Legislative History
Committee Publication No. 93-8

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COAL SURFACE MINING AND RECLAMATION An Environmental and Economic Assessment of Alternatives
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS UNITED STATES SENATE
93RD CONGRESS, 1ST SESSION, MARCH 1973
Serial No. 93 -8 (92-43)

MEMORANDUM OF THE CHAIRMAN

5 To Members and ex officio members of the Senate Committee on Interior and Insular Affairs' National Fuels and Energy Policy Study (S.Res. 45):

5 Legislation to control the adverse environmental and social impacts of surface mining activities has been pending before the Congress for more than a decade. I am confident that this session of Congress will see a Federal regulatory law enacted. Too often, in my view, the Federal Government deals with critical public policy problems without paying adequate attention to the full consequences of proposed solutions. This has frequently been true in matters involving degradation of our environment where actions have been proposed based on emotional reactions without full consideration of all the impacts of the proposal.

5 To better understand the problems presented by the admitted abuses of unregulated surface mining and the policy options available to the Congress, last November I requested the Council on Environmental Quality to undertake an in depth study of various regulatory alternatives, their costs and benefits, their impact on the environment, and how they would influence the social and economic conditions of local communities. The Council's study was done by a task force composed of representatives of a number of Federal agencies. It was received by the committee shortly before the hearings on surface mining legislation held March 13, 14, 15, and 16. The report contains a good deal of information which has not been made available before. It should be of substantial interest to the members of the committee and to the public at large.

5 Accordingly, I have directed that the report and its appendixes be reproduced as a committee print so that it will be readily available to all interested parties.

5 HENRY M. JACKSON, Chairman.

LETTER OF REQUEST

7 NOVEMBER 2, 1972.

7 Hon. RUSSELL E. TRAIN, Chairman, Council on Environmental Quality, Washington, D.C.

7 DEAR CHAIRMAN TRAIN: As you know, the 92d Congress devoted a great deal of time and effort toward the development of Federal legislation to regulate surface mining activities and to minimize the effects of these activities on the environment. Unfortunately, Congress did not take final action on pending measures to regulate surface mining prior to adjournment of the 92d Congress.

7 As chairman of the Senate Interior and Insular Affairs Committee, I intend to make every effort to see that strong and effective legislation is developed to deal with the adverse environmental and social consequences of surface mining activities early in the next session of the Congress.

7 While a great deal is currently known about the adverse environmental impacts of many surface and underground mining practices, very little is known about the transitional problems and the short-and long-term economic consequences of the various surface mining regulatory proposals which have been advanced. For example, many of the bills introduced in the 92d Congress proposed various forms of prohibition and 'slope' degree limitations on surface mining and reclamation activities. To a major extent, the debate over Federal surface mining legislation has narrowed to the question of what the impact of imposing various forms of slope degree limitations would be in terms of improving the quality of the environment, as well as in terms of the future availability of mineral and coal production to meet essential national requirements for energy and materials.The ultimate effects that the proposed bans and slope degree restrictions might have on the availability of mineable coal reserves, on environmental improvement, on electrical power reliability, and on the social and economic conditions of local communities have not been clearly defined by the testimony received in congressional hearings or in information currently available from the Federal agencies. In my view, this is extremely unfortunate. Detailed information on these and other questions is needed to enable the Congress to develop a regulatory framework which will protect the environment and serve the interests of the public.

7 As you may know, on October 6, 1972, I introduced an amendment in the nature of a substitute (amdt. No. 1713) to S. 630, the Surface Mining Reclamation Act of 1972. Section 217 of my amendment authorized and directed the Council on Environmental Quality to conduct a detailed study of the impacts - social, economic, and environmental - of imposing bans and prohibiting surface mining through the use of slope limitations. I am enclosing a copy of the amendment, together with my introductory remarks for your ready reference.

8 In order to explore and better understand the extent of current knowledge, the availability of information and the state of the art of regulating surface

mining activities I request that the Council organize an interagency task force to explore these subjects in anticipation of further congressional action on surface mining legislation. In view of the limited time available, I do not anticipate that the task force would be able to develop the detailed and precise information contemplated in section 217. I do, however, feel that a very important purpose would be served if the task force and the Council could identify existing sources of data and review the state of knowledge of mining technology and reclamation and provide the committee with tentative answers to the questions set forth in section 217 of my amendment.

8 I would appreciate it if this report were available to the committee no later than February 1, 1973.

8 Sincerely yours,

8 HENRY M. JACKSON, Chairman.

PREFACE

9 Surface mining withot adequate reclamation is leaving thousands of acres of land scarred and unstable. Silt and acid mine drainage from surface mining can pollute streams and lakes, destroy fish populations, impair wildlife habitat and damage recreational values. Property and lives are also threatened with landslides and floods.

9 There is no reason for us to continue accepting these damages from strip mining. High levels of control can substantially reduce adverse environmental impacts in most areas.

9 Recognizing these problems from surface mining, the President proposed the Mined Area Protection Act in his 1971 Message on the Environment. Both Houses of the Congress held extensive hearings, but no bill was enacted. Based on these hearings and information developed from this study, the Administration subsequently revised its proposed legislation and has sent to the Congress a greatly strengthened bill to regulate the enviromental effecrs of surface and underground mining. That legislation sets forth very stringent performance standards that must be met by surface and other mining operations to protect against environmental abuses.

9 On November 2, 1972, Senator Henry M. Jackson, Chairman of the Senate Committee on Interior and Insular Affairs, requested the Council on Environmental Quality to conduct this sutdy of coal surface mining, including the state of the art of mining and reclamation technology, a review of State regulatory programs, and the social, economic, and environmental impacts of slope angle prohibitions.

9 Given the time available, the report cannot be considered definitive or all inclusive. Rather, it focuses on a number of major issues in regulating the environmental impacts of coal surface mining which will be considered by the Congress.

9 Many of the data are new, and they would not have been available without the assistance of the Department of Agriculture, Department of the Interior, Department of Commerce, Appalachian Regional Commission, Atomic Energy Commission, Environmental Protection Agency, the Tennessee Valley Authority, and the surface mining regulatory agencies in the 16 States whose laws and enforcement programs were surveyed. These agencies whose laws and enforcement resources, and completion of the report would not have been possible within the time available without their help. While the report embodies a great deal of data and a number of ideas of these agencies, the resulting analyses and conclusions are those of the Council on Environmental Quality.

9 The Council believes that legislative action is urgently needed during this session of the Congress, and recommends prompt action on the Administration's proposed Mined Area Protection Act transmitted to the Congress as part of the President's Message on Natural Resources and the Environment.

9 RUSSELL E. TRAIN, Chairman.

SUMMARY

1 This report analyzes the environmental impacts and alternatives for reducing adverse impacts from surface mining of coal; it does not analyze surface mining or reclamation requirements for other minerals.

1 BACKGROUND

1 Surface mining, in which the overburden is stripped away to expose and then remove the underlying coal deposit, can be divided into two general types - area mining and contour mining. Area mining is practiced in relatively flat to gently rolling terrain. Contour mining is practiced where deposits occur in hilly or mountainous country. Augering - drilling horizontally into a coal seam - is usually used in conjunction with contour mining on steep slopes to increase the coal recovery rate.

1 As of 1972, 4 million acres of land had been disturbed by surface mining; of this, over half was unreclaimed. Twenty thousand miles of highwalls remain, and the water quality of thousands of miles of streams and thousands of acres of lakes has been severely degraded. This disruption of wildlife habitat and impairment of aesthetic and recreational values increases as mining continues to be inadequately controlled.

1 SURFACE MINING TECHNIQUES - EFFECTS AND CONTROL COSTS

1 Although environmental damage from surface mining has been severe, it is not an unavoidable consequence of all forms of surface mining. High levels of control can substantially reduce adverse environmental impacts in most areas. The types and severity of environmental damage depend not only on the mining method used, but also on the level and timing of the reclamation which follows. Table I contrasts in a subjective way the environmental effects of the different surface mining techniques because actual quantitative data are not available to measure differences in environmental impacts among mining techniques or to

measure the significance of such differences. Actual impacts from a given surface mine depend on conditions specific to the site.

2

10 TABLE 1. - ESTIMATED ENVIRONMENTAL EFFECTS OF COAL SURFACE MINING

10[Scale for severity of environmental indicators: n1 3 = Severe adverse impact; 0 = Negligible adverse impact]

Mining technique n2	*3* Water: Surface pollution	Ground water	Changed water courses	Air pollution (dust)	Land use (adjacent land impact and precluded land use)	Health and safety (landslides and flooding)	Wildlife (habitat disruption)	Aesthetics (highwall and vegetation)	Total n3
Area mining: Without reclamation	1-2	0-1	1-3	2-3	2-3	0	1-2	2-3	9-16

With reclamation n4	0-1	0-1	0-1	1	0	0	0	0	1-4
Contour mining (spoils on downslope):									
Conventional contour strip	3	0-1	2-3	2-3	3	3	1-3	3	17-22
Contour strip with spoils shaping	1-3	0	2-3	2-3	2-3	1-3	1-2	2-3	11-20
Contour strip with terrace backfilling	1-2	0	0-2	1-2	1-2	1-2	1-2	0-1	4-13
Contour strip with contour backfilling	1	0	0-1	1-2	0-1	0-1	1	1	3-8
Augering from narrow bench	1-3	1-3	0-1	0-1	1-2	0-1	0-1	1	3-12
Contour mining (no spoils on downslope):									
Modified block cut	1	0	0	1	0	0	0-1	0-1	2-4
Long wall surface	0-1	1-2	0	0-1	0-1	0	0	0	1-5
Augering with backfilling	0-1	1-2	0	0-1	0	0	0	0	1-4

2 n1 Indicators are for both temporary and pervasive impacts.

2 n2 Head of hollow fill technique is not rated here because its environmental effects also depend on the technique(s) for which it serves as a supplemental method for spoil disposal.

2 n3 Aggregating environmental parameters into a single index is difficult and often involves value judgments with respect to relative importance of the factors involved.These totals assume equal weighting of environmental impacts. Use of other weights could alter the ranking of the techniques.

2 n4 This ranking is for area mining in the eastern and central coal regions with adequate rainfall for vegetation. Area mining in the far west may well be unacceptable unless vegetation can be reestablished.

3 For contour mining, several mining techniques can provide concurrent reclamation with minimal disturbance and environmental impacts on adjacent lands. One technique, the modified block-cut, although not applicable to all sites, incorporates reclamation as an integral part of the mining operation. Lands are reclaimed during mining by backfilling the previously worked area with newly removed overburden. Except for the initial cut, spoils are not deposited on the downslopes, and the land is almost immediately restored to its original contour. As a result, landslides, water pollution, aesthetic blight, and other environmental effects are reduced, although disruption during the active mining operation cannot be completely avoided.Although not widely used now, it offers one promising approach to reduce environmental effects in many, although certainly not all areas. Auger mining - drilling directly into a mountain, usually in conjunction with other contour mining - also minimizes environmental damage when continuous reclamation is practiced. Other mining techniques, properly carried out on appropriate sites, can produce substantially similar levels of environmental impacts.

3 Costs of reclamation depend on the character of the desired reclamation, on soil characteristics, local cost factors, coal seam and overburden thickness, rainfall, and the like. Table II contracts total and incremental reclamation costs for the demonstrated contour mining techniques summarized in Table I. This analysis assumes a given slope and coal seam thickness. Both total costs and incremental costs would be different under other conditions. The combination of soe of these techniques with augering could substantially change both the incremental cost per ton and possibly the relative costs of the different reclamation techniques. Total costs of reclamation for contour strip mining are $0.39 per ton for basic reclamation (shaping and revegetation of spoil banks) and $0 .56 per ton for a higher level of reclamation by the modified block-cut method. Other reclamation techniques such as terrace or contour backfilling - which would require pulling spoil back up the downslope - would cost more than the modified block-cut in achieving similar reclamation.

