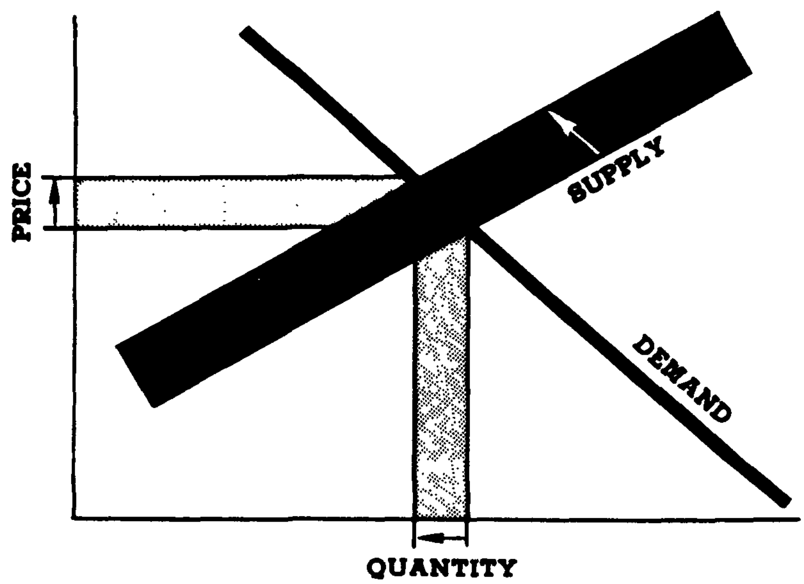
EPA-230/1-75-058a
SEPTEMBER 1975

# ECONOMIC IMPACT OF INTERIM FINAL EFFLUENT GUIDELINES ON THE U.S. COAL MINING INDUSTRY




**U.S. ENVIRONMENTAL PROTECTION AGENCY**
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# ECONOMIC IMPACT

# OF

# INTERIM FINAL EFFLUENT GUIDELINES

# ON THE

# U.S. COAL MINING INDUSTRY



Report to

U.S. ENVIRONMENTAL PROTECTION AGENCY

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# I. SUMMARY

## A. PURPOSE AND SCOPE

The purpose of this study is to provide the Environmental Protection Agency (EPA) with information regarding the economic impact of Proposed Interim Final Effluent Guidelines on the United States coal mining industry. This industry comprises:

SIC Code 1111 - Anthracite (hard coal) Mining and Preparation Plants

SIC Code 1211 - Bituminous Coal and Lignite (soft coal) Mining and Preparation Plants

The proposed Interim Final Effluent Guidelines would impose a pH limitation of 6-9 on point source discharges from existing coal mines and preparation plants to navigable waters of the United States.

## B. IMPACT

### 1. Soft Coal Segment

Only mines with acid mine drainage will be affected by the Guidelines. Acid mine drainage is concentrated mainly in the Appalachian states; consequently our analysis has concentrated on this region.

Many of the states where acid mine drainage is likely to be a problem have some form of regulations limiting on the pH of discharges as part of effluent or waste discharge standards. The most lenient seems to be a pH limitation of 5 to 10. However, our study of state water laws was not exhaustive. We are not certain if existing state regulations are applicable to all point sources from coal mines and preparation plants. We do not know the degree to which state laws are enforced. If the regulations cover all point sources and enforcement of state regulations is good, incremental costs to meet Interim Final Guidelines will be minimal. However, since this may not be so, we studied the impact of neutralization costs on model mines.

A model mine approach was used as there are a large number of establishments engaged in coal mining in the United States, making a mine by mine analysis impossible. The costs of compliance with the Interim Final Guidelines were provided by the EPA.

The annualized operating costs, as a result of compliance, increased less than 12 cents a ton. The capital requirements range from $3,500-77,000. For the large mine segment we have looked at the combination of a large mine and preparation plant and the cost increase is relatively modest. For the medium and small surface mine segments the capital requirements may range from 0.3 percent to 3.2 percent of capital investment (excluding treatment equipment). Thus, on the basis of costs for model

The trends in mining methods for the period 1940-1973 is shown in Figure 1.

## 2. Anthracite ("hard" coal) Mining

The anthracite district of northeastern Pennsylvania is generally characterized by steeply dipping, folded and faulted sedimentation. Anthracite seams vary in thickness from district to district and can range from partings of a foot to major seams averaging 36 feet.

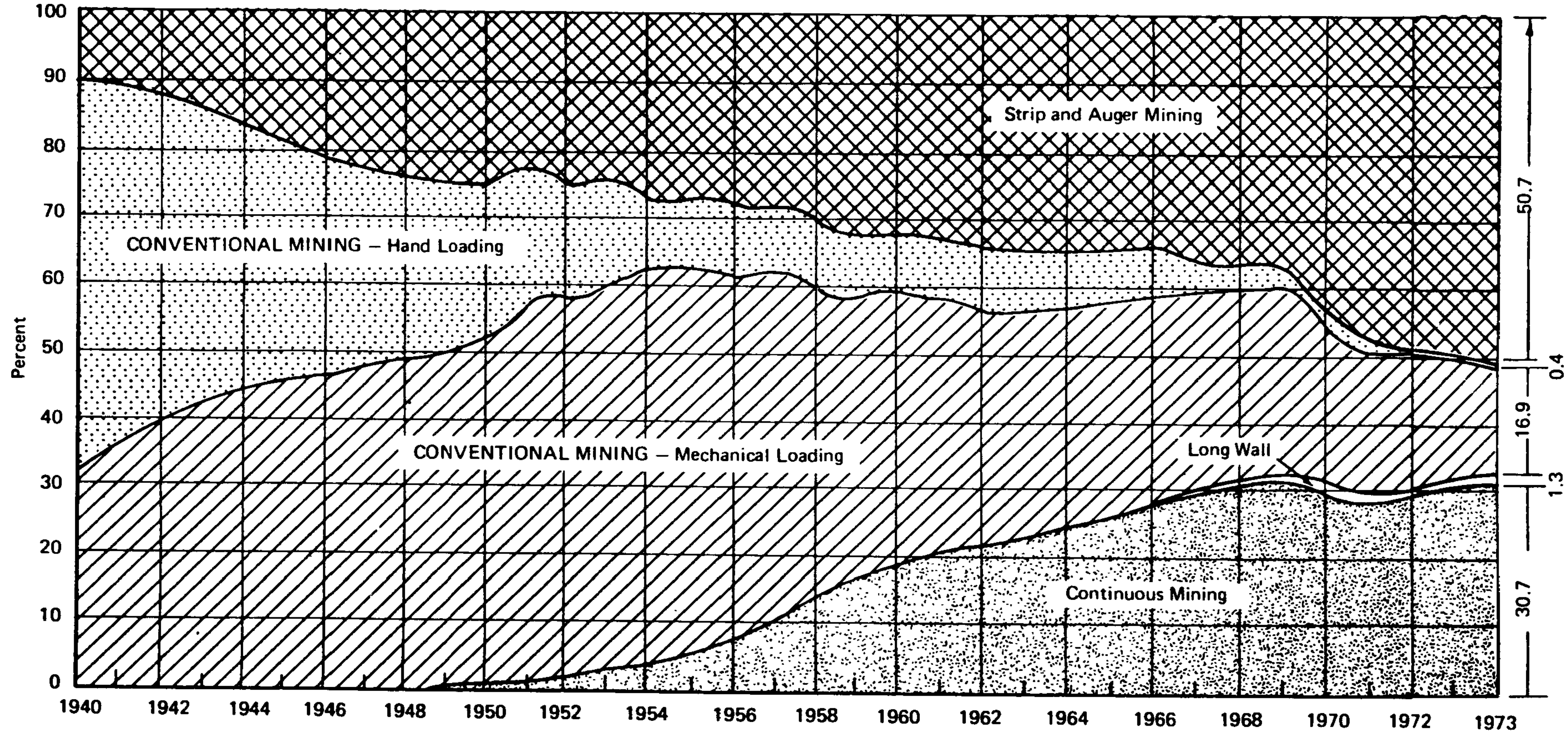
Four methods are currently employed in producing anthracite: deep mining, strip mining, culm bank reprocessing, and dredging. Deep and strip mining have been discussed in reference to soft coal. Anthracite production in 1973 from deep mines was 726,000 tons and 3,279,000 tons from strip mines.

Lower recovery costs have made old culm and silt banks dumped in the early days of anthracite mining an important source of fine sized coal. This source accounted for 2.4 million tons or about 35% of total production in 1973. The culm material, formerly regarded as waste, is currently trucked to preparation plants for reprocessing.

Dredging operations are found on the Susquehana and Schuylkill Rivers. Fine coals which have accumulated from erosion of mine waste and culm and silt banks are recovered by means of suction devices and then processed, washed and sized on board. In 1973, dredging accounted for 441,000 tons.

## 3. Coal Cleaning and Preparation

The objective of coal cleaning is to remove foreign matter such as rock and slate from coal. The advantages thus derived are a reduction in ash and sulfur content, control of ash fusibility, increase in calorific value and improvement of coking properties. The need to clean coal prior to shipment has resulted from factors such as the adoption of mechanized mining that does not differentiate between coal and impurities and the imposition of stringent quality specifications by consumers. Mechanical cleaning of coal is possible because of the difference in specific gravity between the free impurity (1.7-4.9) and coal (1.3). Generally, cleaning processes are classified as gravity-based stratification or non-gravity processes. Included in the former category are wet processes such as launder washers, jigs, classifiers, and tables; the non-gravity category includes the heavy media methods (in air or water) as well as froth flotation.




**Source:** U.S. Bureau of Mines

FIGURE 1 MINING METHODS USED IN UNITED STATES BITUMINOUS COAL PRODUCTION

TABLE 1

DEMONSTRATED COAL RESERVE BASE[1] OF THE UNITED STATES ON JANUARY 1, 1974 BY METHOD OF MINING

(Million short tons)

| State | Potential Mining Method: Underground | Surface | Total |
|---|---|---|---|
| Alabama | 1,798 | 1,184 | 2,982 |
| Alaska | 4,246 | 7,399 | 11,645 |
| Arizona | --- | 350 | 350 |
| Arkansas | 420 | 263 | 665 |
| Colorado | 14,000 | 870 | 14,870 |
| Georgia | 1 | --- | 1 |
| Illinois | 53,442 | 12,223 | 65,665 |
| Indiana | 8,949 | 1,674 | 10,623 |
| Iowa | 2,885 | --- | 2,885 |
| Kansas | --- | 1,388 | 1,388 |
| Kentucky, East | 9,467 | 3,450 | 12,917 |
| Kentucky, West | 8,720 | 3,904 | 12,624 |
| Maryland | 902 | 146 | 1,048 |
| Michigan | 118 | 1 | 119 |
| Missouri | 6,074 | 3,414 | 9,488 |
| Montana | 65,165 | 42,562 | 107,727 |
| New Mexico | 2,136 | 2,258 | 4,394 |
| North Carolina | 31 | ---[2] | 31 |
| North Dakota | --- | 16,003 | 16,003 |
| Ohio | 17,423 | 3,654 | 21,077 |
| Oklahoma | 860 | 434 | 1,294 |
| Oregon | 1 | ---[2] | 1 |
| Pennsylvania | 29,819 | 1,181 | 31,000 |
| South Dakota | --- | 428 | 428 |
| Tennessee | 667 | 320 | 987 |
| Texas | --- | 3,272 | 3,272 |
| Utah | 3,780 | 262 | 4,042 |
| Virginia | 2,971 | 679 | 3,650 |
| Washington | 1,446 | 508 | 1,954 |
| West Virginia | 34,378 | 5,212 | 39,590 |
| Wyoming | 27,554 | 23,674 | 51,228 |
| Total | 297,235 | 136,713 | 433,948 |

Source: U.S. Bureau of Mines.

[1]Includes measured and indicated categories as defined by the USBM and USGS and represents 100% of the coal inplace.
[2]Less than 1 million tons.

TABLE 2

DISTRIBUTION OF U.S. DEMONSTRATED COAL RESERVES BY SEGMENTS AND POTENTIAL MINING METHODS

(million short tons)

| Segment | Component States | Potential Mining Method: Underground | Potential Mining Method: Surface | Total |
|---|---|---|---|---|
| Northern Appalachia | Md., Pa., Ohio, Va., W. Va. | 85,493 | 10,872 | 96,365 |
| Southern Appalachia | Ala., Ga., East Ky., N.C., Tenn. | 11,964 | 4,954 | 16,918 |
| Central | Ark., Ill., Ind., Iowa, Kan., West Ky., Mich., Missouri, Okla., Texas | 81,468 | 26,573 | 108,041 |
| Intermountain | Ari., Colo., N. Mex., Utah | 19,916 | 3,740 | 23,656 |
| Great Plains | Mont., N. Dak., S. Dak., Wyo. | 92,719 | 82,667 | 175,386 |
| West | Alaska, Ore., Wash. | 5,693 | 7,907 | 13,600 |
| Total | | 297,235 | 136,713 | 433,948 |

Source: U.S. Bureau of Mines

TABLE 3

CONSUMPTION OF BITUMINOUS COAL AND LIGNITE, BY CONSUMER CLASS, WITH RETAIL DELIVERIES IN THE UNITED STATES
(Thousand short tons)

| Year | Electric Utilities | Bunker, Lake Vessel & Foreign | Manufacturing and Mining Industries | | | | Retail Deliveries to Other Consumers | Total of Classes Shown |
|---|---|---|---|---|---|---|---|---|
| | | | Beehive Coke Plants | Oven Coke Plants | Steel & Rolling Mills | Other Manufacturing and Mining Industries | | |
| 1967 | 271,784 | 467 | 1,372 | 90,900 | 6,330 | 92,464 | 17,099 | 480,416 |
| 1968 | 294,739 | 417 | 1,268 | 89,497 | 5,657 | 92,028 | 15,224 | 498,830 |
| 1969 | 308,461 | 313 | 1,158 | 91,743 | 5,560 | 85,374 | 14,666 | 507,275 |
| 1970 | 318,921 | 298 | 1,428 | 94,581 | 5,410 | 82,909 | 12,072 | 515,619 |
| 1971 | 326,280 | 207 | 1,278 | 81,531 | 5,560 | 68,655 | 11,351 | 494,862 |
| 1972 | 348,612 | 163 | 1,059 | 86,213 | 4,850 | 67,131 | 8,748 | 516,776 |
| 1973 | 386,879 | 116 | 1,310 | 92,324 | 6,356 | 60,837 | 8,200 | 556,022 |

Source: U.S. Bureau of Mines

consumption and do not include the rapidly growing demand for exported coal needed to support steel operations throughout the Western World and to supply power, mostly in Canada. Exports are discussed in the next section.

