts of some physiographic provinces may lie within more than one coal province. Basic characteristics of the geology and hydrology of these provinces are described below. The facts of this discussion were derived from the Federal coal leasing program Final EIS of 1975 (US-DOI n.d.).

I.C.2.a. Pacific Coast Coal Province. This coal province essentially is mountainous. It thus has wide variations in relief. The mountains of Washington and Oregon trend north to south and are dotted with isolated volcanic cones. These mountains may still be undergoing the mountain-building process of uplift. The Pacific province generally has large supplies of surface and groundwater, but locally, water supply varies greatly. Numerous water management structures control runoff and other surface waters. Most groundwater is obtained from river-deposited sediments (alluvium) and generally has a high iron content. Groundwater in the mountainous permafrost areas generally is of poor quality.

Coal measures of the Pacific Coast province are found in scattered fields in California and Oregon, and in one large field and scattered small fields in Washington (Figure 2). Of these States, only California does not have sufficient coal deposits to justify its inclusion in the demonstrated reserve base (USBM 1977). California coals are mostly of Ecocene to Miocene age, and range in rank from lignite to high volatile bituminous B. These deposits are scattered over 43 counties, and fewer than a dozen locations have undergone mining or intensive prospecting.

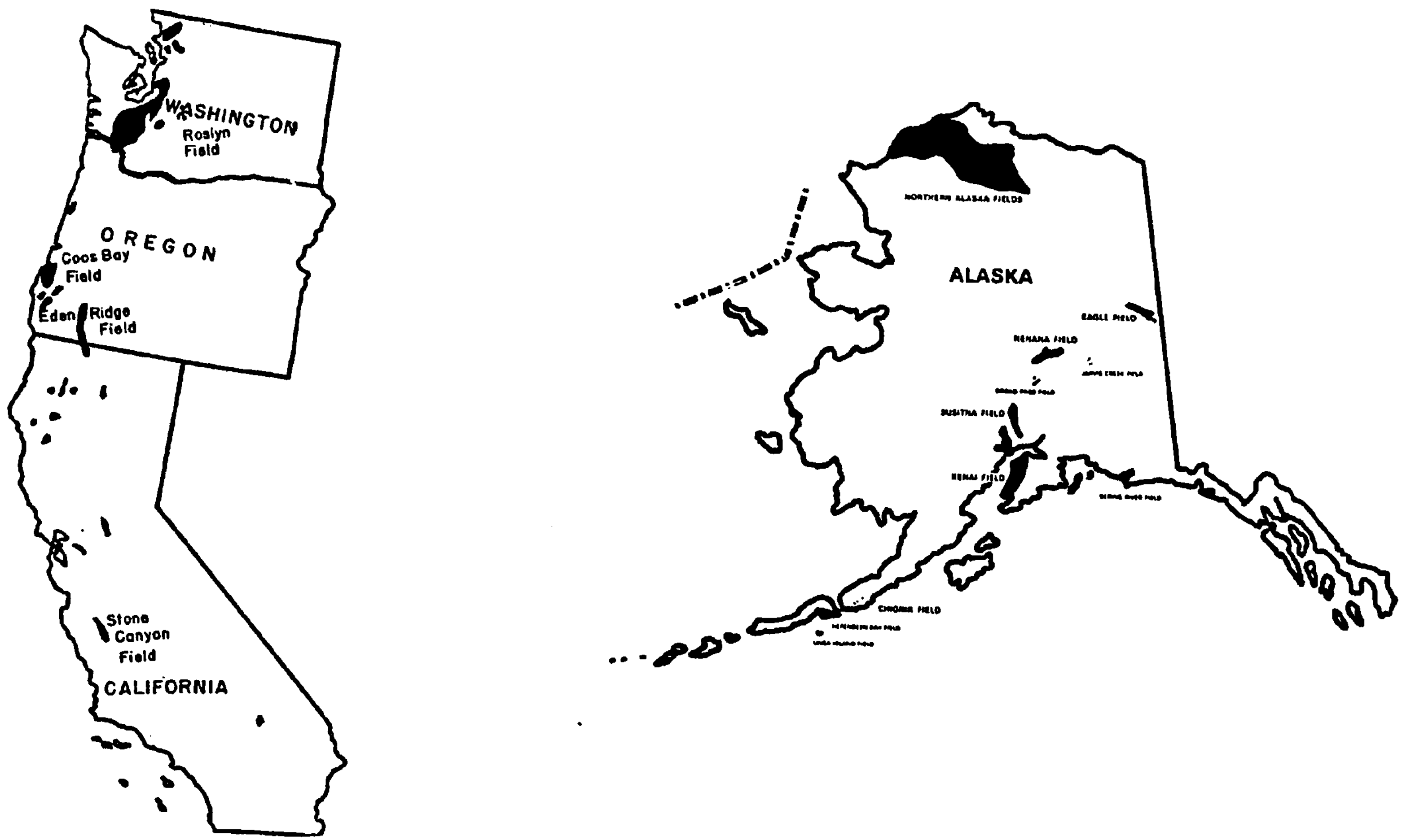


Figure 2. The Pacific Coast Coal Province.

Source: US Department of the Interior. n.d. Final environmental impact statement: proposed Federal coal leasing program. Variously paged.

Ranks of Oregon coals range from subbituminous C to bituminous. The Ecocene age coals of Washington range from subbituminous to anthracite, but most are subbituminous to bituminous; some also are of coking quality. Coals in Alaska range from lignite to high volatile bituminous grades. Coals are found in large fields along the Arctic Coastal Plain, and in smaller fields located both inland and along or near southern shorelines. Less is known of the coal fields in Alaska than in any other State, but it is expected that new coal fields will be discovered as exploration of the Alaskan interior proceeds, and as boundaries of partially explored coal fields and data on the quantity and quality of coals are developed.

I.C.2.b. Rocky Mountain Coal Province. This coal province includes all the physiographic provinces of the Rocky Mountains, parts of the Colorado Plateau Physiographic Province, and the Basin and Range Physiographic Province (Table 4). The Rocky Mountain Coal Province is bordered on the east by the Great Plains, and on the west by a series of high plateaus. These borders are marked by distinct changes in geologic structure and vegetation.

Water supplies in this coal province are limited and thereby can be a severely limiting factor in the exploitation of the vast coal reserves. Much of the province is vulnerable to droughts which can persist for years. The quality of surface waters varies widely over the province, and generally is poorer in basin areas. Groundwater derived from alluvium locally is of good supply and quality, although some alluvium may produce highly mineralized water. Yields from wells drilled into bedrock are low to moderate. Water from these wells may be of good quality, if the water is derived from highly permeable strata. Water drawn from strata of low permeability generally is highly mineralized. Many coal fields are located in areas where there are no perennial streams, and groundwater supplies are either limited or of poor quality.

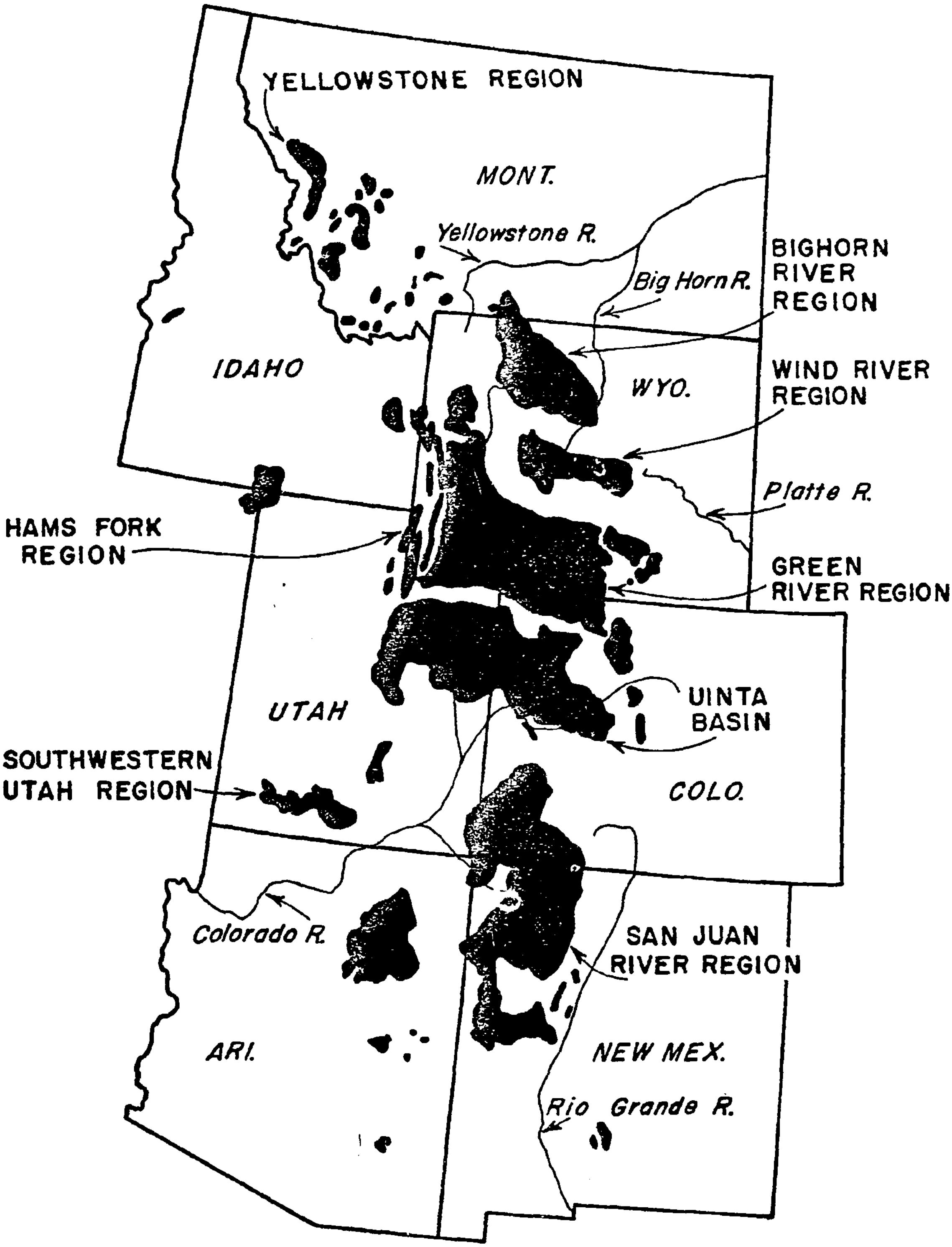
Coal fields of the Rocky Mountain Coal Province are grouped into coal regions. The boundaries of a coal region generally coincide with major physiographic features, and one physiographic province may contain more than one coal region (Table 4). The Basin and Range Physiographic Province does not contain a coal region, but does include scattered small fields in central and southern New Mexico. The coal fields of the Rocky Mountain Coal Province are described below within the framework of the physiographic province categorization (Figure 3). Coal measures range in age from Cretaceous to Miocene and range in rank from lignite to anthracite.

- Northern Rocky Mountain Physiographic Province - This physiographic province contains the Yellowstone Coal Region, where coals of the high volatile bituminous A, B, and C ranks are found in rocks of Upper Cretaceous age. Coal beds are thin, impure, and usually greatly disturbed by folding and faulting.

Table 4. Relationships of physiographic provinces and coal regions in the Rocky Mountain Coal Province.

Physiographic Province	Coal Region	Location
Northern Rocky Mountains	Yellowstone	West Montana
Middle Rocky Mountains	Big Horn Basin	Northwestern Wyoming
	Hams Fork	Western Wyoming
Wyoming Basin	Green River	Wyoming, Colorado
	Wind River	Wyoming
Colorado Plateau	Uinta	Utah, Colorado
	Southwestern Utah	Utah
	San Juan River	Colorado, New Mexico
Basin and Range		Small fields in central and southern New Mexico

Source: US Bureau of Mines. August 1977. Demonstrated coal reserve base of the United States on January 1, 1976.



Source: University of Oklahoma. 1975. Energy Alternatives: A comparative analysis. Prepared for CEQ, ERDA, FEA, FPC, DOI, and NSF. USGPO. 041-011-00025-4.

Figure 3. Rocky Mountain Coal Province

- Middle Rocky Mountain Physiographic Province - This physiographic province contains the Big Horn Basin and Hams Fork Coal Regions. The late Cretaceous and Paleocene age coals of the Big Horn Basin region range in rank from lignite through high volatile C subbituminous, and occur in lenticular beds which rarely persist at minable thickness for more than 5 miles at outcrop. Dips of locally folded strata can reach 50°, resulting in an irregular distribution of coal outcrops. The Paleocene age coals of the Hams Fork region range in rank from subbituminous B to high volatile A bituminous. Beds of higher grade coals may be as thick as 20 feet; thicknesses of lower grade coal range to 100 feet. These coal beds are situated in a highly complex zone of thrust faults and folded rocks, resulting in steeply dipping strata and thereby making mining difficult in most parts of the region.

- Wyoming Basin Physiographic Province - This semi-arid region contains the Wind River and Green River Coal Regions. The Wind River Coal Region of central Wyoming is a basin bordered by narrow ridges formed by steeply dipping sedimentary rocks. Coals of this region are Late Cretaceous to Paleocene in age, and are mostly subbituminous. Although coal beds may approach thicknesses to 17 feet, surface mining is made difficult by the steep dips of the strata. The Green River Coal Region consists of Late Cretaceous to Paleocene age coal in beds up to 42 feet thick. Coals range in rank from subbituminous C to high volatile bituminous C, and higher rank coals locally may occur in areas of igneous intrusion and intense structural deformation.

- Southern Rocky Mountain Physiographic Province - Coals of this province are found in the North Park coal area of the Colorado Mountains. Coals of the North Park area are of subbituminous B rank and occur in several major beds up to 77 feet thick.

- Colorado Plateau Physiographic Province - This province covers 130,000 square miles of Arizona, New Mexico, Colorado, and Utah, and contains the Uinta, Southwestern Utah, and San Juan River Coal Regions. Rocks of the province generally are of sedimentary origin and occur in horizontal strata. Erosion of these strata has resulted in formation of canyons, mesas, and buttes. The landscape comprises wide plateaus, uplifts, and broad basin areas. The Late Cretaceous age coal beds of the Uinta Coal Region range in rank from subbituminous C to coking quality, high volatile A bituminous; some semianthracite and anthracite deposits occur in the Crested Butte Field of the Uinta Region. Coal bed thicknesses generally range from 5 feet to 15 feet, but locally may approach 40 feet. The Late Cretaceous age coals of the Southwestern Utah Coal Region range in rank from subbituminous A to high volatile C bituminous, with local occurrences of semianthracite. These coals are found in flat-lying to gently dipping beds from 2 feet to 30 feet thick. The Late Cretaceous and Eocene age coals of the San Juan River Coal Region occur as lenticular, discontinuous deposits up to 5 feet thick in areas of complex geologic structure. Thicker, more continuous coal beds up to 38 feet thick with numerous shaly partings are found in structurally less complex parts of this region. San Juan River region coals are generally of subbituminous rank, but high volatile bituminous A, B, and C rank coals also are found.

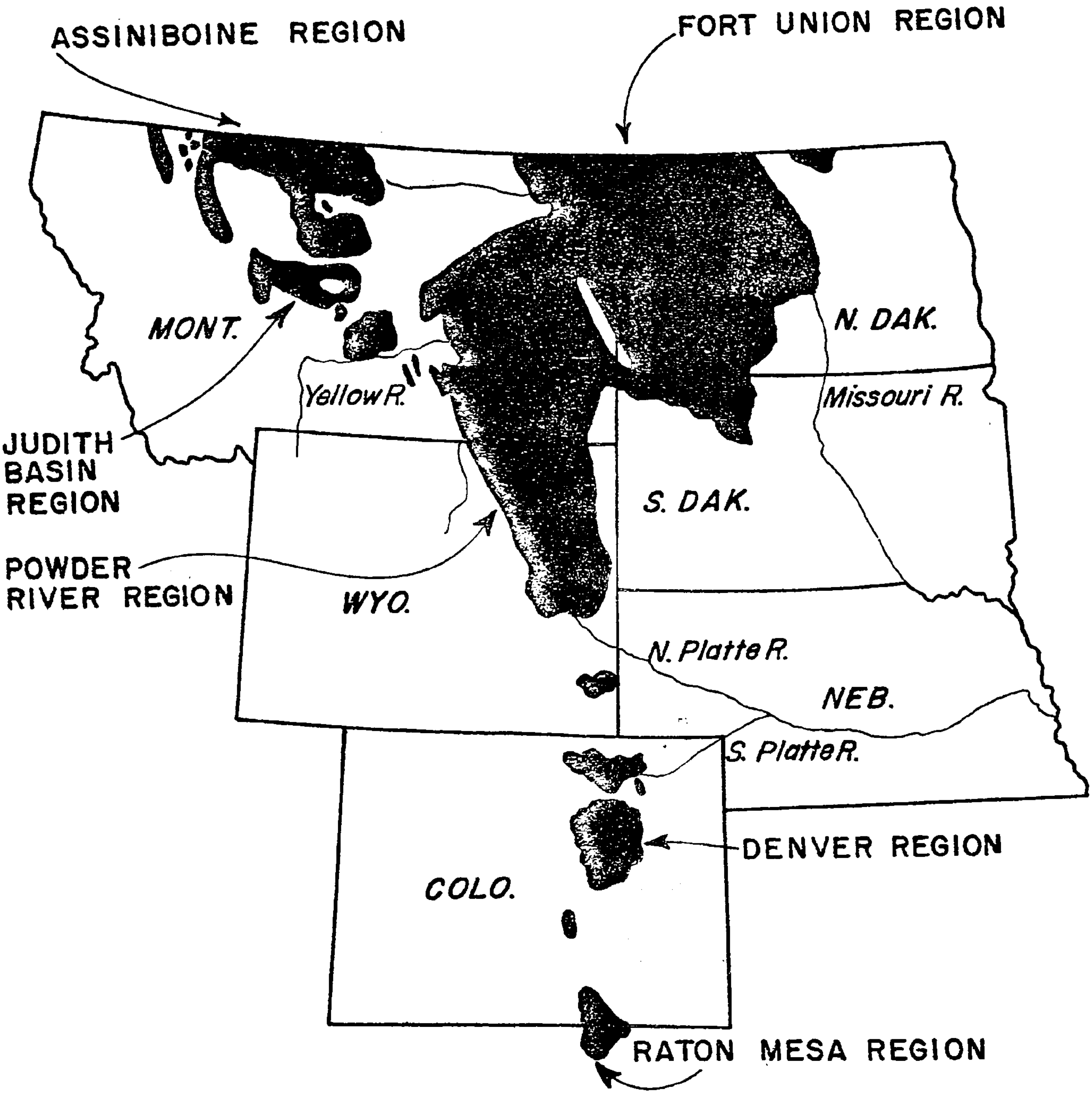
- Basin and Range Physiographic Province - This province comprises isolated, roughly parallel mountain ranges separated by nearly level, sediment-filled desert basins. The province contains several separate coal fields of Late Cretaceous age. Coal occurs in beds up to 7 feet thick and generally is of bituminous rank, some of which is of coking quality. Limited anthracite deposits occur locally.

I.C.2.c. Northern Great Plains Coal Province. This coal province includes coal regions that occur in the Great Plains east of and adjacent to the Rocky Mountains. The area is characterized by little surface relief, gently rolling plains, some areas of badlands and dissected plateaus, and isolated mountains. Rocks of this province occur in nearly horizontal sedimentary strata which curl up sharply along the flanks of the Rocky Mountains. Five Coal Regions are recognized within the Northern Great Plains Coal Province (Figure 4).

- North-Central Coal Region - This region includes the Judith River Basin and Assiniboine Regions shown in Figure 4. The Late Jurassic age coals of the Judith River Basin Region generally are of the high volatile bituminous B and C ranks and contain 1.7 to 4.0 percent sulfur. Late Cretaceous age coals of the Assiniboine Region range in rank from subbituminous A and B to high volatile bituminous B and C. These coal beds generally are discontinuous and too thin to be of commercial importance, other than as sources of local fuel.

- Fort Union Coal Region - This coal region contains an estimated 438 billion tons of lignite, the largest single coal resource in the United States. Coals are Late Cretaceous to Paleocene in age, and increase in rank westward from lignite in North Dakota to subbituminous in Montana.

- Powder River Coal Region - This coal region is a southern extension of the Fort Union Coal Region, covering southern Montana and northeastern Wyoming. Coals are Upper Cretaceous to Eocene in age, and range in rank from subbituminous to high volatile C bituminous.



Source: University of Oklahoma. 1975. Energy Alternatives: A comparative analysis. Prepared for CEQ, ERDA, FEA, FPC, DOI, and NSF. USGPO. 041-011-00036-4.

Figure 4. Northern Great Plains Coal Province.

- Denver Coal Region - This region comprises 8,000 square miles of gently rolling plains underlain by Late Cretaceous and Paleocene age coal bearing rocks. Coals generally are of subbituminous B and C ranks and occur in lenticular, discontinuous beds up to 17 feet thick. Extensive deposits of lignite also are found in this region.

- Raton Mesa Coal Region - This coal region is located in southern Colorado, where Late Cretaceous and Paleocene age coals range in rank from coking high volatile bituminous A and B to non-coking high volatile bituminous C.

I.C.2.d. Interior Coal Province. This coal province is an extensive area of low relief underlain by flat-lying Paleozoic age sandstones, limestones, conglomerates, and shales which lie between the Appalachian Plateaus and the Rocky Mountains. Coal beds of this province are of Pennsylvanian age, and generally comprise high volatile bituminous grades which improve in quality in the western part of the coal region. In Oklahoma and Arkansas, some coal deposits have been devolatilized to coking low volatile bituminous and semianthracite ranks. The subbituminous coal fields of north-central Texas (Figures 1 and 5) are not included in the demonstrated reserve base because of incomplete information on occurrences and thicknesses of local coal deposits.

The Interior Coal Province Province generally has abundant water supplies, although most surface waters and some groundwater must be treated for industrial and municipal use.

I.C.2.e. Gulf Coal Province. This province comprises extensive lowlands and coastal areas. The subsurface generally is composed of unconsolidated beds in detrital sediments and limestones which dip gently seaward. Outcrops of rock become successively older inland. The province has a good supply of surface water and groundwater, and droughts are uncommon except in southwest Texas. Coal deposits consist of Upper Cretaceous age bituminous beds near the Mexican border, and areally extensive deposits of lignite which extend from southern Texas to Alabama (Figure 6).

I.C.2.f. Eastern Coal Province. This coal province extends 800 miles from northern Pennsylvania to northwestern Alabama (Figure 7) and essentially is mountainous for its entire length. The province has abundant surface and groundwater supplies, but extensive mining activity has resulted in serious local water pollution problems. Coals of this province were deposited in the Pennsylvanian age Appalachian Basin, which consists of a series of sandstones, shales, limestones, conglomerates, and coals. Structural features such as faults and fold axes trend northeast-southwest, parallel to the basin margins. The eastern part of the basin is extensively folded and faulted, and contains the higher grade coals of the region. These coals range in rank from medium volatile bituminous coals of the major eastern Appalachian coal fields to the high quality

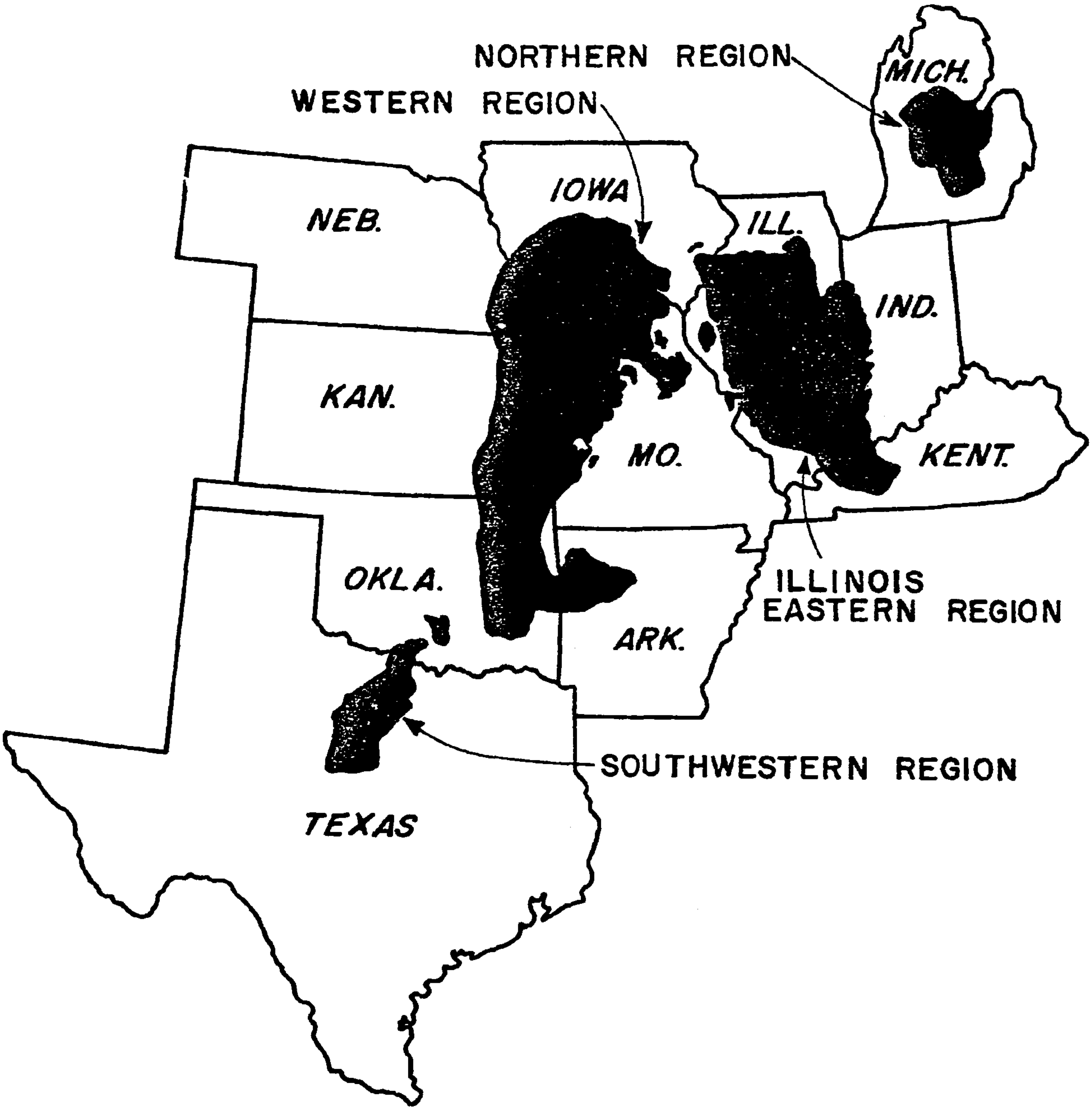


Figure 5. Interior Coal Province.