*4*TABLE II. -
ESTIMATED COSTS OF
MODELS OF CONTOUR

STRIP MINING AND RECLAMATION APPROACHES n1

4[In dollars per ton]

Type and degree of reclamation	Production costs n2	Incremental reclamation costs	Incremental reclamation costs above minimum now required n3
$			
No reclamation (conventional)	3.90		
Shaping of spoil bank n3	4.29	0.39	
Terrace backfilling	4.59	.69	0.30
Contour backfilling	4.85	.95	.56
Modified block-cut	4.46	.56	.17
Augering from narrow bench	3.45		
Augering with backfilling n4	3.51	.06	.03

3 n1 These cost estimates are for a hypothetical mine, using common assumptions with respect to key variables such as slope, bench width, coal seam thickness, etc. See Ch. 1 and App. E for details.

3 n2 Does not include coal cleaning, freight, or profits.

3 n3 Shaping of spoil bank required in all major Appalachian mining States.

3 n4 Assumes complete backfilling of bench, but only plugging of the first few feet of the auger hole.

4 Given that most Appalachian States currently require shaping of spoil banks, the estimated incremental cost per ton of coal with complete reclamation would be $.17 per ton using the modified block-cut technique and $. 56 per ton using contour backfilling. These cost increases represent 3 percent to 9 percent of current coal prices at the mine. Actual price impacts could be different depending on many factors such as elasticity of demand or industry pricing policies.

4 IMPACT OF SLOPE ANGLE PROHIBITIONS ON COAL PRODUCTION AND RESERVES

4 Because most mining on steep slopes is located in Appalachia, the impacts on production and reserves would be greatest in that area. Central and western United States coal reserves and production usually underlie relatively flat terrain.

4 There were no existing data on surface coal mining production and reserves as a function of slope angle. Methodologies were developed to determine these distributions in Appalachia, and the data are summarized in Tables III and IV.

*8*TABLE III. - SURFACE MINE PRODUCTION IN APPALACHIA AS A FUNCTION OF SLOPE ANGLE, 1971

8[In millions of tons]

State	Total	0-9.9 degrees	10 degrees-14.9 degrees	15 degrees-19.9 degrees	20 degrees-24.9 degrees	25 degrees+	Underground mine production, 1971
Alabama	11.09	4.66	1.55	1.77	1.77	1.33	6.75
Kentucky (eastern)	33.10	0	.60	4.20	7.65	20.65	32.99
Maryland	1.47	.43	.66	0	.38	0	.14
Ohio	38.11	4.08	8.00	15.08	6.39	4.56	12.86
Pennsylvania	25.76	10.73	9.89	3.63	1.04	.48	44.29
Tennessee	5.34	.40	.13	.71	1.71	2.40	2.65
Virginia	9.00	0	.08	.20	.83	8.07	21.63
West Virginia	31.92	1.83	4.43	2.71	8.43	14.46	78.76
Total	155.79	22.13	25.34	28.30	28.20	51.95	200.07
Percentage	100.0	14.2	16.3	18.2	18.1	33.3	

*8*TABLE IV. - STRIPPABLE RESERVES IN APPALACHIA AS A FUNCTION OF SLOPE ANGLE

8[In millions of tons]

Total

State	Total	0-9.9 degrees	10 degrees-14.9 degrees	15 degrees-19.9 degrees	20 degrees-24.9 degrees	25 degrees+	deep reserves in Appalachia
Alabama	169.84	124.79	16.42	13.19	10.04	5.40	12,774
Kentucky (eastern)	766.52	44.80	38.84	106.36	219.36	357.16	37,639
Maryland	27.27	25.17	1.71	.26	.13	0	1,117
Ohio	1,334.01	961.04	256.44	102.92	13.42	0	36,505
Pennsylvania	1,293.48	1,116.24	161.34	10.16	3.42	2.45	66,011
Tennessee	135.66	75.85	8.51	22.24	24.26	4.80	2,094
Virginia	226.86	0	0	32.06	131.78	63.02	8,324
West Virginia	2,507.01	364.52	592.04	475.87	608.86	465.72	90,059
Total	6,460.65	2,712.41	1,075.30	763.06	1,011.27	898.55	254,523
Percentage	100.0	42.0	16.6	11.8	15.7	13.9	

4 The impact of a slope prohibition on production depends on the extent to which alternative sources of coal production substitute for the production lost on steep slopes. These alternatives include underground mining and shifting to less steep slopes. There are a number of constraints to such shifts including land availability and production lead time, capital availability, and matters of concern to labor such as job location, working conditions, and health and safety factors.

5 Tables V and VI summarize three possible impacts on production in Appalachia from prohibitions of surface mining on slopes greater than 15 degrees and 20 degrees. The high impact case assumes tht all production on steep slopes is not replaced by other surface or underground mining. The low impact case assumes all steep slope production outside of central Appalachia is shifted to less steep slopes. In central Appalachia, production losses from precluding mining on steep slopes would only partially be made up by a 10 percent increase in underground mining and a small amount of shifting to less steep slopes. The medium impact case assumes that steep slope production is shifted to less steep slopes outside central Appalachia, with the exception of that conducted by small miners. In central Appalachia, it assumes no surface mining on less steep slopes but a 5 percent increase in underground production.

*4*TABLE V. - NET PRODUCTION LOSS FOR A 15 DEGREES SLOPE ANGLE PROHIBITION, 1971

4[In million tons per year]

Region and economic area	High impact case	Middle impact case	Low impact case

NORTHERN APPALACHIA			
11. Williamsport, Pa	2.81	0.72	0
66. Pittsburgh, Pa	15.12	3.11	0
68. Cleveland, Ohio	6.20	1.24	0
64. Columbus, Ohio	9.03	1.80	0
65. Clarksburg, W.Va	7.64	.31	0
Subtotal	40.80	7.18	0
CENTRAL APPALACHIA			
52. Huntington, W.Va.-Ashland, Ohio	25.45	22.18	12.54
53. Lexington, Ky	15.56	15.07	14.58
51. Bristol, Va	10.09	8.26	6.52
50.Knoxville, Tenn	11.60	11.40	8.31
Subtotal	62.60	56.91	41.95
SOUTHERN APPALACHIA			
49.Nashville, Tenn	0	0	0
48. Chattanooga, Tenn	.46	.01	0
45. Birmingham, Ala	4.42	.13	0
Subtotal	4.88	.14	0
Total	108.28	64.23	41.95

*4*TABLE VI. - NET PRODUCTION LOSS FOR A 20 DEGREES SLOPE ANGLE PROHIBITION, 1971

4[In million tons per year]

Region and economic area	High impact case	Middle impact case	Low impact case
NORTHERN APPALACHIA			
11. Williamsport, Pa	0.77	0.20	0
66.Pittsburgh, Pa	6.33	1.39	0
68. Cleveland, Ohio	5.75	1.15	0
64. Columbus, Ohio	0	0	0
65. Clarksburg, W.Va	7.26	.29	0
Subtotal	20.11	3.03	0
CENTRAL APPALACHIA			
52. Huntington, W.Va.-Ashland, Ohio	24.70	9.08	(6.55) n1
53. Lexington, Ky	15.56	15.07	14.58

51. Bristol, Va	9.81	8.06	6.32
50. Knoxville, Tenn	6.69	4.82	2.96
Subtotal	56.76	37.03	17.31
SOUTHERN APPALACHIA			
49. Nashville, Tenn	0	0	0
48.Chattanooga, Tenn	.39	.01	0
45. Birmingham, Ala	2.81	.08	0
Subtotal	3.20	.09	0
Total	80.07	40.15	17.31

5 n1 Gain.

6 A 15 degrees prohibition would preclude production of between 42 and 108 million tons annually, representing between 27 percent and 70 percent of Appalachian surface mine production, 11 percent and 39 percent of total surface production, or 7 percent and 18 percent of total U.S. production. A 20 degrees slope angle prohibition would affect between 17 and 80 million tons annually, representing between 11 percent and 51 percent of Appalachian surface mine production, 5 percent and 29 percent of total surface production, or 3 percent to 14 percent of total U.S. production. The immediate production losses from a ban on steep slopes could approximate the larger quantity in each case. The period of maximum loss would depend on the time necessary to expand production from deep mines or from surface mines on lessteep slopes. This analysis dealt only with production losses in Appalachia and does not take account of possible substitution of coal production in other areas of the country, domestic production of other fossil fuels, or imports of petroleum products.

7 An important amount of the coal production that would be precluded by slope limits is low in sulfur and ash. This coal is not only valuable for steel production and export, but has become increasingly important to meet the requirements of the Clean Air Act. Appalachian surface mines produce about 30 percent of all low-sulfur coal used in electric powerplants. In central Appalachia, which supplies 23 percent of utility low-sulfur coal needs, virtually all of this surface-mined coal is produced on slopes greater than 20 degrees.

7 In Appalachia 41 percent and 30 percent of total strippable reserves would be lost with 15 degrees and 20 degrees slope angle prohibitions, respectively. Because the overwhelming majority of U.S. reserves is recoverable only by underground mining, and because of large and as yet untapped reserves in the West, the loss of reserves from a slope angle prohibition represents under 1 percent of the total reserves physically available.

7 REGIONAL ECONOMIC IMPACT OF SLOPE ANGLE PROHIBITIONS

7 Although conditions are improving, Appalachia remains an economically depressed area. Many parts of the region are highly dependent on all coal

mining for their existence - over 95 percent of basic earnings in some counties. Unemployment and poverty levels are high, and per capita income lags behind the rest of the country. While much of Appalachia is shifting to a more diversified and viable economic base nonetheless, pockets of severe economic depression remain.

7 The direct economic impacts of a 15 degrees and 20 degrees slope angle limitation on Economic Areas in Appalachia are summarized in Tables VII and VII. Although not definitive, these data indicate that a 15 degrees or 20 degrees angle prohibition would not have an appreciable economic impact in major sections of northern and southern Appalachia. The impact, however, could be significant in nearly all of central Appalachia and especially in those Appalachian counties where coal mining is a major source of employment and few alternative employment opportunities exist. The direct earnings and employment impacts in selected counties in central Appalachia could be severe. The total economic impact on each area and county would be even greater taking into account secondary income and employment effects. Because adjacent areas, already depressed economically, may be experiencing the same economic dislocations, the number of jobs outside these selected counties may also be limited. This report does not analyze offsetting economic effects outside Appalachia or secondary economic impacts.

TABLE VII. - DIRECT ECONOMIC IMPACT OF 15 degrees SLOPE ANGLE PROHIBITION

Economic Area	Baseline economic data			Scenarios		
	Unemployment rate March (1970)	Percent of families below poverty level (1969)	Percent of national per capita income (1967)	High impact	Medium impact	Low impact

				Percent basic earnings loss	Employment loss Percent	Employment loss Number	Percent basic earnings loss	Employment loss Percent	Employment loss Number	Percent basic earnings loss	Employment loss Percent	Employment loss Number
11. Williamsport, Pa	5.1	9.9	84	0.9	0.3	490	0.2	0.1	126	0	0	0
66. Pittsburgh, Pa	4.5	8.8	97	.4	.1	1,588	.1	n(1)	344	0	0	0
68. Cleveland, Ohio	3.8	6.8	105	.2	.1	987	n(1)	n(1)	177	0	0	0
64. Columbus, Ohio	4.2	9.5	92	.5	.1	763	.1	n(1)	160	0	0	0
65. Clarksburg, W.Va	4.8	17.1	73	5.0	1.5	1,527	.2	.1	55	0	0	0
52. Huntington, W.Va. - Ashland, Ohio	5.9	21.2	73	3.8	1.2	4,698	2.6	.9	3,168	.4	.1	453
53. Lexington, Ky	4.6	24.1	68	2.6	.9	2,080	2.3	.8	1,829	2.0	.7	1,577
51. Bristol, Va	5.3	21.3	71	2.1	.6	1,477	(.3) .9	(.1) .3	(199) 640	n1	n1	n1
50. Knoxville, Tenn	5.3	23.4	67	1.9	.6	1,523	1.7	.5	1,353	1.0	.3	801
49. Nashville,												

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Total 5 7,869 2,632
[See Table in Original]

8 n1 Nil.