It can be seen from the trend curves of Figure 3 that the principal coal consuming sectors are the electric utility and basic steel industries. The former is by far the largest and fastest growing market, accounting in 1973 for nearly 70% of the domestic consumption. While utility coal demand should remain strong for the next decade or so, the continued utilization of coal as a boiler fuel will depend on present and future air quality standards. In the recent past, it was not uncommon for low-sulfur oil, most of it imported, to displace coal in a wide and increasing segment of the utility market, largely because economically viable pollution control technologies are not yet available for coal-fired boilers. Among the developments that could combat this trend and permit the utilization of higher sulfur coal in the future are conversion of coal to clean (high- or low-Btu) gas, conversion to low-sulfur liquids, and stack gas cleaning systems such as scrubbers.

Coal consumption by the steel industry has remained virtually constant over the last decade, despite large increases in raw steel output. This is a consequence of improvements in blast furnace technology, including supplementary fuel injection, high top-pressure operation, and better furnace burden preparation.

The most important use of coal in modern steel production is in the manufacture of metallurgical coke, either in beehive or byproduct coke ovens. Almost 99% of the coal consumed in coke ovens in 1973 went to byproduct oven coke plants. In modern byproduct coke-making operations, high-volatile coal usually is blended with either or both medium- and low-volatile coals to provide the charge for the coke ovens. These coals should contain as small amounts of sulfur and ash as are economically feasible, because the amount of these components present in the coal mixture directly affects the quality of the coke produced and its performance in the blast furnace. For this reason, most coals used for the production of metallurgical coke are beneficiated prior to use.

Generally, the demand for metallurgical coal is relatively inelastic, in relation to price, in the short run, and may in fact remain so in the long run. Substitution of non-metallurgical coals or other fuels would occur when mechanically acceptable chars can be produced from non-coking coals and if alternative fuel costs become more favorable. Similarly, where coal is clearly the cheapest fuel, the demand for steam coal would be expected also to be inelastic. However, it should be observed that the steam coal demand function is generally complex and dependent to a large degree on interfuel competition, i.e., cost/availability of fuel oil and natural gas.

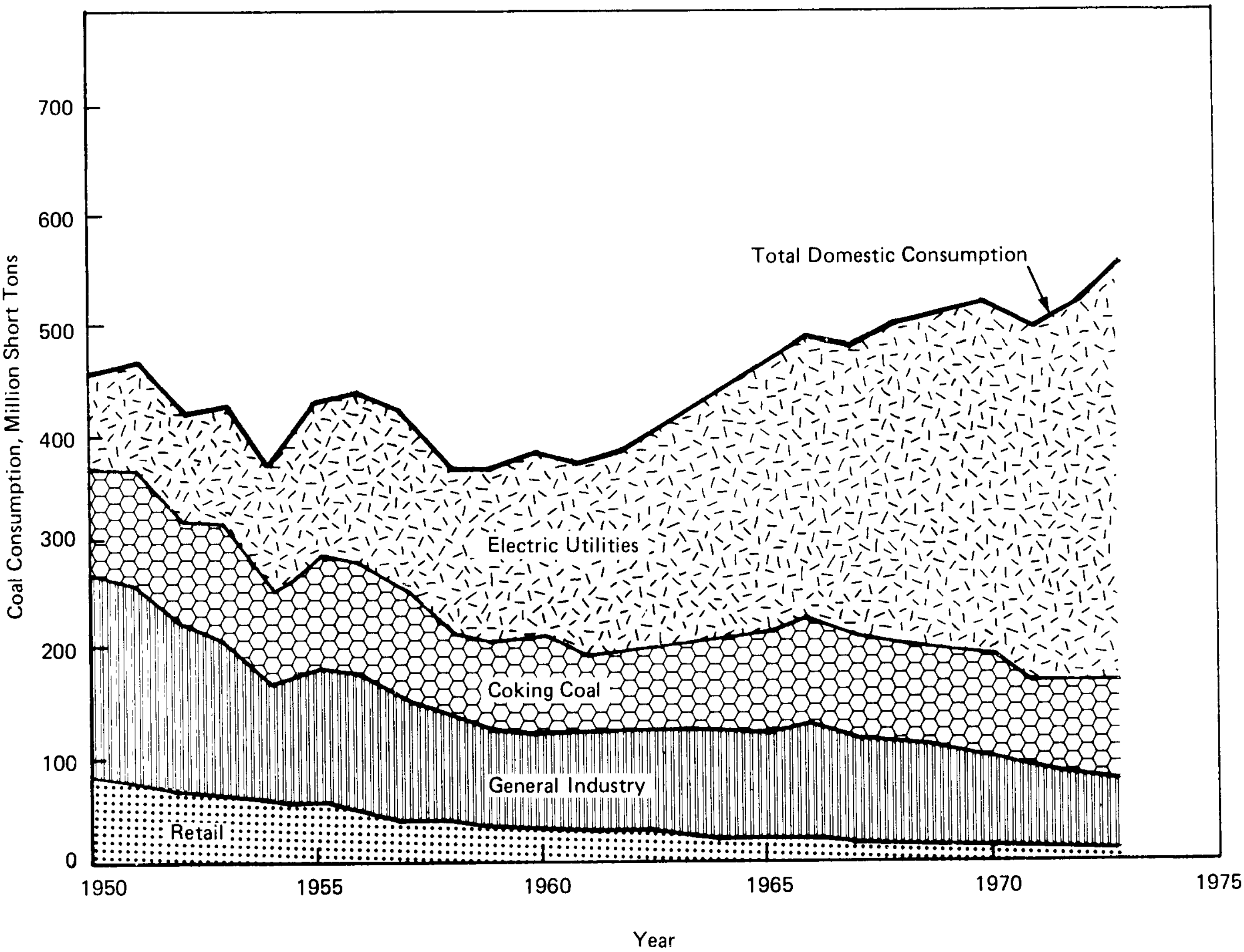



**FIGURE 3 COAL CONSUMPTION BY MARKET CATEGORIES**

## 2. Exports

Following World War II, bituminous coal exports became an important item of U.S. foreign trade contributing positively and significantly to the international balance of payments. Table 4 shows the trend in coal exports for a selection of years between 1940 and 1973. Exports fluctuated prior to 1961 because of various emergencies abroad; the lack of any major fuel crises since then up to 1970 has enabled exports to increase steadily. In 1970, the United States exported 70.9 million tons of coal, stemming from an unprecedented rise in world steel production, a depletion of large coal stockpiles and a reduction in coal mines capacity abroad. Similarly, the reduction in 1972 exports resulted generally from diminished steel demand abroad, improved world coking coal supply, and sufficient coal stocks abroad. Accordingly, coal buying became selective and the adequate world coal supplies and lower demand resulted in a sharp focusing on prices. There was a further decline to 52.9 million tons in 1973, stemming primarily from reduced demands in Canada and Western Europe. But despite the lower export volumes, the value of coal exports rose slightly over the prior year to about $1 billion.

In 1973, Japan retained its premier position as an importer of U.S. coal, receiving about 36% of the total foreign shipments. Shipments to Canada, Europe, and South America accounted for 30.7%, 26.9%, and 5% respectively. U.S. exports accounted for less than 10% of production.

Compared to 1972, less coal was exported from the Appalachian and Central coal regions in 1973. Shipments from the former were 18 million tons less than in 1972 while shipments from Western Kentucky, Illinois and Indiana were approximately 2 million tons below those of 1972. Shipments from the Western states increased almost 14 million tons in 1973.

## 3. "Hard" Coal

Anthracite consumptions by domestic user categories are similarly shown in Table 5. Apparent consumption in the U.S. in 1973, (calculated as production minus exports, including purchases by the Federal Government to supplement the fuel needs of the U.S. Armed Forces in West Germany), totaled about 5.6 million tons, of which 51% was used for space heating, 25% by electric utilities, 13% by the iron and steel industry, and the remaining 11% was distributed among cement plants, colliery fuels, and other uses.

## D. SUPPLY

In 1973, the United States produced 591.7 million tons of bituminous coal and lignite, thus accounting for about 18% of the world's total output of 3.3 billion tons. Domestic anthracite production was 6.83 million tons, equivalent to 3.6% of the world total.

TABLE 4

TREND IN U.S. COAL EXPORTS

| Year | Total Exports* (000 tons) |
|---|---|
| 1940 | 16,466 |
| 1945 | 27,956 |
| 1950 | 25,468 |
| 1955 | 51,277 |
| 1960 | 36,541 |
| 1965 | 50,181 |
| 1970 | 70,944 |
| 1971 | 56,633 |
| 1972 | 55,960 |
| 1973 | 52,903 |

*Excludes fuel or bunker coal loaded in vessels engaged in foreign trade and shipments to U.S. Military Forces.

Source: U.S. Bureau of Mines

## TABLE 5

### Trend in Domestic Consumption of Pennsylvania Anthracite by Consumer Categories

(thousand short tons)

| Year | Residential & Commercial Heating | Colliery Fuel | Electric Utilities | Cement Plants | Iron and Steel Industry: Coke Making | Iron and Steel Industry: Sintering & Pelletizing | Other Uses |
|---|---|---|---|---|---|---|---|
| 1969 | 4,209 | 17 | 1,849 | 213 | 543 | 623 | 1,355 |
| 1970 | 4,042 | 16 | 1,897 | W | 472 | 464 | 1,357 |
| 1971 | 3,850 | 15 | 1,646 | W | 451 | 339 | 1,037 |
| 1972 | 2,960 | 11 | 1,584 | W | 474 | 283 | 603 |
| 1973 | 2,917 | 11 | 1,442 | W | 467 | 231 | 603 |

W = Withheld to avoid disclosing individual company confidential data; included in "other uses."

Source: U.S. Bureau of Mines, Mineral Industry Surveys.

Table 6 shows the distribution of 1973 bituminous coal and lignite production by states, coal regions, and mining methods. Similar data are shown in Table 7 for Pennsylvania anthracite. The data of Table 6 indicate the Appalachian and Central regions dominated coal production, together accounting for about 90 percent of total output. Among the individual states, the leading producers were, in order, Kentucky (21.6% of total), West Virginia (19.5%), Pennsylvania (12.9%), and Illinois (10.4%).

In 1973, underground mining accounted for 50.6% of bituminous coal and lignite production, strip mining 46.8%, and auger mining the balance. Indications are that strip mining probably will increase steadily to about 55% sometime in the mid-1980's, underground mining will probably decline to about 44% and auger mining to 1%. Table 8 shows the trend since 1940 in the methods of coal mining. To some degree, however, the future trends in both total coal output and the method of production will depend on national energy policies and promulgated environmental (especially strip mining) legislations. Assuming that unduly restrictive strip mine legislations are not adopted, Western coals may account for as much as 33% of total U.S. production by 1985.

It should be observed that domestic coal production has shown relatively little increase since 1969 despite an apparent increase in demand. This is believed to be due to the steady decline in labor productivity brought on largely by the enforcement of the 1969 Federal Coal Mine Health and Safety Act and several state strip mine laws. The trend in productivity since 1950 is shown in Figure 4. Note that the decline has been most severe for underground mines where productivity has dropped from 15.61 tons per man-day in 1969 to only 11.20 tons per man-day in 1973. Strip mines have declined only marginally from 35.71 to 34.60 tons per man-day in this period. It had been hoped that 1973 would see the bottoming-out of the productivity slump and that productivity would gradually return to around 14-15 tons per man-day by about 1985. Such an expectation may have been erased by the provisions of the 1974 labor agreement between coal operators and the United Mine Workers. That agreement provided for additional personnel in underground mines, and such an increase will be expected to lower productivity. In surface mining future Federal Strip Mine legislation may have a similarly adverse effect. It ought to be noted that, despite the decline in U.S. coal mine productivity in recent years, it is still substantially higher than that of most other coal-producing countries. In this regard, it is recognized that productivity is not based solely on mining practice, but is also a function of such other variables as seam thickness and geology, overburden ratios, and coal quality.

## E. COAL PRODUCING FIRMS

### 1. Bituminous Coal and Lignite

About 4,000 companies produce bituminous coal and lignite. The top 15 firms are listed in Table 9, along with data on their ownerships, coal

TABLE 6

1973 BITUMINOUS COAL AND LIGNITE PRODUCTION BY STATES, COAL REGIONS AND MINING METHODS

(Thousand short tons)

| Region | State | Bituminous Coal and Lignite | | | |
|---|---|---|---|---|---|
| | | Underground | Strip | Auger | Total |
| NORTHERN APPALACHIA | Maryland | 66 | 1,643 | 79 | 1,789 |
| | Pennsylvania | 46,207 | 29,829 | 366 | 76,403 |
| | Ohio | 16,225 | 28,527 | 1,031 | 45,783 |
| | Virginia | 23,437 | 8,700 | 1,824 | 33,961 |
| | West Virginia | 95,516 | 17,704 | 2,228 | 115,448 |
| Sub Total | | 181,451 | 86,403 | 5,528 | 273,384 |
| SOUTHERN APPALACHIA | Alabama | 7,618 | 11,529 | 84 | 19,230 |
| | Eastern Kentucky | 40,553 | 23,671 | 9,742 | 73,966 |
| | Tennessee | 3,636 | 4,236 | 348 | 8,219 |
| Sub Total | | 51,807 | 39,436 | 10,174 | 101,415 |
| CENTRAL | Arkansas | 3 | 432 | --- | 434 |
| | Illinois | 32,570 | 29,002 | --- | 61,572 |
| | Indiana | 789 | 24,465 | --- | 25,253 |
| | Iowa | 356 | 245 | --- | 601 |
| | Kansas | --- | 1,086 | --- | 1,086 |
| | Western Kentucky | 22,342 | 31,337 | --- | 53,679 |
| | Missouri | --- | 4,658 | --- | 4,658 |
| | Oklahoma | --- | 2,183 | --- | 2,183 |
| | Texas (lignite) | --- | 6,944 | --- | 6,944 |
| Sub Total | | 56,060 | 100,352 | --- | 156,410 |