Source: University of Oklahoma. 1975. Energy Alternatives: A comparative analysis. Prepared for CEQ, ERDA, FEA, FPC, DOI, and NSF. USGPO. 041-011-00025-4.

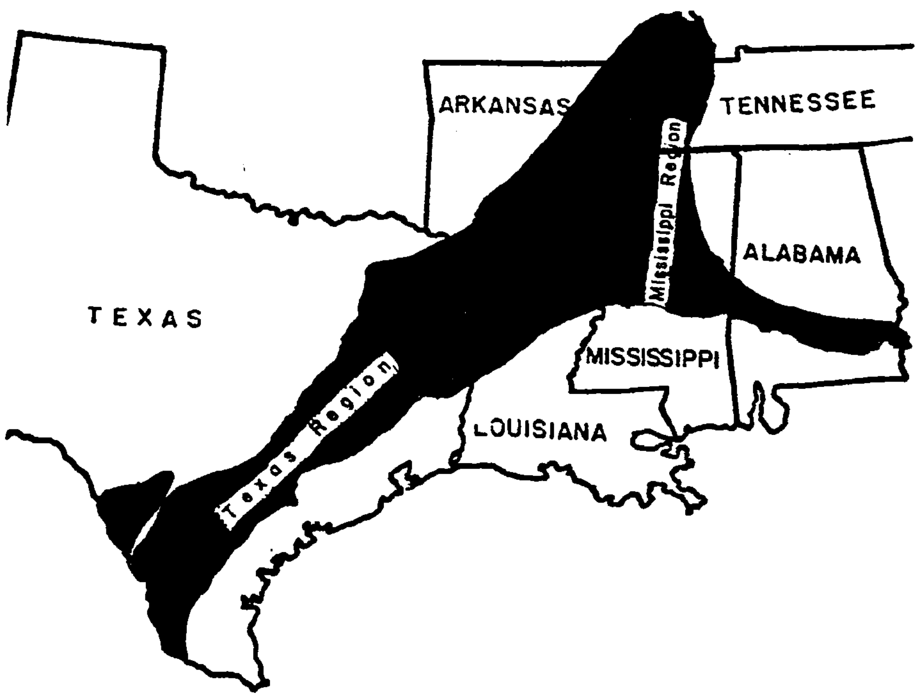


Figure 6. Gulf Coal Province.

Source: US Department of the Interior. n.d. Final environmental impact statement: Proposed Federal coal leasing program. Variously paged.

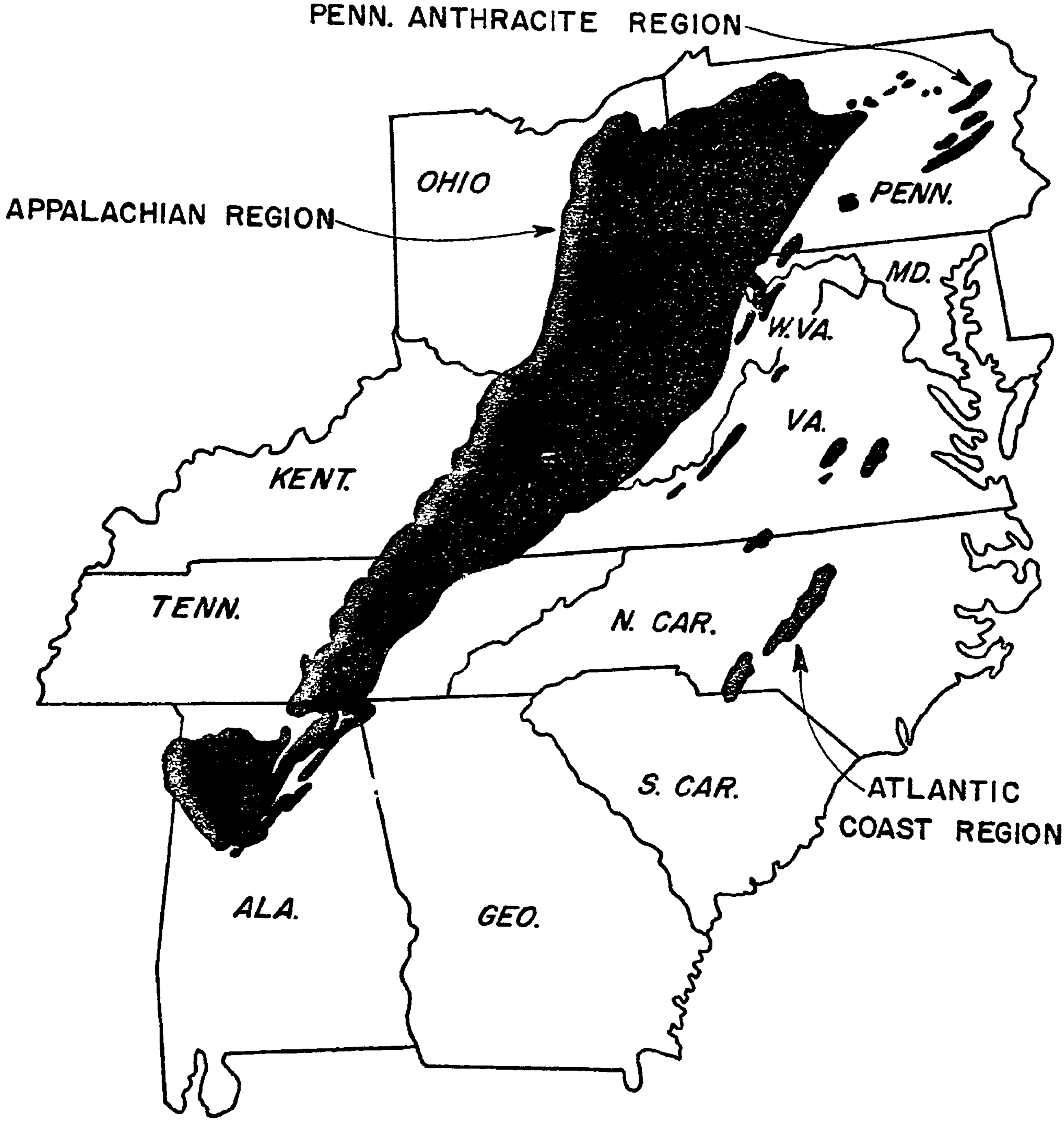


Figure 7. Eastern Coal Province .

Source: University of Oklahoma. 1975. Energy Alternatives: A comparative analysis. Prepared for CEQ, ERDA, FEA, FPC, DOI, and NSF. USGPO. 041-011-00025-4.

anthracite of northeastern Pennsylvania. The western part of the Appalachian basin is marked by strata in broad, open folds which dip gently westward. Coals of the western part of the basin generally are of the high volatile bituminous grade. The ranks of coals in the Eastern Coal Province generally decrease from east to west in bands which trend northeast-southwest, parallel to major structural features.

I.D. TRENDS

Trends in surface mining of coal reflect (1) trends in the regulation of coal mining, (2) trends in the development of surface mining technology, and (3) trends in the use of coal as a fuel. These trends are manifest in (1) the emergence of large, western surface mines as major suppliers of coal, (2) the current interest in recovery of low sulfur coals and desulfurization of high sulfur coals for use as boiler fuels, and (3) the continuing dialogue between regulatory authorities and the coal mining industry on surface mining techniques that will adequately protect the environment, maximize recovery of the mined resource, and provide mine operators with an adequate economic return.

I.D.1. Locational Changes

Locational trends in the surface coal mining industry include (1) shifts of mining activity to coal regions which contain large reserves of economically recoverable and usable coal and (2) shifts of mining activity within regions to situations which previously were avoided because adverse topography, overburden thickness, or other factors precluded an economic return on investment in mining operations.

Several factors have contributed to the dramatic expansion of the western surface coal mining industry. Large tracts of relatively flat land underlain by thick, horizontal seams of low sulfur (less than 1%) coal are amenable to high production surface mining operations. The pit, spoil piles, haul roads, and ancillary facilities can be designed to minimize the cycle times of unit mining operations, thus maximizing productivity per manshift. Such surface mines attract investment capital because high-rate producers can commit to long-term delivery agreements, whereas low-rate producers, generally located in the east, are subject to the exigencies of the open market, and generally cannot guaranty an equitable return on investment capital.

Operators of eastern surface mines use such methods as mountaintop removal and head-of-hollow fill to offset the disadvantages of surface mining in steeply sloping terrain. Although the extent and magnitude of their environmental impacts are controversial, mountaintop removal and head-of-hollow fill will be used by an increasing number of eastern surface mine operators as mining opportunities diminish on gentler slopes (Murray 1978).

I.D.2. Raw Materials

Because it is an extractive process, surface mining does not entail the consumption of large amounts of raw materials normally associated with manufacturing processes. The major raw materials consumed in surface mining operations include:

- Energy
- Chemicals for treatment or neutralization of wastes and discharges
- Chemicals for blasting

Energy is consumed in all phases of the mining operation. Trends in energy consumption include: (1) the use of electricity as a power source for draglines, stripping shovels, overburden drills, and overburden conveyors; and (2) the use of computer simulation techniques to determine the proper sizes and horsepower ratings of mining equipment. In the past, equipment sizing for a given mine primarily was based on desired production rate and operator experience. Mismatches in equipment hauling and load capacities sometimes resulted in the waste of horsepower and cycle time. The current approach to integrated mine planning through computer simulation seeks to maximize productivity and minimize energy consumption and cycle time.

Lime is the chemical most widely used in the treatment of acid and ferruginous mine drainage. Recent trends in the research and development of waste treatment systems include the use of reverse osmosis processes and biochemical agents to treat raw mine drainage. Chemicals such as sodium hydroxide and anhydrous ammonia also have been used to treat mine drainage, with varying degrees of success. Future research efforts in treatment processes will seek to minimize sludge production and costs of treatment chemicals while maximizing pollutant-removal efficiencies.

The chemical most commonly used for blasting in surface mining operations is a mixture of ammonia nitrate and fuel oil (ANFO). Trends in the development of explosives and blasting agents include development of blasting components that deliver maximum energy with minimum costs. These costs accrue not only from the direct purchase of blasting materials, but also from handling and storage requirements for explosive materials, drill-hole pattern designs, and the occasional necessity to reshoot drill holes which did not fire during the main blast.

I.D.3. Surface Mining Systems

A modern surface coal mine is the culmination of years of analysis, planning, and negotiation. To open and operate a surface coal mine successfully, the mine operator must secure startup and operating capital, markets, permits, insurance, bonds, equipment, and a work force without undue expenditures of venture capital. These prerequisites for mining bear sufficient costs so that mine operators generally are compelled to save money wherever feasible during each phase of mining.

Computer simulation techniques increasingly are utilized to streamline and integrate the unit operations which comprise phases in the life of a mine-site (Table 5). Unit operations consist of sequences of operating cycles, each of which has a characteristic time lapse between initiation and completion. These cycle-times are minimized to the extent practicable to achieve efficient operation of the mining system.

For example, hauling is a round trip activity. The hauling cycle begins with the arrival of the hauler at the loading point. Subsequent activities can include:

- Waiting for positioning
- Positioning for loading
- Loading
- Traveling to dumping point
- Waiting to dump
- Dumping
- Traveling to loading point

Hauling cycle-time can be reduced by minimizing waiting, traveling, dumping, and loading times with an optimum combination of equipment selection and site design factors, including:

- Haul road gradients
- Haul road distances
- Relative capacities of loaders and haulers
- Hauler running speeds
- Hauler dumping modes

Table 5 . Phases and unit operations in the surface mining of coal.

Phase	Unit Operation
Exploration	Exploration
Development	Dewatering
	Diversion
Production	Drilling
	Blasting
	Stripping
	Hauling
Rehabilitation	Storage of topsoil or other soil horizons
	Hauling
	Maintenance
	Beneficiation

Source: US Environmental Protection Agency. 1978. User's manual for premining planning of eastern surface coal mining: volume I, executive summary. EPA-600 7-78-180, 81 p.

The optimum choice of each factor may be constrained by limitations in the other cycles with which hauling must interface. For instance, haulers can off-load in one of three modes---from the rear, side, or bottom of the hauling bin. The choice of dumping mode is limited by dumping point factors. The rear-dump mode may be necessary if the dump point is a restricted space, such as a loading hopper which feeds a conveyor. Choice of the bottom-dump mode may be dictated by the necessity to achieve specified lift thicknesses in backfill operations without the use of graders and bulldozers.

Surface mining systems are sequences of unit operations which have been designed to accommodate the a priori limitations on mining imposed by geology, topography, and regulatory authorities. Three kinds of mining systems have evolved which entail the removal of overburden to extract coal. These systems have been modified to reflect regional limitations on mining. The three major systems and their variants include:

- Area mining
  - Conventional
  - Mountain top removal
- Contour mining
  - Box cut
  - Block cut
- Open pit mining

Two other surface coal mining systems, daylighting and longwall stripping, currently are the subjects of Federally funded demonstration projects. Neither system currently is used in commercially operated surface mines, and each system, therefore, will receive only a summary description. More detailed descriptions of the three major surface mining systems follow.

Daylighting includes removal of overburden and recovery of coal pillars from abandoned underground mine workings. After the coal is recovered, the mine-site is backfilled and regraded with the stockpiled overburden, and then is rehabilitated to an appropriate land use.

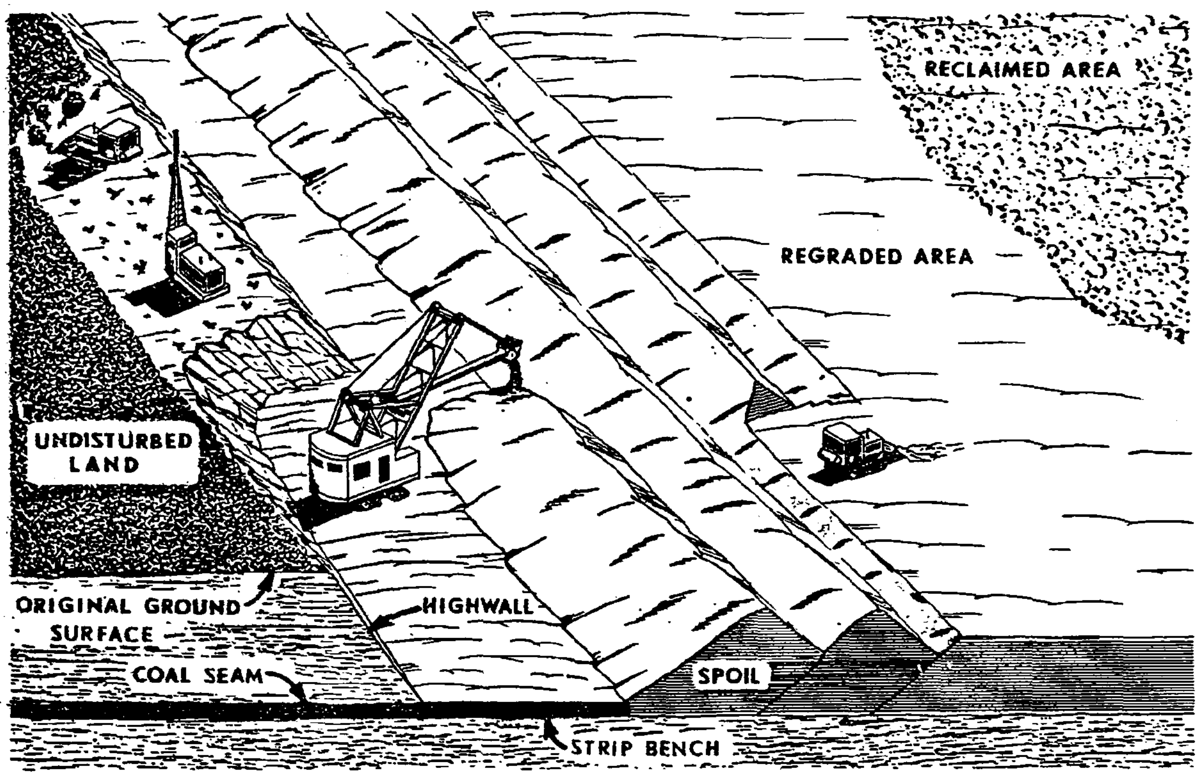
In longwall stripping, the coal outcrop is contour surface-mined to leave an open bench and a highwall. Automated equipment, including self-advancing roof supports, coal conveyors, and a continuous miner, is inserted into entries driven through the coal seam perpendicular to the bench and highwall. Mining advances parallel to the bench, which is backfilled and reclaimed after the undermined highwall has collapsed.

I.D.3.a. Area Mining. Area mining is employed in the gently rolling terrain of the western US and in selected terrains of the Interior and Eastern coal provinces. Conventional area mining is restricted to regions of flat terrain where horizontal or nearly horizontal coal seams can be recovered from shallow depths of overburden, which then can be regraded to approximate original contour. Mountain top removal is used in rugged terrain of the Appalachian Mountains, where regrading to approximate original contour may not be feasible or desirable. Both methods essentially result in total recovery of the mined resource. A typical conventional surface mining operation proceeds in the following manner. A trench (box-cut) is excavated through the overburden to the coal seam. This trench usually is extended linearly either to the perimeter of the permitted area or to the edge of the coal deposit. The mined overburden (spoil) is stockpiled parallel to the trench on unmined ground, and coal is recovered from the exposed seam. Successive cuts are made parallel to the initial trench, and spoil from each succeeding cut is stockpiled in the trench of the previous cut. Spoil from the initial cut is placed in the trench of the final cut, and the disturbed area is progressively regraded to the approximate original contour, thus eliminating all high walls and other man-made escarpments and depressions not needed to facilitate revegetation and reclamation of the disturbed area.

The operational details of an area surface mine primarily depend upon the excavating, loading, and hauling equipment employed at the mine-site. Ignoring the capitalization constraints described in I.D.1, equipment selection generally is based on the depth and kind of overburden to be removed, the number of coal seams to be mined from a single pit, the thickness of partings between the coal seams, the rippability of the coal seams, and the planned geometry of the pit.

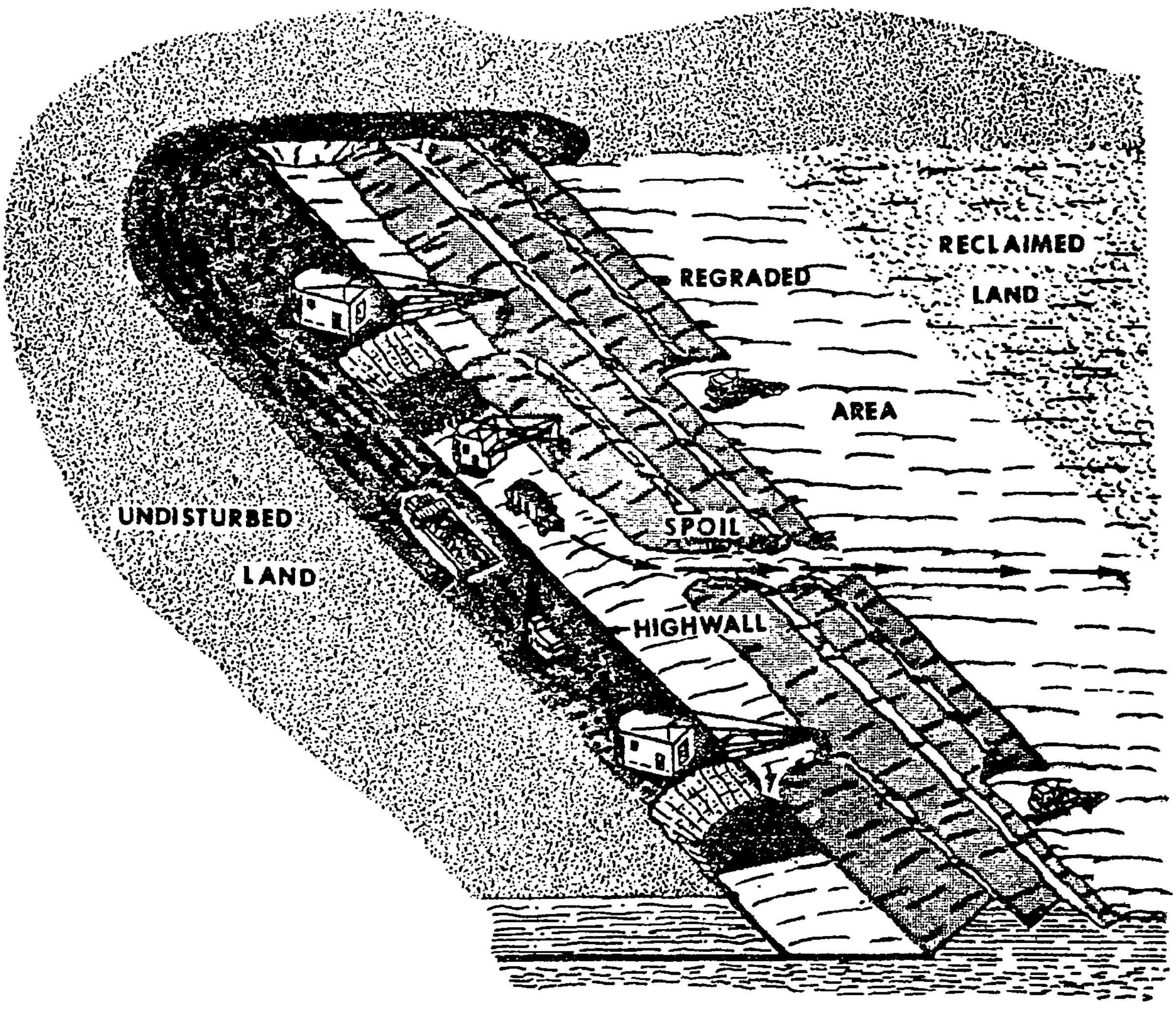
Stripping shovels can be used if the overburden that is to be regraded in the mined-out trench or pit can be homogenized during stripping without adversely affecting the reclamation process (Figure 8). Tandem draglines can be used in the pull-back mode if it is desirable to invert the sequence of overburden strata, thus burying potentially unreclaimable overburden beneath more desirable material found closer to the coal seam (Figure 9).

If segregation or selective placement of overburden horizons is necessary to achieve rehabilitation of the site to a particular post mining land use, a combination of excavators, including scraper-loaders, draglines, bucket wheelexcavators, and stripping shovels can be employed (Figures 10 and 11). Pit geometry may be engineered so that excavators can pass one another during bidirectional mining. It also may be necessary to place two or more excavators on separate benches to achieve proper location of spoil (Figure 12).



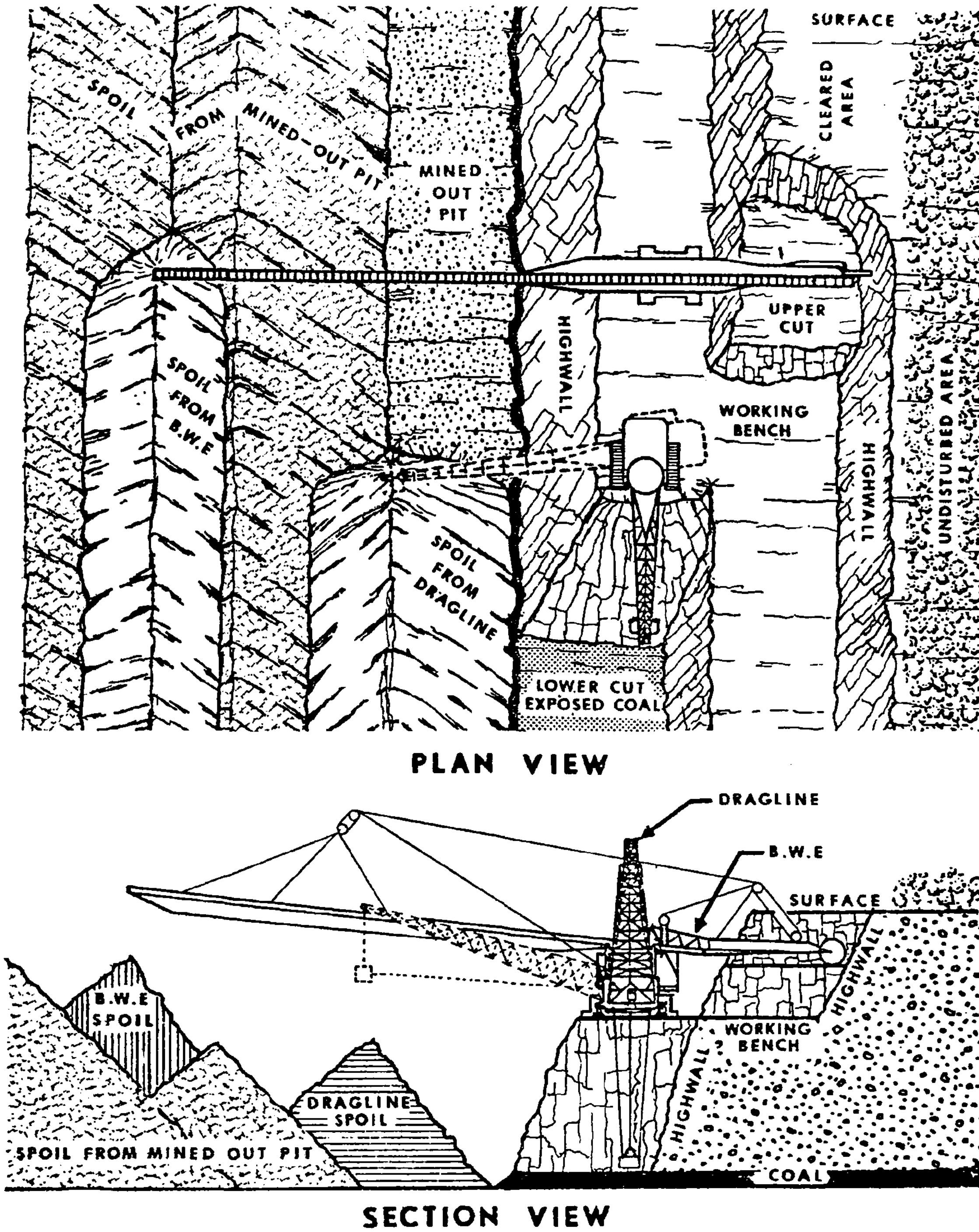
Source: US Bureau of Mines. 1975. Economic engineering analysis of US surface coal mines and effective land reclamation. US Department of Commerce, NTIS PB-245-315/AS.