8 n2 Gain.

8 n3 Not available.

9

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TABLE
VIII.
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				Employment loss Percent	basic earnings loss Number		Employment loss Percent	basic earnings loss Number		Employment loss Percent	Number	
11. Williamsport, Pa	5.1	9.9	84	0.3	0.1	134	0.1	n(1)	35	0	0	0
66. Pittsburgh, Pa	4.5	8.8	97	.2	.1	729	n(1)	n(1)	153	0	0	0
68. Cleveland, Ohio	3.8	6.8	105	.2	.1	917	n(1)	n(1)	183	0	0	0
64. Columbus, Ohio	4.2	9.5	92	0	0	0	0	0	0	0	0	
65. Clarksburg, W. Va	4.8	17.1	73	4.8	1.4	1,451	.2	.1	58	0	0	0
52. Huntington, W.Va. - Ashland, Ohio	5.9	21.2	73	3.7	1.2	4,487	(2.6) .6	(.8) .2	(3.070) 709	n2	n2	n2
53. Lexington, Ky	4.6	24.1	68	2.6	.9	2,080	2.3	.8	1,828	2.0	.7	1,578
51. Bristol, Va	5.3	21.3	71	2.1	.6	1,450	(.3) .9	(.1) .3	(226) 612	n2	n2	n2
50. Knoxville, Tenn	5.3	23.4	67	1.0	.3	818	.6	.2	444	.1	n(1)	68
49. Nashville, Tenn	3.8	17.9	78	0	0	0	0	0	0	0	0	0
48.												

Chattanooga, Tenn	n(3)	17.0	n(3)	n(3)	n(1)	41	n(3)	n(1)	1	0	0	0
45. Birmingham, Ala	4.5	20.0	75	.3	.1	374	n(1)	n(1)	11	0	0	0

[See Table in Original]

9 n1 Nil.

9 n2 Gain.

9 n3 Not available.

10 STATE REGULATORY ACTIVITIES

10 The results of a survey of surface mining laws and regulatory programs in 16 major coal-producing States indicates a progression toward more stringent controls to reduce the environmental damages from surface mining. It is clear, however, that there is a need for further strengthening of the individual State programs. Some States now require concurrent reclamation, but only two also require reshaping to the approximate original contour, or other similarly appropriate condition, for other than area mining. In only a few States have performance standards been adopted for reclamation. Despite an increase in use and amounts of performance bonds, their levels are still generally set at flat rates, unrelated to actual reclamation costs, which frequently exceed such rates. They are usually cancelled shortly after reclamation stops, although environmental damage may continue thereafter or first occur at some future time. Manpower and funds for enforcement of state programs do not appear generally adequate.

10 Any regulatory program can only be judged by its results. The new laws that have been enacted are too new to judge their results, but in general experience under previous laws has not been good. Unless stronger programs are instituted and carried out, more land will predictably be left damaged by surface mining.

10 ELEMENTS OF EFFECTIVE ENVIRONMENTAL CONTROLS

10 Our findings in this report indicate that at the least three elements of regulatory programs are necessary to protect environmental quality during surface mining operations. First, adequate planning, through the careful preparation and analysis of mining and reclamation plans, is required. These plans should be prepared and analyzed before mining begins to assure that operations will result in the achievement of minimal environmental damage.If difficulties are identified, then the plan can be appropriately modified. Second, specific performance standards are necessary so that miners can choose the most effective techniques to meet them. It is clear that some methods such as the modified block-cut and augering with backfilling can reduce environmental abuse at costs that are small relative to those of other methods for achieving

similar results and relative to total coal production costs. Third, there must be sufficiently vigorous enforcement of regulatory programs. Often, in the past, the results of enforcement programs were not satisfactory for a number of reasons. The performance standards did not require an adequate level of reclamation. Earlier reclamation requirements were subject to such broad interpretation that their achievement was often a matter of unnecessary contention between the mine operator and the inspector. And, enforcement did not have behind it adequate performance bonding, manpower, or funding to achieve the desired performance. With stringent, unambiguous performance standards that require reclamation concurrent with mining, it will be easier to judge the adequacy of reclamation performance in each particular case.

10 In the absence of any one of these three components - adequate planning, adequate performance standards and adequate enforcement - experience indicates that efforts to curb environmental and other damages from surface mining will not be truly successful.

CHAPTER 1.
SURFACE MINING AND RECLAMATION TECHNIQUES

11 Exploitation of the fuel and mineral resources in the earth's crust probably began with primitive surface mining techniques. Underground mining followed much later as man developed the ability to locate and exploit deeper and richer deposits. With the emergence of the steam engine and later the internal combustion engine, man's ability to expose fuel and mineral deposits by removing the overlying soil and rock was increased significantly.

11 Although mechanized surface mining for coal began in the late 1800's in the United States, production was limited prior to World War II. The high demand for fuel during the war caused rapid growth in surface mining. Another surge began in the early 1960's. This current expansion is due to the increasing demand for energy and the competitive edge that surface mined coal has over underground mined coal. The underground mining industry faces reduced productivity and increased costs partly because of improved mine health and safety requirements, while surface mining benefits from the development of large, more efficient extraction machinery.

11 The recent spectacular growth in surface mining of coal has brought widespread environmental damage. Surface mining has left substantial areas of farm, range, and forested lands scarred and unsuitable. In mountainous areas, unstable banks of earth cast down the mountainside are landslide hazards to life and property. The water quality of streams has been degraded with siltation and acid mine drainage from abandoned strip mines. These damages need not continue. Mining and reclamation methods which significantly reduce these environmental damages have been developed in the past few years.

11 Surface mining, as the name implies, is any type of mining in which overburden - topsoil, rock, and other strata - is removed in order to expose and extract the underlying mineral or fuel deposits.Strip mining is one type of surface mining, easily recognized by removal of overburden in narrow bands, one cut at a time.

11 Strip mining methods for recovering coal are of two general types - area strip and contour strip. Area strip mining is practiced on relatively flat to gently rolling terrain. Contour strip mining is practiced where deposits occur in hilly or mountainous country. Augering - drilling horizontally into a coal seam - is another type of surface mining often associated with strip mining on steep slopes. Other types of surface mining such as open pit mining, quarrying, hydraulic mining, and dredging are used to extract minerals other than coal, so they will not be covered in this study.

12 Most surface mining and reclamation methods are comprised of nine discrete steps: construction of access roads to the mining site; scalping or clearing of vegetation from the surface of the mining site; drilling and blasting to fracture the overburden; removal and placement of the overburden; removal of the coal; rehandling and grading of the overburden; revegetation; water drainage control; and sediment basin construction. Each step, which may either increase or decrease environmental damage from the total mining and reclamation operation, is described in Appendix A. Differences in the overall environmental effects among surface mining techniques depend largely on the damages associated with removal and placement of the overburden, although damages associated with other steps can also be significant. How the steps are combined and what environmental effects these combinations produce are described in the following section.

12 This review of the surface mining and reclamation techniques used to extract coal does not presume that all areas can be reclaimed with existing techniques. Special attention is focused on those techniques which reduce the environmental damages which have come to be associated with strip mining of coal. Each mining and reclamation plan must be evaluated carefully by experts familiar with the local terrain, geology, rainfall, and the like to determine before mining is authorized if the proposed plan can achieve adequate reclamation. In some cases, mining on steep slopes could result in less potential environmental harm than other types of mining for the above and ?akk?p?lmki l????a???cnml?ake??ade? aka??e??m??mhe?fiklm??pimh?mhe??oek

12 DESCRIPTION OF TECHNIQUES

12 Area Strip Mining

12 Area strip mining is generally limited to lands with topography of 12 degrees to 14 degrees or less and with coal seams (1,2) that are nearly horizontal and less than 200 feet deep. It is employed chiefly in the flatter sections of the Appalachian states of Alabama, Ohio, Pennsylvania, and West Virginia; in the midwest; and in the far west.

12 In area strip mining, a trench or box cut is made through the overburden to expose the mineral or fuel to be extracted. The cuts are long narrow strips.All cuts are made parallel to the first, with the overburden deposited in the cut just previously excavated. The final cut leaves an open trench bounded on one side by the last spoil pile and on the other by the undisturbed highwall, which may be a mile or more from the starting point. The overburden from the

cuts, unless graded or leveled, resembles a gigantic plowed field, as shown in Figure 1-1.

13 [See Illustration in Original]

13 Shovels (with capacities of up to 180 cubic yards), draglines (up to 220 cubic-yard capacity), wheel excavators, pan scrapers, bulldozers, and front-end loaders remove the overburden. The exposed mineral or coal is then lifted by smaller machines before the overburden machine makes the next cut.

13 Although thousands of acres have been disturbed by area strip mining and have been abandoned or only partially reclaimed, advanced reclamation techniques can now minimize the environmental damages of such practices. Grading and reclamation closely following a mining operation can return the land to its original contour and vegetation or other similarly appropriate condition.

13 Without reclamation, area strip mining can preclude future productive land use, pollute water with siltation and acid mine drainage, and destroy the aesthetic values in a large area. With adequate reclamation, the mined area need not be precluded from future productive land use. Agricultural cropland can be returned to farming uses, range land can be restored for grazing, etc.

13 Other potential environmental impacts of area mining are changed surface water courses, ground water pollution, and temporary destruction of ground cover. The serious hazards of landslides and slumping associated with contour mining are virtually nonexistent with area mining. Erosion and sedimentation can be controlled if surface water flow is managed and reclamation is timely. In effect, substantially more erosion and sediment loss should not result from an area mining operation than from a large farming enterprise with crops such as grasses and legumes (as opposed to row crops).

14 Some recently enacted State legislation requires restoring the disturbed area to its original contour and replanting vegetation or other appropriate condition. Thus, all spoil ridges and highwalls are eliminated and no depressions remain to accumulate water, with the exception of the approved water impoundments. (See Chapter 2 for details.) To accomplish contour grading, the spoil from the first cut is graded to blend into the contour of the adjoining land. In addition, several states now require operators to separate topsoil from the subsoil, stockpile the two separately so that they will not be mixed during excavation, and restore the topsoil on the graded overburden. If soil productivity is not restored by saving and replacing the topsoil or by some other equally effective means, then the land use patterns will likely change.

14 While revegetation is not inherently difficult in most parts of Appalachia and in the Central coal region - both have adequate rainfall and sufficient topsoil - there are unanswered questions about the extent to which lands can be revegetated in the far west, where there is little rainfall and the topsoil may be poor. In some areas little or no vegetation may exist under normal circumstances. The largest strippable coal reserves lie in the Fort Union formation of Montana and Wyoming, where the rainfall is only 14 to 16 inches per year, compared to an average of 40 to 45 inches in Appalachia. In

the Southwest region of New Mexico, Arizona, Utah, Nevada, and Colorado, conditions are arid, with less than 5 inches of rain and the surface soil usually alkaline.

14 Experimental reclamation projects in these arid regions are meeting with mixed results (3, 4). None of the projects has continued for an adequate time to demonstrate that the vegetation will be successful. With the growing demand for low sulfur fuels, the answers to questions on reclamation in the far west become increasingly important.

14 Both Great Britain and West Germany have successfully returned to productive use lands disturbed by area mining. Their experience is described in Appendix B.

14 Contour Strip Mining

14 Contour strip mining is practiced on rolling to very steep terrain above 12 degrees to 14 degrees (1, 2). In contour strip mining, the overburden is removed from the coal seam, creating a bench with a highwall often exceeding 100 feet in height. After the coal is removed from the uncovered seam, successive cuts are made into the hillside until the overburden becomes too deep for economical recovery of the mineral. Then the operation continues along the hillside until the seam becomes too thin or the slope too steep. Methods for handling the overburden are described below.