TABLE 6 cont'd

1973 BITUMINOUS COAL AND LIGNITE PRODUCTION BY STATES, COAL REGIONS AND MINING METHODS

| Region | State | Bituminous Coal and Lignite | | | |
|---|---|---|---|---|---|
| | | Underground | Strip | Auger | Total |
| INTERMOUNTAIN | Arizona | --- | 3,247 | --- | 3,247 |
| | Colorado | 3,361 | 2,834 | 38 | 6,233 |
| | New Mexico | 733 | 8,336 | --- | 9,069 |
| | Utah | 5,500 | --- | --- | 5,500 |
| Sub Total | | 9,594 | 14,417 | 38 | 24,049 |
| GREAT PLAINS | Montana - Bituminous | 1 | 10,410 | --- | 10,411 |
| | - Lignite | --- | 314 | --- | 314 |
| | N. Dakota - Lignite | --- | 6,906 | --- | 6,906 |
| | Wyoming | 425 | 14,461 | --- | 14,886 |
| Sub Total | | 426 | 32,091 | --- | 32,517 |
| WEST | Alaska | --- | 694 | --- | 694 |
| | Washington | 16 | 3,254 | --- | 3,270 |
| Sub Total | | 16 | 3,948 | --- | 3,964 |
| TOTAL | | 299,354 | 276,647 | 15,740 | 591,739 |

Source: U.S. Bureau of Mines

TABLE 7

1973 PENNSYLVANIA ANTHRACITE PRODUCTION
BY EXTRACTION METHOD

| Extraction Method | Production (000 tons) |
|---|---|
| Underground | 726 |
| Strip Pits | 3,279 |
| Culm Banks | 2,384 |
| River Dredging | 441 |
| Total | 6,830 |

Source: U.S. Bureau of Mines

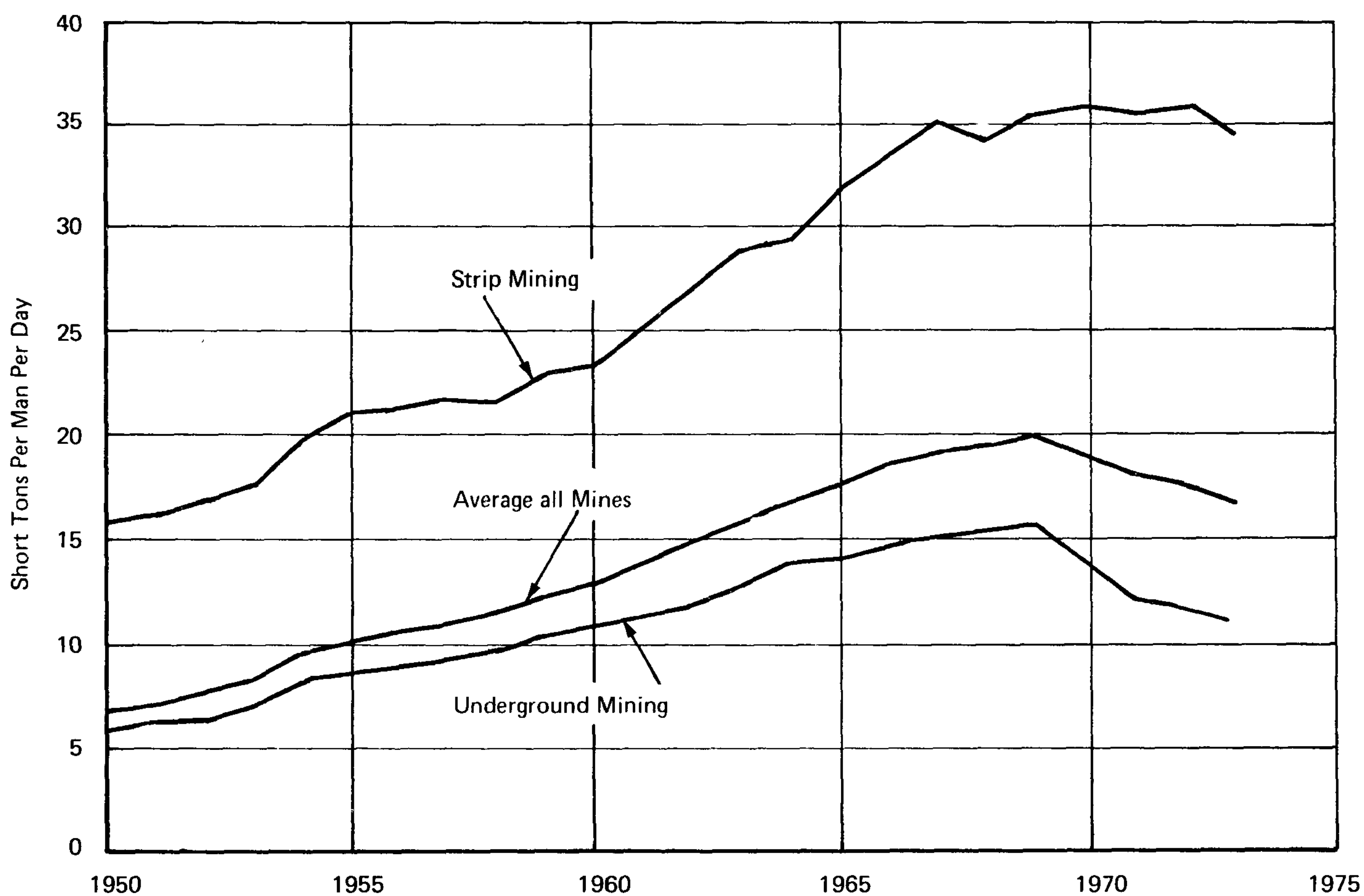
TABLE 8

PRODUCTION OF BITUMINOUS COAL AND LIGNITE, BY TYPE OF MINE

(000 tons)

| Year | Strip Mining | Auger Mining | Underground Mining | Total Production |
|---|---|---|---|---|
| 1940 | 43,167 | ---- | 417,604 | 460,772 |
| 1941 | 55,071 | ---- | 459,078 | 415,149 |
| 1942 | 67,203 | ---- | 515,490 | 582,693 |
| 1943 | 79,685 | ---- | 510,492 | 590,177 |
| 1944 | 100,898 | ---- | 518,678 | 619,576 |
| 1945 | 109,987 | ---- | 467,630 | 577,617 |
| 1946 | 112,964 | ---- | 420,958 | 533,922 |
| 1947 | 139,395 | ---- | 491,229 | 630,624 |
| 1948 | 139,506 | ---- | 460,012 | 599,518 |
| 1949 | 106,045 | ---- | 331,823 | 437,868 |
| 1950 | 123,467 | ---- | 392,844 | 516,311 |
| 1951 | 117,618 | 205 | 415,842 | 533,665 |
| 1952 | 108,910 | 1,506 | 345,425 | 466,841 |
| 1953 | 105,448 | 2,291 | 349,551 | 457,290 |
| 1954 | 98,134 | 4,460 | 289,112 | 391,706 |
| 1955 | 115,093 | 6,075 | 343,465 | 464,633 |
| 1956 | 127,055 | 8,045 | 365,774 | 500,874 |
| 1957 | 124,109 | 7,946 | 360,649 | 492,704 |
| 1958 | 116,242 | 7,320 | 286,884 | 410,446 |
| 1959 | 120,953 | 7,641 | 283,434 | 412,028 |
| 1960 | 122,630 | 7,994 | 284,888 | 415,512 |
| 1961 | 121,979 | 8,232 | 272,766 | 402,977 |
| 1962 | 130,300 | 10,583 | 281,266 | 422,149 |
| 1963 | 144,141 | 12,531 | 302,256 | 458,928 |
| 1964 | 151,859 | 13,331 | 321,808 | 486,998 |
| 1965 | 165,241 | 14,186 | 332,661 | 512,088 |
| 1966 | 180,058 | 15,299 | 338,524 | 533,881 |
| 1967 | 187,134 | 16,360 | 349,133 | 552,626 |
| 1968 | 185,836 | 15,267 | 344,142 | 545,245 |
| 1969 | 197,023 | 16,350 | 347,132 | 560,505 |
| 1970 | 244,117 | 20,207 | 338,788 | 602,932 |
| 1971 | 258,972 | 17,332 | 275,888 | 552,192 |
| 1972 | 275,730 | 15,554 | 304,103 | 595,386 |
| 1973 | 276,647 | 15,740 | 299,354 | 591,739 |

Source: Bituminous Coal Data, National Coal Association




**Source:** Bituminous Coal Data, National Coal Association

**FIGURE 4 PRODUCTIVITY AT BITUMINOUS COAL MINES**

TABLE 9

TOP 15 COAL-PRODUCING GROUPS IN 1973

| Company | Ownership | Coal Production (million tons) | | Relative Standing | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1973 | 1972 | 1973 | 1972 | 1971 | 1970 | 1965 |
| Peabody Coal Co. | Kennecott* | 69.92 | 71.6 | 1 | 1 | 1 | 1 | 1 |
| Consolidation Coal Co. | Continental Oil | 60.5 | 64.9 | 2 | 2 | 2 | 2 | 2 |
| Island Creek Coal Co. | Occidental | 22.9 | 22.6 | 3 | 3 | 3 | 3 | 3 |
| Pittston Co. | Public | 18.8 | 20.6 | 4 | 4 | 4 | 4 | 5 |
| Amax Group | Amax | 16.7 | 16.4 | 5 | 5 | 5 | 5 | 4 |
| U.S. Steel Corp. | Public | 16.2 | 16.3 | 6 | 6 | 6 | 8 | 9 |
| Bethlehem Mines Corp. | Bethlehem Steel | 14.1 | 13.3 | 7 | 7 | 7 | 6 | 7 |
| North American Coal Corp. | Public | 12.5 | 12.0 | 8 | 9 | 11 | 12 | 12 |
| Old Ben Coal Corp. | Sohio | 10.8 | 11.2 | 9 | 10 | 10 | 10 | 11 |
| Eastern Assoc. Coal Corp. | Eastern Gas & Fuel | 10.6 | 12.5 | 10 | 8 | 8 | 7 | 8 |
| Westmoreland Coal Co. | Public | 8.8 | 9.1 | 11 | 12 | 12 | 11 | 13 |
| General Dynamics Corp. | Public | 8.7 | 10.0 | 12 | 11 | 9 | 9 | 6 |
| Pittsburg & Midway | Gulf Oil | 8.1 | 7.5 | 13 | 13 | 13 | 13 | 10 |
| Utah International, Inc. | Public | 7.4 | 6.9 | 14 | 14 | 14 | 14 | 31 |
| American Electric Power | Public | 6.6 | 6.3 | 15 | 15 | 15 | 17 | 20 |
| Total | | 292.6 | 301.2 | | | | | |

*Currently under U.S. Supreme Court order to divest itself of Peabody Coal Company.

Source: 1974 Keystone Coal Industry Manual production in 1972 and 1973, and relative rankings, in terms of coal output since 1965. Two companies, Peabody Coal Company and Consolidation Coal Company, with their subsidiaries, accounted for 22% of the bituminous coal production in 1973. The top 15 firms were responsible for 49.5% while the top 50 accounted for 66.4%

Firms producing a million tons or more in 1973 were responsible for nearly 75% of total output. Of this group, about 26% were controlled by the coal industry itself. The oil industry controlled about 14%, steel and utilities about 12% each, and decreasing percentages by other industries.

The large-scale acquisition of coal companies by "outside" industries was a phenomenon of the late 1960's and early 1970's. The coal industry characteristically had experienced poor profits and its management was regarded as largely outdated. Operators thus were not averse to selling out at an acceptable price. The buyers, frequently large (petroleum) energy groups, saw the acquisition of a coal producer as a means of diversification into another energy source or for obtaining coal reserves in anticipation of substantial growth in coal utilizing industries. The utilities, chemicals, and metals firms generally acquired coal companies as a means of guaranteeing themselves adequate raw materials supplies at economical and controllable prices.

Besides the large producers, the bulk of the coal mining firms are small independent operators or family-owned mines. These companies, though numerous, account for a far smaller proportion of the total coal production than the large firms. Over the last several years, these smaller firms have been forced to yield to economic pressures arising from low profitability, and the trend towards greater concentration in the industry is expected to continue.

### 2. Anthracite

Data from the Pennsylvania Department of Environmental Resources indicate that in 1973 there were about 181 companies involved in anthracite production. These companies operated one or more of the following types of facilities: deep mines, strip mines, culm bank mines, cleaning plants, and breaker preparation plants. Of these companies, only the 20 listed in Table 10 produced in excess of 50,000 tons of shippable anthracite. Their cumulative production amounted to about 5.1 million tons, equivalent to about 75% of the total output of anthracite. The balance of the producers are typically single-facility operations that serve specific local customers. Indications are that with time, these small operators may succumb to the economic and market pressures afflicting the anthracite industry, resulting in a general consolidation and concentration of the industry in the hands of a few relatively large firms.

## F. SEGMENTATION OF MINES AND PREPARATION PLANTS

We have segmented the U.S. coal industry, as shown in Figure 5, as "soft" coal and "hard" coal mining and coal preparation plants, by geographic regions, by type of mine and by size of mine.