Figure 8. Typical area mining with stripping shovel.



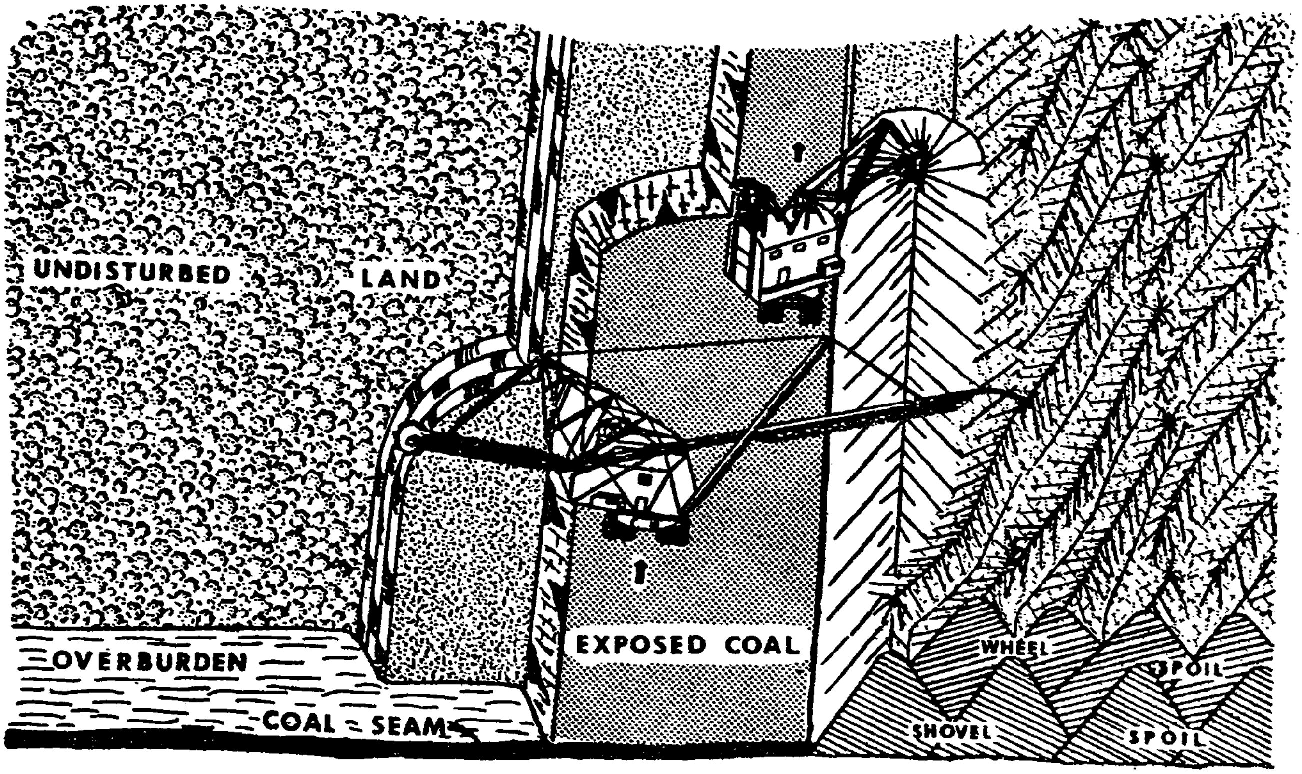
Source: US Bureau of Mines. 1975. Economic engineering analysis of US surface coal mines and effective land reclamation. US Department of Commerce, NTIS PB-245-315/AS.

Figure 9. Typical area mining with tandem draglines.



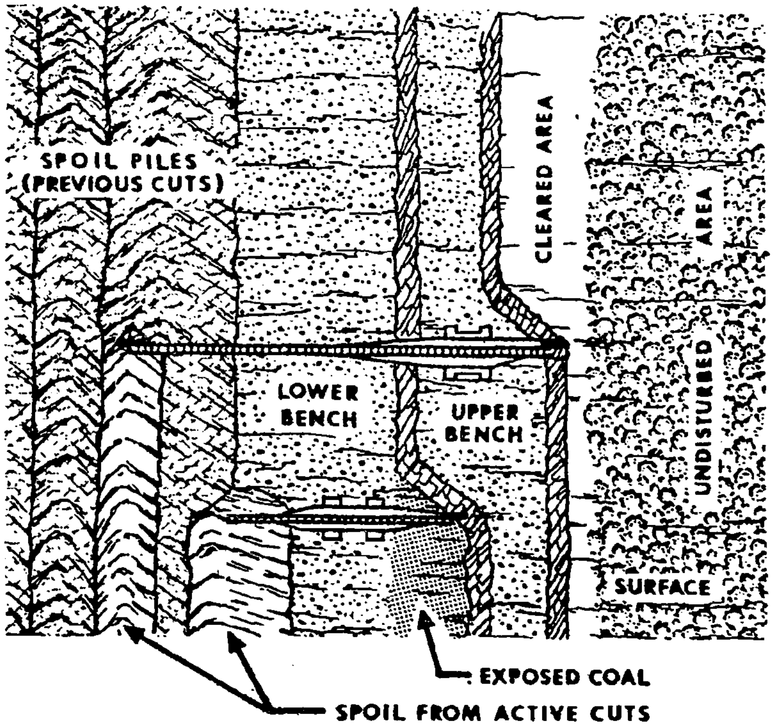
Source: US Bureau of Mines. 1975. Economic engineering analysis of US surface coal mines and effective land reclamation. US Department of Commerce, NTIS PB-245-315/AS.

Table 10. Area mining by utilizing a bucket-wheel excavator and a dragline in tandem.

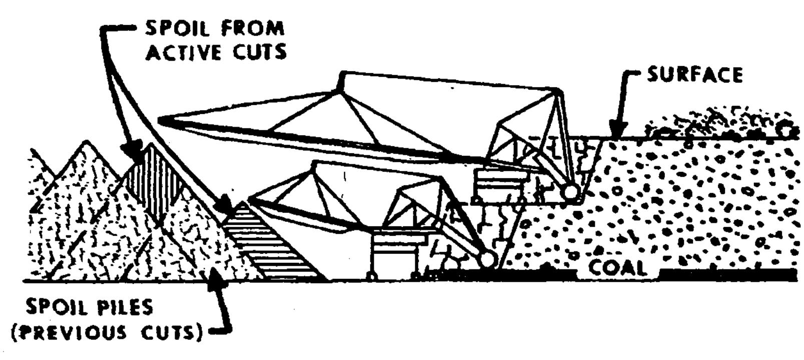


Source: US Bureau of Mines. 1975. Economic engineering analysis of US surface coal mines and effective land reclamation. US Department of Commerce, NTIS PB-245-315-AS.

Figure 11. Typical area mining with bucket-wheel excavator and shovel.



PLAN VIEW



SECTION VIEW

Source: US Bureau of Mines. 1975. Economic engineering analysis of US surface coal mines and effective land reclamation. US Department of Commerce, NTIS PB-245-315/AS.

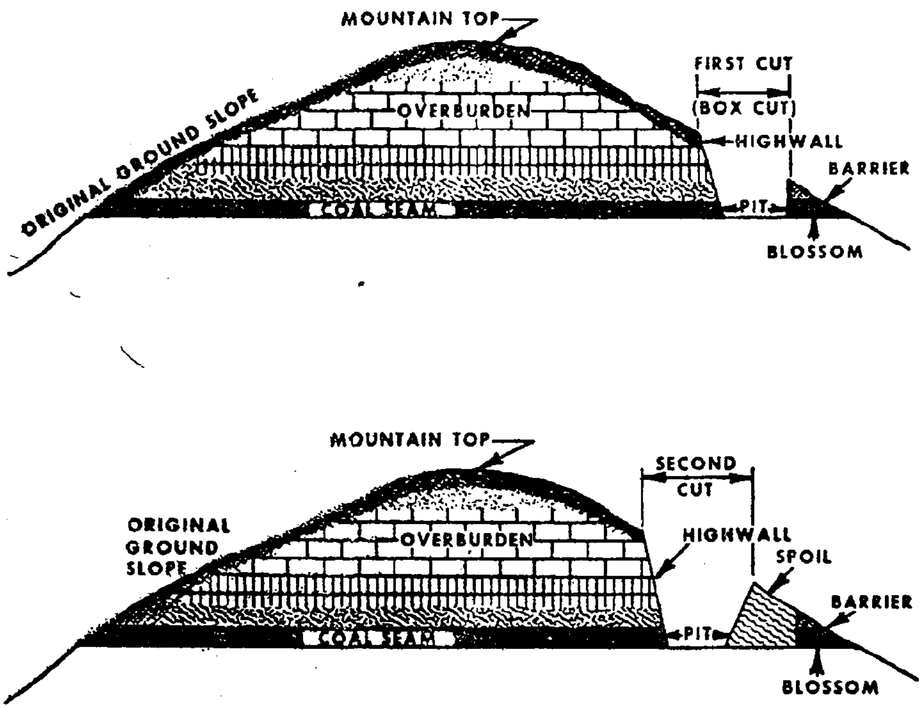
Figure 12. Area mining with tandem bucket-wheel excavators.

The mountain top removal method proceeds in the following manner. After placement of runoff diversions, sedimentation ponds, and any requisite water treatment facilities, a box-cut is made through the overburden along a line more or less parallel to the coal outcrop (Figure 13). This cut is made in a manner such that at least a 15 foot wide barrier of coal seam at the outcrop remains undisturbed. This "bloom" or "blossom" of undisturbed coal acts as a buttress to help stabilize spoil slopes during mining operations and subsequent reclamation. Spoil from the initial cut is transported to approved storage areas and stockpiled in a stable manner. Successive cuts are made parallel to the initial cut, and spoil from each successive cut is stockpiled in the trench of the previous cut (Figure 14). Final stabilization and revegetation of the mined area result in flat to gently rolling terrain suitable for various uses (Figure 15).

Coal is transported from the mine-site to cleaning plants, transfer points, and consumption points via trucks and conveyors. Trucks used for coal hauling range in capacity from 25 to 150 short tons, and may off-load in a rear-dump, bottom-dump, or side-dump mode, depending on the design of the receiving station. Trucks in the lower load ranges can be operated on-road and off-road, subject to State and local restrictions. Mobile conveyor belts are used in some larger mines to decrease the truck haulage cycle time. Permanent conveyors can be employed to transport coal from truck dump points to cleaning plants, railheads, barge points, and consumption points.

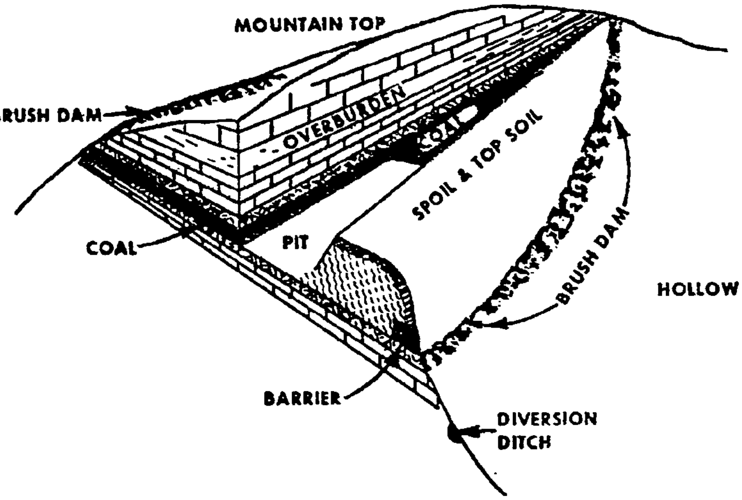
I.D.3.b. <u>Contour Mining</u>. Contour mining methods generally are employed in the mountainous terrain of the Eastern coal province. Contour mining historically consisted of "shoot and shove" operations in which overburden, blasted loose by explosives, was cast downslope from the coal outcrop. Coal was loaded out by shovels, bucket loaders, and dump trucks, and the mining operation proceeded thus around the mountain, more or less on the same contour. The mine-site usually was abandoned with little or no post mining reclamation.

Modern conventional contour mining generally employes the box-cut method, which proceeds in the following manner (Figures 16 and 17). The site is laid out according to the approved mining plans; signs are posted to mark the appropriate components of the mine. Runoff and siltation control structures are installed, and the initial mined area is scalped of topsoil, which is stockpiled separately from other overburden and wastes. The initial cut is made and spoil is piled on the outslope to form a drill bench. The drill bench is then loosened by blasting, and the spoil is hauled to an approved stockpile area. Toxic and acid forming spoils are segregated to prevent contamination of ground and surface waters and facilitate deep burial during the regrading phase. A barrier of undisturbed overburden at least 15 feet wide is left at the coal outcrop.



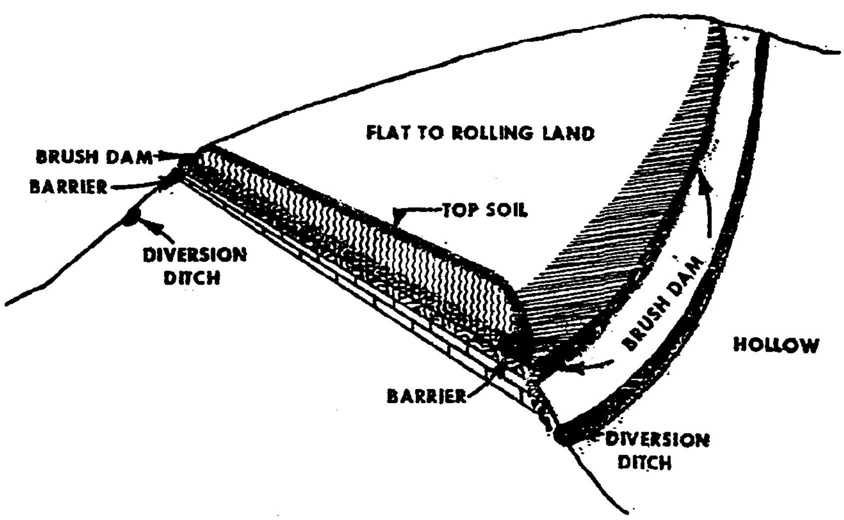
Source: Grim, E. C., and R. D. Hill. 1974. Environmental protection in surface mining of coal. Office of Research and Development, U. S. Environmental Protection Agency, Cincinnati OH, 277 p., EPA-670/2-74-093.

Figure 13. Mountain top removal: first and second cuts.



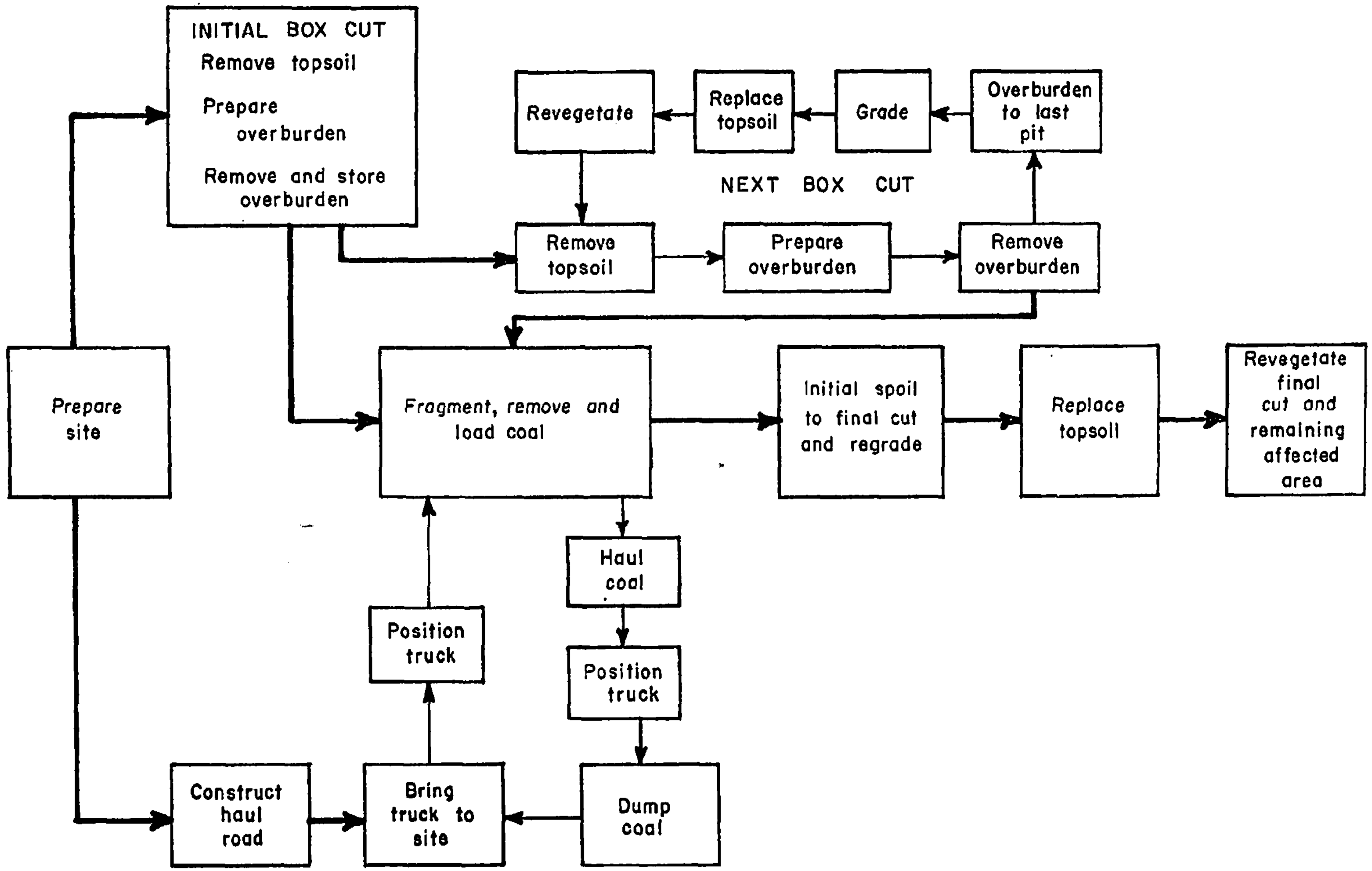
Source: Grim, E. C., and R. D. Hill. 1974. Environmental protection in surface mining of coal. Office of Research and Development, U. S. Environmental Protection Agency, Cincinnati OH, 277 P., EPA-670/2-74-093.

Figure 14. Mountain top removal: successive cuts.



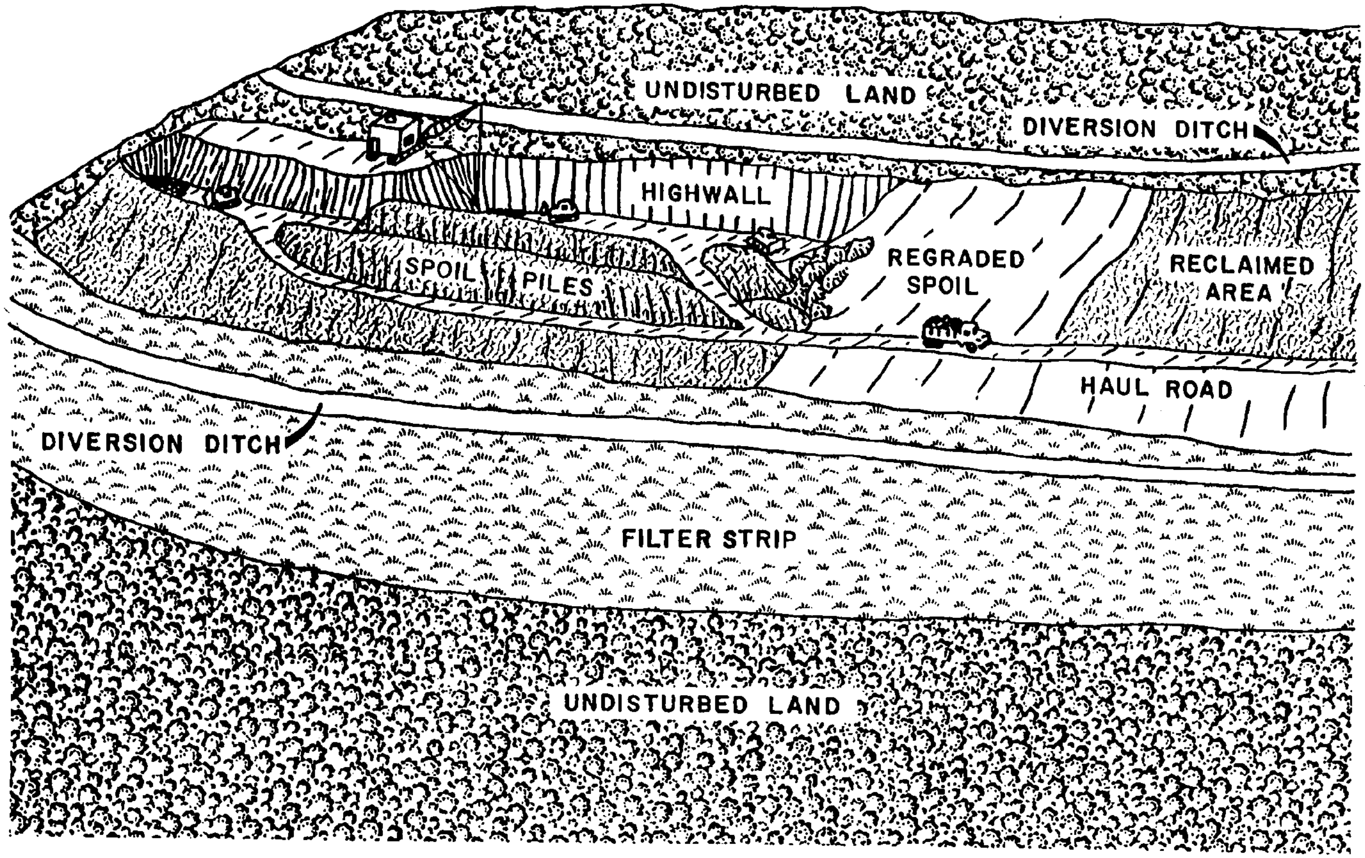
Source: Grim, E. C., and R. D. Hill. 1974. Environmental protection in surface mining of coal. Office of Research and Development, U. S. Environmental Protection Agency, Cincinnati OH, 277 p., EPA-670/2-74-093.

Figure 15. Mountain top removal: reclaimed area.



Source: Chironis, Nicholas P. (ed.). 1978. Coal age operating handbook of coal surface mining and reclamation. McGraw-Hill, Inc., New York, NY, 442 pp.

Figure 16. Sequence of operations for box cut contour surface mining.



Source: Adapted from Chironis, Nicholas P. (ed). 1978. Coal age operating handbook of coal surface mining and reclamation. McGraw-Hill, Inc., New York NY, 442 p.