14 Conventional Contour Mining

14 In conventional contour strip mining, the overburden removed from above the coal bed is cast down the hillside and stacked along the outer edge of the bench, creating a mound which is often unstable, as shown in Figure 1-2. The unstable spoil material results in severe erosion and landslides; thus many more acres are affected than those disturbed by the original cut and overburden placement. n1

14 n1 A 1967 Interior Department study, Surface Mining and Our Environment (5) estimated that, of the 25,000 miles of existing contour bench, spoil material was stacked on the outer edge for about 18,000 miles and pushed entirely off the bench on the remaining 7,000 miles.Approximately 1,700 miles of outslope were affected by massive slides and about 20,000 miles of highwalls were created by coal mining in Appalachia alone.

15 When the overburden or spoil is stabilized by regrading, compaction, and revegetation, the most severe problems are reduced. These measures, however, are only partially successful on steep slopes and in areas of high rainfall. n2 In addition, a permanent bench and exposed [See Graph in Original] highwall are left on the hillside. To mitigate these problems, several major coal mining States have enacted legislation which prohibits contour strip mining on slopes greater than 27 degrees to 28 degrees and establishes limits for the width of the mining cut in relation to slope for the less steep slopes. For instance, Kentucky regulations stipulate that bench widths for the first cut may not exceed 80 feet for a 27 degrees slope, 90 feet for a 26 degrees slope, etc., to

reduce the amount of material pushed off the bench and therefore the hazards of landslides, erosion, and flooding. While such measures provide partial protection, landslides as well as erosion, sedimentation and other environmental problems still occur.

15 n2 The stabilization of spoil material in steep terrain is complex. In addition to the slope angle, other factors affecting soil stability are the type of spoil material, amount of rainfall, location of the spoil on the hillside, methods of compaction, and type and timing of revegetation. Even with engineered safeguards, these factors interact, often leading to unexpected and undesirable results - landslides, slumps, and massive erosion. This subject is discussed further in Appendix C.

16 Erosion increases dramatically when the protective vegetative cover is removed and the soil is not stabilized. For example, suspended sediment concentration in small Appalachian streams draining strip mined areas can be increased 100 times over that in forest lands (6). Over 7,000 miles of streams have been affected by surface runoff from coal stripping operations (5).

16 Acid mine drainage is another major problem from contour strip mining. Until the mid-1960's, topsoil was normally placed on the bottom of the spoil pile and covered by low-quality and often toxic overburden. The material next to the coal deposit often contains pyrites and other acid forming substances. When such harmful materials are exposed to weathering, they are converted to soluble acids and minerals and are carried away to streams and ground water.About 12 percent of the acid mine drainage in Appalachian streams derives from abandoned coal surface mines and access roads, while the rest comes from underground mines (7).

16 Unstable highwalls are a hazard to life and property. Highwalls that crumble and erode from weathering ruin drainage patterns and significantly add to water pollution. Material falling off the highwall can retard surface water flow and thereby prolong the contact between water and acid producing materials.

16 Contour Mining with Shaping of Spoil Bank

16 The potential for landslides and erosion can be reduced by spreading and stabilizing the spoil over a large area. (1) In this approach, all vegetation is removed from the hillside below the cut, and the overburden is spread over the downslope in compacted layers. Part of the spoil material can be stored along the edge of the bench and, after coal is removed, redistributed on the bench.

16 Two methods of shaping the spoil material on the downslope are slope reduction and parallel slope. In the first, the spoil is graded to form a reduced slope angle on the spoil bank. In the second method, the spoil is spread over the downslope in layers parallel to the original slope of the hillside. These two methods are diagrammed in Figure 1-3.

17 [See Graph in Original]

17 Establishing a sufficient vegetative cover on the large spoil disposal area on the slope is generally difficult, however. While reducing the potential for landslides, both methods may cause massive sheet and gully erosion and slumping on the slopes, especially in a high rainfall area such as Appalachia.

17 Even when spoil piles are graded, problems have occurred in the past. With grading toward the highwall and improper design of the drainage system, water may accumulate on the bench and may come in contact with pyritic material, leading to acid mine drainage. This impact has been considerably reduced in recent years. Where underground mining is conducted behind the highwall, grading toward it can result in surface water flowing into the underground mine. Such flow often flushes toxic material from the mine.

18 Erosion may be as bad or worse when spoil piles are graded away from the highwall. Water management practices - such as diversion ditches across the top of the highwall, ditches or terraces across the slope to break the slope length, and control structures to remove the water from the mining area - can minimize erosion from these spoil piles.

18 Grading should be accompanied by adequate revegetation. A vegetative cover should be established to hold the bare surface in place. First consideration should be given to plant species that quickly cover and hold the soil. Neither planting nor grading alone is a satisfactory answer to the spoil bank problem, but a combination of the two can reduce many of the environmental damages.

18 Exposed highwalls remain with either of these two approaches. Aesthetic blight, interference with land access, disruption of wildlife patterns and potential water pollution can be reduced somewhat by grading the spoil back against the highwall and "knocking off" the top of the highwall, but some of these problems will remain.

18 Contour Mining with Backfilling of Bench

18 In bench backfilling, the material in the spoils bank is moved back onto the bench and regraded to a specified shape (1, 2, 8) If contour backfilling is used, most of the spoil material is returned to the bench and regraded to approximately the original contour of the hillside. Because the volume of the spoil material is typically larger than the volume of the cut, part of the spoils is usually stabilized on the downslope. This method is depicted in Figure 1-4a.

18 [See Graph in Original]

19 If a slope is too steep or the soil condition would lead to excessive erosion, a modified form of backfilling can be used. In terrace backfilling, part of the spoil bank is used to cover the acid-producing spoil in the face of the highwall and part is used to reduce the slope below the bench. This method usually reduces the bench width by creating a series of terraces. This method is shown in Figure 1-4b. As with the methods discussed previously, this technique applied in the wrong places leads to substantial erosion and bank

movement, especially from the materials placed on the outslope. However, it does eliminate the highwall and leaves the mined area in a configuration roughly resembling the pre-mining condition.

19 [See Graph in Original]

19 One conventional contour strip mining approach which lends itself easily to the terrace backfilling method is the box-cut (1). This is an adaptation of area mining techniques to recover coal from a wide bench.It is generally used when, because of the limitations of the machinery, it is not possible to remove the overburden from the coal across the entire bench. Thus several cuts are made parallel to the bench and the spoil material from successive cuts is moved back into the previous cut, as in area mining. Because spoil is continually placed in the previous cut, less spoil material is placed on the downslope, thus under a broad range of circumstances reducing the potential for landslides and slumping.

19 In the two-cut box-cut technique, part of the overburden is first used to create a fill bench resting on an undisturbed section of the outside edge of the bench (see Figure 1-5). Then the remaining overburden above the coal nearest the highwall is stacked on the fill bench and the coal removed. The stacked overburden is pushed back into the previous cut, and the overburden over the coal on the outside half of the bench is stacked against the highwall. The remaining coal is removed, the fill bench is graded back into the second pit, and the mined area is graded for revegetation.

20 [See graph in Original]

20 Reclamation can proceed concurrently with the mining operat ion in order to reduce both the costs of reclamation and the environment al impacts that occur prior to reclamation.

20 Contour Mining Usin g Modified Block-Cut

20 The modified block-cut method of contour strip mining is also basically an adaptation of the conventional area mining method for steep terrain (1, 2, 9, 10, 11). The method is also known as cut and fill, fill and haul back, and pit storage, depending on the locality. In the modified block-cut method, an initial box-cut is made into the hillside at a site along the coal seam selected to minimize landslide potential. As with other types of contour mining, the overburden from the initial cut is placed on the edge of the bench on the downslope so that the coal can be removed. However, the overburden from successive cuts along the coal seam is not pushed over the edge of the bench but is deposited in the void left by the previous cut, as

21 [See Graph in Original] shown in Figure 1-6. Mining is continuous, working in both directions around the hill as indicated in Figure 1-6, or in only one direction. The bench is totally backfilled, and the excess spoil material that accumulates during mining can be used to reclaim the final cut.

22 The salient feature of this method is that the removal of the overburden

and the reforming of the original contour are integral processes. Topsoil can be saved and spread over the regraded spoils. This method minimizes impact on the downslope, disturbing only onethird to one-fifth the total area disturbed by the techniques previously described. Consequently, it tends to reduce many of the associated environmental impacts which occur prior to complete reclamation.

22 [See Illustration in Original] Optimally, the spoils from the first cut are stored for restoration of the last cut if needed or a stable permanent disposal site should be used.

23 It should be noted that the modified block-cut technique is being successfully used in Pennsylvania, West Virginia, and eastern Kentucky, and it is thought to be applicable in other areas with steeper slopes. The Tennessee Valley Authority demonstration project is using this method in Campbell County, Tennessee, and should have both physical results and cost data in the near future.

23 Head of Hollow Fill Method

23 The head of hollow fill is used in conjunction with one or more of the techniques previously described (1). Head of hollow fill has been used primarily with contour strip mining where all of the overburden is removed from the bench and deposited in a fill, leaving an unreclaimed bench and highwall. It has also been used to store spoil from the removal of entire mountain tops where the entire coal seam is mined as in area mining. More recently it has been used as a supplement to the more advanced mining techniques previously described.

23 Narrow V-shaped, steep-sided hollows, near the ridge top, that are free of underground mine openings or wet weather springs, are selected for filling. The size of the selected hollow must be such that the overburden generated by the mining operation will completely fill the prepared head of hollow. A diagram of the head of hollow fill technique is shown in Figure 1-7.

23 [See Illustration in Original]

24 Unless the fill is graded, compacted, and revegetated as soon as possible, erosion and sediment transport may be severe. Much care must be given to the design of such fills, particularly regarding water management, in order to ensure stability of the fill.

24 Of equal or more importance is the condition in which the mined area is left. If the bench and highwall are not reclaimed, the highwall will be a potential hazard to life and property and both the highwall and bench may cause sedimentation and acid drainage problems. If the head of hollow fill is used only for permanent disposal of excess spoils from a modified block-cut or contour backfilling operation, the likelihood of damages will be minimized.

24 Auger Mining

24 Auger mining extracts coal from the seam by boring horizontally into the

seam from its exposed edge (1, 2). It is often done after contour stripping is completed, thus allowing the removal of additional tonnage after the economical overburden-to-coal ratio has been reached. In this case, the auger mining machine is mounted on the bench remaining from the contour mining operation. Sometimes auger mining is performed only from a narrow bench constructed along the hillside below the natural coal outcrop. In this case, only augering is used to extract the coal so the efficiency of recovery is reduced and future exploitation of the unmined coal is probably precluded by the auger cavities.

24 The cutting heads of some augers are as large as 7 feet in diameter, although most are much smaller. By adding sections behind the cutting head, holes can be drilled in excess of 200 feet into the coal seams. It is possible to set up and operate a large augering machine on a bench which is only 15 feet wide. By reducing the bench width, the resulting environmental impacts would also be substantially reduced.

24 Augering from a narrow bench disturbs far less area than the other contour mining methods discussed. It does, however, have the potential for substantially disturbing both the flow and quality of ground water. It also has the potential for penetrating water-filled underground mines, thus releasing acidic water.

24 Long Wall Surface Mining

24 With the exception of auger mining, all methods discussed above depend upon excavating all overburden above the coal to get at the resource (1, 10). In most instances, this amounts to a massive earthmoving operation. This operation along with the changed site characteristics are the causes of most of the environmental damage of surface mining. Auger mining, the only existing surface mining alternative and the one with the highest labor productivity (38 tons per man-day) is relatively inefficient when measured in terms of resource recovery. Some underground techniques are considerably more efficient in recovering a larger fraction of the available coal. Conceptually it is possible to adapt some of the high-recovery underground mining techniques to a combination surface and underground mine.