TABLE 10

TOP 20 PRODUCERS OF ANTHRACITE IN 1973

| Operator | Production |
|---|---|
| Reading Anthracite Co. | 757,759 |
| Jeddo-Highland Coal Co. | 572,808 |
| Blue Coal Corporation | 459,969 |
| Greenwood Stripping Corporation | 359,741 |
| Kocher Coal Co., Inc., Leon E. | 326,266 |
| Lehigh Valley Anthracite, Inc. | 324,390 |
| Manbeck Dredging Co., Inc. | 275,800 |
| Gilberton Coal Co. | 269,920 |
| Hecla Machinery & Equipment Co. | 246,221 |
| United Gas Improvement Corporation | 244,935 |
| B-D Mining Co. | 237,411 |
| Kerris & Helfrick, Inc. | 182,688 |
| Beltrami Enterprises, Inc. | 179,767 |
| Glen-Nan, Inc. | 164,153 |
| Schuylkill Contracting Co. | 147,029 |
| Northwest Mining Co., Inc. | 97,393 |
| Split Vein Coal Co., Inc. | 66,801 |
| Raymond Colliery Co., Inc. | 64,317 |
| Schickram, William | 59,845 |
| Rosini Coal Co. | 58,752 |
| Total | 5,095,965 |

Source: Pennsylvania Department of Environmental Resources

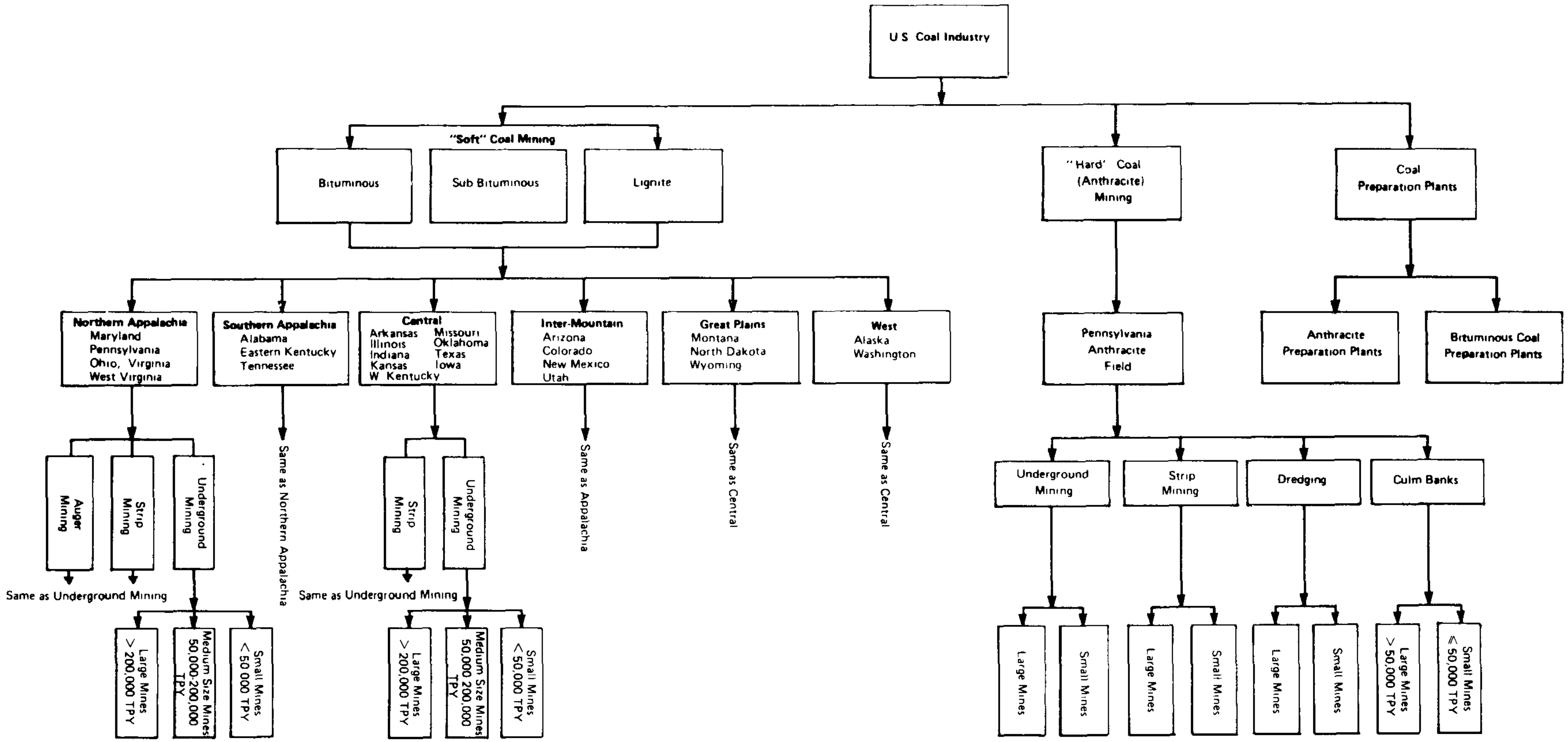



FIGURE 5 CHARACTERIZATION SCHEME FOR U.S. COAL INDUSTRY

## 1. "Soft" Coal Mines

Table 11 shows, for the period 1960-73, the distribution of active bituminous coal and lignite mines as a function of mine size. The total number of mines declined from 7,865 in 1960 to 4,744 in 1973. Virtually all of this decline occurred in the less than 10,000 net tons category decreasing from 4,645 in 1960 to 1,093 in 1973. All other categories remained relatively stable or increased in number.

In terms of the proportionate share of coal production, all except the largest have lost ground since 1960. The over 50,000 tons/yr category has increased its share of total production from 49% in 1960 to 58% in 1973. On the other hand, the combined shares of the two smallest categories has slipped from 15.5% to 9.8%

Tables 12 and 13 represent the number of mines and production derived from 1973 statistics from the U.S. Bureau of Mines--by mine size, mine type and region.

Nearly 60% of the nation's coal mines were located in Northern Appalachia and accounted for about 46% of the total production. Auger mines accounted for 11% of the mines in the region and 2% of the production in this region. Southern Appalachia had the following distribution for its 1,586 mines--41% underground, 34% strip and 25% auger.

The Central region had 226 mines (4.8% of the national total) but accounted for a far higher proportion of "soft" coal output in 1973--i.e., 26%. In this region there were three times as many strip mines as underground mines and strip mines accounted for almost two-thirds of the region's coal production.

Only 1% of the nation's coal mines were located in the Intermountain region but these accounted for 4% of the "soft" coal production. In the Great Plains and West regions, strip mines dominate coal production.

Table 14 shows the distribution of employment, based on 1973 statistics from the U.S. Bureau of Mines. Northern Appalachian mines accounted for nearly 86,000 workers, of whom 55,000 were employed in underground mines producing over 200,000 tons per year. Small mines with coal outputs of less than 50,000 tons/yr accounted for only 15,500 employees, a little over 10% of the total.

## 2. Hard Coal Segment

Table 15 shows the distribution of number of mines, production and employment for anthracite based on data from the Pennsylvania Department on Environmental Resources.

Strip mining was the dominant mining method, accounting for 45% of the mines, 48% of anthracite production and 60% of employment.

TABLE 11

PRODUCTION OF BITUMINOUS COAL, BY SIZE OF MINE OUTPUT

| Year | Over 500,000 Net Tons | 200,000 500,000 Net Tons | 100,000 200,000 Net Tons | 50,000 100,000 Net Tons | 10,000 50,000 Net Tons | Less than 10,000 Net Tons | Total |
|---|---|---|---|---|---|---|---|
| | | | | NUMBER OF MINES | | | |
| 1960 | 202 | 258 | 262 | 396 | 2,102 | 4,645 | 7,865 |
| 1961 | 195 | 225 | 242 | 420 | 2,183 | 4,383 | 7,648 |
| 1962 | 204 | 240 | 255 | 414 | 2,201 | 4,426 | 7,740 |
| 1963 | 224 | 242 | 262 | 499 | 2,250 | 4,463 | 7,940 |
| 1964 | 238 | 220 | 270 | 553 | 2,299 | 4,050 | 7,630 |
| 1965 | 259 | 224 | 279 | 555 | 2,367 | 3,544 | 7,228 |
| 1966 | 274 | 221 | 327 | 589 | 2,386 | 2,952 | 6,749 |
| 1967 | 281 | 244 | 267 | 542 | 2,079 | 2,360 | 5,873 |
| 1968 | 275 | 260 | 249 | 533 | 1,951 | 1,959 | 5,327 |
| 1969 | 295 | 263 | 352 | 524 | 1,898 | 1,786 | 5,118 |
| 1970 | 307 | 266 | 405 | 617 | 2,104 | 1,902 | 5,601 |
| 1971 | 256 | 315 | 408 | 671 | 1,888 | 1,611 | 5,149 |
| 1972 | 280 | 310 | 417 | 617 | 1,945 | 1,310 | 4,879 |
| 1973 | 280 | 308 | 384 | 600 | 2,079 | 1,093 | 4,744 |
| | | | | PRODUCTION (THOUSANDS OF NET TONS) | | | |
| 1960 | 204,999 | 81,013 | 37,204 | 27,894 | 44,238 | 20,164 | 415,512 |
| 1961 | 202,923 | 73,118 | 33,694 | 30,325 | 45,682 | 17,235 | 402,977 |
| 1962 | 213,772 | 76,458 | 35,878 | 28,831 | 48,463 | 18,748 | 422,149 |
| 1963 | 242,548 | 77,411 | 36,001 | 33,745 | 49,821 | 19,403 | 458,928 |
| 1964 | 267,363 | 73,893 | 37,540 | 37,985 | 52,695 | 17,523 | 486,998 |
| 1965 | 292,707 | 71,897 | 39,498 | 38,390 | 54,311 | 15,285 | 512,088 |
| 1966 | 308,868 | 70,177 | 45,220 | 41,335 | 55,212 | 13,068 | 533,881 |
| 1967 | 326,578 | 77,011 | 51,787 | 37,695 | 49,398 | 10,159 | 552,626 |
| 1968 | 318,938 | 84,118 | 48,822 | 27,890 | 46,576 | 8,898 | 545,245 |
| 1969 | 337,683 | 83,370 | 48,770 | 37,108 | 45,649 | 7,925 | 560,505 |
| 1970 | 359,516 | 84,297 | 55,729 | 43,310 | 50,849 | 9,227 | 602,932 |
| 1971 | 294,171 | 97,661 | 58,096 | 46,920 | 47,576 | 7,772 | 552,192 |
| 1972 | 336,604 | 100,313 | 58,523 | 44,072 | 48,708 | 7,165 | 595,386 |
| 1973 | 344,380 | 95,074 | 52,629 | 41,707 | 52,391 | 5,553 | 591,738 |

Source: U.S. Bureau of Mines

TABLE 12

1973 DISTRIBUTION OF "SOFT" COAL MINES BY SIZE OF PRODUCTION AND TYPE OF MINE

| Region | Number of Mines in Category: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | >200,000 Tons/Yr/Mine | | | 50,000-200,000 Tons/Yr/Mine | | | <50,000 Tons/Yr/Mine | | |
| | Underground | Strip | Auger | Underground | Strip | Auger | Underground | Strip | Auger |
| Northern Appalachia | 249 | 59 | --- | 243 | 345 | 18 | 494 | 1,139 | 290 |
| Southern Appalachia | 65 | 53 | 1 | 111 | 157 | 48 | 475 | 336 | 340 |
| Central | 41 | 73 | --- | 9 | 37 | -- | 5 | 61 | --- |
| Inter-Mountain | 17 | 7 | --- | 9 | 4 | -- | 12 | 3 | 1 |
| Great Plains | 1 | 20 | --- | 1 | 2 | -- | 4 | 10 | --- |
| West | --- | 2 | --- | --- | --- | -- | 1 | 1 | --- |
| TOTAL | 373 | 214 | 1 | 373 | 545 | 66 | 991 | 1,550 | 631 |

SOURCE: U.S. Bureau of Mines

TABLE 13

1973 DISTRIBUTION OF "SOFT" COAL PRODUCTION BY MINE SIZE AND TYPE

| Region | Cumulative Coal Output (000 Tons) By Mines in Category | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | >200,000 Tons/Yr/Mine | | | 50,000-200,000 Tons/Yr/Mine | | | <50,000 Tons/Yr/Mine | | |
| | Underground | Strip | Auger | Underground | Strip | Auger | Underground | Strip | Auger |
| Northern Appalachia | 147,880 | 29,986 | --- | 24,583 | 31,161 | 1,597 | 8,989 | 25,254 | 3,930 |
| Southern Appalachia | 33,686 | 19,059 | 267 | 10,637 | 14,717 | 4,715 | 7,484 | 5,659 | 5,191 |
| Central | 55,181 | 95,511 | --- | 930 | 2,552 | --- | 89 | 978 | --- |
| Inter-Mountain | 8,097 | 13,794 | --- | 1,283 | 607 | --- | 214 | 16 | 38 |
| Great Plains | 315 | 31,739 | --- | 96 | 291 | --- | 15 | 62 | --- |
| West | --- | 3,940 | --- | --- | --- | --- | 16 | 8 | --- |
| TOTAL | 245,159 | 194,029 | 267 | 37,529 | 49,328 | 6,312 | 16,807 | 31,977 | 9,159 |

SOURCE: U.S. Bureau of Mines

TABLE 14

## 1973 DISTRIBUTION OF EMPLOYMENT IN "SOFT" COAL MINES BY SIZE AND TYPE OF MINE

| Region | Total Number of Employees in Category | | | | | | | | | Sub-Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | >200,000 Tons/Yr/Mine | | | 50,000-200,000 Tons/Yr/Mine | | | <50,000 Tons/Yr/Mine | | | | | |
| | Underground | Strip | Auger | Underground | Strip | Auger | Underground | Strip | Auger | Underground | Strip | Auger |
| Northern Appalachia | 55,294 | 4,750 | -- | 9,111 | 6,183 | 285 | 3,861 | 5,428 | 979 | 68,266 | 16,361 | 1,264 |
| Southern Appalachia | 13,997 | 3,228 | 45 | 4,435 | 2,529 | 787 | 3,089 | 986 | 866 | 21,521 | 6,743 | 1,698 |
| Central | 12,043 | 9,795 | -- | 178 | 597 | --- | 24 | 160 | --- | 12,245 | 10,552 | --- |
| Inter-Mountain | 2,462 | 784 | -- | 392 | 38 | --- | 65 | 2 | 9 | 2,919 | 824 | 9 |
| Great Plains | 126 | 1,380 | -- | 38 | 11 | --- | 11 | 4 | --- | 175 | 1,395 | --- |
| West | --- | 375 | -- | --- | --- | --- | 16 | 1 | --- | 16 | 376 | --- |
| Sub-Totals | 83,922 | 20,312 | 45 | 14,154 | 9,358 | 1,072 | 7,066 | 6,581 | 1,854 | 105,142 | 36,251 | 2,971 |
| | | | | | | | | | | TOTAL | | 144,364 |

SOURCE: Derived from U.S.B.M.'s manpower productivity data.

TABLE 15

CHARACTERIZATION OF ANTHRACITE INDUSTRY (1973)
BY MINE SIZE AND MINING METHOD

| | UNDERGROUND | | STRIP | | CULM BANKS | |
|---|---|---|---|---|---|---|
| | >50,000 Tons/Mine | <50,000 Tons/Mine | >50,000 Tons/Mine | <50,000 Tons/Mine | >50,000 Tons/Mine | <50,000 Tons/Mine |
| Number of Mines | 2 | 70 | 17 | 99 | 12 | 50 |
| 1973 Production (000 tons) | 243 | 483 | 2,336 | 943 | 1,393 | 991 |
| Mine Employment | 286 | 430 | 814 | 819 | 104 | 223 |

Source: 1973 Annual Report of the Pennsylvania Department of Environmental Resources

The trend for both strip and underground mines has been one of declining output. In 1963 strip mines accounted for 7.5 million tons of anthracite compared with 2.3 million in 1973. This is due to the scarcity of economically strippable reserves. The decline in underground anthracite output may be related to the fact that it is becoming increasingly more expensive to extract anthracite by underground methods from steeply dipping seams at greater depths. Culm and silt bank recovery is currently a promising source of anthracite and its proportionate share is likely to decrease.