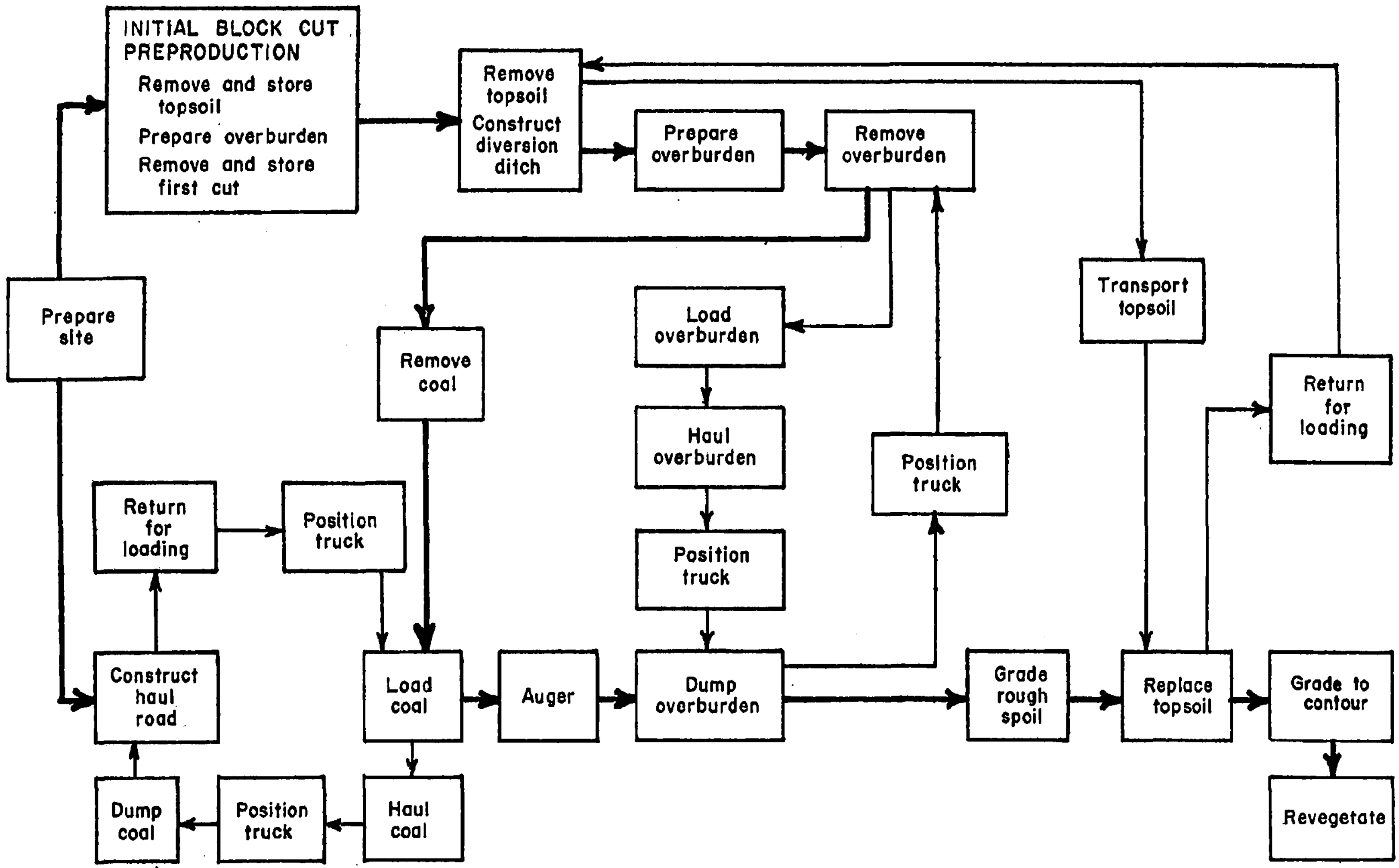
FIGURE 17. TYPICAL BOX CUT CONTOUR MINING OPERATION

A haul road and parallel drainage ditch are constructed along the coal outcrop and the exposed coal is removed. The unrecovered coal seam is mined with augers, and the auger holes generally are sealed with clay or some other nondeleterious, impervious material. The cut then is backfilled with previously stockpiled overburden so that (1) the backfilled slope is stable, (2) all highwalls are eliminated, and (3) toxic and acid-forming wastes and unmined coal seams will not contaminate ground and surface waters with deleterious siltation or leachate. Backfill is regraded to the approximate original contour, where possible. The regraded site is then replanted with appropriate species of plants and monitored for a specified length of time to insure success of the revegetation effort. Haul roads are either abandoned in an acceptable manner or are stabilized for use during and after replanting (US-EPA 1977; Grim and Hill 1974).

The development of a block cut contour mine is similar to box cut mining, with major differences in spoil handling techniques and the sequence of mining sections (Figure 18). Whereas the box cut method generally proceeds around the mountain in one direction, block cut mining progresses in both directions along the coal outcrop (Figure 19). An initial block of overburden is excavated near the center of the permit area, and spoil temporarily is placed downslope of the coal outcrop, or in a head-of-hollow fill. After the coal has been loaded out, spoil from the second cut is placed in the trench of the first cut. Because the second cut is only one-third to one-half the length of the first cut, spoil from the third cut also can be placed in the first cut. The third cut is stripped as coal is loaded out of the second cut. Each successive cut is smaller than the previous cut, so that the amount of spoil to be hauled to final cuts is minimized.

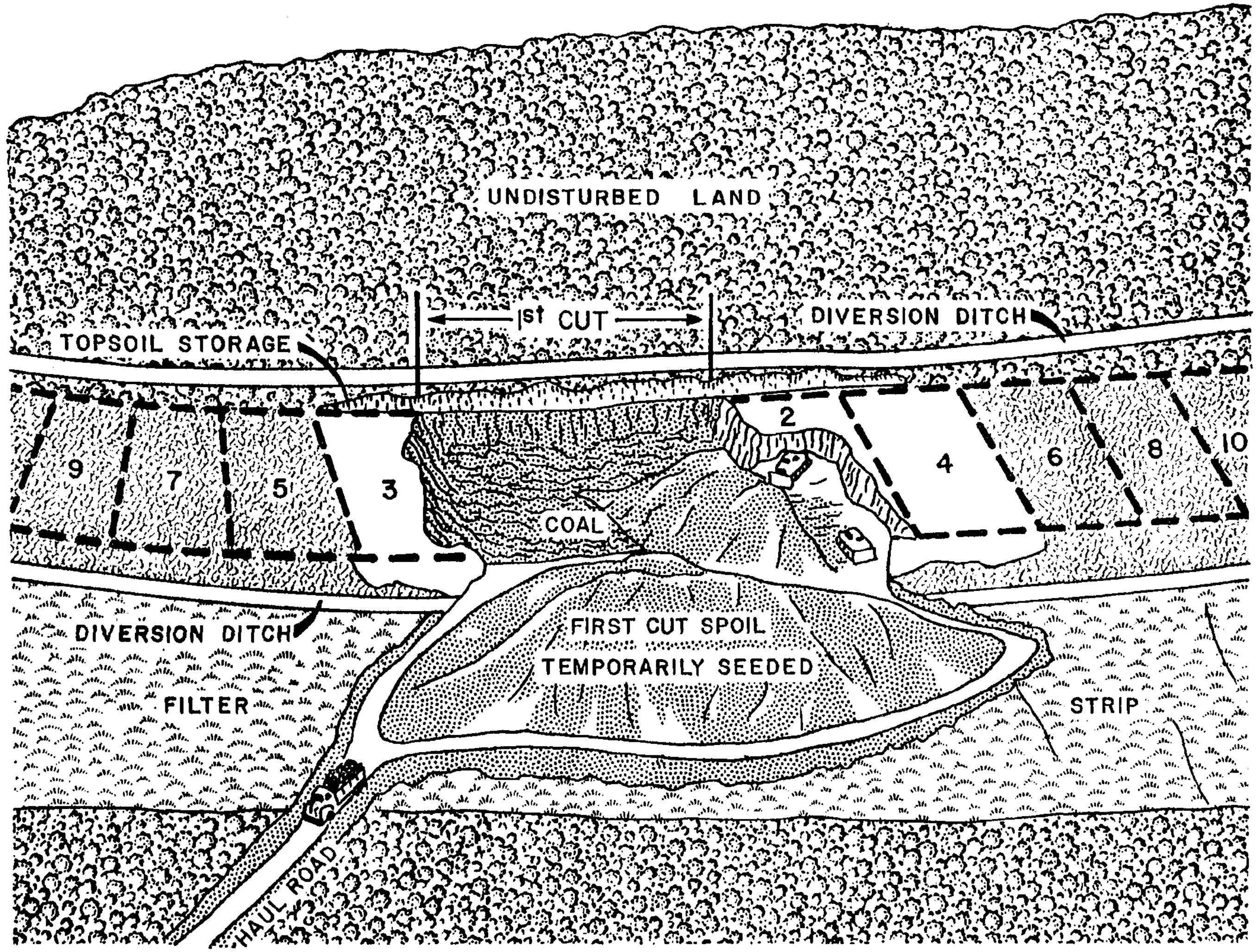
Transport of coal from contour surface mining operations generally is accomplished by dump trucks with capacities that range from 25 to 50 tons. These relatively small capacity trucks generally operate both on mine haul roads and public highways and, thus, must conform to the weight limitations specified by state motor vehicle agencies and local highway authorities. Mobile conveyors which feed permanent conveyors also may be used to transport coal to preparation plants.

I.D.3.c. Open Pit Mining. Open pit operations include a combination of area mining and contour mining techniques to recover coal from steeply dipping seams in the mountainous terrain of the Rocky Mountain coal provinces. Such operations in Wyoming are classified as Special Bituminous Coal Mines by OSM, and are subject to special performance standards which closely parallel existing Wyoming law.



Source: Chironis, Nicholas P. (ed.). 1978. Coal age operating handbook of coal surface mining and reclamation. McGraw-Hill, Inc., New York, NY, 442 pp.

Figure 18. Sequence of operations for block cut contour mining.



Source: Adapted from Chironis, Nicholas P. (ed.). 1978. Coal age operating handbook of coal surface mining and reclamation. McGraw-Hill, Inc., New York NY, 442 p.

FIGURE 19. TYPICAL BLOCK CUT CONTOUR MINING OPERATION

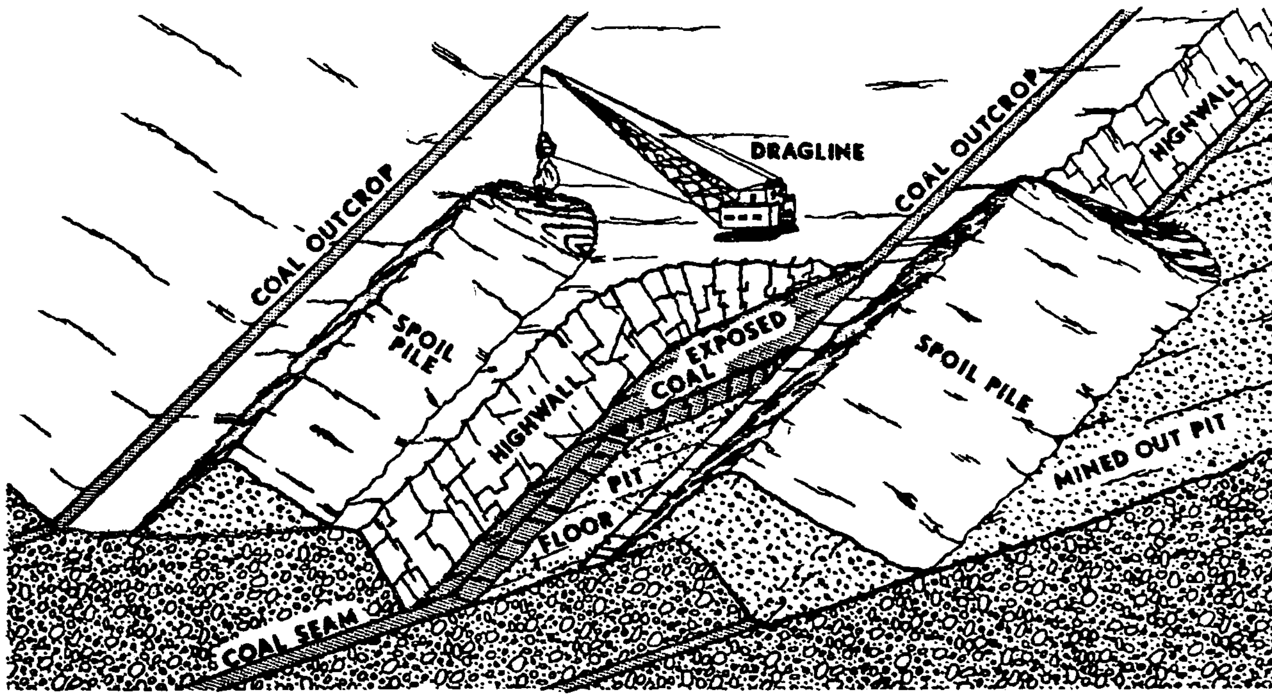
Equipment selection, spoil placement, and the depth to which coal will be mined are dependent on the ratio of overburden thickness to coal seam thickness (overburden ratio) and the number of seams to be mined. Mining usually is initiated in the oldest (lowest) coal seam in the permit area. A dragline or stripping shovel can be used to cast overburden on both sides of the pit, forming spoil piles on the previously mined highwall and adjacent to the outcrop of the next coal seam to be mined (Figure 20). Coal is loaded out with shovels or bucket loaders, and bulldozers reclaim the mined area to a configuration approved by regulatory authorities. Combinations of scraper loaders and stripping shovels also can be used for overburden removal (Figure 21).

Coal seams thicker than 70 feet with overburden ratios of 1:1 or less are mined by multiple bench open pit methods (Figure 22). Emphasis in the development of this mining method is placed more on proper sequencing of coal loading, hauling, and storage techniques than on overburden handling. Overburden is removed from the initial cut by scraper loaders or a combination of shovels and haulers, and is stockpiled adjacent to the pit. Subsequent overburden cuts are backfilled into the pit as stripping shovels load coal into haulers for transport to conveyors or unit trains (see page 47). Both of these transport systems can feed preparation facilities or generating plants.

I.D.4. Pollution Control

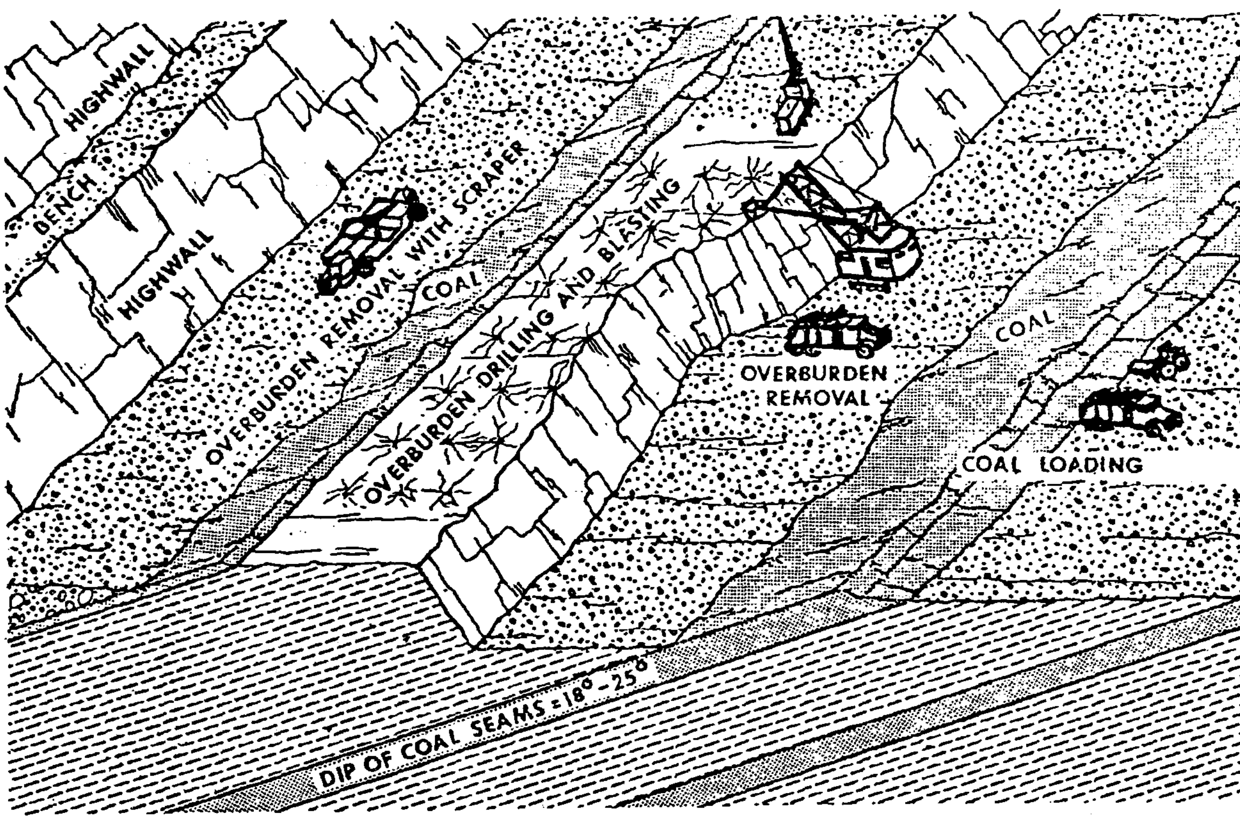
Significant advances have been made in pollution control techniques used in the surface coal mining industry. Evolving or improved technologies include:

- Alternate mining methods, emphasizing controlled spoil placement and reclamation concurrent with extraction
- Wastewater treatment systems, emphasizing innovative techniques to replace limestone treatment systems and rapid-filling sediment ponds, both of which suffer from reduced treatment cost ratios as a result of recent regulations (see section I.G.)
- Revegetation systems, emphasizing the replanting of reclaimed areas with plant species which have been specially bred for replanting of local minespoils
- Soil stabilization systems, emphasizing (1) the use of soil mechanics in slope design, and (2) soil covering agents such as quick-growing vetches and grasses, artificial soil amendments and chemical binders, and mulches to prevent wind and water erosion of recently backfilled or temporarily stockpiled soils



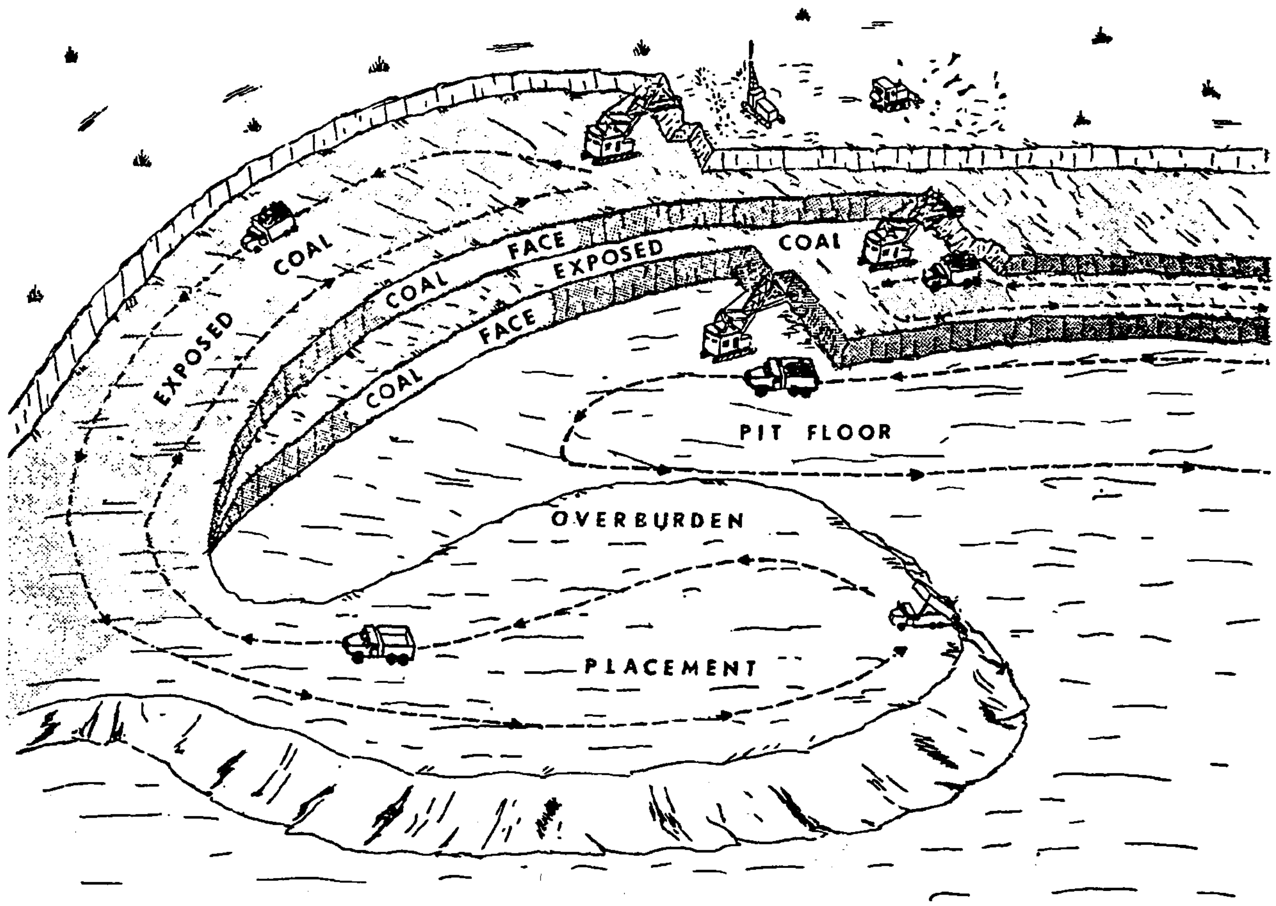
Source: US Department of the Interior Office of Surface Mining Reclamation and Enforcement. 1978. Draft environmental statement: Permanent regulatory program implementing section 501(b) of the surface mining control and reclamation act of 1977. Washington, DC. Variously paged.

Figure 20. Open pit mining with dragline.



Source: US Department of the Interior Office of Surface Mining Reclamation and Enforcement. 1978. Draft environmental statement: Permanent regulatory program implementing section 501(b) of the surface mining control and reclamation act of 1977. Washington, DC. Variously paged.

Figure 21. Open pit mining with scraper loader and stripping shovel.



Source: US Department of the Interior Office of Surface Mining Reclamation and Enforcement. 1978. Draft environmental statement: Permanent regulatory program implementing section 501(b) of the surface mining control and reclamation act of 1977. Washington, DC. Variously paged.

Figure 22. Open pit operation with multiple coal benches.

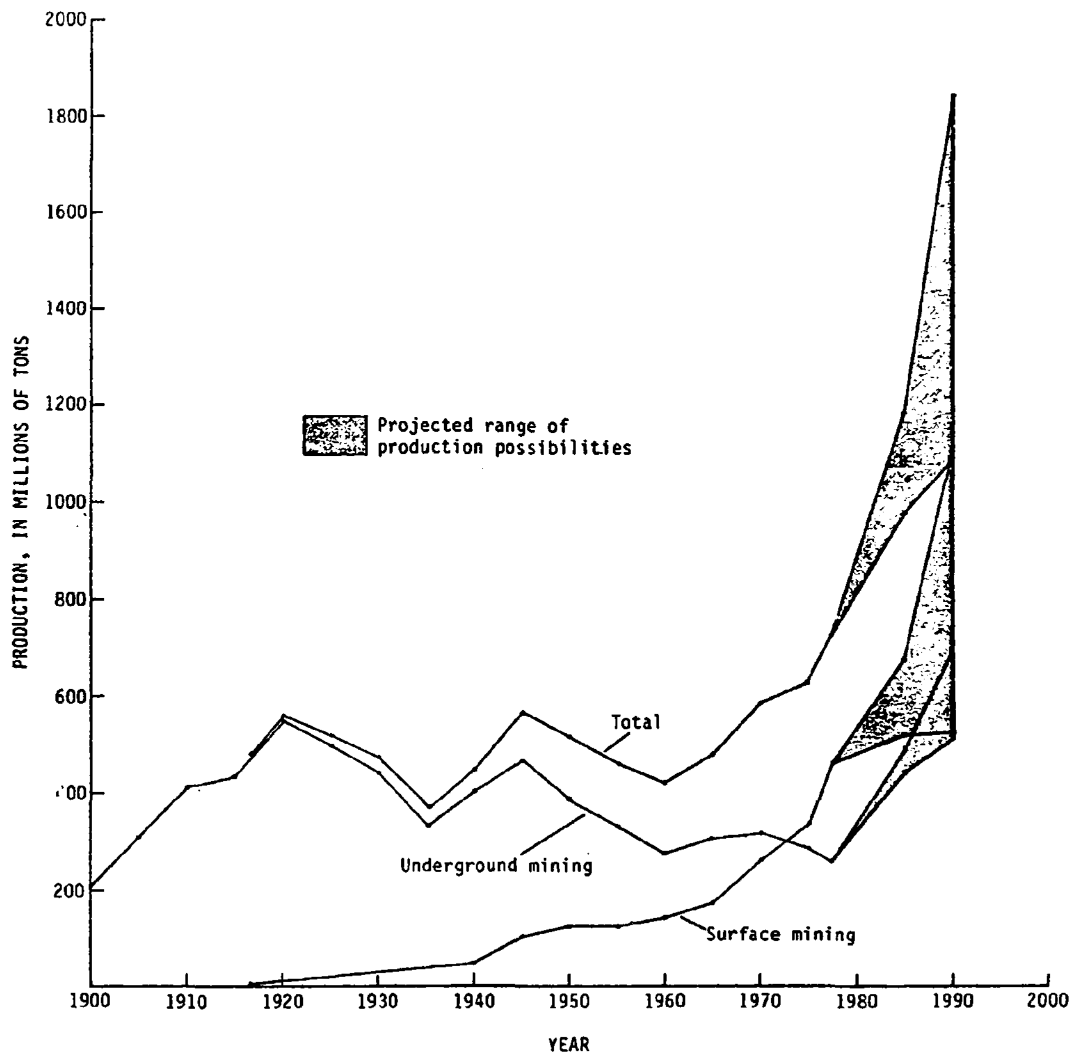
I.E. MARKETS AND DEMANDS

Approximately 95 percent of the total coal produced in the US is committed to sales contracts or other delivery agreements in advance of production. This figure includes the production from mines wholly owned by steel producers, utilities, and other high volume coal consumers. The remaining 5 percent is sold on the open market, known in the industry as the spot market. Most of the coal sold on the spot market is mined in the East and generally is produced by relatively small mining operations which do not produce the high volume of coal necessary to win long-term sales agreements.