24 The long wall surface mining technique is one possibility for applying underground long wall mining equipment to a surface approach. The idea is to work the equipment from a narrow bench similar to but much narrower than those prepared for contour strip mining. The coal cutting and removal equipment would operate back and forth along a wide coal face accompanied by self-moving jacks to prevent the overburden which subsides behind the operation from binding the cutting machine. Land disturbance would be small and would be limited primarily to controlled surface subsidence during the course of mining.

25 This technique has only been proposed as a conceptual alternative to the massive earth moving techniques of surface mining. A feasibility study has been funded by the Environmental Protection Agency to evaluate the economic and environmental desirability of this mining method. Although showing promise for almost any type of terrain, longwall surface mining would substantially increase the capital costs of surface mining and thus may not be used by many present

mining operations.

CHAPTER 2
STATE REGULATORY PROGRAMS

35 During the past four decades as surface mining has affected more and more acreage, and as the adverse environmental effects of surface mining have become more apparent, a number of state legislatures have enacted laws in an attempt to regulate or control the environmental effects of surface mining. West Virginia first enacted legislation to regulate surface mining of coal in 1939. By 1955, Indiana, Pennsylvania, Ohio, Kentucky, and Maryland had enacted similar legislation. Most current State legislation, however, has been enacted since 1965.

35 In the seven years between 1965 and 1972, the 16 major coal-producing states surveyed for this report (see list in Figure 2-1) n5 have taken a total of 28 major legislative actions. As shown in Figure 2-1, only 7 of these states had enacted surface mining legislation prior to 1965. Since then, the remaining 9 states have enacted new legislation. In the past three years alone, 13 of the 16 states have enacted new legislation or amended their existing authority.

35 n5 These States account for more than 90% of total U.S. coal production.

35 Throughout the past seven years, there has been a general trend in state laws away from post-mining reclamation requirements to more extensive reclamation requirements that must be carried out as an [See Illustration in Original] integral part of mining operations. This development can be closely correlated with changes in surface mining technology and research results.

36 While differing in requirements, state reclamation laws are similar in general outline. The following sections summarize the general characteristics of the regulatory authorities of the 16 states surveyed, focusing particular attention on their recent changes and new requirements.

36 Evaluation of the material presented in this chapter and in Appendix F, which contains a summary of each of the survey state's laws, should be tempered by two important considerations. First, most of the laws have been enacted or significantly amended very recently - 1971 or later in 11 of the 16 states.As a result, it is too early in many cases to measure results meaningfully in terms of the condition of surface-mined lands. The results of reclamation under earlier laws have been largely unsatisfactory, with a 1967 survey revealing inadequate vegetation on 53 percent of the reclaimed sites surveyed and sites incapable of supporting vegetation in another 18 percent of the cases. Second, substantial discrepancies may exist between what a law says and the regulations that are actually imposed and enforced. Further, some laws are phrased in such general terms that weak rules and regulations can be promulgated without violating the law.In addition, regardless of a law's specificity, its impact depends on the extent to which it is actually enforced.

36 ADMINISTRATIVE AGENCY

36 In all States, an administrative agency is given the authority to oversee the surface mining regulatory programs. This is the Department of Natural Resources in Colorado, Indiana, Maryland, Ohio, West Virginia, and Washington; the Department of Mines in Illinois and Oklahoma; the Department of Industrial Relations in Alabama; the Department of Conservation and Economic Development in Virginia; and the Public Service Commission in North Dakota.For the Western States of Montana and Wyoming, the State lands agency is responsible. The Department of Conservation administers the program in Tennessee; the Department of Environmental Protection in Kentucky; and the Department of Environmental Resources in Pennsylvania.

36 The responsibilities of these agencies include issuing rules and regulations for the administration of the State law, issuing surface mining permits or licenses, supervising mining operations, and approving completed reclamation work. The laws of Pennsylvania, Tennessee, and Washington explicitly require a separate permit or approval for drainage from the State water quality agency.

36 REQUIREMENTS AND LIMITATIONS

36 Procedural Permits

36 All of the States surveyed require an operator to have a valid operating permit for conducting surface mining activities, although the requirement is limited to a minimum amount of overburden (10,000 cubic yards) in Montana and a minimum depth of overburden (10 ft.) in North Dakota. In Illinois, a permit is not required if the overburden is less than 10 ft. in depth or less than 10 acres/year will be affected. In Montana, the permit is called a "reclamation contract," which gives the State the additional enforcement option of suing for breach of contract. Montana also requires that the Department of State Lands prepare an environmental impact statement, pursuant to the Montana Environmental Policy Act, for each reclamation contract (reclamation plan) that covers a major coal mining operation. Illinois has a similar requirement in its surface mining law, under which permit applicants are required to prepare a statement of environmental effects that the Department of Mines and Minerals must consider before issuing a permit. Maryland requires both a general operator's license and a permit for each mining operation. In general, the operating permits are issued (or renewed) annually. In Maryland, Montana, Pennsylvania, and Wyoming, however, the operating permit is valid for the life of the operation. North Dakota issues permits for a three-year term.

37 The permit application ordinarily must be accompanied by a wide variety of information as well as one or more mining, drainage or reclamation "plans". Most of the States surveyed require that a reclamation plan accompany the permit application. The notable exceptions to this requirement are Alabama, Colorado, North Dakota, and Wyoming. Alabama requires a "statement" of the intended reclamation program, but the law does not require that it be approved. North Dakota requires the reclamation plan to be submitted in the December following the issuance of a permit. Operators in Wyoming are required only to submit an annual reclamation report, although they may submit a plan which, if approved, becomes the basis for all reclamation requirements. There are substantial

differences among the States as to the content of the reclamation plan.

37 New permit and plan requirements have been added by several States over the past several years. The new regulations of Kentucky, Pennsylvania, and Tennessee, adopted in the past three years, require either a separate drainage (water discharge) permit or an erosion and silt control plan that must be approved before the issuance of a surface mining permit. The Virginia law, as amended in 1972, requires the operator to submit a plan of operation discussing his proposed method of mining operation, including the expected impact on the environment, along with drainage and reclamation plans.

37 All the States require a fee to obtain a permit. These fees are generally a fixed amount of $50 to $2 50 per acre. The proceeds in Maryland, Pennsylvania, Tennessee, Virginia, and Wyoming go to a special State fund to be used for reclaiming abandoned lands. Maryland and West Virginia assess a separate reclamation charge of $30/acre and $6 0/acre, respectively, which is devoted to the reclamation of abandoned or "orphaned" mined areas. Ohio's new law, enacted in 1972, levies a Severance Tax of 4 cents/ton of coal which is deposited in the State's general fund to be used for environmental protection activities of the State and for the reclamation of land affected by strip mining.

37 Of the 16 States surveyed, only seven have requirements for a general public notice of intent to surface mine or for holding public hearings on surface mining activities. Tennessee requires a public notice in a newspaper of general circulation in the county of proposed operation. Both West Virginia and Montana require the application to be published as a legal advertisement in the county of operation. In West Virginia, written protests may be filed within 30 days. Pennsylvania's regulations require that the pending application be published in the monthly Pennsylvania Bulletin at least 15 days before a strip mining permit is issued. Illinois requires the operator to file his conservation and reclamation plan with the county governing body for its recommendations on future land use, and the plan is available for public inspection at the county offices. Indiana's Natural Resources Commission reviews permit applications in public meetings, and Maryland holds monthly public hearings to review such applications.

38 Performance Bonds

38 To assure compliance with State regulations and completion of required reclamation work, all of the States surveyed require the filing of a performance bond. For most of the States the bond is $100 to $600 per acre, with a required minimum amount of $1 000 to $2 000 per mining operation. Maryland law provides for a separate revegetation bond of$50- $125 per acre, in addition to a regrading bond of $4 00 per acre. The actual reclamation costs for a particular project can be much greater than the maximum bond allowed under most State laws, depending on the type of mining and reclamation techniques. Only the Colorado, Ohio, Pennsylvania, Tennessee, and Wyoming laws which establish no maximum bond limitations are sufficiently flexible to allow bond amounts to be set by reference to the estimated costs of reclamation. In each of these States except Tennessee, the law explicitly requires the bond to be

based on estimated reclamation costs. Under the new Ohio law, performance bonds of $800-$3 000 per acre are being required.

38 Substantive

38 It has been recognized for nearly a decade that the most severe adverse environmental efforts occur or are caused during the mining operation itself, although such effects may continue for an extended period of time after the mining operation has ceased. The greatest adverse environmental impacts from bench cuts, removal of vegetation, and soil disturbance occur during the mining operation. Some of the greatest impacts on water quality occur during mining, and a major cause of failure of revegetation has been the presence of highly acidic and other non-organic material unearthed during the mining (and reclamation) process. In spite of this realization, the necessary controls were essentially non-existent in the early 1960's.

38 Prior to the mid-1960's the Appalachian States had very few requirements for the abatement of pollution and siltation during the mining operation.For example, Maryland and West Virginia had no statutory provisions at all. Kentucky had only minimum provisions that required covering the pit being mined, burying acid producing material under adequate fill, and sealing any breakthrough of acid water creating a "hazard." Only Pennsylvania required the operator to have a drainage permit for the mining operation. None of the States during the early 1960's had any restrictions on bench width and the replacement of overburden as they relate to slope angle.

38 Since the mid-1960's, however, there have been significant changes in several States' statutes that are designed to prevent the adverse environmental consequences of surface mining. The States of Pennsylvania sylvania, Kentucky, Maryland, Tennessee, and West Virginia have adopted mine drainage and/or bench width limitations to reduce sedimentation, acid mine drainage, landslides, and aesthetic blight.

39 Drainage

39 The States of Kentucky, West Virginia, Pennsylvania, and Maryland have established minimum acceptable standards for mine drainage. Pennsylvania regulations allow no discharge of mine drainage with a pH content of less than 6.0 or greater than 9.0, or with an iron content of greater than 7 milligrams/liter. Kentucky and West Virginia have similar stipulations, requiring the construction of facilities such as collection basins, silt dams, and water diversion measures prior to the commencement of mining and maintenance of these facilities in working order during the mining process. Maryland requires the prevention of avoidable pollution and maintenance of facilities to divert surface water from the mining operation. Maryland also requires that a 50-foot barrier be left between the mining operation and any permanent stream. Few States rewuire maintenance of water-impounding facilities after reclamation is completed.

39 The foregoing discussion of drainage requirements is essentially limited to provisions in the surface mining laws. Drainage problems are also covered by

State water quality laws and by the Federal Water Pollution Control Act.

39 Bench Width

39 The States of Kentucky, Tennessee, West Virginia, and Maryland restrict, in relation to slope angle, the allowable bench width and the placement of overburden. These limitations, designed primarily to prevent landslides and excessive erosion, apply in areas where the slope of the ground originally covering the coal seam exceeds 15 degrees (12 degrees in Kentucky). As seen in Table 2-1 the maximum width of the solid benech produced by the first cut varies substantially among the States. The mining operation must be conducted so that no overburden from second or subsequent parallel cuts is placed beyond the solid bench. These requirements reportedly have resulted in substantial reductions in the frequency and severity of landslides.

*2*TABLE 2-1. - MAXIMUM BENCH WIDTH DIMENSIONS IN KENTUCKY, WEST VIRGINIA, MARYLAND, AND TENNESSEE (FIRST CUT ONLY)

	Maximum bench width
Maryland and West Virginia:	
Slope in degrees:	
15	250
20	150
25	120
30	100
33	60
33 plus	n(1)
Kentucky:	
Slope in degrees:	
12 to 14	220
15 to 18	170
19 to 20	155
21	140
22	130
24	110
25	100
26	90
27	80
28 n2	60
29 to 30 n2	55
31 to 33 n2	45
Tennessee:	
Slope in degrees:	
15 to 18	125
18.1 to 20	106
20.1 to 22	94
22.1 to 24	82
24.1 to 26	71
28 plus	n(1)

39 n1 No fill bench allowed.

39 n2 Only auger mining is permitted over 27 degrees.