3. Coal Cleaning/Preparation

"Soft" Coal. Table 16 indicates that only about half of U.S. "soft" coal production in 1973 had been cleaned prior to shipment to the consumers. Ninety-five percent of the active cleaning plants were located in Northern and Southern Appalachia and in the Central Region.

It should be pointed out that over 96% of the cleaned coal shipments in 1973 involved "wet" processes which had the potential of generating liquid effluents.

A more detailed breakdown of the cleaning plants by states is given in Table 17. It is worth indicating that the metallurgical coal producing states (Alabama, Eastern Kentucky, Pennsylvania, Utah, and West Virginia) in 1973 accounted for a combined total of about 250 of the 382 cleaning plants, producing 159 million tons of cleaned coal (55% of the total). In addition, the high-sulfur coal states of Ohio, Western Kentucky, Illinois, and Indiana contributed 81 plants and above 102 million tons of coal. Coal cleaning is not generally practiced in the sub-bituminous and lignitic coal regions of the Great Plains and the West.

Table 17 also suggests that jigs, heavy media separation, and water tables are, in that order, the most popular mechanical cleaning techniques. Their percentage contributions to the total cleaned coal output in 1973 were respectively 46%, 31%, and 12%.

"Hard" Coal. To remove shale, slate, and other contaminants recovered along with the coal during mining, and to meet the quality specifications set by the consuming markets, it is necessary to clean all non-dredge Pennsylvania anthracite prior to shipment.

Table 18 is a listing of the major cleaning plants operating in 1973. Estimated daily cleaned coal capacity is about 36,600 tons, equivalent to an annual value, on the basis of 250 operating days per year at full capacity, of 9.2 million tons. Actual preparation plant output in 1973 (excluding dredge production) was 6.4 million tons, suggesting an apparent capacity utilization in that year of about 70%.

It may be noted from Table 18 that the heavy-media, washing, and water table techniques are the preferred methods of anthracite preparation.

TABLE 16

1973 REGIONAL CHARACTERIZATION
OF "SOFT" COAL CLEANING PLANTS

| Region | Number of Cleaning Plants | Cleaned Coal Production (000 Tons) | Percent of Total Coal Production |
|---|---|---|---|
| Northern Appalachia | 241 | 153,687 | 56.6 |
| Southern Appalachia | 54 | 35,114 | 34.6 |
| Central | 67 | 88,107 | 61.7 |
| Inter-mountain | 10 | 5,237 | ~21.8 |
| Great Plains | N.A. | N.A. | N.A. |
| West | 3 | 3,312 | 83.6 |
| Other States [1] | 7 | 3,460 | 5.7 |
| Total | 382 | 288,918 | 48.8 |

1. Includes Arizona, Arkansas, Iowa, Kansas, Maryland, Missouri, Montana, New Mexico, North Dakota, Texas, and Wyoming

Source: U.S. Bureau of Mines

TABLE 17

1973 DISTRIBUTION OF MECHANICAL COAL CLEANING PLANTS, BY STATES

| State | No. of Cleaning Plants | Total Cleaned Coal Production, ($10^3$ tons) | No. of Plants Employing Cleaning Methods* Jigs | Air Tables | Flotation | Heavy-Media | Water Tables | Washer |
|---|---|---|---|---|---|---|---|---|
| Alabama | 19 | 11,705 | 12 | -- | 3 | 7 | 12 | 3 |
| Alaska | 1 | 50 | ←Not Available→ | | | | | |
| Colorado | 3 | 1,662 | -- | -- | 1 | 3 | -- | -- |
| Illinois | 36 | 48,091 | 14 | 2 | 4 | 12 | 4 | 10 |
| Indiana | 10 | 19,699 | 5 | -- | -- | -- | 1 | 5 |
| Kentucky: | | | | | | | | |
| Eastern | 33 | 22,264 | 20 | 3 | 11 | 31 | 21 | 15 |
| Western | 18 | 20,005 | | | | | | |
| Ohio | 17 | 14,588 | 88 | 2 | -- | 5 | 1 | 6 |
| Oklahoma | 3 | 312 | ←Not Available→ | | | | | |
| Pennsylvania (Bituminous) | 68 | 45,731 | 13 | 25 | 13 | 29 | 15 | 6 |
| Tennessee | 2 | 1,145 | 1 | 1 | -- | 2 | 1 | -- |
| Utah | 7 | 3,575 | 2 | -- | 1 | 1 | 1 | 1 |
| Virginia | 32 | 17,696 | 16 | 8 | 10 | 17 | 12 | 6 |
| Washington | 2 | 3,262 | 1 | -- | -- | -- | -- | -- |
| West Virginia | 124 | 75,672 | 42 | 18 | 47 | 97 | 57 | 15 |
| Other States | 5 | 3,460 | 2 | 3 | 1 | 1 | -- | 2 |
| TOTAL | 382 | 288,918 | 136 | 62 | 91 | 205 | 125 | 69 |
| Clean Coal Production by each method (thousand tons): | | | 132,655 | 10,505 | 14,201 | 88,203 | 34,935 | 8,418 |

*A plant may employ more than one cleaning method.

Source: U.S. Bureau of Mines, 1973 Mineral Industry Surveys; 1974 Keystone Coal Industry Manual.

TABLE 18

PENNSYLVANIA ANTHRACITE PREPARATION PLANTS, 1973

| Company/Location | Plant Name | Cleaned Coal Capacity (tons/day) | Cleaning Method(s)* |
|---|---|---|---|
| Blaschak Coal Co., Inc., Nicholas | Blaschak | 1,050 | W |
| Blue Coal Corp., Ashley | Huber | 7,500# | HM-W |
| Taylor | Taylor | | HM |
| Buckley Coal Co., Eckley | Eckley | 800 | HM-W |
| Cass Contr. Co., Marlin | Marlin | 450 | HM-W |
| Gilberton Coal Co., Gilberton | Gilberton | 1,000 | HM-W |
| Glen Burn Colliery, Shamokin | Glen Burn | 1,800 | HM |
| Gowen Coal Co., Fern Glen | Gowen | 600 | HM-WT |
| Greenwood Min. Co., Tamaqua | Greenwood | 6,000 | HM-F-W |
| Honey Brook Mines, Inc., Audenreid | Audenreid | 2,000 | HM |
| Jeddo-Highland Coal Co., Jeddo | Jeddo #7 | 3,500# | HM-F |
| Lehigh Valley Anthr. Inc., Swoyerville | Harry E | | HM-W |
| Hazleton | Hazleton Shaft | 1,625# | HM-W |
| Shenandoah | Mammoth | | HM-W |
| Manbeck Dredging Co., Tremont | Westwood | 400 | WT |
| Pine Creek Coal Co., Spring Glen | Pine Creek | 400 | WT-W |
| Reading Anthracite Co., Pottsville | New St. Nicholas | | HM-W |
| St. Nicholas | St. Nicholas | 3,795# | W |
| Trevorton | Trevorton | | HM-W |
| Reidinger Coal Service, Paxinos | Reidinger | 350 | HM |
| Rosini Coal Co., Shamokin | Carbon Run | 1,000 | J-WT-W |
| Thos. W. Schenck Coal Co., Pine Grove | Breaker | NA | HM |
| Sun Coal Co., Inc., Atlas | Diamond | 2,000 | HM |
| Swatara Coal Co., Minersville | Breaker | 800 | HM-WT |
| Underkoffler Coal Service, Lykens | Underkoffler | 500 | HM |

* J = Jigs, jig washers
F = Flotation, froth flotation
HM = Heavy media
WT = Water tables
W = Washery

# ADL Estimate

Source: 1974 Keystone Coal Industry Manual, and ADL Estimates.

### 4. Relationship of Segments to the U.S. Coal Mining Industry

Tables 19 and 20 summarize the relationship of each segment to the total "soft" and "hard" coal industry, in terms of the number of mines, production and employment. This information can be used to judge the importance of any significant adverse impacts to a segment as a result of compliance with Interim Final Effluent Guidelines, as it relates to U.S. Coal Mining Industry.

## G. COAL TRANSPORTATION

In 1973, 52% of all coal was moved entirely by rail, nearly 19% was moved wholly or partly by barge, 12% by truck and lesser amounts on the Great Lakes, tidewater conveyor belts, and pipelines. Rail freight rates vary between 7 and 20 mils per ton-mile depending on location and distance. It costs about $7.00 to move a ton of coal 1,200 miles.

## H. GOVERNMENT INFLUENCE

Spurred by public concern, government activity has focussed on (1) preserving or restoring the environmental quality of mined land and (2) ensuring the health and safety of the mine workers. Although President Ford recently vetoed bill HR 25, other state and federal laws regulate strip mining.

State Strip Mine Laws. About thirty-three states have laws relating to strip mining, with most of the current legislation enacted since 1965. All of the state laws provide for an adminstrative agency to oversee regulatory programs. The assigned responsibilities consist of approving permits, supervising mines, collecting bonds, and approving reclamation work. Three states, Pennsylvania, Washington, and Tennessee, require an additional permit from the state water pollution control agency. Although state laws on strip mining are fairly extensive, they are generally regarded as sensible by the industry. Enforcement, which has been weak and spotty, is becoming more effective.

Leasing of Federal Lands for Coal Mining. The Bureau of Land Management under the Department of the Interior is charged with the leasing of Federal lands for coal mining. It has proposed new regulations that will impose rigorous land reclamation requirements on Federal lands leased for coal mining.

Federal Air-Quality Standards. While compliance with primary standards for the sulfur dioxide concentration of ambient air was set for July 1, 1975, compliance with secondary standards was set for October 1, 1977. Individual air quality control regions have already submitted implementation plans,

TABLE 19

NUMBER OF MINES, PRODUCTION AND EMPLOYMENT AS PERCENTAGES OF THE SOFT COAL SEGMENT OF THE U.S. INDUSTRY (1973)

| | Deep | | | Strip | | | Auger | | | Subtotals |
|---|---|---|---|---|---|---|---|---|---|---|
| | Large | Medium | Small | Large | Medium | Small | Large | Medium | Small | |
| **N. Appalachia** | | | | | | | | | | |
| No. of Mines | 5.3 | 5.1 | 10.4 | 1.2 | 7.3 | 24.0 | x | 0.4 | 6.1 | 59.8 |
| Production | 25.0 | 4.2 | 1.5 | 5.0 | 5.3 | 4.3 | x | 0.3 | 0.7 | 46.2 |
| Employment | 38.3 | 6.3 | 2.7 | 3.3 | 4.3 | 3.8 | x | 0.2 | 0.7 | 59.5 |
| **S. Appalachia** | | | | | | | | | | |
| No. of Mines | 1.4 | 2.3 | 10.0 | 1.1 | 3.3 | 7.1 | x | 1.0 | 7.2 | 33.4 |
| Production | 5.7 | 1.8 | 1.3 | 3.2 | 2.5 | 1.0 | 0.1 | 0.8 | 0.9 | 17.2 |
| Employment | 9.7 | 3.1 | 2.1 | 2.2 | 1.8 | 0.7 | x | 0.6 | 0.6 | 20.8 |
| **Central** | | | | | | | | | | |
| No. of Mines | 0.9 | 0.2 | 0.1 | 1.5 | 0.8 | 1.3 | | | | 4.8 |
| Production | 9.3 | 0.2 | x | 16.1 | 0.4 | 0.2 | | | | 26.3 |
| Employment | 8.3 | 0.1 | x | 6.8 | 0.4 | 0.1 | | | | 15.8 |
| **Intermountain** | | | | | | | | | | |
| No. of Mines | 0.4 | 0.2 | 0.3 | 0.2 | 0.1 | 0.1 | | | x | 1.1 |
| Production | 1.4 | 0.2 | x | 2.3 | 0.1 | x | | | x | 4.1 |
| Employment | 1.7 | 0.3 | 0.1 | 0.5 | x | x | | | x | 2.6 |
| **Great Plains** | | | | | | | | | | |
| No. of Mines | x | x | 0.1 | 0.4 | x | 0.2 | | | | 0.8 |
| Production | 0.1 | x | x | 5.4 | 0.1 | x | | | | 5.4 |
| Employment | 0.1 | x | x | 1.0 | x | x | | | | 1.1 |
| **West** | | | | | | | | | | |
| No. of Mines | | | x | x | | x | | | | 0.1 |
| Production | | | x | 0.7 | | x | | | | 0.7 |
| Employment | | | x | 0.3 | | x | | | | 0.3 |

Note: x = <0.04%

Source: U.S. Bureau of Mines.

TABLE 20

NUMBER OF MINES, PRODUCTION AND EMPLOYMENT AS PERCENTAGES OF THE HARD COAL SEGMENT OF THE U.S. INDUSTRY (1973)

| | Deep | | Strip | | Subtotals |
|---|---|---|---|---|---|
| | Large | Small | Large | Small | |
| No. of Mines | 0.8 | 28.0 | 6.8 | 39.6 | 75.2 |
| Production | 3.8 | 7.5 | 36.6 | 14.8 | 62.7 |
| Employment | 10.7 | 16.1 | 30.4 | 30.6 | 87.8 |

Source: U.S. Bureau of Mines.

had them approved by the EPA, and set them into effect locally. Nevertheless, when these regulations will be enforced is unclear. A second uncertainty is how to achieve acceptable sulfur dioxide levels in the stack-gas when high sulfur coals are used. Since this uncertainty is enough to curtail the use of high sulfur coals severely, amendments have been proposed to extend the compliance schedules of the Clean Air Act and permit the use of intermittent control systems under certain circumstances.

The Federal Coal Mine Health and Safety Act of 1969. This act was passed to reduce the hazards of underground coal mining. It seeks to ensure adequate underground ventilation at the coal face, ensure proper cleaning and rock dusting practices, provide adequate roof support, limit the rate of advance of continuous miners in order to keep the operator under bolted roof, and regulate the specification of underground coal mining equipment.

## III. IMPACT ANALYSIS

In this chapter, we take a look at the sources and characteristics of mine drainage; the proposed EPA Interim Final Guidelines and state water regulations; and the effect of compliance with Interim Final Guidelines based on a model mine treatment plant approach.

### A. SOURCES AND CHARACTERISTICS OF MINE DRAINAGE

Water handled and discharged in coal mining and preparation may generally be classified into two broad categories: (1) "process" water from either coal preparation by wet methods or that used for dust and fire protection and (2) "mine" drainage.