Based on projections developed by the US Department of Energy (US-DOE 1978) a substantial increase in coal production and utilization is expected through 1990 (Figure 23). The extent of the production increase will depend primarily on production rates achieved in surface mining operations in the Powder River Basin and, to a more limited extent, other western coal provinces. The US-DOE forecasts are based on three scenarios for production rates of western coal mines (Table 6). The low production scenario is a conservative estimate based solely on production for which sales contracts existed as of 1 January 1978. The high production scenario represents the probable upper limit of expected production without some type of Federal administrative action. The medium production estimate accounts for coal production reasonably expected during the target years 1985 and 1990, including 120 million tons of currently planned production not under contract for delivery as of 1 January 1978.

The expected increase in coal utilization reflects the current Federal energy policy which, in part, is targeted at reducing dependence on imported energy commodities. Production during 1976 was about 665 million short tons of which 67% (444 million tons) was utilized to generate electricity. A production shortfall of 31.4 to 196.3 million short tons is forecast for the 1985 medium and high scenarios; shortfall under the low scenario could reach 57.4 million short tons. The predicted 1990 production shortfall could range from 6.4 to 679.2 million short tons, again depending upon which scenario is considered (US-DOE 1978).

Surface-mined coal varies from high value coking coals to low value, low BTU, high ash fuel coals. To satisfy air pollution standards for the generation of electricity, coals with naturally low sulfur contents and coals that are susceptible to significant reduction of sulfur content by cleaning will be in higher demand than coals of comparatively lower quality. The demand for metallurgical grade coals generally has decreased since 1973, reflecting the general decrease in US steel production (US Bureau of Mines 1978).



Source: US Department of the Interior Office of Surface Mining Reclamation and Enforcement. 1978. Draft environmental statement: Permanent regulatory program implementing section 501(b) of the surface mining control and reclamation act of 1977. Washington, DC. Variously paged.

Figure 23. Production of bituminous and lignitic coal by method of mining, from 1900 to 1990.

Table 6. Regional forecasts of coal production by method of mining.

Region	1985			1990		
	Low	Medium	High	Low	Medium	High
East:						
Underground-------	297.7	308.3	319.1	299.9	345.4	377.8
Surface-----------	129.1	132.3	135.2	96.4	99.9	101.0
Midwest:						
Underground-------	123.6	145.7	154.9	225.6	274.1	287.6
Surface-----------	125.7	127.0	127.0	110.5	128.3	153.2
West:						
Underground-------	27.9	28.6	28.6	28.4	37.0	36.1
Surface-----------	286.2	375.3	423.0	353.8	636.5	900.5
Total:[1]						
Underground-----	449.2	482.7	502.7	554.0	656.5	701.8
Surface---------	541.0	634.6	685.5	560.4	864.6	1,154.6
Total-------------	990.2	1,117.3	1,188.2	1,114.4	1,521.0	1,856.4

[1]Total may not add due to independent rounding.

Source: US Department of the Interior Office of Surface Mining Reclamation and Enforcement. 1978. Draft environmental statement: Permanent regulatory program implementing section 501(b) of the surface mining control and reclamation act of 1977. Washington, DC. Variously paged.

Desulfurization of coal by physical or chemical cleaning currently is not practiced at commercial scale, although demonstration plants and pilot facilities currently are in use. Projected demand for steam grade coal, therefore, will concentrate initially on coals with comparatively lower sulfur contents. As the feasibility of coal desulfurization is enhanced by implementation of improved, demonstrated technology, coal consumers may elect to use local, cleanable, high sulfur coals instead of more distant low sulfur coals. The factors which constrain such choices include the costs of transportation, beneficiation, and environmental regulation, all of which may vary significantly at the regional level.

I.F. SIGNIFICANT ENVIRONMENTAL PROBLEMS

Indiscriminate, unregulated surface mining of coal historically has resulted in the degradation of surface-mined lands and adjacent areas. The environmental impacts popularly associated with surface coal mining are related to the disruption of the surface and subsurface of the mine-site. Impacts on transportation, energy, and other community and regional assets generally are at least as significant as site-related impacts, although such infrastructure impacts are more subtle than site-related impacts. The type of impacts associated with surface coal mining are similar industry-wide (i.e., sedimentation, discharge of mine drainage, preemptive land use). The significance and intensity of these impacts, however, will vary with such local and regional factors as topography, surface and subsurface hydrology, geology, climate, and land use planning.

The following description of the environmental effects of surface coal mining is intended solely as a nontechnical introduction to the elements of the subject. A more complete analysis is presented in Chapter II of this Appendix.

I.F.1. <u>The Natural Environment</u>

Natural features of the environment which are affected significantly by surface mining include earth resources, vegetation and wildlife, air quality, and surface and groundwater resources.

I.F.1.a. <u>Earth Resources</u>. Surface mining includes such activities as blasting; overburden removal; coal extraction; construction of haul roads, dewatering and diversion structures; spoil disposal; and rehabilitation which can alter topography and geology permanently. Surface mining not only removes or alters the coal bed as a geologic unit, but also destroys the geologic units overlying the mined coal. Regardless of the reclamation techniques employed, the postmining land surface will bear only approximate resemblance to the natural, premining topography. In addition, spoil placement precludes many types of land uses for years after mining ceases.

Erosion is the most potentially significant adverse effect of surface mining activities on earth resources. Mine development includes the clearing and grubbing of the mine-site, topsoil removal, and haul road construction, all of which contribute to the erodibility of the mine-site; spoil piles, exposed overburden, and bare embankments also are erodible surfaces. Disturbed, exposed soil is easily eroded by wind and precipitation. In addition to the potential for degradation of air quality and water quality, as will be discussed in subsequent sections, erosion adversely affects soil stability and productivity. Because soil is the growing medium for vegetation which provides the Nation's food, fiber, wood, and wildlife habitat, the adverse effects of surface coal mining on soil productivity are a significant environmental concern. It is estimated that 26% of the Nation's total strippable coal reserves underlie prime farmland in the States east of the Mississippi River (US-DOI 1978). Only 3% of the coal-minable acreage in States west of the 100th meridian are located on alluvial valley floors (Hardaway and others 1977 within US-DOI 1978). Alluvial valley floors are important areas of agricultural production in the arid and semi-arid western part of the Nation. At present, the degree of success of reclamation of these areas disturbed by surface mining cannot be assured (US-DOI 1978).

I.F.1.b. Vegetation and Wildlife. Surface mining eliminates vegetation from the area of active mining for the duration of the mining operation. The major types of vegetation destroyed by mining include forage plants, trees and shrubs, and cultivated crops (US-DOI 1978). In addition to the initial clearing and grubbing, surface coal mining reduces soil productivity by (1) destroying topsoil, (2) depositing toxic materials on or near the soil surface, (3) polluting the soil from mine water sources, (4) soil erosion, and (5) landslides on unstable reclaimed land (US Department of Agriculture 1977 within US-DOI 1978).

Destruction of vegetation eliminates wildlife habitat. Animals dependent upon vegetation for shelter and food also are eliminated from the mine-site. Although displaced wildlife initially may move to adjacent, undisturbed areas, the resulting competition and behavioral interaction between immigrant and resident wildlife contributes to increased stress and mortality among the general wildlife population. Ground-dwelling animals, common in grasslands and scrublands in western States, may be killed directly by mining activities.

Wildlife in areas adjacent to mining operations may be disturbed by blasting, equipment and transportation noise, and fugitive dust.

I.F.1.c. Air Quality. The major air quality impact from surface mining is an increase in total suspended particulates (primarily fugitive dust). The aspects of mining which contribute fugitive dust to the local environment include blasting of overburden and coal, coal and spoil transportation over unpaved haul roads, and stockpiling of topsoil and overburden which are susceptible to wind erosion. Fugitive dust emissions are highest in the arid, windy regions typical of the western States (US-EPA 1978 within US-DOI 1978). Such emissions can be a specially significant problem in air quality regions where ambient air quality already exceeds standards or where air quality degradation by new sources is not permissible.

Other atmospheric emissions from mining activities include NO_x from blasting, and vehicular exhaust emissions.

I.F.1.d. Surface and Groundwater Resources. Surface coal mining operations may affect hydrology significantly in the mined area and surrounding areas. The erosion of exposed soil, waste piles, and coal storage piles can transport sediment and toxic substances to nearby streams. Increased sediment loads, acid mine drainage, and mine water which may contain toxic trace elements and high dissolved solids contribute to the: (1) deterioration of stream quality, (2) degradation or elimination of aquatic life, (3) diminution of water supplies and water-use opportunities, and (4) increase in downstream flood potential by reducing the water carrying capacity of downstream channels and floodpaths.

Surface mining also may affect groundwater supply and quality. Mining activities can cause: (1) the fracturing of aquifers and confining strata, with subsequent drainage of usable water, (2) lowering of water tables in adjacent areas, and (3) contamination of aquifers with acid mine drainage, toxic trace elements, and high dissolved solids from mine water and leaching of spoil piles. The potential for significant groundwater problems is particularly high in alluvial valley floors, located west of the 100th meridian. Alluvial sediments in these areas transmit and store much of the water available to vegetation during the growing season. Restoration of the hydrological characteristics of these areas following surface mining is, at present, unassured.

I.F.2. The Human Environment

Socioeconomic factors which may be affected significantly by surface mining include aesthetics, land use, local sound and vibration levels, and transportation resources. These direct impacts primarily are a result of the size of the operation and site specific conditions. The extent and significance of secondary or indirect impacts such as induced growth, infrastructure changes, and demographic changes largely depend on the local economy, existing infrastructure, availability of workers, and other related factors.

Long-term secondary impacts are seldom significant unless the mining operation leads to the development of significant supporting facilities (commercial, industrial, and residential). A discussion of secondary impact analysis is contained in the EPA document, Environmental Impact Assessment Guidelines for Selected New Source Industries.

I.F.2.a. Aesthetics. Surface coal mining impairs virtually all of the aesthetic qualities of a mine-site. The land is denuded of vegetation, scarred by excavations, and lined with piles of overburden and spoil. Alterations of the land surface disrupt the continuity of the adjacent topography. Noise and dust generated by blasting and equipment further accentuate the presence of the mining operation.

I.F.2.b. Land Use. Surface mining can destroy the potential of the land to sustain uses that were possible prior to mining. Prime agricultural land or areas of unique and valuable scenic, archaeological, historic, or biologically noteworthy features can be irretrievably lost through surface mining.

I.F.2.c. Sound and Vibration. The noise of blasting, heavy equipment, and coal transportation may affect neighboring residents and communities adversely. Similarly, vibrations generated by these activities may cause structural damage to surrounding facilities.

I.F.2.d. Transportation. The transportation of coal by trucks can generate fugitive dust (from haul roads and coal), noise, and traffic congestion. Coal truck traffic also can hasten the deterioration of local roads. Extractive activity immediately adjacent to public roads may weaken roadbeds through removal of adjacent, supporting material. Changes in local drainage patterns and sedimentation of downstream surface waters can contribute to flooding of local public roads.

I.G. REGULATIONS

Currently there are no national air pollution performance standards which directly apply to atmospheric emissions from new source surface coal mines. In the absence of Federal emission standards for the surface coal mining industry, air quality impacts will be assessed on the basis of receiving air quality standards, and applicable State and local standards.

Federal water pollution performance standards are covered primarily by the Standards of Performance for the coal mining point source category, and are contained in Section 40 CFR 434. Control is through the issuance of the NPDES permit. Administration and enforcement rest either with EPA or with those States with approved NPDES permit programs.

Other pollution control regulations (or amendments) which may apply include the Surface Mining Control and Reclamation Act of 1977, Clean Air Act of 1977, and Clean Water Act Amendments of 1977. Solid waste regulations include the Federal Resource Conservation and Recovery Act of 1976 and any State regulations which govern the management and disposal of solid wastes.

I.G.1. Air Pollution Performance Standards

Federal air pollution regulations normally specify both the maximum amounts of specific pollutants that can be emitted from a source and standards for controlling pollution of ambient air. Although no new source performance standards (NSPS) have been proposed for surface coal mines, NSPS have been proposed for coal preparation, which is the activity associated with the mining of coal that is most likely to affect air quality. Other air quality regulations that also apply include National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) requirements. The following paragraphs discuss these Federal regulations.

The regulatory program designed to achieve the objectives of the Clean Air Act is a combined Federal/State function. The rule of each State is to adopt and submit to EPA a State Implementation Plan (SIP) for maintaining and enforcing primary and secondary air quality standards in Air Quality Control Regions. EPA either approves the State's SIP or proposes and implements its own plan. The SIP's contain emission limits which may vary within a State due to local factors such as concentrations of industry and population. New source regulations require the Administrator to develop standards of performance for new stationary sources of air pollution. These standards must reflect levels of control which can be achieved by applying the Best Available Control Technology (BACT), taking cost into account. New source performance standards for coal preparation plants are presented in Table 7 .

Ambient air quality standards (40 CFR 50) specify the ambient air quality that must be maintained outside the project boundary or within the boundary where the general public has access. Applicable Federal standards are shown in Table 8 . Standards designated as primary are those necessary, with an adequate margin of safety, to protect the public health; secondary standards are those necessary to protect the public welfare from any known or anticipated adverse effects of an air pollutant.

In 1974, EPA issued regulations for the prevention of significant deterioration of air quality (PSD) under the 1970 version of the Clean Air Act (Public Law 90-604). These regulations established a plan for protecting areas that possess air quality which is cleaner than the National Ambient Air Quality Standards. Under EPA's regulatory plan, clean air areas of the Nation could be designated as one of three "Classes."

Table 7 . Summary of new source performance standards for bituminous coal preparation plants and handling facilities capable of processing more than 181 metric tons (200 short tons) of coal per day.

Equipment	Opacity Limitation %	Particulate Concentration Standard g/dscm	Particulate Concentration Standard gr/dscf
Thermal Dryers	20	0.070	0.031
Pneumatic Coal Cleaning Equipment	10	0.040	0.018
Coal Handling and Storage Equipment	20	-	-

Source: 40 CFR 250.

Table 8. Summary of National Ambient Air Quality Standards (from 40 CFR 50)

Emission	Standard: Primary	Standard: Secondary
Sulfur dioxide	80 micrograms/m^3 annual arithmetic mean	1,300 micrograms/m^3 maximum 3-hour concentration*
	365 micrograms/m^3 maximum 24-hour concentration*	
Particulate matter	75 micrograms/m^3 annual geometric mean	150 micrograms/m^3 maximum 24-hour concentration*
	260 micrograms/m^3 maximum 24-hour concentration*	60 micrograms/m^3 annual geometric mean (as guide in assessing implementation plans)
Hydrocarbons	160 micrograms/m^3 (0.24 ppm) maximum 3-hour concentration *	160 micrograms/m^3 (0.24 ppm) maximum 3-hour concentration*
Nitrogen dioxide	100 micrograms/m^3 annual arithmetic mean	100 micrograms/m^3 annual arithmetic mean
Ozone	235 micrograms/m^3 (0.12 ppm) maximum 1-hour concentration*	235 micrograms/m^3 (0.12 ppm) maximum 1-hour concentration*
Carbon monoxide	10 mg/m^3 (9 ppm) maximum 8-hour concentration*	10 mg/m^3 (9 ppm) maximum 8-hour concentration*
	40 mg/m^3 (35 ppm) maximum 1-hour concentration*	40 mg/m^3 (35 ppm) maximum 1-hour concentration*
Lead	1.5 micrograms/m^3 maximum calendar quarterly average	1.5 micrograms/m^3 maximum calendar quarterly average

*The maximum allowable concentration may be exceeded for the prescribed period once each year without violating the standard.

The plan permitted specified numerical "increments" of air pollution increases from major stationary sources for each class, up to a level considered to be "significant" for that area. Class I provided extraordinary protection from air quality deterioration and permitted only minor increases in air pollution levels. Under this concept, virtually any increase in air pollution in the above pristine areas would be considered significant. Class II increments permitted increases in air pollution levels such as would usually accompany well-controlled growth. Class III increments permitted increases in air pollution levels up to the NAAQS.

Sections 160-169 were added to the Act by the Clean Air Act Amendments of 1977. These amendments adopted the basic concept of the above administratively developed procedure of allowing incremental increases in air pollutants by class. Through these amendments, Congress also provided a mechanism to apply a practical adverse impact test which did not exist in the EPA regulations.

The PSD requirements of 1974 applied only to two pollutants: total suspended particulates (TSP) and sulfur dioxide (SO_2). However, Section 166 requires EPA to promulgate PSD regulations by 7 August 1980 addressing nitrogen oxides, hydrocarbons, carbon monoxide, and photochemical oxidants by use of increments or other effective control strategies. For these additional pollutants, States may adopt non-increment control strategies which, if taken as a whole, accomplish the purposes of PSD policy set forth in Section 160.

Whereas the earlier EPA regulatory process had not resulted in the Class I designation of any Federal lands, the 1977 Amendments designated certain Federal lands Class I. All international parks, national memorial parks, and national wilderness areas which exceed 5,000 acres, and national parks which exceed 6,000 acres, are designated Class I. These 158 areas may not be redesignated to another class through State or administrative action. The remaining areas of the country are initially designated Class II. Within this Class II category, certain national primitive areas, national wild and scenic rivers, national wildlife refuges, national seashores and lakeshores, and new national park and wilderness areas which are established after 7 August 1977, if over 10,000 acres in size are Class II "floor areas" and are ineligible for redesignation to Class III.

Although the earlier EPA regulatory process allowed redesignation by the Federal land manager, the 1977 amendments place the general redesignation responsibility with the States. The Federal land manager only has an advisory role in the redesignation process, and may recommend redesignation to the appropriate State or to Congress.

In order for Congress to redesignate areas, proposed legislation would be introduced. Once proposed, this probably would follow the normal legislative process of committee hearings, floor debate, and action. In order for a State to redesignate areas, the detailed process outlined in Section 164(b) would be followed. This would include an analysis of the health, environmental, economic, social, and energy effects of the proposed redesignation to be followed by a public hearing.

Class I status provides protection to areas by requiring any new major emitting facility (generally a large point source of air pollution--see Section 169[1] for definition) in the vicinity to be built in such a way and place as to insure no adverse impact on the Class I air quality related values.

The permit may be issued if the Class I increment will not be exceeded, unless the Federal land manager demonstrates to the satisfaction of the State that the facility will have an adverse impact on the Class I air quality related values.

The permit must be denied if the Class I increment will be exceeded, unless the applicant receives certification from the Federal land manager that the facility will not adversely affect Class I air quality related values. Then the permit may be issued even though the Class I increment will be exceeded. (Up to the Class I' increment--see Table 9 .)

I.G.2. Water Pollution Standards of Performance

Under the authority of the 1972 Federal Water Pollution Control Act, as amended (Public Law 92-500), EPA has issued standards of performance which specify maximum allowable concentrations of impurities in the various wastewater streams from coal mining activities. These regulations on the coal mining point source category (40 CFR 434,10-434.42; 44 FR 2589, 12 January 1979) form the basis for this discussion. All coal mines that begin operations after January 12, 1979, the date when EPA New Source Standards of Performance for the mining industry went into effect require National Pollutant Discharge Elimination System (NPDES) permits. They must meet at a minimum the National new source effluent guidelines and standards for the industry, if they propose to discharge wastewaters into the surface waters of the Nation (Table 10). New Source NPDES permits for the coal mining industry.

Table 9. Nondeterioration increments: maximum allowable increase by class.

Pollutant*	Class I ($\mu g/m^3$)	Class II ($\mu g/m^3$)	Class III ($\mu g/m^3$)	Class I' exception ($\mu g/m^3$)
Particulate matter:				
Annual geometric mean	5	19	37	19
24-hour maximum	10	37	75	37
Sulfur dioxide:				
Annual arithmetic mean	2	20	40	20
24-hour maximum	5**	91	182	91
3-hour maximum	25**	512	700	325

*Other pollutants for which PSD regulations will be promulgated are to include hydrocarbons, carbon monoxide, photochemical oxidants, and nitrogen oxides.

**A variance may be allowed to exceed each of these increments on 18 days per year, subject to limiting 24-hour increments of 36 $\mu g/m^3$ for low terrain and 62 $\mu g/m^3$ for high terrain and 3-hour increments of 130 $\mu g/m^3$ for low terrain and 221 $\mu g/m^3$ for high terrain. To obtain such a variance both State and Federal approval is required.

Source: Public Law 95-95. 1977. Clean Air Act Amendments of 1977, Part C, Subpart 1, Section 163.

will differ significantly from the existing source NPDES permits which EPA began to administer several years ago (final existing source regulations are in 40 CFR 434; 42 FR 80:21379-21390, 26 April 1977). First, the proposed Nationwide new source limitations (Table 10) are more restrictive than the existing source limitations for total iron (Table 11). Second, each new source permit must be approved prior to the construction of the proposed new source. Third, new source NPDES permit actions may be subject to comprehensive environmental review by EPA in accordance with NEPA, as well as other applicable environmentally protective laws and regulations. Hence the new source program offers significantly enhanced opportunity, as compared with the existing source program, for (1) public and interagency input to the Federal NPDES permit review process, (2) effective environmental review and consideration of alternatives, and (3) implementation of environmentally protective permit conditions on mine planning, operation, and decommissioning.

New source coal mining industries will be defined to include three basic categories of operations, according to the proposed regulations. First, new coal preparation plants independent of mines will be considered new sources as of the effective date of the regulations. Second, surface and underground mines that are assigned identifying numbers by the Mining Enforcement Safety Administration subsequent to the effective date of the regulations automatically will be considered new sources. Third, other mines may be regarded by EPA as "substantially new" operations if they (i) begin to mine a new coal seam, (ii) discharge effluent to a new drainage basin, (iii) cause extensive new surface disruption, (iv) begin construction of a new shaft, slope, or drift, (v) make significant additional capital investment, or (vi) otherwise have characteristics deemed appropriate by the Regional Administrator to place them in the new source category. The determination of whether or not a mine is a new source will be conducted case by case, based largely on the information supplied by each applicant.

EPA's new source effluent limitations have been proposed to apply only to wastewater discharged from active mining areas. They do not apply to runoff from land that has been regraded in accordance with a mining plan. Areas undergoing reclamation, that have been regraded but not yet released from revegetation bonds by other agencies, are to be considered a separate subcategory from active mines and coal preparation plants. No limitations for the new subcategory have been proposed. EPA discharge regulations do not address directly the long-term effluents from surface mining operations following the completion of revegetation.

Table 10. Nationwide performance standards for wastewater discharged after application of the best available demonstrated control technology by new sources in the coal mining point source category. The limitations are not applicable to excess water discharged as a result of precipitation or snow melt in excess of the 10-year, 24-hour precipitation event (40 CFR 434; 44 FR 2590, 12 January 1979). Units are milligrams per liter (mg/l) except as otherwise indicated.

	Coal Preparation Plants[1]		Bituminous, Lignite, and Anthracite Mining			
			Acid or Ferruginous Mine Drainage[3]		Alkaline Mine Drainage[3]	
Parameter	1-day Maximum	Average of 30 consecutive daily values	1-day Maximum	Average 30 consecutive daily values	1-day Maximum	Average of 30 consecutive daily values
Total suspended solids	70.0	35.0	70.0[4]	35.0[4]	70.0[4]	35.0[4]
Total iron	6.0	3.0	6.0	3.0	6.0	3.0
Total manganese	4.0	2.0	4.0	2.0		
pH (pH units)	range[2] 6.0 to 9.0		range[2] 6.0-9.0		range 6.0-9.0	

[1] Maganese discharge limitations are applicable only to discharges which are acidic prior to treatment.

[2] Slightly higher pH may be allowed if necessary to achieve the maganese limitation.

[3] Drainage which is not from an active mining area (for example, a regraded area) is not required to meet the stated limitations unless it is mixed with untreated mine drainage that is subject to the limitations.

[4] Total suspended solids limitations do not apply to discharges from coal mines located in Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming.

Table 11 . Nationwide performance standards for wastewater discharged after application of the best available demonstrated control technology by existing sources in the coal mining point source category. The limitations are not applicable to excess water discharged as a result of precipitation or snow melt in excess of the 10-year, 24-hour precipitation event (40 CFR 434; 42 FR 80:21379-21390, 26 April 1977). Units are milligrams per liter (mg/l) except as otherwise indicated.

	Coal Preparation Plants[1]		Bituminous, Lignite, and Anthracite Mining			
			Acid or Ferruginous Mine Drainage[3]		Alkaline Mine Drainage[3]	
Parameter	1-day Maximum	Average of 30 consecutive daily values	1-day Maximum	Average 30 consecutive daily values	1-day Maximum	Average of 30 consecutive daily values
Total suspended solids	70.0	35.0	70.0[4]	35.0[4]	70.0[4]	35.0[4]
Total iron	7.0	3.5	7.0	3.5	7.0	3.5
Total manganese	4.0	2.0	4.0	2.0		
pH (pH units)	range[2] 6.0 to 9.0		range[2] 6.0-9.0		range 6.0-9.0	

[1] Maganese discharge limitations are applicable only to discharges which are acidic prior to treatment.

[2] Slightly higher pH may be allowed if necessary to achieve the maganese limitation.

[3] Drainage which is not from an active mining area (for example, a regraded area) is not required to meet the stated limitations unless it is mixed with untreated mine drainage that is subject to the limitations.

[4] Total suspended solids limitations do not apply to discharges from coal mines located in Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming.