40 Reclamation

40 As with the other provisions of the State laws the reclamation requirements vary substantially among the States. The four basic characteristics which were identified are the following: (1) the time, relative to the mining operation itself, within which regrading and backfilling activities must be initiated; (2) the influence of future land use on the degree of reclamation; (3) backfilling and regrading requirements; and (4) revegetation requirements.

40 Timing. - With respect to the timing for initiation of regrading and backfilling, the reclamation requirements of the 16 States surveyed have been classified as either "standard" or "concurrent," terms defined in the text that follows. Table 2-2 identifies the States in each category.

*2*TABLE 2-2. - CLASSIFICATION OF STATE SURFACE MINING RECLAMATION REQUIREMENTS ON THE BASIS OF TIMING

"Standard" reclamation requirement	"Concurrent" reclamation requirement
Alabama	Indiana
Colorado	Kentucky
Illinois	Maryland
Montana	Ohio n1
North Dakota	Oklahoma n2
Washington	Pennsylvania n2
Wyoming	Tennessee
	Virginia
	West Virginia

40 n1 Must commence 3 months after mining starts and "whenever possible" take place as mining progresses.

40 n2 Required by regulations, not by statute.

40 Concurrent reclamation regulations essentially require the operator to conduct his reclamation (backfilling and regrading) activities as an integrated part of the ongoing mining operation rather than allowing him to begin after the mining operation is completed. Stipulations for concurrent reclamation have been established for both contour mining and area mining.

40 For contour mining, the States generally specify a time and/or linear distance beyond which the mining operation cannot proceed before backfilling is initiated. Regulations have not yet been promulgated for Ohio, but the specific time and distance requirements for the six other States with such regulations for contour mining are shown in Table 2-3.

*3*TABLE 2-3. - CONTOUR MINING CONCURRENT RECLAMATION REQUIREMENTS FOR GRADING AND BACKFILLING n1

State	Time (days) n2	Distance (feet) n3
West Virginia:		
Stripping	60	3,000
Auger, highwall	30	1,000
Pennsylvania		1,500
Kentucky: Bench mining (contour strip, auger, highwall)	15	1,500
Maryland		2,000
Tennessee:		
Strip	15	1,500
Auger	15	1,500
Virginia:		
Strip	60	700
Auger	30	350

40 n1 Whichever limit is first reached - time or distance - is the governing restriction.

40 n2 Time following mining within which grading and backfilling must start.

40 n3 Linear distance beyond which mining cannot proceed until grading and backfilling is started.

41 Indiana and Oklahoma, in addition to the States in Table 2-3, require concurrent reclamation for area mining. In most of these states, grading and backfilling for area mining must not be more than two spoil ridges behind the pit being worked. For both area and contour mining, all grading and backfilling is usually required to be completed from within 90 days to one year after completion or abandonment of the mining operation.

41 "Standard" reclamation requirements generally allow the initiation of reclamation activities after the completion (or abandonment) of a mining operation. Reclamation is essentially a separate job from the mining operation. In general, backfilling and regrading operations are required at "the earliest possible time" and are to be completed within a 2 or 3 year period after the completion of mining.

41 Alabama law has no provision for when the reclamation work is to start, requiring only that grading be completed within three years after the permit period expires. Colorado's law requires reclamation to be completed "with all reasonable diligence" and completed within three years after the date on which the operator reports that his reclamation work has started. North Dakota's legislative statement of policy provides for reclamation after the surface mining operations are completed. Wyoming only requires the operator to submit

an annual report stating what steps have been taken to reclaim the mined area. There are no time requirements.

41 Prior to 1969, most of the States currently imposing the "standard" reclamation requirements were essentially without any form of surface mining regulations, and most of the States now requiring "concurrent" reclamation were conducting their reclamation programs under the "standard" reclamation requirements. During the 1968-1972 period, the States with no reclamation requirements adopted the "standard" reclamation requirements, while many States which already had "standard" requirements shifted to the "concurrent" form of regulation.

41 Land Use. - Prior to the 1969-1970 period, reclamation requirements generally did not include explicit consideration of the use of the land prior to mining or its intended use after mining and reclamation. Now many of the States surveyed require the surface mining operator to specify in his reclamation plan proposed land use activities for the reclaimed mined area. A commonly stated objective is to return surface mined land to a productive use.Such land use activities as agriculture, corps, forestry, water-oriented real estate developments, and industrial sites are frequently encouraged by the laws. Such approved uses can function as general performance standards or guides for the conduct of grading, backfilling, and revegetation activities. The relationship between land use considerations and reclamation activities is discussed below in connection with regrading and revegetation requirements.

41 Grading and Backfilling. - There are three general types of backfilling and grading requirements often imposed by the States.These are (1) regrading to the approximate original contour, (2) some form of terrace backfilling, and (3) grading to create a "rolling topography." In general the Eastern States surveyed require either regrading to the approximate original contour or terrace backfilling.

42 The laws of Kentucky, Maryland, Ohio, Pennsylvania, and West Virginia n3 require that area mined lands be graded to the approximate original contour. Tennessee requires approximate original contour or rolling topography for such lands. Only the Pennsylvania and Ohio laws require reclamation to approximate original contour for both area and contour mining. In both States, however, the laws permit terracing or other alternatives under certain conditions.

42 n3 The law requires backfilling "not to exceed" original contour.

42 Pennsylvania's regulations require the operator to regrade and backfill the mined area to its approximate original contour or submit a full explanation of the conditions which do not permit contouring. If the alternative of terrace backfilling is permitted, the steepest contour of the restored highwall is limited to 35 degrees. The operator may propose other alternatives requiring less grading in conjunction with such future land uses as water-oriented real estate development, recreational area development, or industrial site development.Such alternatives may be permitted if they are "reasonable" and do not pose water quality problems.

42 Ohio's law is similar to Pennsylvania's. The operator must regrade and backfill the mined area to the approximate original contour, unless natural conditions preclude this or "contouring" would not allow vegetative growth. In addition, an alternative that will permit equal or greater "economic or public use of the land" may also be permitted. The most common acceptable alternative is terracing with the resulting slope usually limited to 35 degrees.

42 While regrading to the approximate original contour is the primary reclamation standard in Ohio and Pennsylvania, some form of terrace backfilling is the principal regrading requirement for contour mining for the other Eastern States surveyed. For example, both Maryland and Kentucky require terrace backfilling with the maximum slope angle of the highwall and outslope limited to 45 degrees. Tennessee's regulations are similar, but the slope angle of the remaining highwall and outslope is limited to 35 degrees. Virginia's law, however, only requires the reduction of the ultimate highwall to the maximum extent feasible. In addition, all of the above States require that some minimum amount of over-burden be placed over the coal pit.

42 The primary regrading standard for most of the western States (Colorado, North Dakota, Oklahoma, Washington, and Wyoming) and for Alabama, Illinois, and Indiana is creation of a "rolling topography9" That is, the peaks and ridges of spoil banks must be rounded (or struck off to a specified width) to allow the planting of trees and shrubs, to create a "rolling topography," or to create a gently undulating skyline. The regulations further stipulate that the reclaimed area must be traversable by livestock if its future use is range land or by agricultural equipment if the future use is agriculture. Montana requires only that the land be reclaimed for "productive use," with no physical specifications.

42 Revegetation Requirements. - All of the States surveyed require the operator at least to replant or reseed the mined area upon the completion of regrading and backfilling. While these requirements vary substantially among the States, they generally set out the objective or purpose of revegetation and include stipulations on the number of seeding attempts, timing and/or seeding rates per acre to achieve that objective.The new regulations of Tennessee, for example, require the operator's plan to provide for planting that will achieve "quick and permanent" soil stabilization while Ohio requires operators to "provide for immediate establishment of grasses or other plant cover to prevent soil erosion." The Western States of Montana and Wyoming, however, only require two seeding attempts, regardless of the success of the vegetative growth. For many of the States, reseeding must take place no later than the planting season following completion of backfilling, with the objective of obtaining a "satisfactory vegetative cover," which is subject to the approval of the administrative agency, after two growing seasons. Extension of time may be granted up to 10 to 15 years.

43 Of the 16 States surveyed, only four - Illinois, Kentucky, Tennessee, and West Virginia - have specified in their regulations performance standards in terms of vegetative survival rates for approved future uses of the reclaimed mine site.

43 As noted above, a major cause of failure of revegetation is the presence of highly acidic or other non-organic material unearthed during the mining process. The laws of Illinois, Tennessee, Maryland, Ohio, Pennsylvania, and West Virginia now require in most cases that the topsoil be separately removed and then redeposited upon the completion of regrading. Tennessee requires that topsoil be saved for area mining only. Topsoil restoration requirements generally assist in more quickly stabilizing the reclaimed area, hence reducing soil erosion.

43 Table 2-4 summarizes the basic features of the State reclamation provisions discussed above. The new requirements that have been

10 Table 2-4 *10* State Surface Mining Reclamation Requirements *2*

	Timing	Grading/Backfilling					Revegetation		
State	Concurrent	Standard	Future Land Use	Approximate Orig. Contour	Terracing	Rolling Topography	Topsoil Saved	Planting Required	Survival Standards
Alabama		x				x		x	x n1
Colorado		x	x			x		x	
Illinois		x	x		x n2	x	x	x	x
Indiana	x		x			x		x	
Kentucky	x			x n3	x n4			x	x
Maryland	x		x	x n3	x n4		x	x	
Montana		x				x		x	
N. Dakota		x	x			x		x	
Ohio	x		x	x	x n5		x	x	
Oklahoma	x		x			x		x	
Pennsylvania	x		x	x	x n5		x	x	
Tennessee	x		x	x n3	x n6		x n3	x	x
Virqini									

a	x		x		x n7			x	
Washington		x	x			x		x	
W. Virginia	x		x	x n3	x n8		x n9	x	x
Wyoming			x			x		x	

43 n1 Where soil conditions do not inhibit growth.

43 n2 Grade to 30% on all outslopes over 40 vertical feet.

43 n3 Area mining only.

43 n4 Maximum slope angle limited to 45 degrees.

43 n5 If approved by administrating agency in conjunction with approved land use, slope angle limited to 35 degrees.

43 n6 Slope angle of highwall and outslope limited to 35 degrees.

43 n7 Reduce highwall to maximum extent possible, no slope angle limitations.

43 n8 Slope angle limited to 32 degrees for highwall and outslope.

43 n9 In acia producing areas only enacted since the mid-1960's include "concurrent" reclamation, the consideration of future uses of the reclaimed areas, regrading to the original contour or a satisfactory alternative, and replacement of topsoil. The adoption of these new reclamation requirements, together with drainage and bench width limitations, reflects an effort to reduce both the level and duration of the adverse environmental impacts associated with surface mining and to restore mined lands to productive use.

CHAPTER 3.
IMPACT OF SLOPE ANGLE PROHIBITIONS ON COAL PRODUCTION AND RESERVES

49 A Chapter 1 analyzed a number of technologies that would greatly reduce environmental impacts on steep slopes. This chapter analyzes the impacts on reserves and production (including low sulfur coal) from complete prohibitions of surface mining on steep slopes. Although some proposals would only partially preclude mining on steep slopes, it has not been possible to evaluate their impacts because of the wide range of potential administrative discretion in considering such factors as use of different technologies, soil stability, and the like. To the extent legislation is enacted which only partially excludes mining on steep slopes, the impacts would be reduced.

49 Coal is the Nation's most abundant fuel resource. Known coal resources total 1,552 billion tons, or over 2,500 years' supply at current coal consumption rates (1). Coal now provides over 18 percent of current energy requirements and over 44 percent of the fuel that enerates electric power (2).

49 Total U.S. coal production in 1971 was 552 million tons; half, or 276 million tons, was surface mined (3). As indicated in Table 3-1, 68 percent of U.S. coal production is in Appalachia, which accounts for 56 percent of total U.S. surface mined coal.