"Process" Water. The coal mining and preparation industry consumes relatively little "process" water. The major usage of "process" water is in preparation plants. A majority of wet cleaning plants recycle a major portion of their process water. Suspended solids consisting of semi-colloidal particles of coal, shale and clay form one of the principal preparation plant pollutants. Additionally, some minerals and salts such as chlorides and sulfates of alkalis and alkaline earth metals dissolve easily in water. In certain circumstances, these salts significantly change the pH of the water.

Mine Drainage Discharge. Compared with process water discharges, the handling and disposal of unwanted mine drainage water is a much larger problem. The amount and nature of mine discharge is determined largely by the mining methods and the characteristics of the mine site. Two important mine characteristics which affect drainage properties are the geologic history and the chemistry of the coal-bearing strata.

Mine drainage water originates from direct precipitation or from groundwater. Surface mining areas are directly exposed to precipitation and the nature of the exposed materials will affect the quality of the surface runoff. The degree of groundwater discharge depends on the depth of penetration made by cutting into the groundwater zone of the sub-surface. In general, the topographically high surface mines will encounter the least amount of groundwater and will provide smaller quantities of mine drainage, unless the surface mining intersects a water-filled underground mine.

Water encountered in deep mines may come from different sources. In mines with light cover and without a firm solid roof, rainwater may seep directly into mine workings. This may also be true of deeper mines where pillar falls have broken the roof to the surface. In such cases, except where passing under a year round stream, the amount of water generated is usually pretty closely related to the precipitation in the region--more water during the wet months, less during the dry. The deeper a mine is, the longer it is before changes in rainfall are reflected in the quantity of drainage generated. Another source of water in underground mines, not connected with seasonal changes, is "old" water, accumulated over a period of time in abandoned workings of the mine, or from flooded adjacent mines. Here the water filters through coal and parting, or comes up through cracks in the floor. Similarly, core holes drilled to prospect the coal property can be a source of water.

Water must be disposed from the mining areas, so that mining can continue smoothly. Because of the interaction between mineral wastes from mining and related operations and mine waters, dissolved or suspended pollutants are generated. Pyrite oxidation leads to the production of acid in mine drainage ("acid mine drainage").

One of the main characteristics of wastes from coal mining operations is that they are generally unrelated to production quantities. The principal treatment method involves the use of alkaline chemicals, mainly hydrated lime and limestone and is usually combined with an aeration process for ferrous iron removal.

## B. REGIONAL DISTRIBUTION OF ACID MINE DRAINAGE

Acid mine drainage from coal mining activity is concentrated in the Appalachian states particularly Pennsylvania, West Virginia, Maryland, Ohio, and Kentucky. It occurs to a limited extent in Illinois.

## C. INTERIM FINAL EFFLUENT GUIDELINES

The Interim Final Effluent Guidelines proposed by the U.S. Environmental Protection Agency will impose a pH limitation of 6 to 9 on point source discharges from existing coal mines and preparation plants to navigable waters of the United States.

## D. STATE WATER REGULATIONS

Almost all the states have water quality standards which are essentially stream standards based on the designated usage of the water. Many states have approved programs for the National Pollutant Discharge Elimination System (NPDES). This system requires a discharger to obtain a permit, which specifies limitations on the pollutants being discharged. Some states have effluent limitation based on state laws regulating waste discharges to state waters. The pH limitation for certain states are summarized in Table 21. Usually water quality standards are stricter than effluent standards. If there is a potential conflict, some state regulations require suitable limitations of pollutants (usually in the writing of the permit) to ensure

TABLE 21

EFFLUENT LIMITATIONS FOR CERTAIN STATES

| State | pH |
|---|---|
| Colorado | 6.0-9.0 (standards for waste discharge) |
| Illinois (NPDES) | 5.0-10.0 (in case of violation of WQS, suitable limitation to comply with WQS) |
| Indiana (NPDES) | 6.0-8.5 (WQS)<br>Regulation on disposal of gob and coal fines so as create minimal acid mine drainage and minimum deposit of coal fines in state waters. Law similar to Illinois in that WQS cannot be violated. |
| Maryland (NPDES) | 6.0-8.5 (effluent limitation) |
| Ohio (NPDES) | Standards on industrial waste<br>5.0-9.0 |
| Pennsylvania (NPDES) | 6.0-9.0 |
| Tennessee | 6.0-9.0 (WQS) |
| W. Virginia | 6.0-8.5 (predominantly acid streams relaxed to 5.5) |

Source: Environmental Reporter - State Water Laws, The Bureau of National Affairs, Inc., Washington, D. C.

TABLE 22

COSTS OF MEETING INTERIM FINAL EFFLUENT GUIDELINES IN NORTHERN APPALACHIAN MINES

| | Deep | Surface |
|---|---|---|
| Large (1,000,000 tpy) | | |
| Capital ($) | 61,250 | 61,250 |
| O & M[1], Chemicals ($/yr) | 60,600 | 20,000 |
| Medium (100,000 tpy) | | |
| Capital ($) | 3,500 | 13,000-26,000[2] |
| O & M[1], Chemicals ($/yr) | 5,300 | 6,600 |
| Small (50,000 tpy) | | |
| Capital ($) | 3,500 | 6,000-12,000[2] |
| O & M[1], Chemicals ($/yr) | 2,900 | 3,500 |

[1] O & M includes sludge removal.

[2] The upper range represents having to build 2 treatment facilities over the life of the mine, as surface mines are not fixed at a location.

Source: EPA, B. M. Jarrett's memo of August 27, 1975. (Effluent Guidelines Project Officer.)

## TABLE 23

## COSTS OF MEETING INTERIM FINAL EFFLUENT GUIDELINES IN NORTHERN APPALACHIAN PREPARATION PLANTS

Size: 1 million tons per year, 25-year life, 350-400 tons per hour

| | | |
|---|---|---|
| Capital ($) | | |
| | Settling Basin | 3,000 |
| | Lime Feeders | 12,000 |
| | Total | 15,000 |
| Operating Costs ($/yr) | | |
| | O & M | 1,000 |
| | Chemicals | 2,500 |
| | O & M and Chemicals | 3,500 |

Source: EPA, B. M. Jarrett's memo of August 27, 1975 and discussions with him. (Effluent Guidelines Project Officer.)

that water quality standards are not violated.

Based on a review of the Environmental Reporter - State Water Laws (compiled by the Bureau of National Affairs, Inc.), a survey by the EPA of water pollution control agencies and our telephone conversations with state water pollution control agency personnel, we find that a number of state agencies have jurisdiction on the control of effluents. Of the current state laws limiting the pH of discharges, the most lenient standard is pH 5-10.

We found that local conditions may be taken into account in the writing of permits. For example, West Virginia allows discharge with pH of 5.5 if the receiving stream is predominantly acid. In Pennsylvania where the effluent standards for coal mining are pH 6 to 9 effluents may be allowed from a neutralization plant with a pH greater than 9 into predominantly acid streams for its beneficial effect on the stream.

Our study of state water laws is not exhaustive in that we have not looked at all agencies that might have control on the discharge of effluents. We do not know the extent to which state laws are being enforced. An analysis of such enforcement practices is beyond the scope of this study.

## E. COSTS OF COMPLIANCE WITH INTERIM FINAL GUIDELINES

The costs of compliance with Interim Final Guidelines were provided by EPA--(B.M. Jarrett's memo of August 27, 1975, Effluent Guidelines Project Officer, Appendix A). These represent neutralization costs, allowing sufficient retention time for completion of the neutralization reaction and stabilization of pH for model plants in the Appalachian region. We have used these costs in the assessment of impact.

The compliance costs have been summarized in Tables 22 and 23.

## F. COAL PRODUCTION COSTS

Numerous factors, often interacting complexly, affect the cost of coal production. These factors vary between mining regions, between mines in the same region, and even within a given mine. Of the physical factors, seam thickness and depth below the surface dominate since they largely determine the system used in mining the deposit. Some of the other factors influencing coal production costs are mining technology, mine size, operating conditions and labor productivity.

Since conditions vary from one mine/region to the other, no single production model will be applicable to all coal mines. In this section, we have derived model mining costs by type of mining--underground or strip--and by mine size for the Appalachian region. The actual costs experienced

TABLE 24

SUMMARY OF ESTIMATES OF INVESTMENT AND OPERATING COSTS FOR MODEL UNDERGROUND COAL MINES IN APPALACHIA

(December 1974)

| | Large[1] | Medium[2] | Small[2] |
|---|---|---|---|
| Size ($10^6$ tpy) | 1.0 | 0.1 | 0.05 |
| Seam Thickness (inches) | 66 | 48 | 48 |
| Investment Cost ($/annual ton) | | | |
| Capital Investment | 26.68 | 11.42 | 12.32 |
| Operating Cost ($/ton) | | | |
| Direct Costs | 9.74[3] | 7.05[4] | 6.18[4] |
| Indirect Costs | 0.94[5] | 1.07[6] | 1.10[6] |
| Insurance and Taxes | 0.53[7] | 0.18[8] | 0.21[8] |
| Subtotal | 11.21 | 8.30 | 7.49 |
| Depreciation | 1.78[9] | 1.14[10] | 1.23[10] |
| TOTAL | 12.99 | 9.44 | 8.72 |

[1]Average mine life - 20 years.

[2]Average mine life - 10 years.

[3]Based on a union labor rate $11,890 of mine life per man-year and supervisory labor rate of $16,100 per man-year.

[4]Based on a non-union labor at $9,500 per man-year and salaried rate of $12,825 per man-year.

[5]At 15% of labor and supplies.

[6]At 25% of labor and supplies.

[7]At 2% of initial capital investment, does not include Federal Income Tax.

[8]At 2% of initial mine investment, does not include Federal Income Tax.

[9]15-year straight line depreciation of initial investment.

[10]10-year straight line depreciation of initial investment.

Source: ADL estimate, Phase II Report Industry Charactrization, Economic Impact of Proposed Effluent Guidelines on the Coal Mining Industry.

TABLE 25

SUMMARY OF ESTIMATES OF INVESTMENT AND OPERATING COSTS FOR MODEL SURFACE COAL MINES IN APPALACHIA
(December 1974)

| | Large[1] | Medium[2] | Small[2] |
|---|---|---|---|
| Size ($10^6$ tpy) | 1.0 | 0.1 | 0.05 |
| Type of Mine | Contour | Contour | Strip |
| Investment ($/annual ton) | | | |
| Capital Investment | 30.64 | 9.55 | 7.51 |
| Operating Costs ($/ton) | | | |
| Direct Costs | 6.29[3] | 5.29[4] | 5.29[4] |
| Indirect Costs | 0.49[5] | 0.38[6] | 0.52[6] |
| Insurance & Taxes | 0.61[7] | 0.19[8] | 0.15[8] |
| Subtotal | 7.39 | 5.86 | 5.96 |
| Depreciation | 2.04[9] | 0.96[10] | 0.75[10] |
| Total | 9.43 | 6.82 | 6.71 |

[1] Average mine life - 20 years.

[2] Average mine life - 10 years.

[3] Based on an hourly labor rate of $9,700 per man-year and salaried at $13,200 per man-year.

[4] Based on a non-union labor at $9,500 per man-year and salaried rate of $12,850 per man-year.

[5] At 15% of labor and supplies.

[6] At 25% of labor and supplies.

[7] At 2% of initial capital investment, does not include Federal Income Tax.

[8] At 2% of initial mine investment, does not include Federal Income Tax.

[9] 5-year straight line depreciation of initial investment.

[10] 10-year straight line depreciation of initial investment.

Source: ADL estimate, Phase II Report Industry Characterization, Economic Impact of Proposed Effluent Guidelines on the Coal Mining Industry.

by a specific mine will approach those synthesized in the model only to the extent that its operating conditions approximate those assumed in the derivation.

Tables 24 and 25 present a summary of our estimates for costs in the Appalachian region for small, medium, and large underground and surface mines. For large underground and surface mines, capital requirements were derived from U.S. Bureau of Mines estimates with suitable revisions and escalations to December 1974. These are presented in terms of the capital investment to put a mine into operation (including items such as the cost of land acquisition, exploration and development, working capital and initial cost of equipment and their installation, preparation plants and loading facilities).

We have hypothesized that medium and small mines operate under a different set of coal placement, availability, and market conditions. They are likely to lower their costs by using used and/or rebuilt equipment, employ fewer people (doing multiple jobs) and operate in coal seams relatively close to the point of entry such as into the high wall of former strip operations. In such mines one would not probably have extensive entries and elevators. This philosophy is also extended in the calculation of operating costs. The nature of these operations is reasoned to be such that they could not survive (except in unusual spot market conditions) unless their costs are less than (or at most equal to) those experienced by the large mines. Profitable operation would hinge on the use of minimal equipment, the ingenuity of the operator in devising practical mining short-cuts, the ability of personnel to perform a wide variety of jobs, and the existence of very favorable geologic and topographic mining conditions amenable to utilization of minimum equipment and personnel. Coupled with these factors lower wage rates have been assumed as well as a faster depreciation schedule for purchased equipment.

## G. COAL PRICES

In considering coal markets, we have to look at three commodities--metallurgical, low-sulfur, and high-sulfur steam coal--and whether coal is sold through long term contracts at specified prices or on the spot market.

Until the mid-1960's coal contracts were generally fixed price and long term particularly for steam coal. In a market where consumption was declining, such contracts were acceptable both to the producer and the consumer. However, with increasing demand for coal and escalating costs such contracts have become unacceptable to the producer. Recent contracts are shorter term and generally include provision for pass-through of full costs on an annual basis. Presently, 80-85% of all coal is sold on long term contracts.

Historically, coal price levels have been based on production costs, which vary greatly by type of mining and geography. The average f.o.b. price for all coal was \$8.53/ton in 1973; that is, \$10.84/ton for under-

TABLE 26

F.O.B. MINE WEIGHTED VALUE OF COAL FOR 1974
($/ton)

| State | Underground | Strip | Average |
|---|---|---|---|
| Alabama | 30.30 | 17.84 | 21.79 |
| Illinois | 13.89 | 5.33 | 9.38 |
| Indiana | 11.12 | 8.70 | 10.00 |
| Kentucky | - | - | approx. 16.00 |
| Maryland | 21.25 | 20.58 | 20.81 |
| Pennsylvania | - | - | 18.00 |
| Tennessee | 13.70 | 22.05 | 18.02 |
| W. Virginia | - | - | approx. 21.00 |
| U.S. | - | - | 15.00 |

Source: USBM, preliminary figures.

ground coal, $6.11/ton for strip and $7.39/ton for auger coal. The average f.o.b. price varied from a high of $13.37/ton in Arkansas to a low of $2.82/ton in Montana. The average f.o.b. price of coal in 1974 was $15.00 per ton according to Bureau of Mines preliminary estimates. The average f.o.b. price of coal in 1974, based on preliminary data from the Bureau of Mines, is listed in Table 26 for selected states. These average figures include coal sold under long term contracts and in the spot markets.