I.G.3. Other Federal Regulations

The regulations for OSM's permanent program (44 FR 50: 15311-15463; 13 March 1979) apply EPA's existing source effluent limitations (Table 11) to all surface mine discharges except those which originate in the undisturbed parts of the mine-site. Drainage from undisturbed areas will be treated if mixed with raw mine drainage prior to discharge. Drainage from areas undergoing reclamation also shall meet the limitations in Table 11 prior to discharge.

I.G.4. State Regulations

As of December 1975 all States that contain surface minable coal reserves had passed laws and promulgated regulations to control the surface mining of coal (Imhoff and others 1976). State regulations typically apply to mining methods, reclamation procedures, and post mining land uses. Only the regulations promulgated in Montana, Maryland, North Dakota, Ohio, and Texas provided State authority to designate lands unsuitable for mining. The information required by an applicant to satisfy permit requirements varies between States and the effectiveness of enforcement of regulations also has varied.[2] Minimum standards of performances now are prescribed by OSM. Under the Surface Mining Control and Reclamation Act of 1977, State surface mining regulations may be more stringent, but not less stringent, than the minimum Federal standards. As of November 1978, State mining regulations were being revised to meet the requirements of the new Federal law. The permit applicant is advised to consult early with the appropriate State authorities relative to State regulations and procedures applicable to surface coal mine operations.

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[2] Table 12 presents a hypothetical list as an indication of the range of State and local controls and permits that may apply to a surface mine.

Table 12. Hypothetical example of State and Local controls and permits required for a surface mine[1].

Time Period/Activity	Zoning and Related Local Land Use Controls	State Reclamation Controls	Water, Air, and Noise Pollution Controls	Other Controls, As Named
Pre-mining (years 0-4):				
Existing land use	X	--	X	--
Prospecting the area	--	X	--	--
Mineral and economic evaluations	--	X	--	--
Acquisition of rights	--	X	--	State water rights.
Surveying and design of mine	--	X	--	--
Natural Resources studies	--	X	X	--
Reclamation planning	--	X	--	--
End land-use planning	X	X	--	--
Costs analyses	X	X	X	State and local environmental controls.
Obtaining mine permit[2]	X	X	--	Waste discharge permits
Constructing roads and buildings[2]	X	X	X	State location of development (e.g., as in Maine).
Obtaining utilities	X	--	--	State utilities regulation.
Drainage and erosion control[2]	--	X	X	State water board
Fencing and screening[2]	X	X	--	State fish and game.
Environmental monitoring[2]	--	X	X	--
Joint mining and reclamation (years 4 to 30):				
Removal and segregation of soils[2]	X	X	--	Local soil and water conversation.
Disposal of debris[2]	X	X	X	Sanitary land fills.
Drilling and blasting[2]	X	X	X	State permit.
Extracting and hauling minerals[2]	X	X	X	State severance taxes.
Filling and grading[2]	X	X	X	--
Reducing pitwalls or highwalls[2]	X	X	X	--
Burying toxic materials[2]	X	X	X	--
Revegetation[2]	--	X	--	--
Post-mining (4 to 36):				
Vegetation survival studies[2]	--	X	--	State agriculture.
Pest and weed control[2]	X	X	--	State agriculture.
Land capability studies	X	X	--	State agriculture.
Divesting ownership or rights	X	--	--	Official acceptance of lakes and roads.
Water quality performance	X	X	X	State agriculture.
Decommissioning mine (dismantling, demolishing, etc.)	X	X	--	State mine abandonment laws.
Established end use	X	--	X	--
Recovery of bonds	X	X	--	--

[1]Does not include controls pertaining to mine safety.
[2]A process that tends to be maintained or repeated, as necessary, throughout much of the life of the mine.

Table 12. Hypothetical example of State and Local controls and permits required for a surface mine (concluded).

Source: Imhoff, E.A., et al. 1976. A guide to State programs for reclamation of surface mined areas. US Geological Survey Circular 731. Resource and Land Investigations (RALI) Program. Arlington VA.

II. IMPACT IDENTIFICATION

Surface coal mining is an extractive process rather than a manufacturing process, and therefore generates environmental impacts which are of the same general types Nationwide, but which vary in intensity and significance locally. Key mine-site characteristics which influence the magnitude and significance of environmental impacts include topography, geology (depth of overburden to coal seam, thickness and position of the coal seam), soil composition, land use, the presence of unique or sensitive natural features, hydrology, and climate. Therefore, it is important that the permit applicant thoroughly describe the environmental setting of the proposed permit area and appropriate adjacent areas. Adjacent area means those natural and human resources contiguous to or near the proposed permit area that may be affected by surface coal mining and reclamation operations conducted within the proposed permit area. The applicant should consult with EPA to delineate the adjacent area proximate to the proposed permit area. The following information should be included in the EID:[1]

- Earth Resources

  A map which shows clearly the topography of the proposed permit area and adjacent lands, accompanied by additional maps, illustrations, and text as needed to delineate or describe slopes greater than 25%, unstable slopes, existing spoil piles, existing mine workings, and other special or extraordinary topographic features.

  Maps which delineate the flood prone areas associated with precipitation events of 100-year recurrence interval or other recurrence intervals as appropriate, included in or proximate to the proposed permit area and adjacent area.

  Maps, cross sections, and text which delineate and describe the soils and geology of the proposed permit area and adjacent areas. The composition and thickness of all strata, including those which directly underlie the lowest stratum to be disturbed, should be described in sufficient detail to support the applicant's proposed plans for spoil handling, waste treatment or burial, and post-mining rehabilitation. Coal and overburden material should be analyzed to determine chemical parameters such as acid producing potential, concentrations of trace elements, sulfur content, and coal rank. Soils should be analyzed chemically to determine the kinds and amounts of soil amendments necessary to rehabilitate the disturbed site.

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1 The US Department of Interior Office of Surface Mining Reclamation and Enforcement (OSM) requires applicants for OSM or State-administered permits to furnish similar information with the permit application (30 CFR Chapter VII; 44 FR 50:15311-15463, 12 March 1979).

- Climate

  Text and illustrations which describe the maximum, minimum, and annual and monthly average for rainfall, snow, temperature, inversions, velocity and direction of winds, and probable occurrence of severe weather events at the proposed mine-site and adjacent areas.

- Air Quality

  Baseline data and explanatory text which describe the atmospheric concentration of particulates at the mine-site and adjacent areas. Baseline data for concentrations of other parameters, including NOx, may be required by the Regional Administrator on a case by case basis.

- Groundwater

  Maps, text, and illustrations (including cross sections) which delineate and describe the depth, areal extent, hydrogeology, and water quality of all aquifers and confining strata to be disturbed during exploration, mining; or reclamation.

  Maps and text which delineate and describe all water wells located within the proposed permit area and adjacent areas. The text should describe water withdrawal rates, groundwater uses, water well ownership, local or regional plans for groundwater development, and projections for increases or decreases in local groundwater demand through an appropriate planning year, to be designated by the Regional Administrator.

- Surface Waters

  Maps, text, and illustrations which describe all proposed receiving waters. Receiving waters include seeps, springs, streams, impoundments, wetlands, and navigable waters which would receive discharge from, or otherwise are proximate to the proposed permit area and adjacent areas. The text should include descriptions (supported by appropriate illustrations and maps) of all drainage basins located wholly or partially within the permit area and adjacent areas. The hydrology of receiving waters should be described on the basis of data presented in the EID, including statistics on low flow, normal flow, and flood flow. Existing flow control installations should be identified, and existing or proposed flood control plans should be described.

Maps and text that describe the chemical quality of proposed receiving waters and delineate stream segments that are classified as water quality limited and effluent quality limited by an appropriate State or Federal agency. Stream segments classified by other systems also should be described. Chemical quality of receiving waters should be characterized on a seasonal basis by the following parameters:

--temperature

--pH

--acidity

--alkalinity

--hardness

--dissolved oxygen

--total suspended solids

--total dissolved solids

--sulfate

--ammonia

--total dissolved concentrations of iron, manganese, zinc, aluminum, and nickel

- Aquatic Biota

Text which describes a seasonal, quantitative baseline of data on the biota of receiving waters. Appropriate biota include, but are not limited to:

--phytoplankton

--macrophytes

--invertebrates

--fish

Text (and maps, where appropriate) which describes the occurrence or potential for occurrence of rare or endangered species of aquatic life in proposed receiving waters.

- Terrestrial Biota

  Maps and text which delineate and describe existing vegetation in the permit area and adjacent areas. The text should characterize vegetation by factors such as:

  --species composition

  --importance as wildlife habitat

  --local and regional uniqueness

  --noteworthy specimens or associations

  --rare or endangered species

  --species of economic importance

  Text (and maps, where appropriate) which describes the wildlife that inhabit or otherwise use the permit area or adjacent areas, including an inventory of species of amphibians, reptiles, birds, and mammals, and the occurrence or potential for occurrence of rare or endangered species.

The wastes generated by surface coal mining include effluents, air emissions, and solid wastes. Many wastes consist of locally occurring natural materials which, if left undisturbed, would have minimal potential to degrade the environment. Other wastes consist of substances transported to the mine-site during the course of normal operations.

The EID should identify and describe all sources of waste associated with both the proposed mining method and the proposed permit area and adjacent area. Effluents, air emissions, and solid wastes should be discussed separately. The remainder of this chapter describes the minimum information requirements and supporting rationale for a general characterization of the environmental impact of wastes generated by surface coal mines. Regional Administrators may identify additional information requirements for specific EID's.

II.A. MINING WASTES (EFFLUENTS)

To characterize proposed effluents adequately, the EID should provide, at a minimum, maps, text, and illustrations which describe:

- Wastewater sources, including:

  groundwater

  runoff

  interdicted receiving waters

- Wastewater quantities, including the volume and duration of flows from each source

- Wastewater quality, including the parameters listed in Table 13

- Environmental impacts of the proposed discharge. The environmental resources to be considered include those identified in the description of the existing environment included in the EID

Wastewater associated with surface coal mining generally occurs as nuisance water which must be managed effectively to avoid disruption of or damage to the mining and reclamation operation. Groundwater normally is encountered during excavation for mine development or coal recovery. Groundwater is held in fractures, joints, solution channels, and interstitial voids that commonly occur in natural geologic materials. Coal seams locally may be significant sources of groundwater. These coal seams generally have well-developed fracture systems, and overlie relatively impermeable shales, clays, or claystones.

Runoff occurs as the result of precipitation, and includes water which does not infiltrate the surface to recharge groundwater. Runoff patterns at a given location can change with alterations in ground cover, topography, and baseflow. Wastewater attributable to runoff should be quantified for drainage areas of the proposed permit area and adjacent area using an accepted method (Chow 1964; USDA-SCS 1972). Quantities should be calculated for each configuration of drainage areas that will result from the progress of the mining operation. Wastewater quantities thus calculated can be compared to runoff from the pre-mining drainage pattern to assess the impact of proposed mining operations on streamflow.

The proposed permit area or adjacent area may include receiving waters that require impoundment, channelization, or other interdiction for mining to progress. Contamination of interdicted receiving waters with pollutant-bearing mine drainage generates a waste stream which must be treated adequately. The volume of the waste stream can be predicted and minimized during the design process.

Four basic types of effluents may be discharged from mining operations:

- Discharge effluent

- Sediment-bearing effluent

- Acid mine drainage

- Treated mine drainage

Table 13. Potential chemical constituents of coal industry wastewater.

Major Constituents - Total	Minor Constituents - Total
Acidity	Arsenic
Alkalinity	Barium
Aluminum	Cadmium
Boron	Chromium
Calcium	Copper
Chlorides	Cyanide
Dissolved Solids	Lead
Fluorides	Mercury
Hardness	Molybdenum
Iron	Selenium
Magnesium	
Manganese	
Nickel	
Potassium	
Silicon	
Sodium	
Strontium	
Sulfates	
Suspended Solids	
Zinc	

Major Constituents - Dissolved	Minor Constituents - Dissolved
Aluminum	Arsenic
Boron	Barium
Calcium	Cadmium
Iron	Chromium
Magnesium	Copper
Manganese	Lead
Nickel	Mercury
Silicon	Molybdenum
Strontium	Selenium
Zinc	

Additional Analyses
Acidity, net
Acidity, pH8
Ammonia
Color
Ferrous Iron
Oils*
pH
Specific Conductance
Turbidity

* Preparation Plants Only

Source: US-EPA. 1976a. Development document for interim final effluent limitations guidelines and new source performance standards for the coal mining point source category. Washington, DC, 288 p. EPA 440/1-76/057-a.

Discharge effluent is untreated mine drainage that is of acceptable quality for discharge without sedimentation or neutralization treatment. This type of discharge may result from collection of runoff from undisturbed areas or from effective management of interdicted receiving waters.

Sediment-bearing effluent is mine drainage which has passed through settling basins for removal of excessive amounts of sediment. Sediment-laden water generated by the erosion of exposed land is a common, but significant, problem encountered in surface mining. Erosion and resulting sedimentation contribute to the exposure of toxic substances, onsite and offsite water pollution, and the loss of soil nutrients leading to reduced soil productivity. Estimates of erosion from unreclaimed mined land vary from a few tons per acre to greater than 300 tons per acre (US-DOI 1978). Active and abandoned coal mines are estimated to generate 17,850 tons of sediment per square kilometer of exposed soil per year (US-EPA 1973 within US-DOI 1978). The susceptibility of surface-mined land to erosion is dependant on site conditions. To assess adequately the extent of potential erosion, the permit applicant should consider and document in the EID the following factors (Grim and Hill 1974):

- Degree of slope
- Length of slope
- Climate
- Amount and rate of rainfall
- Type and percent vegetation cover

Acid mine drainage (AMD) is untreated mine drainage characterized as acid with high iron content. The removal of overburden often exposes pyritic materials which, when oxidized, eventually produce ferric hydroxide and sulfuric acid. This wastewater is characterized by low pH and high concentrations of heavy metals such as iron, manganese, copper, and zinc (Table 14). The amount and rate of acid formation and the quality of discharge are a function of the amount and type of pyrite in the overburden and coal, other geological and chemical characteristics of the overburden, and the amount of water and air available for chemical reaction.

Raw mine drainage also may be alkaline in areas where the overburden contains alkaline material such as limestone or where no acid-producing material is associated with the coal seam. The general chemical characteristics of raw alkaline mine drainage are listed in Table 15. These discharges usually are high in sulfates and generally are less detrimental to the environment than acid mine discharges.

Table 14 . General chemical characteristics of raw acid mine drainage from surface coal mines.

Parameter	Minimum (mg/1)	Maximum (mg/1)	Mean (mg/1)	Std. Dev.
pH	2.6	7.7	3.6	
Alkalinity	0	184	5	32
Total Iron	0.08	440	52.01	101
Dissolved Iron	0.01	440	50.1	102.4
Manganese	0.29	127	45.11	42.28
Aluminum	0.10	271	71.2	79.34
Zinc	0.06	7.7	1.71	1.71
Nickel	0.01	5	0.71	1.05
TDS	120	8,870	4,060	3,060
TSS	4	15,878	549	2,713
Hardness	24	5,400	1,944	1,380
Sulfate	22	3,860	1,842	1,290
Ammonia	0.53	22	6.48	4.70

Source: US-EPA. 1976a. Development document for interim final effluent limitation guidelines and new source performance standards for the coal mining point source category. Washington, DC, 288 p. EPA 440/1-76/057a.

Table 15. General chemical characteristics of raw alkaline mine drainage from surface coal mines.

Parameter	Minimum (mg/l)	Maximum (mg/l)	Mean (mg/l)	Std. Dev.
pH	6.2	8.2	7.7	
Alkalinity	30	860	313	183
Total Iron	0.02	6.70	0.78	1.87
Dissolved Iron	0.01	2.7	0.15	0.52
Manganese	0.01	6.8	0.61	1.40
Aluminum	0.10	0.85	0.20	0.22
Zinc	0.01	0.59	0.14	0.16
Nickel	0.01	0.18	0.02	0.04
TDS	152	8,358	2,867	2,057
TSS	1	684	96	215
Hardness	76	2,900	1,290	857
Sulfate	42	3,700	1,297	1,136
Ammonia	0.04	36	4.19	6.88

Source: US-EPA. 1976a. Development document for interim final effluent limitations guidelines and new source performance standards for the coal mining point source category. Washington, DC, 288 p. EPA 440/1-76/057-a.

Acid mine drainage, untreated by neutralization and sedimentation, has destroyed productivity in approximately 11,000 miles of US streams (H. R. Rep. No. 95-218, 95th Cong., 1st Sess. at 58, 1977 within US-DOI 1978). For the Appalachian Region, it is estimated that a residual acid load in excess of 300,000 tons per year is not neutralized until it reaches the larger streams (US-SCS 1978 within US-DOI 1978). Approximately 97 percent of the acid pollution in streams and 63 percent in impoundments is generated by coal mining operations (US-DOI 1978).

Treated mine drainage is effluent which has been treated by neutralization and sedimentation and generally is of acceptable quality for discharge. The water quality of discharge effluent and sediment-bearing effluent, however, generally is superior to the quality of treated mine drainage (US-EPA 1976a).

II.A.1. Wastewater From Coal Transportation

Water is utilized in coal transportation as a dust suppressant applied to haul roads, coal loads on trucks and conveyors, and coal storage piles. Water also is utilized as the transporting medium in slurry pipelines to carry coal to coal preparation facilities. The waste characteristics of water utilized for coal transportation are similar to sediment-bearing effluents and raw mine drainage at the mine-site.

II.B. MINING WASTES (EMISSIONS)

Air emissions result from all phases of surface coal mining and can affect air quality for considerable distances from the mine-site. The principal impact on air quality is an increase in total suspended particles, primarily fugitive dust generated from haul roads, topsoil and overburden handling, dragline operations and spreading activities associated with rehabilitation.

To assess the environmental impacts of air emissions adequately, the EID should contain, at a minimum, the following information:

- Sources of emissions
- Quantities of emissions
- Physical and chemical composition of emissions

The impact of dust on air quality depends on particle size and composition, and air flows of sufficient velocity to carry the dust from the point of origin. The pick-up velocities for various dusts are listed in Table 16 (Djamgouz and Ghonein within Down and Stocks 1978). In mining operations, however, machinery and transportation increase the distribution of dust by imparting a velocity to the dust particle which effectively lowers the wind speed required to raise the dust. On asphalt roads, as much as 1% of newly deposited dust may

Table 16. The pick-up velocities of dry dusts*.

Particle Size (μm)	Air Velocity, m/s (ft./s) Granite	Silica	Coal
75–105	7 (23)	6 (20)	5 (16)
35–75	6 (20)	5 (16)	4 (13)
10–35	4 (13)	3 (10)	3 (10)

* Add 1m/s (3 ft./s) for wet dusts.

Source: Down, C. G. and J. Stocks. 1978. Environmental impact of mining. Applied Science Publishers, Ltd. London, England. 371 p.

be resuspended by each vehicle passage (Down and Stocks 1978). Other factors affecting dust transport are season, time of day, soil moisture, temperature, humidity, and wind direction (Downs and Stocks 1978).

Fugitive dust emissions can be transported up to 20 km from mining operations (Dvorak and others 1977 within US-DOI 1978). Generally this environmental problem is greater in the western States where arid conditions and high winds are common. To demonstrate the magnitude of the problem, uncontrolled fugitive dust emissions from a western mine operation which produced one million tons of coal per year was estimated at 1,750 tons per year, of which 265 tons per year were of respirable size (US-EPA 1978 within US-DOI 1978). The problem is less severe in the eastern States where rainfall and humidity are greater and wind velocity and intensity are less (Hittman Associates, Inc. 1975).

Other atmospheric emissions include equipment and vehicular exhausts which generate particulates, sulfur oxides, carbon monoxide, hydrocarbons, oxides of nitrogen (also a product of blasting), and minor amounts of aldehydes and organic acids (Hittman Associates, Inc. 1975).

II.C. MINING WASTES (SOLID WASTE)

Solid wastes generated by surface coal mining include:

- Natural wastes
- Treatment wastes

Natural wastes include overburden materials, organic debris, rock partings in coal seams, or other materials occurring naturally at the mine-site, which have a high potential to contaminate the environment. Acid-bearing or toxic-forming overburdens are potentially detrimental to the success of reclamation, and, if improperly handled, can release pollutants to the environment long after mining ceases.

Treatment wastes are products of the pollution control systems employed at mine-sites. Treatment wastes include sludges from sediment ponds, treatment ponds, clarifiers, centrifuges, and runoff control structures. To adequately assess the impact of solid wastes on the environment, the EID should furnish, at a minimum, the following information:

- Sources of solid waste
- Quantity of solid waste
- Quality of solid waste

Solid wastes contaminate the environment through release of pollutants. Solid waste pollutants may be transported to surface waters in sediment-laden runoff. Groundwater quality may be affected adversely by leachate from improperly designed waste piles or wastes which are buried improperly. Potential contaminants in solid wastes include the parameters in Table 13 .

II.D. TOXICITY AND POTENTIAL FOR ENVIRONMENTAL DAMAGE FROM SELECTED POLLUTANTS

The most common pollutants associated with the surface mining industry are: (1) sediment, (2) acid, (3) iron, and (4) manganese. Other heavy metals commonly found in mine drainage include nickel, aluminum, zinc, and sulfates. These pollutants can affect the environment adversely and may be toxic to both humans and wildlife.

II.D.1. Human Health Impacts

Principal pollutants found in coal which may have effects adverse to human health are:

- Fugitive dust
- Sulfates
- Iron
- Manganese
- Zinc
- Other trace elements

II.D.1.a. Fugitive Dust. Fugitive dust, if uncontrolled, can result in ground level ambient air quality which is hazardous to those working at or living downwind of the mine-site. Twenty-four hour and annual average ambient air quality standards may be exceeded not only at the mine-site but also for miles downwind (Murray 1978 within US-DOI 1978).

II.D.1.b. Sulfates. Sulfates can cause both a bad taste and a laxative effect in drinking water. EPA (1976b) recommends an upper limit of 250 mg/l to provide reasonable protection to humans from these adverse effects.

II.D.1.c. Iron. Based upon aesthetic and taste considerations a limit of 0.30 mg/l iron has been established for domestic water supplies (US-EPA 1976b).

II.D.1.d. Manganese. The upper limit for manganese in domestic water supplies is 0.5 mg/l (US-EPA 1976b). Although this limit was established primarily for aesthetic and taste considerations, there have been reported cases of manganese poisoning from contaminated drinking water (US-EPA 1976a).

II.D.1.e. Zinc. Concentrations of zinc in excess of 5 mg/l can cause an undesirable taste in public water supplies. In addition, zinc can have an adverse effect on humans at high concentrations (US-EPA 1976a).

II.D.1.f. Trace Elements. Various trace elements which may be found in coal can have effects adverse to human health. Table 17 presents a summary of trace metals, their associated health problems, and pertinent references for more detailed documentation.

II.D.2. Biological Impacts

Aquatic and terrestrial biota may be affected adversely by pollutants commonly found in wastes from surface mining operations.

II.D.2.a. Sediment. Sediment transported by water during erosion and by air as fugitive dust is the most abundant pollutant from surface coal mining. If uncontrolled, sediment transported by runoff may degrade receiving waters by causing increases in turbidity, oxygen demanding materials, nutrients, and potentially toxic substances. Increased sediment loads to receiving water also hasten the aging of ponds and lakes through filling and nutrient enrichment. Excess sediment reduces the holding capacity of waterways, increases flooding, degrades water for consumptive uses, increases water treatment costs, and decreases the useful life of reservoirs and navigation channels.

Aquatic life also is affected adversely by excess sediment. Increased suspended sediment loads reduce primary productivity (photosynthesis) in surface waters by limiting the penetration of light. Sedimentation buries and suffocates the organisms of the periphyton and macroinvertebrates which have limited mobility, and reduces or eliminates fish spawning success. Physical abrasion from suspended sediments also destroys aquatic organisms. As sediment load increases in streams, the interstices between the gravel and rocks which compose the bottoms of riffle areas gradually will be filled. This process effectively eliminates many habitats otherwise occupied by a variety of aquatic organisms. Aquatic macroinvertebrates and fish respond to high concentrations of suspended solids by exhibiting increased rates of downstream movement (drift), decreases in population, and changes in community composition (Gammon 1970). Sediment, as a major constituent of fugitive dust, also may damage the plants on which it settles.

Table 17. Possible health problems associated with trace metals found in coal.

Metal or metal compound	Health problems	Reference
Nickel carbonyl	Suspected carcinogenesis	(Sunderman and Donnelly 1965) (Cavanaugh 1975)
Antimony, arsenic, cadmium, cobalt, copper, iron, lead, magnesium, manganese, tin, and zinc oxides	Fume fever	(Waldbott 1973)
Nickel	Nasal cancers	(Gilman and Ruckerbauer 1963)
Cadmium	Prostate cancer	(Pott 1965); (Kipling and Waterhouse 1967)
Chromium and compounds	Carcinogenesis	(Hueper 1961)
Berylium and compounds	Carcinogenesis	(Reeves et al. 1967); (Wager et al. 1969)
	Poisoning	(Nishimuta 1966)
Arsenic	Cancer of the skin	(Wickstrom 1972)
	Poisoning	(Lee and Fraumeni 1969)
Cobalt	Carcinogenesis	(Gilman and Ruckerbauer 1963)
Lead and compounds	Nasal cancers	(Zawirsica and Medras 1968)
	Kidney damage	(Zollinger 1953)
Mercury and compounds	Mutagenic and teratongenic effects	(D'Itri 1972)
Vanadium	Inhibition of lipid formation	(Stokinger 1963)

II.D.2.b. Acid. Acid water discharges can affect aquatic life adversely by acting as a toxicant, causing osmotic imbalances, physiological harm to fish, and affecting aquatic plants, algae, and benthic macroinvertebrates (US-DOI 1978).