*7*TABLE 3-1. - U.S. BITUMINOUS COAL AND LIGNITE PRODUCTION, 1971

	Underground n1	Percent	Strip and auger n1	Percent	Total production n1	Percent
Appalachia	219	80	155	56	374	68
Central States	48	17	88	32	136	25
Western States	9	3	32	12	42	7
Alaska	0	0	1	0	1	0
Total	276	100	276	100	552	100

49 n1 Million tons per year.

49 Source: U.S. Department of the Interior, Bureau of Mines, Division of Fossil Fuels. "Coal - Bituminous and Lignite in 1971." Washington, D.C.: Department of the Interior. Sept. 27, 1972. p. 12.

49 Although surface mining accounts for half of current coal production, most of the Nation's coal resources will have to be deep mined if they are to be exploited. Table 3-2 indicates that only 45 billion tons of the total 1,552 billion tons of mapped resources, less than 3 percent, can now be classified as strippable reserves. Almost 70 percent of the strippable reserves is in the West, including Alaska. Only 13 percent is in Appalachia.

50

*5*TABLE 3-2. - U.S. BITUMINOUS AND LIGNITE COAL RESOURCES AND STRIPPABLE RESERVES

	Total coal reserves		Strippable coal reserves	
	Billion tons	Percent	Billion tons	Percent
Appalachia	304	20	6	13
Central States	239	15	9	20

Western States	878	57	26	58
Alaska	130	8	4	9
Total	1,552	100	45	100

50 Source: U.S. Department of the Interior, Bureau of Mines, Division of Fossil Fuels."Coal - Bituminous and Lignite in 1971." Washington, D.C.: Department of the Interior. Sept. 27, 1972. p. 8.

50 PRODUCTION AND RESERVES BY ANGLE OF SLOPE IN APPALACHIA

50 Much of the surface mining production in Appalachia is on slopes of 15 degrees or more. On the other hand, surface mining production in the central and western coal regions typically comes from slopes of less than 10 degrees (4).

50 In conducting this study, the Council found that there were no preexisting data on surface mining coal production or reserves as a function of slope angle. Therefore, methodologies were devised to develop these data rapidly. Appendix G briefly describes the methodology used.

50 Surface Mine Production

50 Surface mine production on various slope angle ranges is presented in Table 3-3 for the Appalachian States. Similar data are given in Table 3-4 for the economic areas of Appalachia. n1 Appalachian surface mining represents about 28 percent of all U.S. coal production and 56 percent of all U.S. surface mine production. Because less than 10 percent of the surface mining in other coal regions comes from slopes greater than 15 degrees, these data may be used to determine with sufficient precision the impact of slope limitations on the Nation's coal production.

50 n1 The economic areas are defined by the Bureau of Economic Analysis, Department of Commerce. These economic areas are delineated according to the concept of cities as the hubs around and within which integrated economic activity concentrates. Figure 3-1 shows the location of these economic areas relative to the coal reserves in Appalachia. For purposes of this analysis, Appalachia is represented by the composite of 12 economic areas, which are identified in Table 3-4.

51

*8*TABLE
3-3. -
CURRENT
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OF SLOPE ANGLE, 1971 *8*[In millions of tons per year]

State	Surface mine production, 1971, as function of slope angle: Total	0-9.9 degrees	10 degrees-14.9 degrees	15 degrees-19.9 degrees	20 degrees-24.9 degrees	25 degrees+	Underground mine production, 1971
Alabama	11.09	4.66	1.55	1.77	1.77	1.33	6.75
Kentucky (eastern)	33.10	0	.60	4.20	7.65	20.65	32.99
Maryland	1.47	.43	.66	0	.38	0	.14
Ohio	38.11	4.08	8.00	15.08	6.39	4.56	12.86
Pennsylvania	25.76	10.73	9.89	3.63	1.04	.48	44.29
Tennessee	5.34	.40	.13	.71	1.71	2.40	2.65
Virginia	9.00	0	.08	.20	.83	8.07	21.63
West Virginia	31.92	1.83	4.43	2.71	8.43	14.46	78.76
Total	155.79	22.13	25.34	28.30	28.20	51.95	200.07
Percentage	100.00	14.2	16.3	18.2	18.1	33.3	

51 n1 May be less than quantity of all coal produced in these States because data on slope angle distributions were not available for all mines.

51 Source: 1971 data supplied by Department of the Interior, Bureau of Mines, Division of Fossil Fuels. "Coal - Bituminous and Lignite in 1971." Washington, D.C.: Department of the Interior, Sept. 27, 1972. Pp. 26-36. See App. G for slope angle distribution.

*8*TABLE 3-4. - CURRENT SURFACE MINE PRODUCTION IN APPALACHIA AS FUNCTION OF SLOPE ANGLE

8[In millions of tons per year]

Economic Area	Surface mine production, 1971, as function of slope angle: Total	0-9.9 degrees	10 degrees-14.9 degrees	15 degrees-19.9 degrees	20 degrees-24.9 degrees	25 degrees+	Underground mine production, 1971
11. Williamsport, Pa	8.51	3.15	2.55	2.04	0.60	0.17	1.65
66. Pittsburgh, Pa	44.04	12.10	16.84	8.77	2.87	3.46	59.42
68. Cleveland, Ohio	6.89	.69	0	.45	4.34	1.41	.79
64. Columbus, Ohio	12.32	.60	2.69	9.03	0	0	2.54
65. Clarksburg, W. Va	7.64	0	0	.38	7.25	0	24.27
52. Huntington, W.Va.-Ashland, Ohio	27.27	.53	1.30	.75	1.55	23.15	65.52
53. Lexington, Ky	15.56	0	0	0	5.91	9.65	9.76
51. Bristol, Va	10.09	0	.08	.20	.87	8.94	22.80
50. Knoxville, Tenn	11.97	.12	.26	4.91	3.03	3.66	6.46
49. Nashville, Tenn	.29	.28	.01	0	0	0	.10
48. Chattanooga, Tenn	1.04	.44	.15	.17	.17	.12	0
45. Birmingham, Ala	10.04	4.22	1.41	1.61	1.61	1.20	6.75

Total	155.66	22.13	25.29	28.31	28.21	51.76	200.06
Percentag e	100.0	14.2	16.2	18.2	18.1	33.3	

[See Table in Original]

51 Source: See references for Table 3-3.

52 As indicated in the tables, a large percentage of surface mined coal now comes from steep slopes. Indeed, only 14 percent of surface mining in Appalachia is on slopes of less than 10 degrees, 16 percent is on slopes of 10 degrees to 15 degrees, 18 percent on 15 degrees to 20 degrees, 18 percent on 29 degrees to 25 degrees, and 33 percent over 25 degrees. If a 15 degrees slope limitation were applied immediately, it would affect:

52 70 percent of Appalachian surface mining production

52 39 percent of total U.S. surface mining production

52 20 percent of total U.S. production.

52 If a 20 degrees slope limitation were applied immediately, it would affect:

52 51 percent of Appalachian surface production

52 29 percent of total U.S. surface mining production

52 14 percent of total U.S. production.

52 These figures do not say that all this production would necessarily be lost if contour strip and auger mining were phased out over a period of time, for there are several ways of compensating for loss of surface mining on steep slopes. These alternatives and their implications for mitigating the production and reserve losses which might otherwise be associated with a slope angle ban are discussed later in this chapter.

52 Strippable Reserves

52 Strippable coal reserves are but a small percentage of the Nation's total coal resources. Further, although the Nation's strippable reserves are largely in the West, it is apparent from Tables 3-5 and 3-6 that sizable strippable coal reserves are found in Appalachia. Of the 6.5 billion tons of strippable reserves in this region, 41 percent would be precluded from mining by a 15 degrees slope angle limitation.As seen in Table 3-5, there are strippable reserves on relatively flat land in Alabama, Ohio, Pennsylvania, and Tennessee to support current levels of production for many years. This fact suggests that it may be possible to shift surface mining production on steep slopes to less steeply sloped areas. The potential impact of this alternative to surface mining on steep slopes is discussed below.

*8*TABLE

3-5. - STRIPPABLE RESERVES IN APPALACHIA AS A FUNCTION OF SLOPE ANGLE *8*[Millions of tons]

State	Total	0-9.9 degrees	10 degrees-14.9 degrees	15 degrees-19.9 degrees	20 degrees-24.9 degrees	25 degrees +	Total deep reserves in Appalachia
Alabama	169.84	124.79	16.42	13.19	10.04	5.40	12,774
Kentucky (eastern)	766.52	44.80	38.84	106.36	219.36	357.16	37,639
Maryland	27.27	25.17	1.71	.26	.13	0	1,117
Ohio	1,334.01	961.04	256.44	102.92	13.42	0	36,505
Pennsylvania	1,293.48	1,116.24	161.34	10.16	3.42	2.45	66,011
Tennessee	135.66	75.85	8.51	22.24	24.26	4.80	2,094
Virginia	226.86	0	0	32.06	131.78	63.02	8,324
West Virginia	2,507.01	364.52	592.04	475.87	608.86	465.72	90,059
Total	6,460.65	2,712.41	1,075.30	763.06	1,011.27	898.55	254,523
Percentage	100.0	42.0	16.6	11.8	15.7	13.9	

52 Source: All data sources and analytical techniques are described in App.G.

53

*7*TABLE 3-6. - STRIPPABLE RESERVES IN APPALACHIA AS FUNCTION OF SLOPE ANGLE *7*[In millions of tons]

Economic Area	Total	0-9.9 degrees	10 degrees-14.9 degrees	15 degrees-19.9 degrees	20 degrees-24.9 degrees	25 degrees +
11. Williamsport, Pa	235.89	208.04	25.51	2.34	0	0
66. Pittsburgh, Pa	1,284.76	1,040.40	183.01	41.58	15.04	2.73
68. Cleveland, Ohio	412.19	337.64	72.87	1.68	0	0
64. Columbus, Ohio	596.12	480.05	63.87	50.37	1.83	0
65. Clarksburg, W.Va.	600.19	62.62	420.09	104.25	13.23	0
52. Huntington, W.Va., Ashland, Ohio	2,122.84	248.40	236.40	445.65	630.59	561.80
53. Lexington, Ky	276.62	0	0	0	78.06	198.56
51. Bristol, Va	313.88	0	0	44.36	182.32	87.20
50. Knoxville, Tenn	274.06	65.02	31.09	56.95	78.80	42.20
49. Nashville, Tenn	41.09	40.41	.68	0	0	0
48. Chattanooga, Tenn	32.05	23.55	3.10	2.49	1.89	1.02
45. Birmingham, Ala	157.41	115.66	15.22	12.22	9.30	5.01
Total	6,347.10	2,621.79	1,053.84	761.89	1,011.06	898.52
Percentage	100.0	41.3	16.6	12.0	15.9	19.6

[See Table in Original]

53 Source: See sources for Table 3-5.

53 IMPORTANCE OF CENTRAL APPALACHIA

53 It is not difficult to see that the areas that would be affected most by

slope angle prohibitions are southern West Virginia, eastern Kentucky, western Virginia, and northeastern Tennessee, those largely covered by Economic Areas 50, 51, 52 and 53. n2 In this discussion, this region will be identified as central Appalachia. $

53 n2 These four EA's roughly coincide with Districts 7 "Southern Numbered 1" and District 8 "Southern Numbered 2" defined in the Bituminous Coal Act of 1937.

53 In Table 3-7, the production and reserve data for the central Appalachian region are aggregated for comparison. As Table 3-7 shows, less than 4 percent of the coal surface mined in central Appalachia currently comes from slopes of less than 15 degrees, whereas almost 20 percent of the strippable reserves underlie slopes of less than 15 degree. At the other extreme, over 70 percent of current surface production in this region comes from slopes of more than 25 degrees while only 30 percent of the strippable reserves underlie slopes of more than 25 degrees. Even more dramatic is the fact that in western Virginia and eastern Kentucky (Economic Areas 51 and 53), there is little current surface production and virtually no strippable reserves underlying slopes of less than 15 degrees.