Spot prices change in response to short term supply-demand imbalances. When demand exceeds supply, spot prices tend to rise quite quickly in response. Contract prices on the other hand are not as quickly influenced by such an imbalance. Should premium prices prevail in the spot market over a period of time, producers can renew long term agreements from a position of considerable strength.

Since the oil embargo and the lifting of price controls in the spring of 1974, the spot price for coal has risen substantially due to shortages, higher price levels for competing fuels, and the anticipation of a long coal strike in November 1974.

During 1974 spot price quotations advanced 149% for metallurgical in the low to medium volatile grades, 156% in the high volatile grades, and 44% for utility grade coal. Around March 1975, prices for low-sulfur utility coal were around $20-25/ton compared to a high of $35-50/ton in 1974. Prices of metallurgical grades had declined except for low to medium volatile grades which were holding around $45/ton.

## H. IMPACT ANALYSIS

We have considered the possible impact from two viewpoints:

(1) Status of Current State Regulations

(2) Impact based on model mines and treatment plants in Appalachia.

Acid mine drainage is concentrated mainly in the Appalachian region of the country, principally Pennsylvania, West Virginia, Maryland, Ohio, and Kentucky and to a limited extent in Illinois.

The coal industry is composed of a large number of mines that are widely distributed geographically. It was not possible to do a mine-by-mine analysis as costs by specific mines are not available.

We have, therefore, decided to look at the impact of Interim Final Guidelines based on model mine/preparation plant and model treatment plants. We assumed that such a mine is not in compliance with the Interim Final Guidelines and would therefore have to incur additional capital expenditure and operating costs.

TABLE 27

EFFECT OF INTERIM FINAL GUIDELINES ON
ANNUALIZED OPERATING COST OF
MODEL UNDERGROUND MINES

| Category | Large | Medium | Small |
|---|---|---|---|
| Size ($10^6$ tpy) | 1.0 | 0.1 | 0.05 |
| PRODUCTION | | | |
| Capital Investment ($) | 26,680,000 | 1,142,000 | 616,000 |
| Direct, Indirect, Insurance Tax ($) | 11,210,000 | 830,000 | 374,500 |
| Depreciation ($) | 1,780,000 | 114,000 | 61,500 |
| Interest Expense[1] ($) | 711,000 | 30,500 | 16,000 |
| Annual Operating Cost ($) | 13,701,000 | 974,500 | 452,000 |
| Before Interim Guidelines ($/ton) | 13.70 | 9.75 | 9.04 |
| WATER TREATMENT | | | |
| Capital: Mine ($) | 61,250 | 3,500 | 3,500 |
| Prep. Plant ($) | 15,000 | -- | -- |
| | 76,250 | 3,500 | 3,500 |
| Depreciation, Interest[2] ($) | 11,401 | 500 | 500 |
| O & M, Chemicals: Mine ($) | 60,600 | 5,300 | 2,900 |
| Prep. Plant ($) | 3,500 | -- | -- |
| Annual Treatment Cost ($) | 75,500 | 5,800 | 3,400 |
| Annual Operating Cost After Interim Guidelines ($/ton) | 13.78 | 9.80 | 9.11 |
| $\frac{\text{Water Treatment Cost}}{\text{Production Cost B.I.G.}} \times 100$ (%) | 0.6 | 0.6 | 0.8 |

[1] Debt to equity ratio 1:2; interest rate 8%.

[2] Amortized at 8% over 10 years.

Source: Arthur D. Little, Inc. estimates and EPA estimates.

TABLE 28

EFFECT OF INTERIM FINAL GUIDELINES ON ANNUALIZED OPERATING COST OF SURFACE MINES

| Category | Large | Medium | Small |
|---|---|---|---|
| Size ($10^6$ tpy) | 1.0 | 0.1 | 0.05 |
| PRODUCTION | | | |
| Capital Investment ($) | 30,640,000 | 955,000 | 375,500 |
| Direct, Indirect, Insurance Tax ($) | 7,390,000 | 586,000 | 298,000 |
| Depreciation ($) | 2,040,000 | 96,000 | 37,500 |
| Interest Expense[1] ($) | 817,000 | 25,500 | 10,000 |
| Annual Operating Cost ($) | 10,247,000 | 707,500 | 345,500 |
| Before Interim Guidelines ($/ton) | 10.25 | 7.08 | 6.91 |
| WATER TREATMENT | | | |
| Capital: Mine ($) | 61,250 | 13,000-26,000[3] | 6,000-12,000[3] |
| Prep. Plant ($) | 15,000 | -- | -- |
| | 76,250 | 13,000-26,000 | 6,000-12,000 |
| Depreciation, Interest[2] ($) | 11,400 | 1,950- 3,900 | 900- 1,800 |
| O & M, Chemicals: Mine ($) | 3,500 | -- | -- |
| Prep. Plant ($) | 20,000 | 6,600 | 3,500 |
| Annual Treatment Cost ($) | 34,900 | 8,550-10,500 | 4,400- 5,300 |
| Annual Operating Cost After Interim Guidelines ($/ton) | 10.28 | 7.16-7.18 | 7.00-7.02 |
| $\frac{\text{Water Treatment Cost}}{\text{Production Cost B.I.G.}}$ x 100 (%) | 0.3 | 1.2-1.5 | 1.3-1.5 |

[1]Debt to equity ratio 1:2; interest rate 8%.

[2]Amortized at 8% over 10 years.

[3]The upper range represents two treatment facilities over the life of the mine.

Source: Arthur D. Little, Inc. estimates and EPA estimates.

## 1. Status of Current State Regulations

Most of the states, where acid mine drainage is likely to occur, have some form of regulation limiting the pH of discharges either as a result of effluent limitations or water quality standards. The least stringent of these seems to be a pH limitation of 5-10 in Illinois. However, in writing permits in Illinois a more stringent standard such as pH 6-8.5 may be imposed if the water quality standards are likely to be violated under the more lenient effluent standards. It is not clear if all effluents arising from coal mining and preparation are controlled, nor do we know the extent to which state laws are enforced. We feel that, if state laws are strictly enforced, the additional impact arising out of Interim Final Guidelines would be minimal. An analysis of such enforcement practices is beyond the scope of this study.

## 2. Impact Based on Model Mine/Treatment Plant on the "Soft" Coal Segment

### a. Effect on Mines--Annualized Operating Costs

Tables 27 and 28 summarize the effect of meeting Interim Final Guidelines on the annualized operating costs of model underground and surface mines for soft coals. In addition to the cost items presented in Tables 22 and 23, the annual operating costs before interim final guidelines include interest expenses based on assumed debt to equity ratio of 1:2 and 8% interest rate. The large mine category includes a preparation plant and therefore water treatment costs associated with a preparation plant are included in this category. The capital costs for water treatment are assumed to be financed by loans that are amortized at 8% over a 10-year period.

The annual costs after compliance with Interim Effluent Guidelines increase less than 12¢/ton (1.5% maximum). These increases are not very significant, in comparison to the average price of all coal in 1974 of $15/ton.

### b. Capital Requirements

Table 29 summarizes the capital requirements for meeting Interim Final Guidelines. In this table, capital requirements for water treatment are compared to the capital investment of each model mine.

We find for deep mines that the capital needed for building treatment facilities to meet Interim Guidelines is small compared to the mine investment (less than 1%). For surface mines in the medium and small category these ratios tend to become more significant (less than 4%).

### c. Mine Profitability

In this section we have tried to estimate the profits of model medium

## TABLE 29

## CAPITAL REQUIREMENTS FOR MEETING INTERIM FINAL EFFLUENT GUIDELINES BY MINE TYPE

| Size, Category | Deep | | | Surface | | |
|---|---|---|---|---|---|---|
| | Large | Medium | Small | Large | Medium | Small |
| Capital Investment ($) $C_I$ | 26,680,000 | 1,142,000 | 616,000 | 30,640,000 | 955,000 | 375,500 |
| Capital for Meeting Interim Effluent Guidelines ($) $C_{WT}$ | 76,250 | 3,500 | 3,500 | 76,250 | 13,000 (26,000)[1] | 6,000 (12,000) |
| Capital for Water Treatment to Capital Investment (%) $\left(\frac{C_{WT}}{C_I} \times 100 = D_1\right)$ | 0.3 | 0.3 | 0.6 | 0.25 | 1.4 (2.7) | 1.6 (3.2) |

[1] Figures in parenthesis include cost of two treatment plants over the life of the mine as surface mines are not fixed in location.

TABLE 30

ESTIMATED EARNINGS OF MODEL SURFACE MINES BEFORE AND AFTER INTERIM FINAL GUIDELINES

| Size, Category | Medium | | Small | |
|---|---|---|---|---|
| Size (tpy) | 100,000 | | 50,000 | |
| Price of Coal ($/ton) | 16.00 | | 16.00 | |
| | Before($) | After($) | Before($) | After($) |
| Sales Revenue | 1,600,000 | 1,600,000 | 800,000 | 800,000 |
| Annual Costs | 707,500 | 716,050<br>(718,000)[1] | 345,500 | 349,900<br>(350,800) |
| Gross Profits | 892,500 | 883,950<br>(882,000) | 454,500 | 450,100<br>(449,200) |
| Tax (48% Gross Profits) | 428,400 | 424,300<br>(423,400 | 218,200 | 216,000<br>(215,620) |
| After Tax Profits | 464,100 | 459,650<br>(458,600) | 236,300 | 234,100<br>(233,580) |
| % Change in After Tax Profits Due to Effluent Guidelines (%) | 1.0-1.2 | | 0.9-1.2 | |

[1] Figures in parentheses include costs of two treatment plants over the life of the mine as surface mines are not fixed in location.

TABLE 31

EFFECT OF COAL PRICES ON THE AFTER TAX PROFITS OF MODEL SURFACE MINES BEFORE AND AFTER COMPLIANCE WITH INTERIM FINAL GUIDELINES

| Value of Coal f.o.b. Mine ($/ton) | Medium | | | Small | | |
|---|---|---|---|---|---|---|
| | Before($) | After($) | Change(%) | Before($) | After($) | Change(%) |
| 16.00 | 464,100 | 459,650 (458,600)[1] | 1.0 (1.2) | 236,300 | 234,100 (233,580) | 0.9 (1.2) |
| 15.00 | 412,100 | 407,650 (406,600) | 1.1 (1.3) | 210,300 | 208,100 (207,580) | 1.0 (1.3) |
| 14.00 | 360,100 | 355,650 (354,600) | 1.2 (1.5) | 184,300 | 182,100 (181,580) | 1.2 (1.5) |
| 13.00 | 308,100 | 303,650 (302,600) | 1.4 (1.8) | 158,300 | 156,100 (155,580) | 1.4 (1.7) |

[1] Figures in parenthesis include costs of two treatment plants over the life of the mine, as surface mines are not fined in location.

TABLE 32

EFFECT OF INTERIM FINAL GUIDELINES ON CAPITAL REQUIREMENTS AND ANNUALIZED OPERATING COSTS OF MODEL PREPARATION PLANTS

| | |
|---|---|
| Size ($10^6$ tpy) | 1.0 |
| **Coal Preparation** | |
| Capital, $C_I$($) | 6,700,000 |
| Operating Cost($) | 550,000 |
| Depreciation, Interest[1]($) | o26,000 |
| Annual Operating Cost before Interim Guidelines($) | 1,126,000 |
| ($/ton) | 1.13 |
| **Water Treatment** | |
| Capital, $C_{WT}$($) | 15,000 |
| O & M, Chemicals | 3,500 |
| Depreciation, Interest[2] | 2,250 |
| Annual Treatment Cost($) | 5,750 |
| Annual Operating Cost after Interim Guidelines($/ton) | 1.13 |
| $\frac{\text{Water Treatment Cost}}{\text{Production Cost B.I.G.}}$ x 100(%) | 0.5 |
| Capital for Water Treatment to Capital Investment (%) $\left(\frac{C_{WT}}{C_I} \times 100\right)$ | 0.2 |

[1]Debt to equity ratio 1:2, interest rate 8%

[2]Amortized at 8% over 10 years.

Source: Arthur D. Little, Inc. Estimates and EPA Estimates.

and small surface mines--mines whose capital expenditure for pollution control as a percent of capital requirements was around 1-3%.

Based on preliminary statistics from the Bureau of Mines, the average value per ton f.o.b. mine for Pennsylvania and W. Virginia coal for 1974 was $18 and $21/ton. We estimate the strip coal value for Pennsylvania and W. Virginia at $16/ton.

Table 30 summarizes our estimates of earnings of model surface mines. The possible change in earnings arising out of compliance with Interim Final Guidelines, assuming that all treatment costs are passed on, is between 0.9-1.2%. Based on estimated 1974 earnings it would not be difficult for such operations to raise the capital for pollution control. If the prices were $3/ton lower, the change in earnings due to compliance with Interim Effluent Guidelines would still be small (less than 2%). The effect of price on profits is presented in Table 31.

## 3. Impact on Anthracite Segment

In the United States, anthracite is mined predominantly in Pennsylvania. According to the memorandum of July 2, 1975, by Mr. B. M. Jarrett (Appendix B), "drainage from active mines is treated to meet Pennsylvania effluent standards of less than 7 mg/l Fe, alkalinity greater than acidity, pH6-9; or is effectively not discharged to a receiving stream with drainage going to abandoned mines; or the mine is located in one of ten water sheds covered in the Pollution Abatement Escrow Fund, Pennsylvania Act 443, 1968 in which case the mine can discharge to a receiving stream untreated mine drainage and pay $0.15 per saleable ton mined." Consequently, there would be no additional expenditures necessary to comply with the Interim Final Guidelines.

## 4. Impact on Coal Preparation Plants

For the "soft" coal segment, the large mine category was a mine with a preparation plant. In the analysis of this category, the cost of coal preparation and effluent treatment cost associated with compliance with Interim Final Guidelines was taken into account.