II.D.2.c. Iron. Iron discharged with mine wastewater can be very toxic to aquatic life. It kills fish by coating gills with iron hydroxide precipitates ("yellow boy") and by coating stream bottoms, thus burying macroinvertebrates and other food organisms (US-EPA 1976a and US-DOI 1978). Although tolerance to iron varies greatly among aquatic species, EPA (1976b) recommends an upper limit of 1 mg/l for the protection of freshwater aquatic life.

II.D.2.d. Manganese. Similar to iron, manganese discharges from surface mines act both as toxicants to aquatic biota and as precipitates, burying bottom-dwelling organisms (US-EPA 1977 within US-DOI 1978).

There are no specific criteria for the concentration of manganese allowed in freshwater. It appears that levels up to 1 mg/l would be safe for aquatic animal life (US-EPA 1976b). Much lower levels, however, may pose a hazard to aquatic plants. Levels down to 0.005 mg/l soluble Mn were found to be toxic to algae (McKee and Wolf 1963).

II.D.2.e. Zinc. In soft water, concentrations of zinc ranging from 0.1 to 1.0 mg/l can be lethal to fish by affecting the gills or acting as an internal poison (US-EPA 1976a). The sensitivity of fish to zinc varies with species, age, condition, and chemical and physical characteristics of the water. Freshwater plants may be affected adversely by concentrations of 10 mg/l (US-EPA 1976a).

II.E. OTHER IMPACTS

Other impacts of surface coal mining include the potential effects of:

- Transportation of coal
- Preparation of coal
- Post mining activities

II.E.1. Coal Transportation

This section discusses in some detail the emissions from various modes of coal transportation.

II.E.1.a. Railroads. Railroads, diesel and electrical powered, transport nearly 70% of all bituminous coal mined in the US.[2] Three types of trains are used in transporting raw coal:

- Conventional
- Unit
- Dedicated

When conventional trains are used, cars carrying coal are treated like any other car. Unit trains are made up entirely of cars carrying coal. When coal is transported by conventional trains, the Interstate Commerce Commission's (ICC) general rates apply. In contrast, a special rate of almost one third less applies to special unit trains.

Unit trains offer several other advantages including better use of equipment, elimination of standard railroad tie-ups such as classification yards and layover points, and promotion of better coordination between mine production and consumers, particularly consumers dependent on coal supplied by a single mine (National Academy of Engineering, 1974).

The dedicated railroad, the third rail option, is used exclusively for transporting coal. A dedicated railroad generally is used only when an existing railroad is not available and when the railroad will link a mine to a single-source user.

II.E.1.b. Barges. Barges only move about 11% of the raw coal shipped in the U.S. (based on the fact that bituminous accounts for over 90% of all coal produced in the U.S.). In such areas as the Ohio River Valley, barges can be loaded directly from the mine. When mines are not located adjacent to a navigable river, the coal has to be transported to the barge loading facility by either truck or train (usually by train).

II.E.1.c. Trucks. Moving as much coal as barges do, trucks offer the major advantage of flexibility; their major disadvantage is a failure to be cost effective for moving large quantities long distances.

II.E.1.d. Pipelines. Slurry pipelines can be used to transport pulverized coal suspended in water. In this system, coal has to be processed to obtain the proper particle size. Pumping stations, dewatering facilities, and in some cases, storage facilities also are required. The major advantage of slurry pipelines for transporting coal long distances is low operating cost (Mutschler and others, 1973). High capital costs and water requirements are major disadvantages.

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[2]Although data for all coals are not available, bituminous coal represents all but a small fraction of coal mined.

In terms of potential environmental impacts, four impact categories should be addressed in the EID (see Table 18 for an estimate of environmental residuals for six transportation technologies by region):

- Water
- Air
- Solids
- Land

--<u>Water</u> - Barges may contribute dissolved solids to the river water. Drying the coal, after transporting via a slurry pipeline, produces a water effluent with negligible amounts of coal in it. Other modes of coal transportation do not involve water.

--<u>Air</u> - Particulates, ranging from 1 to 46 tons per 10^{12} BTU's transported (Table 18), represent those associated with wind losses along the route and at the end points. A 2% wind loss is assumed for conventional trains as opposed to 1% for unit trains, river barges, and trucks. Based on these assumptions, transportation methods emit more particulates than any of the technologies in the coal development system. Other air emissions from transportation methods are due to diesel fuel combustion; thus, haul distances govern the magnitude of the total amounts emitted. In any case, the nitrous oxide and sulfur dioxide emissions are low, ranging from 0.5 to 4.3 tons and 0.1 to 4.4 tons, respectively, for each 10^{12} BTU's transported. Comparisons between transportation modes are meaningful because equal haul distances have not been assumed.

--<u>Solids</u> - Solids arise from water and air emissions.

--<u>Land</u> - The National Academy of Engineering (NAE) has pointed out that most new overland transportation systems will need additional rights-of-way and new facilities. Railroad land use requirements for coal transport are based on the percentage of coal to total rail freight and on the percentage of coal originating in the area. Because haul distances are not equal among the 6 transportation modes, values given in Table 6 are not directly comparable. Land used for coal transported ranges from 1 to 70 acres per 10^{12} BTU's transported. Of additional interest are the assumptions that rail rights-of-way average 6 acres per mile (approximately 55 feet wide), a conveyor requires 30 feet of right-of-way along its length (3.64 acres per mile), and trucks average 1.67×10^{-6} acres per ton-mile (allow 50% error in the data) (University of Oklahoma, 1975).

Table 18 . Environmental and health impacts of coal transportation: By coal region and transportation mode.

System	Air pollutants (tons/10^{12} Btu's)							F/Ia	Occupational health 10^{12} Btu's		
	Particulates	NO_x	SO_x	Hydrocarbons	CO	Aldehydes	Solids	Land acre-year/10^{12} Btu's	Deaths	Injuries	Man-days lost
Unit train											
Northwest coal	23.6	2.67	2.32	1.78	2.5	.392	NA	75.1/0 75.1	.075	.599	55.6
Central coal	20.3	4.17	3.7	2.85	3.99	.626	NA	30.4/0 30.4	.066	.876	81.3
Northern Appalachian coal	18.4	4.28	3.71	2.85	4.	.627	NA	27.670 27.6	.065	.856	79.6
Central Appalachian coal	18.1	5.06	4.39	3.38	4.73	.743	NA	26.6/0 26.6	.062	.767	71.4
Southwest coal	20.9	1.59	1.38	1.06	1.49	.234	NA	67.2/0 67.2	.067	.0534	49.6
Mixed or conventional train											
Northwest coal	46.3	2.12	1.83	1.41	1.97	.31	NA	75.1/0 75.1	.075	.599	55.6
Central coal	38.9	3.42	2.96	2.28	3.18	.502	NA	30.4/0 30.4	.066	.876	81.3
Northern Appalachian coal	35.	3.4	2.94	2.27	3.17	.499	NA	27.6/0 27.6	.065	.856	79.6
Central Appalachian coal	33.8	2.89	2.51	1.93	2.7	.424	NA	26.6/0 26.6	.062	.767	71.4

(Continued next page)

Table 18. Environmental and health impacts (Concluded).

System	Air pollutants (tons/10^{12} Btu's)							F/I[a]	Occupational health 10^{12} Btu's		
	Particulates	NO_x	SO_x	Hydrocarbons	CO	Aldehydes	Solids	Land acre-year 10^{12} Btu's	Deaths	Injuries	Man-days lost
Slurry pipeline river barge											
Central coal	20.	.794	.85	.566	.67	.045	NA	NA	.0019	.0032	.243
Northern Appalachian coal	19.7	1.9	2.04	1.22	1.63	.095	NA	NA	.0019	.0032	.243
Central Appalachian coal	17.4	.689	.739	.443	.591	.034	NA	NA	.0019	.0032	.243
Trucking											
Northwest coal	22.9	1.69	.124	.169	1.03	.027	NA	0	.032	.692	45.4
Central coal	19.	1.4	.104	.14	.866	.023	NA	1.84/0 1.84	.032	.692	45.4
Northern Appalachian coal	17.	1.28	.093	.128	.776	.021	NA	1.67/0 1.67	.032	.692	45.4
Central Appalachian coal	16.4	1.29	.09	.124	1.754	.02	NA	1.6/0 1.6	.032	.692	45.4
Conveyor											
Central coal	0	NA	NA	NA	NA	NA	NA	.42/0 .42	0	0	0
Northern Appalachian coal	0	NA	NA	NA	NA	NA	NA	.386/0 .386	0	0	0
Central Appalachian coal	0	NA	NA	NA	NA	NA	NA	.376/0 .376	0	0	0

NA = Not applicable   [a]Fixed land requirement $\left(\frac{\text{acre-yr.}}{10^{12}\ \text{Btu}}\right)$/Incremental land requirement $\left(\frac{\text{acres}}{10^{12}\ \text{Btu}}\right)$

Source: University of Oklahoma, Science and Public Policy Program. 1975. Norman, Oklahoma

II.E.2. Coal Preparation[3]

Coal preparation includes the crushing and/or cleaning of coal. Preparation of coal which is low in impurities, as from many Western mines, only requires crushing and sizing. When impurities in coal occur in quantity, however, cleaning also is required. Impurities include clays, shale and other rock, and pyrite. Coal cleaning processes vary in complexity and may produce several types of wastes. The types and quantities of waste products produced by coal preparation facilities depend upon the size of the facility, the chemical properties of the coal, and the extent and method of coal cleaning. Depending on the amount of impurities in the raw coal, refuse quantities will range from 0 to 25 percent of the total coal processed (US-DOI 1978).

The simplest coal preparation plant utilizes crushing and screening to remove large refuse material. Because this usually is a dry process, wastes consist of coal dust, solid waste refuse, and surface runoff from ancillary areas, including coal storage piles and refuse disposal areas. Other preparations plants are more complex and perform additional cleaning processes. These processes may utilize water, thermal dryers, and various separation procedures. These preparation facilities produce wastewater, process sludges, and additional air emissions (from thermal dryers). The characteristics of wastewater from coal storage, refuse storage, and coal preparation plant ancillary areas generally are similar to the characteristics of raw mine drainage at the mine supplying the preparation plant. The general chemical characteristics of process wastewater are listed in Table 19 (US-EPA 1976a). The principal pollutant in coal preparation wastewater is suspended solids (coal fines and clays) which may be reduced through clarification processes.

II.E.3. Post Mining Impacts

Post mining environmental effects potentially are similar to those which occurred during active mining. Improper or incomplete post mining reclamation may result in the continuation of all or some of the adverse impacts of surface coal mining. Denuded land, such as spoil banks and haul roads, can continue to erode from surface runoff and wind, resulting in additional sedimentation, fugitive dust, and exposure of toxic material. Similarly, if unchecked, mine water contaminated with acid and other toxic substances may continue to degrade receiving waters long after active mining has ceased. Therefore, poorly planned and incomplete mining reclamation may result in further degradation of aquatic and terrestrial resources and impair alternative land uses.

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[3]More guidance for assessing impacts associated with coal preparation facilities will be contained in a separate guideline report, Environmental Impact Assessment Guidelines for New Source Underground Coal Mines and Coal Preparation Plants.

Table 19. General chemical characteristics of process wastewaters from coal preparation plant process water.

Parameters	Minimum (mg/l)	Maximum (mg/l)	Mean (mg/l)	Std. Dev.
pH	7.3	8.1	7.7	
Alkalinity	62	402	160	96.07
Total Iron	0.03	187	47.8	59.39
Dissolved Iron	0	6.4	0.92	2.09
Manganese	0.3	4.21	1.67	1.14
Aluminum	0.1	29	10.62	11.17
Zinc	0.01	2.6	0.56	0.89
Nickel	0.01	0.54	0.15	0.19
TDS	636	2,240	1,433	543.9
TSS	2,698	156,400	62,448	8,372
Hardness	1,280	1,800	1,540	260
Sulfates	979	1,029	1,004	25
Ammonia	0	4	2.01	1.53

Source: US-EPA. 1976a. Development document for interim final effluent limitations guidelines and new source performance standards for the coal mining point source category. Washington, DC, 288 p. EPA 440/1-76/057-a.

Early planning and proper reclamation immediately following mining can eliminate many of the potential adverse impacts which may continue after mining has ceased. However, erosion, sedimentation, and dust may increase temporarily during reclamation activities such as backfilling, topsoil handling, regrading, and road removal. In addition, post mining reclamation will eliminate some minor benefits to water-associated wildlife and aquatic life that have colonized water held in deep cuts. Restoration of the terrain to approximate original contour will eliminate such habitats created during mining. These adverse effects, however, will be minor and of short duration.

III. POLLUTION CONTROL METHODOLOGIES

The adverse effects of surface coal mining wastes can be avoided or minimized through the use of appropriate pollution control technologies during mine development, extraction, and reclamation. Pollution control technologies are classified as in-process or end-of-process controls, depending on where they are applied in the waste stream.

In-process controls:

- Reduce wastewater volume
- Reduce solid waste volume
- Reduce fugitive dust concentration

by application of measures such as:

- Selective routing of runoff
- Control of groundwater and leachate migration
- Selective handling of toxic and acid-forming wastes, usable spoil, and topsoil
- Phased grubbing and clearing of mine sections prior to extraction
- Appropriate stabilization of exposed soils

End-of-process controls prevent or minimize the contamination of groundwater and receiving water by:

- Sediment-bearing effluent
- Acid mine drainage
- Noxious leachate

End-of-process controls include:

- Adequate treatment of effluent wastes
- Proper disposal of solid wastes

Both in-process and end-of-process controls are applied to active mining and post mining operations. The balance of this chapter describes the kinds of process controls used or available for use during mining and reclamation. The applicant should consult the appropriate sections of OSM's permanent program regulations for specifications applicable to the design of structures and systems. Additional guidance is available from references listed in the bibliography under DESIGN.

The EID will include, at a minimum, the following information:

- Description of proposed mining method in sufficient detail to facilitate an assessment of proposed control strategies for adequacy
- Description of proposed wastewater management systems
- Description of proposed treatment methods for each waste stream expected during mining
- Description of proposed disposal methods for sludges and other solid wastes expected during mining
- Description of proposed control methods for fugitive dust

Each description should be accompanied by maps, plans, illustrations, cross-sections, and specifications that clearly indicate the final design of disposal sites, slopes, structures, systems, and processes.

III.A. ACTIVE MINING CONTROLS

Active mining controls reduce the amounts of effluent, solid waste, and air emissions requiring treatment, containment, or disposal at the mine-site and adjacent areas. Many active mining controls are multipurpose and simultaneously abate air, water, and solid waste pollution problems. Some active mining controls are integral parts of the reclamation process, and thus may also qualify as post mining controls. Active mining controls frequently used in the surface coal mining industry include:

- Runoff control systems
- Infiltration and groundwater migration abatement systems
- Spoil handling systems
- Effluent treatment systems
- Stabilization of bare soils

Precipitation produces runoff which becomes contaminated with sediment and other pollutants if permitted to drain freely over the mine-site. Appropriate controls include:

- Diversion ditches to prevent inundation of disturbed areas with runoff from undisturbed areas above the highwall. These diversions may feed into collectors or outfalls which bypass other wastewater collection and treatment systems employed at the mine-site

- Grassy filter strips between exposed soil surfaces and receiving waters

- Collection ditches to handle runoff from haul roads, pit areas, maintenance yards, load-out yards, spoil piles, and other areas where runoff potentially is contaminated by sediment or pollutant-bearing wastes. These collectors feed into appropriate treatment systems for removal or neutralization of pollutants

Infiltration of polluted runoff into the groundwater regime can result in contamination of local surface and groundwater supplies. Controls used to minimize the potential for groundwater degradation include:

- Burial and neutralization, as appropriate, of toxic, acid-forming, and other objectionable spoils, wastes, and exposed coal seams under at least 4 feet of acceptable material during backfill of the mined area. The minimum requirements for such burial are contained in OSM's regulations promulgated on 13 March 1979 previously cited

- Grout curtains, plugs, seals, and subsurface drainage systems to reduce the influx of groundwater to the active mining area and other areas where groundwater may either contribute significantly to wastewater volume or become contaminated by pollutant-bearing infiltration

Spoil handling systems prevent or minimize the contamination of usable backfill and topsoil with objectionable solid wastes and runoff. Spoil handling systems should achieve the following:

- Separation of topsoil from other overburdens and preservation of topsoil through proper construction and seeding of topsoil storage piles

- Separation of objectionable spoils from usable spoils. Objectionable spoils will be backfilled into the mined area first and then covered with a requisite thickness of usable material; therefore, properly designed spoil handling systems should minimize cycle times required to achieve the proper sequence of backfill

- Stabilization of bare soils

Effluent treatment systems remove or neutralize the objectionable constituents of raw mine drainage and sediment-bearing effluent. Treatment systems generally consist of one or more ponds which conform to OSM's specifications for construction of sediment ponds. A typical large-volume treatment system is illustrated schematically in Figure 24. Raw water is mixed with lime slurry in batches in the flash mix tank. Treated water is aerated as it flows to one of three settling ponds. As one settling pond fills with sludge, treated water is routed to other settling ponds, and sludge from the full pond is pumped to sludge drying ponds, for dewatering, removal, and eventual burial. Typical treatment systems employed at surface coal mines include:

- Lime neutralization

- Sodium hydroxide neutralization

- Hydrous ammonium neutralization

- Reverse osmosis

- Ion exchange processes

- Iron oxidation by

    aeration

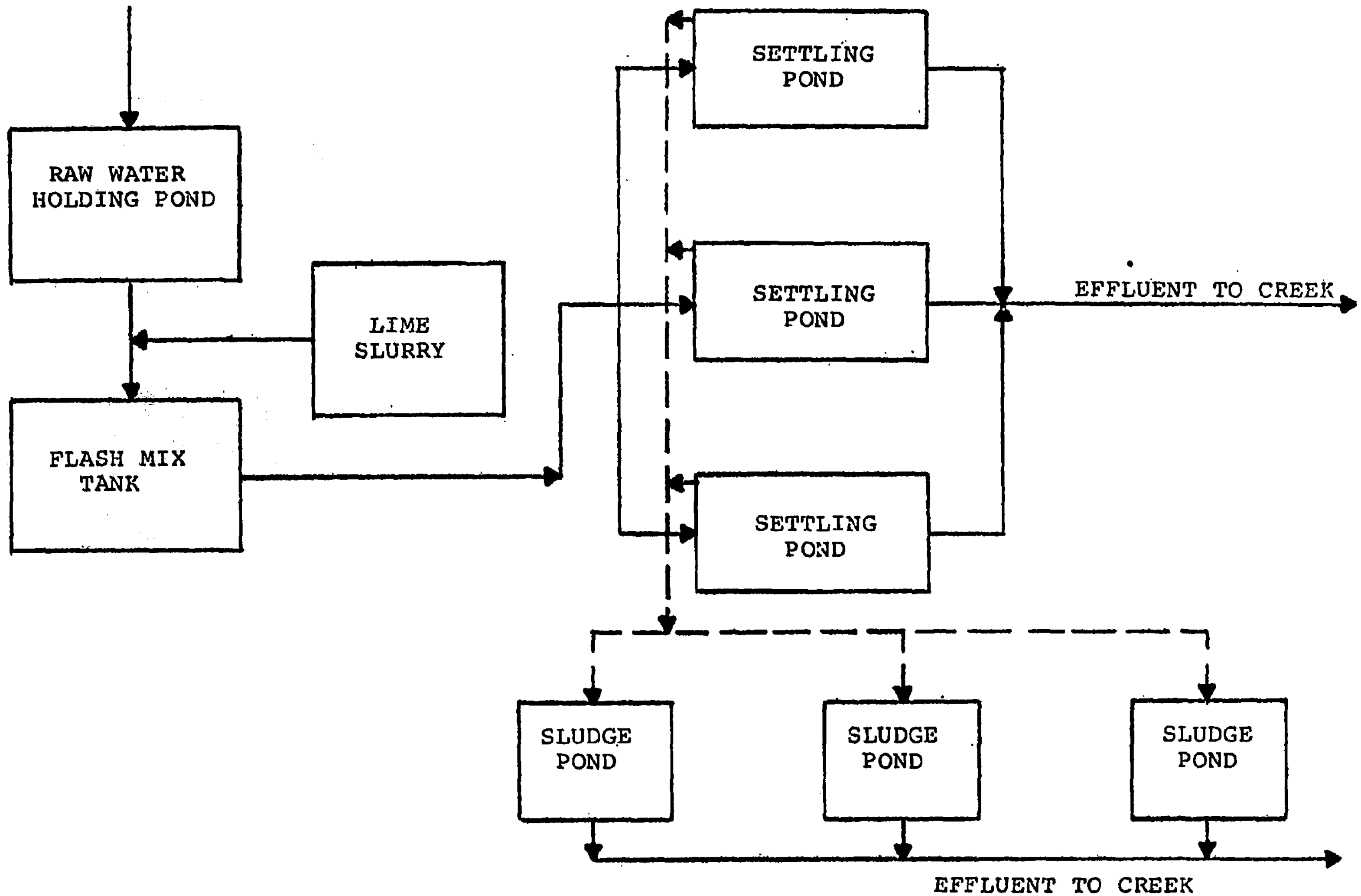
    electrochemical oxidation

    ozone oxidation

Lime neutralization is the most common method used to treat acidic and ferruginous mine effluents. Specific guidance on acceptability, design, and costs of individual treatment systems is available from references listed in the bibliography under TREATMENT.

Sediment-bearing effluents may be treated effectively without the use of neutralization processes. Sediment ponds should be constructed to provide minimum detention times of 10 hours or 24 hours, depending on the kinds of coagulants used for sediment removal.

Figure 24. Flow diagram for a typical coal mine wastewater treatment system.



Source: US Environmental Protection Agency. 1976a. Development document for interim final effluent limitations guidelines and new source performance standards for the coal mining point source category. EPA-440/9-75-008. Washington, DC. 467 pp.

Stabilization of bare soils prevents contributions of excessive sediments to wastewater handling and treatment systems and reduces the potential for air pollution by fugitive dust. Soil stabilization should be considered for all:

- Haul roads
- Spoil banks
- Backfilled areas
- Denuded areas

Soil stabilization activities include the use of:

- Water
- Mulch
- Synthetic soil amendments
- Quick growing species of suitable plants
- Pavement
- Canvas and plastic blankets

to protect exposed soil surfaces from erosion by wind and water. The particular activity appropriate for protection of exposed soils will depend on the planned use of the exposed soil. Normal mining operations result in many exposed soil surfaces which ultimately will be protected by backfill and post-mining reclamation. With the exception of pavement, the soil stabilizing agents listed above are appropriate for temporary protection of temporarily exposed soils. Pavement is appropriate for soil protection in high-use areas, including ancillary cleaning, loading, and maintenance areas, parking lots, and haul roads projected for long-term use. Specific guidance for temporary stabilization of exposed soils is contained in the references listed in the bibliography under SOIL PROTECTION.

III.B. POST MINING CONTROLS

Post mining controls prevent or minimize the long-term release of pollutants to the environment after active mining has ceased. These measures also can mitigate the unavoidable impacts associated with surface coal mining by rehabilitating affected areas to an appropriate land use consistent with the provisions of OSM regulations previously cited. Post mining controls are multipurpose and simultaneously prevent or minimize air, water, and solid waste pollution problems. Post mining controls include:

- Reclamation
- Monitoring

Reclamation occurs simultaneously with extraction in the ideal case. Spoil excavated from one part of the operation is transported and backfilled into mined-out areas, which are then regraded and replanted in accordance with an approved reclamation plan. In practice, however, the sequence of mine operations may require that spoils, topsoil, and other excavated material be stockpiled until needed for restoration of disturbed areas. In such instances, appropriate Active Mining Controls should be applied to reduce the potential for environmental degradation during reclamation. Runoff control, soil stabilization, and treatment are included among such controls.

Failure of reclamation efforts generally results from:

- Death of replanted species

- Failure of backfilled slopes

Monitoring of the reclaimed area insures that these problems are identified and corrected before they result in significant environmental degradation.

IV. OTHER CONTROLLABLE IMPACTS

IV.A. AESTHETICS

New source surface coal mines may be large and complex operations occupying an area of hundreds of acres. Highwalls, coal storage and handling areas, haul roads, spoil and refuse piles, exposed soils, dust, erosion, sediment-laden streams, etc., are aesthetically displeasing to many. Particularly in rural and suburban areas, surface mining can represent a noticeable intrusion on the landscape. Measures to minimize the impact on the environment must be developed during site selection, mine planning design, and reclamation. The applicant should consider the following factors where feasible to reduce potential aesthetic impacts:

- Existing Nature of the Area: The topography and major land uses in the area of the candidate sites are important. Topographic conditions, such as hills, can be used to screen the mining from view. A lack of topographic relief will require other means of minimizing impact, such as regrading or vegetation buffers.

- Proximity of Mining Sites to Parks and Other Areas Where People Congregate for Recreation and Other Activities: The location of public use areas should be mapped and presented in the EID Representative views of the mining site from observation points should be described. The visual effects on these recreational areas should be described in the EID in order to develop the appropriate mitigation measures.

- Transportation System: The visual impact of new access roads, rail lines, haul roads, refuse piles, etc. on the landscape should be considered. Locations, construction methods and materials, and maintenance should be specified.

- Creation of Aesthetically Pleasing Areas: If planned carefully, the development of a surface coal mine can create aesthetically pleasing areas. Through effective reclamation, the creation of usable recreational and open space lands may be an important improvement to an area. Such positive impacts should be presented in the EID.

IV.B. NOISE

The major sources of noise associated with a surface coal mine operation are:

- Coal transportation system (railroads, haul roads)

- Coal preparation facilities (crushers and screens)

- Blasting operations

- Coal extraction equipment

- Land reclamation/grading equipment

Such surface mining activities can create significant ambient noise levels. These levels can be expected to decrease with distance and, the more vegetation and natural barriers which exist, the greater the rate of noise decrease. It has been documented that at distances of 1500 to 2000 feet from the coal mining equipment, noise levels may decrease by 20dBA; however, even at such distances, the increases in noise levels due to coal mining activities still may be quite noticeable. Noise receptors within one-half mile are the most affected and should be documented in the EID.

Noise also can create serious health hazards for exposed workers; therefore, the necessary source and operational control methods should be employed.[1] Such measures include:

- Mufflers

- Lined ducts

- Partial barriers

- Vibration insulation

- Imposed speed limits on vehicles

- Scheduled equipment operations and maintenance

A suitable methodology to evaluate noise generated from a proposed new source surface coal mine would require the applicant to:

- Identify all noise-sensitive lands uses and activities adjoining the proposed mine-site

- Measure the existing ambient noise levels of the areas adjoining the site

- Identify existing noise sources, such as traffic, aircraft flyover, and other industry, in the general area.

- Determine whether there are any State or local noise regulations that apply to the site

- Calculate the noise level of the mining operation and compare with the existing area noise levels and the applicable noise regulations

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[1] US-EPA has recommended a 75-dBA, 8-hour exposure level to protect from loss of hearing, and a 55-dBA background exposure level to protect from annoyance of outdoor activity.

- Assess the noise impact of the mine's operational noise and, if required, determine noise abatement measures to minimize the impact (quieter equipment, noise barriers, improved maintenance schedules, etc.)

IV.C. SOCIOECONOMIC

The introduction of a large new coal mine operation into a community may cause economic and social changes. Therefore, it is necessary for an applicant to understand the types of impacts or changes that may occur so that they can be evaluated adequately. The importance of these changes usually depends on the nature of the area where the mine is located (e.g., composition and size of existing community). Normally, however, the significance of the changes caused by a mine of a given size will be greater near a small, rural community than near a large, urban area. This is primarily because a small, rural community is likely to have a nonmanufacturing economic base and a lower per capita income, fewer social groups, a more limited socioeconomic infrastructure, and fewer leisure pursuits than a large, urban area. There are situations, however, in which the changes in a small community may not be significant and, conversely, in which they may be considerable in an urban area. For example, a small community may have had a manufacturing (or natural resource) economic base that has declined. As a result, such a community may have a high incidence of unemployment in a skilled labor force and a surplus of housing. Conversely, a rapidly growing urban area may be severely strained if a large surface mine operation is located nearby. The rate at which the changes occur (regardless of the circumstances) also is an important determinant of the significance of the changes.

During the mine operation, the impact will be greater if the project requires large numbers of workers to be brought in from outside the community than if local, unemployed workers are available. The impacts are well known and include:

- Creation of social tension
- Demand for increased housing, police and fire protection, public utilities, medical facilities, recreational facilities, and other public services
- Strained economic budget in the community where existing infrastructure becomes inadequate

Various methods of reducing the strain on the budget of the local community during operation should be explored. For example, the company itself may build the housing and recreation facilities and provide the utility services and medical facilities for its imported work force; or the company may prepay taxes and the community may agree to a corresponding reduction in the property taxes paid later. Alternatively, the community may float a bond issue, taking advantage of its tax-exempt status, and the company may agree to reimburse the community as payments of principal and interest become due.

The permit applicant should document fully in the EID the range of potential impacts that are expected and demonstrate how possible harmful changes will be handled. For example, an increased tax base generally is regarded as a positive impact. The revenue from it usually is adequate to support the additional infrastructure required as the mining employees and their families move into the community. The spending and respending of the earnings of these employees have a multiplier effect on the local economy, as do the interindustry links created by the new plant. Socially, the community may benefit as the increased tax base permits the provision of more diverse and higher quality services and the variety of its interests increases with growth in population. Contrastingly, the transformation of a small, quiet community into a larger, busier community may be regarded as an adverse change by some of the residents who chose to live in the community, as well as by those who grew up there and stayed because of its amenities. The applicant also should consider the economic repercussions if, for example, the quality of the air and water declines as a result of various waste streams from the coal mine operation and its ancillary facilities (e.g., coal preparation plant, etc.).

In brief, the applicant's framework for analyzing the socioeconomic impacts of developing and operating a surface coal mine should be comprehensive. Most of the changes described should be quantified to the extent possible to assess fully the potential costs and benefits. The applicant should distinguish clearly between expected short-term and long-term changes.

The applicant should develop and maintain close coordination with State, regional, and local planning and zoning authorities to ensure full understanding with all existing and/or proposed land use plans and other related regulations.

IV.D. ENERGY REQUIREMENTS

The impact of surface coal mining on local energy supplies will depend largely on the type of mine operation proposed and the extent of ancillary facilities. Two criteria commonly are used to assess the efficiency of various mining methods:

- Percentage of in-place coal recovered
- Amount of ancillary energy required (ancillary energy requirements are the diesel fuel and electricity required to operate all mining equipment, including drills, draglines, tractors, trucks, and, under controlled conditions, to reclaim the land) (University of Oklahoma 1975)

Table 20 presents expected recovery efficiencies and ancillary energy requirements per 10^{12} BTU's for three major types of surface mine operations. Recovery efficiencies range from a low of 46 percent for Central Appalachian auger mining to a high of 98 percent for Northwest strip mining. Area strip mining in other regions is about

Table 20. Energy efficiencies (in percent) and energy requirements of various surface mining methods in different geographical regions of the US.

Method of Mining	Northwest	Central	Northern Appalachia	Central Appalachia	Southwest
	Geographical Region				
Area mining				NA	
Recovery efficiency (percentage)	98	81	81		81
Ancillary energy (10^9 BTU's per 10^{12} BTU's)					
Uncontrolled	1.92	6.48	5.82		5.09
Controlled	1.93	6.62	5.94		5.11
Contour mining	NA	NA			NA
Recovery efficiency (percentage			80	80	
Ancillary energy (10^9 BTU's per 10^{12} BTU's)					
Uncontrolled			10.9	10.6	
Controlled (modified block cut)			U	10.7	
Auger	NA	NA	NA		NA
Recovery efficiency (percentage)				46	
Ancillary energy (10^9 BTU's per 10^{12} BTU's)					
Uncontrolled				0.86	
Controlled				0.93	

NA = Not applicable; U = Unknown

Source: Hittman Associates, Inc. 1974. Environmental impacts, efficiency, and cost of energy supply and end use. Final report: Volume 1, Columbia MD

80 percent efficient. No variation occurs between the uncontrolled and controlled case[2], and the data are established for all of the recovery efficiencies to within 10 percent.

Ancillary energy consumptions are not well documented and data are valid only to within an order of magnitude. Of the total ancillary energy requirement, approximately 85 percent is electrical and 15 percent is diesel. An exception is the Northwest Region, where diesel fuel accounts for 50 percent of the total ancillary energy required.[3]

Ancillary energy needs for area mining are low, averaging 5×10^9 (five billion) BTU's for every 10^{12} (trillion) BTU's mined indicating that only 0.5 percent of the energy mined is used in mining. The ancillary energy requirements for contour mining are higher than for either of the other mining methods, averaging about 1.4 percent. The ancillary energy needed under controlled conditions increases slightly for all types of mines.

Because these energy requirement data are very generalized, the permit applicant should evaluate the energy efficiencies and demands of all methods considered during project planning in the context of an alternative analysis. Also, feasible design modifications should be considered in order to reduce energy needs.

At a minimum, the applicant should provide the following information in the EIA:

- Total external energy demand for operation of the mine
- Total energy generated on site
- Energy requirements by type
- Source of energy off-site
- Proposed measures to conserve or reduce energy demand and to increase efficiency of mine operation

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2 Controlled conditions include land reclamation and water treatment as part of the mining operation; under uncontrolled conditions, they are not.

3 The electric energy was calculated as three times the BTU equivalent of a kilowatt hour (kwh) to obtain the petroleum equivalent.

V. EVALUATION OF AVAILABLE ALTERNATIVES

The alternatives section of the EID is important and should address each reasonable alternative equitably. The purpose of this analysis is to identify and evaluate alternate plans and actions that may accomplish the desired goals of the project. The types of alternatives can include modifications to the proposed method of mining, relocation of the proposed mining operation, or the alternative that always must be considered--no project.

For the alternatives to a proposed project to be designated and assessed properly, the impact assessment process should commence early in the planning phase. In this manner, social, economic, and environmental factors, against which each alternative is to be judged, can be established. Alternatives should not be limited to a cost/benefit analysis in deciding their attributes. Environmental and social benefits also must be weighed with each alternative. As a guide, the complexity of the alternative analyses should be a function of the magnitude and significance of the expected impacts of the proposed mining operation. For instance, a mining operation that is shown to have minimal impact on a region generally would require fewer alternatives presented in the EIA.

The proposed surface mine operation and its alternatives, as influenced by public opinion, also should be evaluated carefully. In this way key factors such as aesthetics, social settings, and land use can be assessed properly.

V.A. ALTERNATIVE MINE LOCATION AND SITE LAYOUT

Because it is not possible to move the coal resource, the site alternative analysis ordinarily should include a detailed description of the proposed mine location, site layout, and alternative configurations of mining activities (haul roads, diversion ditches, sedimentation ponds, preparation plants) within the site boundaries.

In the EID the applicant should display the proposed mining site (and alternative locations) on map(s) that show existing environmental conditions and other relevant site information. Important information would include:

- Proposed and alternative mining areas (if any) established by the applicant
- Placement of integral components of the surface mining operation
- Major centers of population density (urban, high, medium, low density or similar scale)
- Water bodies suitable for water use

- Railways, highways (existing and planned), and waterways suitable for the transportation of raw materials and wastes

- Important topographic features (e.g., mountains, wetlands, floodplains)

- Dedicated land-use areas (parks, historic sites, wilderness areas, wildlife refuge lands, testing grounds, airports, etc.)

- Other sensitive environmental areas (prime agricultural lands, historic sites, critical habitats of imperiled species)

- Soil characteristics

Using these graphic materials, the applicant should provide a condensed description of the major considerations that led to the selection of the proposed site, including quality of the coal resource, adequacy of transportation systems, economic factors, environmental considerations, license or permit conditions, compatibility with any existing land use planning programs, and current attitudes of interested citizens.

Quantification, although desirable, may not be possible for all factors because of lack of adequate data. Under such circumstances, qualitative and general comparative statements, supported by documentation, may be used. Where possible, experience derived from operation of other mines in the same area, or at an environmentally similar site, may be helpful in appraising the nature of expected environmental impacts.

Through such analyses, if the proposed site location or site layout proves undesirable, then alternative sites and layouts from among others originally considered could be reevaluated or new sites could be identified and evaluated. Therefore, it is important that a permit applicant systematically identify and assess all feasible alternative site locations and site layouts as early in the planning process as possible, so that a complete explanation of the steps, factors, and criteria used to select the proposed location can be presented in the EID.

V.B. ALTERNATIVE MINING METHODS AND TECHNIQUES

All feasible methods and techniques for extraction of the coal resource should be examined carefully on the basis of reliability, economy, and environmental considerations. Section I.D.3. of this report presents a description of the major alternative mining methods that are in commercial use. Those alternatives that appear practical and best suited to the situation should be screened further on the basis of factors such as:

- Land, raw materials, waste generation, waste treatment, and storage requirements

- Release to air of dust, total suspended particulates, indirect source emissions, and other potential pollutants subject to Federal, State, or local limitations

- Releases to water of sediment, acids, trace metals, and other constituents subject to Federal, State, and local regulations

- Water consumption rate

- Fuel consumption and the generation of solid wastes with associated waste disposal requirements

- Capability, reliability, and energy efficiency

- Economics

- Aesthetic considerations for each alternative process

- Noise generation

A tabular or matrix form of display often is helpful in comparing feasible mining alternatives. Alternative mining methods which are not feasible should be dismissed with an objective explanation of the reasons for rejection.

V.C. OTHER ALTERNATIVE CONSIDERATIONS

In addition to identifying and evaluating alternative mining locations, site layout configurations, and mining methods, the permit applicant should also consider the following:

- Phased or staged mining of coal to avoid an area that could be seasonally sensitive

- Alternative access to and from mining site

- Alternative production rates

- Alternative reclamation techniques (e.g., selective replacement of overburden materials, etc.)

One or a combination of these considerations could avoid or minimize potentially adverse impacts associated with the mining operation.

V.D. NO-PROJECT ALTERNATIVE

In all proposals for facilities development, the applicant must consider and evaluate the impact of not constructing the proposed new source. Because this analysis is not unique to the development of a surface coal mine, no specific guidance is provided as part of this appendix. The permit applicant, therefore, is referred to Chapter IV (Alternatives to the Proposed New Source) in the EPA document, Environmental Impact Assessment Guidelines for Selected New Source Industries, which was published in October 1975.

VI. REGULATIONS OTHER THAN POLLUTION CONTROL

The applicant should be aware that there may be a number of regulations other than pollution control regulations that may apply to the construction and operation of new surface coal mine operations. The applicant should consult with the appropriate EPA Regional Administrator regarding applicability of such regulations to the proposed new source mine. Federal regulations that may be pertinent to a proposed surface mine operation include, but are not limited to, the following:

- Coastal Zone Management Act of 1972 (16 USC 1451 et seq.)
- The Fish and Wildlife Coordination Act of 1974 (16 USC 661-666)
- USDA Agriculture Conservation Service Watershed Memorandum 108 (1971)
- Wild and Scenic Rivers Act of 1969 (16 USC 1274 et seq.)
- The Flood Control Act of 1944
- Federal-Air Highway Act, as amended (1970)
- The Wilderness Act of 1964
- Endangered Species Preservation Act, as amended (1973) (16 USC 1531 et seq.)
- The National Historical Preservation Act of 1966 (16 USC 1531 et seq.)
- Executive Order 11593 (Protection and Enhancement of Cultural Environment, 16 USC 470) (Sup. 13 May 1971)
- Archaeological and Historic Preservation Act of 1974 (16 USC 469 et seq.)
- Procedures of the Council on Historic Preservation (1973) (39 FR 3367)
- Executive Order 11988 (replaced EO#11296, 10 August 1966)
- The Federal Coal Mine Health and Safety Act of 1969 (88 Stat. 742)
- Energy Policy and Conservation Act of 1975 (Section 102)
- Energy Conservation and Production Act of 1976 (Section 164)

Because surface mine operations characteristically disrupt many surface acres, the applicant should place particular emphasis on obtaining the services of a recognized archaeologist to determine the potential for disturbance of an archaeological site, such as an early Indian settlement or a prehistoric site. The National Register of Historic Places should also be consulted for historic sites such as battlefields.

The applicant also should consult the appropriate wildlife agency (State and Federal) to ascertain that the natural habitat of a threatened or endangered species will not be adversely affected.

From a health and safety standpoint, most industrial operations involve a variety of potential hazards and to the extent that these hazards could affect the health of mine workers, they may be characterized as potential environmental impacts. These hazards exist in the coal mining industry because of the very nature of the mine operation (e.g., heavy equipment movement, raw material handling and transport, blasting, etc.). All mine operators should emphasize that no phase of operation or administration is of greater importance than safety and accident prevention. Company policy should provide and maintain safe and healthful conditions for its employees and establish operating practices that will result in safe working conditions and efficient operation. All proposed plans to maximize health and safety should be described by the permit applicant in the EID.

The mine must be designed and operated in compliance with the standards of the US Department of Labor, the Coal Mine Health and Safety Act, and the appropriate State statutes relative to mine safety.

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- Full citations listed alphabetically by author
- Author-date citations listed alphabetically by topic

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US Department of the Interior 1978a and b
US Environmental Protection Agency 1973 and 1975c
US Office of Energy, Minerals, and Industry 1976
West Virginia Department of Natural Resources 1975
Woodley and Moore 1967

Overburden Quality

Caruccio 1973
Caruccio and others 1977
Davidson 1977
Deely and Borden 1973
Division of Plant Sciences 1971
Drnevich 1976
Grube and others 1973 and 1974
Hounslow 1978
Krause 1973
Neckers and Walker 1951
Smith and others 1974 and 1976
US Environmental Protection Agency 1971
Van Lear 1971

Reclamation

Adams and others 1971 and 1972
Aguar 1971
Aha-rah and Hartman 1973
Allen and Marquis 1970
Allen and Plass n.d.
Andreuzzi 1976
Augustine 1966
Ballou 1976
Barnhisel 1977
Bay 1976
Beattie 1957
Bengtson, Allen, Mays, and Zarber 1973
Bengtson, Mays, and Allen 1973
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Beng 1961, 1965, 1969, and 1973
Berg and Barrau 1972
Berg and May 1969
Berg and Vogel 1968 and 1973
Beyer and Hutnik 1969
Boesch 1974
Bondurant 1971
Breeding 1961
Brenner and others 1975
Brown 1973
Capp and Gilmore 1973
Cary 1971
Coates 1973
Cole and others 1976
Curtis 1973b
Czapowskyj 1973a, 1973b, and 1976
Czapowskyj and Sowa 1976
Darden 1971
Davidson 1977
Deely and Borden 1973
Dickerson and Sopper 1973
Dougherty and Holzen 1976a and b
Economic Development Council of Northeastern Pennsylvania 1977
Edgerton and Sopper 1974
Evans and Bitler 1976
Everett and others 1974
Feiss 1965
Fenton 1973
Fisser and Ries 1975
Fowler and Peery 1973
Funk 1973
Glover 1976
Goldberg and Power 1972
Goodman and Bray 1975
Grandt 1974
Greenbaum and Harvey 1974
Greene and Roney 1974
Griffith and others 1966

Reclamation (Cont'd)

Grim and Hill 1974
Hamilton 1974
Higgins 1973
Hill 1971 and 1976
Holland 1973
Hunt and Sopper 1973
Hutnik and Davis 1973
Hyslop 1964
Imhoff and others 1976
Jacoby 1969
Jarrett 1968
Jones and others 1973 and 1975
Kentucky Department for Natural Resources and Environmental Protection and others 1975a and 1975b
Kimball 1975
Mallary and Carlozzi 1976
McGuire 1977
National Coal Association/Bituminous Coal Research, Inc. 1973, 1974, 1975, and 1976b
Ohio State University Research Foundation 1968
Otte and Boehlje 1975
Peterson and Gschwind 1973
Plass 1975 and 1977
Plass and Burton 1967
Plass and Capp 1974
Redente and others 1976
Riley 1972 and 1973
Saperstein 1971
Saperstein and Secor 1973
Scott 1976
Skelly and Loy
Sopper and others 1974 and 1975
Sutton 1973a and b
Tennyson 1962
US Bureau of Mines 1973
US Department of Agriculture 1968
Van Lear 1971
Vimmerstedt and Struthers 1968
Vimmerstedt and Finney 1973
Vogel 1970, 1971, 1973, 1974, and 1975
Vogel and Berg 1968 and 1973
Vories 1976
West Virginia Department of Natural Resources 1975
Zande 1973
Zaval and Robins 1972

Socioeconomic Infrastructure

A. W. Martin Associates, Inc. 1975
Ballou 1976
Bohm and others 1973
Economic Development Council of Northeastern Pennsylvania 1977

Socioeconomic Infrastructure (Cont'd)

E. S. Preston and Associates, Ltd. 1967
Fowler and Peery 1973
Higgins 1973
Jarrett 1968
Moore and others 1977
Zonde 1973

Soil Protection

Allen and Curtis 1975
Augustine 1966
Barnhisel and Rotromel 1974
Barnhisel 1977
Bartee 1964
Beyer and Hutnik 1969
Brenner and others 1975
Brown 1973
Capp and others 1975
Curtis 1973b and 1974
Czapowskyj 1973a
Davidson 1977
Grier and others 1976
Hill 1976
Hoffman and others 1964
Kimball 1975
US Department of Agriculture Soil Conservation Service 1975
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US Environmental Protection Agency 1973 and 1976d
Vogel 1970, 1974 and 1975
Vogel and Berg 1968 and 1973
Weigle 1966
Weigle and Williams 1968
West Virginia Department of Natural Resources 1975
Williams 1973

Terrestrial Biota

Conant 1975
Fowells 1965
Goodwin and Niering 1975
Kuchler n.d.
Mumford and Bramble 1973
National Park Service 1975
Nature Conservancy n.d.
Samuel and others 1978
Sanderson 1977
US Fish and Wildlife Service 1977
Vohs and Birkenholz 1962

Transport

American Public Works Association 1973
Grier and others 1976
Martin and Harris 1977
Weigle 1965 and 1966
West Virginia Department of Natural Resources 1975

Treatment

Applied Science Laboratories, Inc. 1971
Bituminous Coal Research, Inc. 1968, 1970, and 1971
Continental Oil Company 1971
Corbitt 1971
Doyle and others 1974
Grube and Wilmoth 1976
Gulf Environmental Systems Company 197
Herricks and Cairns 1974
Herricks and others 1975
Hill 1974 and 1976
Hill and Wilmoth 1971
Hill and others 1971
Horizons Incorporated 1970
Kathuria and others 1976
Kennedy 1973
Kimball 1974a, 1974b, and 1976
Lovell 1973
Michael Baker, Jr., Inc. 1973
Mineral Resources Research Center 1971
National Coal Association/Bituminous Coal Research, Inc. 1976c and 1977
Rex Chainbelt, Inc. 1970 and 1972
Strohl and Hern 1976
Tyco Laboratories, Inc. 1971
US Environmental Protection Agency 1973 and 1975c
Vir Kathuria and others 1976
West Virginia Department of Natural Resources 1975
Wilmoth 1973 and 1977
Wilmoth and Hill 1970
Wilmoth and Kennedy 1976 and n.d.
Wilmoth and others 1972
Wilmoth and Scott n.d.
Wilmoth, Scott, and Harris 1977
Wilmoth, Scott, and Kennedy 1977
Woodley and Moore 1967
Young and others 1973

Waste Disposal

Bituminous Coal Research, Inc. 1971
Capp and Gilmore 1973
Capp and others 1975
Czapowskyj 1973b

Waste Disposal (Cont'd)

Czapowskyj and Sowa 1976
Dickerson and Sopper 1973
Dougherty and Holzen 1976
Edgerton and Sopper 1974
Grube and Wilmoth 1976
Hill and Montague 1976
Hunt and Sopper 1973
Martin 1974
Martin and others n.d.
Maryland Department of Health and Mental Hygiene 1971
Mining Enforcement and Safety Administration 1975
Peterson and Monk 1967
Peterson and Gschwind 1973
Plass and Capp 1974
Sopper and others 1975
Sopper and others 1974
US Bureau of Mines 1973
Wilmoth and Scott 1974

Wastewater Control

Brackenrich 1974
Corbitt 1971
Gong and Longmuir 1974
Grier and others 1976
Herricks and others 1975
Kathuria and others 1976
Kimball 1974a, 1974b, and 1976
Michael Baker, Jr., Inc. 1973
National Coal Association/Bituminous Coal Research, Inc. 1976c and 1977
Ramsey 1970
US Environmental Protection Agency 1973
Woodley and Moore 1967
Young and others 1973

Water Quality

Ahmad 1971
Akamatsu 1977
Aleem 1974
Appalachian Regional Commission 1969
Baker and Wilshire 1968 and 1973
Berg and May 1969
Beyer and Hutnik 1969
Bituminous Coal Research
Blevins and others 1970
Boccardy and Spaulding 1968
Brant and Moulton 1960
Cook 1969
Cooper 1975
Curtis 1974
Emrich and Merritt 1969
Foreman and McLean 1973

Water Quality (Cont'd)

Gammon 1970
Gang and Langmuir 1974
Gasper 1976
Good and others 1970
Grimm and Hill 1974
Herricks and Cairns 1974
Herricks and others 1975
Hill 1960, 1970, 1973, and 1976
Horizons Incorporated 1970
Hounslow and others 1978
Keller and Silvester 1974
Kimball 1974a and b
Kinney 1964
Martin 1976
Martin and others n.d.
McKee and Wolf 1963
National Coal Association/Bituminous Coal Research, Inc. 1976c and 1977
NUS Corporation 1971
Pegg 1968
Pegg and Jenkins 1976
Pennington 1975
Pettyjohn 1975
Ramsey 1970
Smith and others 1972 and 1973
Smith and Sykora 1976
Striffler 1973
Thompson and Wilson 1975
US Environmental Protection Agency 1973 and 1976b
van der Leeden 1973
Vimmerstedt and others 1973
Warner 1974
Woodley and Moore 1967
Young and others 1973
Zaval and Robins 1972

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16. ABSTRACT

The report provides guidance for evaluating the environmental impacts of a proposed surface coal mine requiring a new source National Pollutant Discharge Elimination System (NPDES) permit from the Environmental Protection Agency (EPA) to discharge wastewater to the navigable waters of the U.S. The guidelines are intended to assist in the identification of potential impacts, and the information requirements for evaluating such impacts, in an Environmental Information Document (EID). An EID is a document prepared for EPA by a new source permit applicant; it is issued by the Agency to determine if the preparation of an Environmental Impact Statement (EIS) is warranted for the proposed facility.

The report includes guidance on (1) identification of potential wastewater effluents, air emissions, and solid wastes from pulp and paper mills, (2) assessment of the impacts of new facilities on the quality of the environment, (3) state-of-the-art technology for in-process and end-of-process control of waste streams, (4) evaluation of alternatives, and (5) environmental regulations that apply to the industry. In addition, the guidelines include an "overview" chapter that gives a general description of the surface coal mining industry, significant problems associated with it, and recent trends in location, raw materials, processes, pollution control, and the demand for industry output.

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