In this section we have examined the effect of compliance with Interim Final Guidelines on an "independent" preparation plant (one that is not associated with a mine), both from the standpoint of increased operating cost and capital requirements. The results have been summarized in Table 32. The increase in annualized operating cost is less than 1¢/ton, compared with a cost of preparation of approximately $1.00/ton. The capital requirements for water treatment compared to preparation plant investment is about 0.2%.

We did not have information on effluents and treatment costs for anthracite preparation plants and therefore excluded them from our analysis.

## 5. Summary

The analysis of model mines and treatment plants shows that the effect of the Interim Final Guidelines would be to increase operating costs around 12¢/ton. The capital costs requirements vary from \$3,500 to \$77,000. The impact on an individual mine would be relatively modest. Our analysis was based on models and site specific factors can alter the economics of the situation. Whether medium and small mines can raise capital required to comply with Interim Final Guidelines depends on the profitability of these mines in the future. Should the earnings be similar to the situation in 1974, the raising of capital should not be a problem. If, however, the profits are marginal, the small and medium categories are likely to face hardships and would have to fight for survival. In such a case, the Interim Final Guidelines may carry sufficient weight in a decision to close a mine.

Based on B.M. Jarrett's memo, (Appendix B), there would be no impact on the anthracite segment as a result of the Interim Final Guidelines on existing mines.

The effect of Interim Final Guidelines on independent preparation plants is quite small (less than 1¢/ton increase in annual operating cost due to compliance with Interim Final Guidelines, compared with cost of preparation of approximately \$1.00/ton). The capital requirement for water treatment is \$15,000 (less than 0.2% of preparation plant investment). We could not analyze anthracite preparation plants because of a lack of information.

APPENDIX A

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**

SUBJECT: Coal Mine Effluent Guidelines DATE: AUG 27 1975

FROM: BM Jarrett, Project Officer
Effluent Guidelines Division (WH-452)

TO: Gail Coad, Project Officer
Economic Analysis Division (PM-220)

You requested an estimate of capital expenditure to meet the interim final effluent limitations proposed for the mining industry subcategory which includes coal preparation plant ancillary areas. This capital investment would only be for meeting pH limitations 6-9.

A telephone survey was made of 6 representative coal preparation plants in Pennsylvania, Ohio, and West Virginia. These plants have a capacity of from 225 tons/hour to 800 tons/hour clean coal. These ranges in capacity do not reflect the total area included in the preparation plant ancillary area. As example, a preparation plant with a 250 ton/hour capacity reported the largest area affected: 10 acres; and a larger preparation plant with the capacity of 800 tons/hour reported a total area of less than 4 acres.

In that the interim final regulation to be promulgated has no limitation on suspended solids, only neutralization with an alkali would be required to meet the pH limitation of 6-9. It is recommended that sufficient time be allowed for the reaction between the alkali and the acid mine drainage to go to completion and for the pH to stabilize. A stipulation in the regulation is "any untreated overflow from facilities designed, constructed, and operated to treat the process waste water and the runoff from the coal preparation plant ancillary area resulting from a 10 year/24 hour precipitation event shall not be subject to the limitation set forth" (i.e. pH limitation). With this consideration, any treatment facilities for the runoff from preparation plant ancillary areas would normally be designed for containing considerably less than the total flow resulting from a 10 year/24 hour precipitation event as the requirement is for treating and not containing this volume. Heavy rainfall events would create a natural dilution of the pollutants associated with the coal and coal refuse. Therefore, it would seem logical that any treatment facility designed only for pH control of the runoff from coal preparation plant ancillary areas would be designed to treat a limited flow. The areas primarily affected by pH control are the Northern Appalachian States. For the purposes of estimating flow to be treated, the largest average rainfall in any month is used. This occurs in June. This average monthly precipitation is something less

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than 5 inches. On this basis, there would be a requirement to treat approximately 5,000 gal/day/acre included in the coal preparation plant ancillary area.

For flows of 50,000 gal/day, and periodic operation, assuming 10 acres included in the coal preparation plant ancillary area, the obvious method of treatment would be with sodium hydroxide, or lime, plus a settling basin. The cost of such a facility is less than $3000.

In a previous memo, you were furnished an estimate of $12,000 for lime feeders which might be required to treat the surface runoff from a refuse storage area associated with a coal preparation plant producing one million ton/year with a 25 year life and 20% reject. This preparation plant would have a capacity of 350 ton/hour to 400 ton/hour assuming two shift operation. Estimation for larger or smaller preparation plants can be proportioned from $12,000.

Also, in a previous memo you were furnished costs for meeting requirements of BPT, BAT, and NSPS as initially suggested in the contractor's draft development document for models in your industry segmentation.

Your request for costs to meet a BPT limitation of pH 6 to 9 only would apply to those Bituminous mines located in Northern Appalachia primarily.

Below are costs for meeting a BPT limitation of pH 6 to 9 for the models in your industry segmentation in Northern Appalachia.

The following assumptions are made: For ease in costing a package, which can be supplied by either MSA or Butler Silo Company, is used for estimating cost of the control building, lime storage, lime feed and mixer, and pH controls. This package is available at $60,000 to $80,000. In addition to these facilities a settling basin is required of sufficient size to allow reaction between the alkali, and the acid mine drainage to go to completion and the pH to stabilize. This size is based on a four hour retention of a flow attributable to a 10 year/24 hour precipitation event. Cost of alkali (lime) is a function of the total acidity in the raw mine drainage. This cost is based on the documented costs at eight AMD treatment facilities in the development document. The cost used is $8000 per year per 1000 cum/day of AMD treated. This cost is most probably high as the eight AMD plants are treating not only to meet a pH limitations, but also to meet total iron and an alkalinity limitation. For mine drainage of less than 100,00- gal/day (378 cum/day), it is assumed a sodium hydroxide feeder would be used in conjunction with a settling basin.

Northern Appalachia (Maryland, Pennsylvania, Ohio, Virginia, West Virginia)

Mines of this region can generally be categorized as being Acidic or Ferruginous in Maryland, Pennsylvania, Ohio, and the northern part of West Virginia. It should be noted, however, that 2/3 the production of West Virginia and the mines of Virginia can be categorized as alkaline, which requires either no treatment for deep mines or only settling for deep mines and settling for surface mines. This region also has over 50% of the total mines in the U.S. in your small deep mine (50,000 ton/yr) category with most of these mines in the alkaline mine drainage category requiring no treatment of mine drainage, or the mine is dry.

1. Deep Mines

a. Large Mine

(Total in category - 225, visited - 56)

Mine life - 25 years; 1 million ton/yr; 70% recovery; 60 in. thick seam; 7000 ton/acre recoverable; 143 acres mined/year; 1857 acre mined in 13 yrs; 400 ft of cover (below drainage); 600 gal/acre AMD; 1,114,000 gal/day; design 1 1/2 million gal/day (5700 cum/day).

| | |
|---|---|
| Plant | $60,000 |
| Settling Basin | 1,250 |
| | $61,250 |

| | |
|---|---|
| Chemicals | $45,600/year |
| O&M | $15,000/year incl. sludge removal |

In that state law in the areas affected by AMD presently require treatment of mine drainage and this universally consists of lime neutralization (with or without aeration) and precipitation, additional capital to meet Interim Final BPT would be negligible.

b. Medium Mine

(Total in category - 227, visited - 3)

Mine life - 15 years; 100,000 ton/yr; 70% recovery; 40 in. thick seam; 4270 ton/acre recoverable: 23.4 acre/yr; 187.4 acres mined in 8 years; 200 ft cover (above drainage); 300 to 600 gal/acre AMD; 113,000 gal/day; design 150,000 gal/day (568 cum/day).

| | |
|---|---|
| $ 500 | for settling basin |
| | for either sodium hydroxide or lime |
| 3,000 | holding tank, pump. |
| $3,500 | |

Chemicals - $4,000/year
O&M - $1,300/year incl. sludge removal

As with large mines, existing state law requirements would affect no capital expenditure to meet BPT.

c. Small Mine

(Total in category - 439, visited - 10)

Mine life - 10 years; 50,000 ton/yr; 75% recovery; 36 in. thick seam; 3920 ton/acre recoverable; 12.8 mined acre/yr; 64 acres mined in 5 years; 200 ft of cover (above drainage); 600 gal/acre AMD; 38,400 gal/day; design 50,000 gal/day (190 cum/day).

| | |
|---|---|
| $ 500 | for settling basin |
| | for either sodium hydroxide or lime |
| 3000 | holding tank, pump. |
| $3500 | |

Chemicals - $1600/year
O&M - $1300/year incl. sludge removal

As with large mines, existing state law requirements would affect no capital expenditure for BPT.

2. Surface Mine

a. Large Mine

(Total in category - 101, visited - 10)

Mine life - 20 years; 1/2 million ton/yr; 90% recovery; 60 in. thick seam; 7840 ton/acre recoverable; 64 acre/yr; 320 acres mined in 5 yrs; design 64.5 million gal/day (1890 cum/day).

| | |
|---|---|
| Plant | $60,000 |
| Settling Basin | 1,250 |
| | $61,250 |

Chemicals $15,000/year
O&M $ 5,000/year incl. sludge removal

As with deep mines producing AMD, state laws require treatment of AMD from surface mines. Additional capital to meet Interim Final BPT would be minimal.

b. Medium Mine (Including auger)

(Total in category - 290, visited - 13)

Mine life - 10 yrs; 100,000 ton/yr; 42 in. thick seam; 80% recovery (with auger); 4880 ton/acre recoverable; 20.5 acre/yr; 5 yr in mine area 102.5 acres; design 120,000 gal/day AMD.

| | |
|---|---|
| Plant | $12,000 |
| Settling basin | 1,000 |
| | $13,000 |

| | |
|---|---|
| Chemicals | $5,000/year |
| O&M | $1,600/year incl. sludge removal |

Additional capital to meet Interim Final BPT would be minimal.

c. Small Mine

(Total in category - 101, visited - 10)

Mine life - 5 years; 50,000 ton/yr; 90% recovery; 36 in. thick seam; 4705 ton/acre recoverable; 10.6 acres/yr; total in mine area 53 acres.

| | |
|---|---|
| Plant | $5,000 |
| Settling basin | 1,000 |
| | $6,000 |

| | |
|---|---|
| Chemicals | $2,500/year |
| O&M | $1,000/year incl. sludge removal |

Additional capital to meet Interim Final BPT would be minimal.

If you need any additional information or clarification of information in this memo, please contact me.

## APPENDIX B

Excerpts from Mr. B.M. Jarrett's Memo entitled "Coal Mining Effluent Guidelines" of July 2, 1975

## II - ANTHRACITE MINING

Anthracite mining is included with bituminous coal and lignite mining as it was determined that rank of coal did not effect the chemical characteristics of raw mine drainage.

Anthracite coal is found to some extent in four states: Pennsylvania, Colorado, New Mexico, and Washington. However, approximately 90% of mineable anthracite with present day mining technology is found in Pennsylvania; and all current anthracite mining operations are found in Pennsylvania.

Comments on anthracite mining are limited to mines in Pennsylvania.

Mining methods for anthracite include deep mining, strip mining, and culm bank. For purpose of developing effluent limitation guidelines culm bank mining is included with strip mining.

Mining methods for anthracite are influenced to a great extent by past mining in the area with most mines doing a second and third pass at mining in some locations plus culm bank recovery. Mines and seams of anthracite are most often interconnected and are inundated. Water drainage tunnels established in the 1800's convey large quantities of mine drainage from abandoned mines. Currently operating mines often must handle large quantities of drainage. This drainage from active mines is: treated to meet Pennsylvania effluent standards of less than 7 mg/l of Fe, alkalinity greater than acidity, pH 6-9; or is effectively not discharged to a receiving stream with drainage going to abandoned mines; or the mine is located in one of ten water sheds covered in Pollution Abatement Escrow Fund, Pennsylvania Act 443, 1968 in which case the mine can discharge to a receiving stream untreated mine drainage and pay $.15 per saleable ton mined.

For the purpose of developing effluent limitation guidelines only mines discharging to a receiving stream are considered, and these mines would be located most generally in the Northern and Eastern Middle Anthracite Fields. Mines not discharging to a receiving stream are not covered. Mines discharging to one of the ten watersheds are not covered as the drainage of the water shed is treated in a state owned treatment facility.

Unlike bituminous and lignite mines where mine drainage is fundamentally related to precipitation with side concerns from adjacent or abandoned mines, anthracite mine drainage is primarily from abandoned areas, seams or mines. There is literally no relationship between mine drainage volumes and tons mined, area mined, roof exposed, depth of cover, or permeability.

In 1973 there were 82 mining companies listed by Pennsylvania as deep anthracite mine operations of which 12 showed no deep mine production for the year, and 21 had a deep mine production of less than 500 tons for 1973. Two deep anthracite mines had a production of over 50,000 tons in 1973.

In 1973 there were 115 mining companies listed by Pennsylvania as surface mine operations of which 9 operations were back filling with no production; 44 operations were operating in culm banks; and 27 operations had a production of less than 500 tons in 1973. Thirty-four surface mining companies had a production of over 50,000 ton/yr.

1. Deep Mines

   a. Large (Visited 1)

One large deep mine is located in the Northern Fields. This mine had no discharge with drainage returned to abandoned mines. The mine visited mines approximately 90,000 ton/yr and contributes $.15/ton to the State of Pennsylvania. In order to operate the mine visited pumps 1500 gpm 24 hr/day, or approximately 2.2 million gal/day.

A primary consideration in opening a new large deep anthracite mine is cost of pumping. This consideration is quite aside from cost of treating AMD. Facilities to meet current Pennsylvania effluent requirements would be adequate to meet NSPS.

   b. Small (Visited 0)

Five small deep mines are located in the Northern or Eastern Middle Field of which two had no production for 1973. A telephone survey indicated that the remaining three mines had an effective no discharge.

As with large deep mines facilities for a small deep mine to meet current Pennsylvania effluent requirements would be adequate to meet NSPS.

2. Surface Mines

a. Large (Visited 2)

Included in this category are 14 culm bank mines. Twelve large surface mines are located in the Northern or Eastern Middle Fields.

A mine visited in the Northern Field consists of three pits with an annual production of 1.5 million ton/yr. This mine has no discharge with all mine drainage going to abandoned areas and mines.

As with deep mines, facilities for large surface mines to meet current Pennsylvania effluent requirements would be adequate to meet NSPS.

b. Small (Visited 0)

Included in this category are 30 culm bank mines. Twenty-five small surface mines are located in the Northern or Eastern Middle Fields of which 18 had no production for 1973.

As with large surface mines, facilities for small surface mines to meet current Pennsylvania effluent requirements would be adequate to meet NSPS.