*7*TABLE 3-7. - SUMMARY OF SURFACE PRODUCTION AND RESERVE DATA FOR CENTRAL APPALACHIA

7[Surface production and reserves in central Appalachia as function of slope angle]

	Total	0-9.9 degrees	10 degrees-14.9 degrees	15 degrees-19.9 degrees	20 degrees-24.9 degrees	25 degrees +
Surface mining production:						
Millions of tons per year	64.89	0.65	1.64	5.86	11.36	45.00
Percentage	100.00	1.00	2.50	9.00	17.50	70.00

Strippable reserves:						
Millions of tons	2,987.00	313.00	267.00	547.00	970.00	890.00
Percentage	100.00	10.50	9.00	18.00	32.50	30.00

53 Source: Developed from Tables 3-4 and 3-6.

54 Coal Quality

54 The coal produced in Appalachia by both surface and deep mining is generally of high quality and is in demand for steam electric plants, coke and gas plants, and exports, particularly to Canada and Japan. The coal produced by both surface and underground methods in the central Appalachia region - which could be most highly impacted by a slope angle prohibition - has the lowest sulfur content of any coal in the Appalachian and central U.S. regions. Table 3-8 presents the sulfur content of surface mined coal in central Appalachia as a function of slope angle.

54 Low sulfur fuel is already in high demand for use in steam electric plants to meet national sulfur oxides air quality standards. As indicated in Table 3-9, utiliyies are paying premium prices of $9 .90 per ton for the surface mined low sulfur coal from the central Appalachian region, compared with the average price of $8.16 and $7 .69 for that from other parts of Appalachia and of the Nation respectively.

*7*TABLE 3-8. - SULFUR CONTENT OF CENTRAL APPALACHIAN SURFACE MINED COAL AS A FUNCTION OF SLOPE ANGLE

7[Millions of tons per year]

Sulfur Content	Total	0-9.9 degrees	10 degrees- 14.9 degrees	15 degrees- 19.9 degrees	20 degrees- 24.9 degrees	25 degrees +
1 percent	40.17	0.35	0.53	0.75	6.58	31.96
1 to 1.49 percent	15.80	.12	.41	.44	3.48	11.35
1.5 to 1.99 percent	7.30	.09	.37	4.12	.95	1.77

2 to 2.99 percent	1.42	.19	.32	.22	.36	.33
> 3 percent	.34	0	0	.34	0	0
Total	65.03	.75	1.63	5.87	11.37	45.41
PERCENTAGE OF TOTAL PRODUCTION						
1 percent	61.8	0.5	0.8	1.1	10.1	49.1
1 to 1.49 percent	24.3	.2	.6	.7	5.4	17.5
1.5 to 1.99 percent	11.2	.1	.6	6.3	1.5	2.7
2 to 2.99 percent	2.2	.3	.5	.3	.6	.5
> 3 percent	.5	0	0	.5	0	
Total	100.0	1.1	2.5	8.9	17.6	69.8

54 Source: Based on Bureau of Mines filed survey, January, 1973.

*5*TABLE 3-9. - COAL PURCHASED FOR STEAM ELECTRIC PLANTS, BY REGION OF PRODUCTION

	Surface		Underground	
	Quantity (million tons per year)	Price per ton n1	Quantity (million tons per year)	Price per ton
Low sulfur (less than 1 percent S) steam electric coal:				
North Appalachia	3.30	$8.90	1.82	$1 5.01
Central Appalachia	21.32	9.90	31.01	10.63
South Appalachia	3.88	7.54	2.00	9.85
Total, Appalachia	28.50	9.45	34.83	10.80
Total, United States	57.30	7.69	37.32	10.61
All steam electric coal:				
North Appalachia	54.42	8.93	50.91	9.29
Central Appalachia	35.75	9.51	48.14	10.23
South				

Appalachia	8.99	8.07	4.11	10.30
Total, Appalachia	99.16	9.04	103.16	9.75
Central (western Kentucky, Illinois, Indiana)	87.92	6.95	39.08	7.99
Total, United States	229.16	7.71	145.02	9.40

[See Table in Original]

54 n1 Value, F.O.B. mine.

54 Source: Based on Federal Power Commission Form 423, data supplied to CEQ by the FPC, 3d quarter, 1972.

55 Coal produced in central Appalachia also has a high Btu content, a low ash content, and other physical characteristics which recommend it for coking and gas plants and for export as metallurgical grade coal. In recent years over 40 percent of the central Appalachian coal, generally that with a sulfur content under 1 percent, has been used for coking and gas plants (5). This coking coal cannot be replaced by most coals with higher sulfur and ash content mined elsewhere in Appalachia or in the central region of the U.S.

55 Over 15 percent of the region's coal, averaging 0.8 percent sulfur, enters the export market, accounting for about 75 percent of the Nation's coal exports of $9 00 million in 1971 (6). These exports are rising and may now be approaching $1.3 billion annually (7).

55 A number of observations can be made about the potential impact of slope limitations on low sulfur coal production in central Appalachia. First, the 40 million tons of low sulfur, surface mined coal production accounts for 62 percent of total surface mine production in central Appalachia. Virtually all of this production is on slopes over 20 degrees. Second, about half of this production is purchased by utilities for steam electric power plants, representing 23 percent of all low sulfur coal consumed in the Nation's steam electric plants. Hence, a slope limitation would have significant effects on the availability of low sulfur coal for both utility and metallurgical uses, unless production from underground mines increased substantially in central Appalachia. Because of the costs of transportation, low sulfur Western coal could make up little of this deficit for electric power production and is not of high enough quality for metallurgical uses.

*5*TABLE 3-10.
- IMPACT ON
UNDERGROUND
RESERVES OF A
SHIFT TO
UNDERGROUND
FROM STEEP

SLOPES

Economic Area	Production lost on steep slopes for 15 degrees restriction (million tons per year)	Years remaining for underground mining at current production levels	Years remaining for underground production if all production above 15 degrees goes to underground	Percent increase in annua underground production if all steep slope production lost is recovered by underground mining
11. Williamsport, Pa	2.81	n(1)	n(1)	170.0
66. Pittsburgh, Pa	15.10	915	730	25.4
68. Cleveland, Ohio	6.20	n(1)	n(1)	785.0
64. Columbus, Ohio	9.03	n(1)	n(1)	356.0
65.Clarksburg, W.Va.	7.64	n(1)	n(1)	31.4
52. Huntington, W.Va.-Ashland, Ohio	25.45	529	381	38.9
53. Lexington, Ky	15.56	542	209	159.0
51. Bristol, Va	10.09	171	132	28.9
50. Knoxville, Tenn	11.60	487	126	297.0
49. Nashville, Tenn	0	n(1)	n(1)	0
48. Chattanooga, Tenn	0.46	n(1)	n(1)	n(1)
45. Birmingham, Ala	4.42	n(1)	n(1)	65.4

55 n1 Not available.

55 Source: See sources for Tables 3-4 and 3-6.

55 SUBSTITUTION OF UNDERGROUND PRODUCTION FOR SURFACE PRODUCTION ON STEEP SLOPES

55 Physical Availability

55 The extensive mining of coal on steep slopes is concentrated in several economic regions of Appalachia, particularly eastern Kentucky and southern West Virginia. Production from deep mines in these regions is also significant.

56[See Map in Original]

56 Table 3-10 shows that coal reserves removable by underground mining in many of the major economic areas would last several hundred years even with a shift from surface mining on steep slopes to underground mining. In terms of the available resources, a shift from surface to underground production in the economic areas discussed would not necessarily lead to coal production curtailment. However, as indicated in the last column of the table, to make up for lost production on steep slopes, current underground production would need to expand significantly. The following analysis focuses on the ability to open new mines, as well as on other constraints such as capital and equipment requirements, the economics of such a shift, and the availability of labor.

57 Economic and Technical Constraints

57 In general, switching to deep mining would be constrained by the time required to expand production from existing deep mines and to open new underground mines. Opinions differ on whether existing deep mines are now producing close to capacity. If they are, then new equipment would be required to expand capacity. If they are not, then expanded capacity is subject to the availability of labor. Because deep mining requires entirely different mining equipment than do surface operations, surface mining equipment cannot be used to expand deep mining production.

57 Significant expansion of deep mining production from new mines and from existing mines if there is no excess capacity would necessitate the purchase of highly specialized equipment, such as cutters, loaders, track, ventilation devices, and roof jacks. The lead time for delivery of this equipment may be up to several years (8). To open new mines, it may take from 2 to 4 years to perform geological analyses, develop mining plans, provide railroad spurs, develop access roads and processing facilities, sink mine shafts to the coal seams, and install the necessary mining and safety equipment (9).

57 Capital availability may also constrain accelerating deep mine production. The necessary investment in a new deep mine may vary between $8 and $2 0 per ton of annual production of uncleaned coal (10). The wide range is a function of variations in depth of cover, thickness and slope angle of the coal seam, roof conditions, the number of working faces, and gaseous conditions. Because economies of scale dictate a deep mine which can produce over 1 million tons per year, a capital investment of perhaps tens of millions of dollars may be required.

57 It is not likely that most displaced contour mine operators could easily enter deep mining, because they lack the necessary capital and mining and management expertise. Most contour mine operations are relatively small, producing under 100,000 tons each year (11). Their total investment in equipment may be as little as the cost of dragline, a coal loader, a bulldozer,

and two trucks, valued at a few hundred thousand dollars.

57 In addition to capital and labor constraints, underground mining may not substitute for surface mining because it would appear less economic than alternative surface production. Although costs of surface and underground mining vary widely due to mine size, topography, and coal seam variations, data on numbers of mines and total production clearly indicate the relative competitive advantages of surface mining. Figures 3-2 and 3-3 illustrate the declining importance of underground mining and the rapid growth of surface mining - a trend due largely to economics, one which may not be easily reversed.Similarly, individual decisions to substitute underground mining for surface mining may be largely influenced by the relative diseconomies of deep mining.

58 [See Graph in Original]

58 Labor Constraints

58 Slope angle limitations on surface mining would affect many miners. Limitations of production on slopes over 15 degrees and 20 degrees would affect an estimated 16,000 and 12,000 employees, respectively.

58 If the amount of coal currently surface mined in Appalachia on slopes of over 20 degrees were replaced with underground mined coal, given the current output per man-day for underground mining, there would be a demand for about 36,000 underground miners, almost triple the number of surface miners displaced.

59 Some portion of the displaced surface miners would probably find employment in underground mines. However, surface miners are operators of earthmoving equipment. Their skills are more common to heavy construction than to underground mining. Because of the dissimilarity of surface and underground mining, a surface miner would generally require about the same training as any new underground worker. The few jobs common to surface and underground mining, such as for electricians and mechanics, would require little additional training.

59 Because of the skill requirements and the danger of accidents, many States require that new underground employees be accompanied by an experienced miner for the first 6 months or year (12). With the high employee turnover rate (approximately 18 percent) and the high absentee rate (approximately 20 percent), even more people would be required (13). And this is in addition to the manpower required to meet growth in coal demand - 71 percent by 1985 (14). Hence, even if all the surface miners could be shifted into deep mining, many additional people would still be needed, necessitating a greatly expanded recruitment and training program.

59 There are differences of opinion on how difficult it would be to recruit such a large number of underground miners. Underground mining is a noisy, dirty and dangerous job, but pays high wages. It does appear likely, however, that there will be shortages of supervisors at the foreman level. Another manpower constraint of lesser magnitude may be the lack of engineers with experience in

underground mining, particularly if underground mining is to expand greatly in the near future.

59 The economic implications of a shift from surface to underground employment are discussed in Chapter 4. Appendix H details the occupational health and safety impacts ofsuch a shift in employment.

CHAPTER 4
REGIONAL ECONOMIC IMPACT OF SLOPE ANGLE LIMITATIONS

69 The impacts of slope angle restrictions on production and reserves are discussed in Chapter 3. This chapter explores in a preliminary way the effects of slope angle prohibitions on the employment, earnings, and the general economic health of Appalachia.

69 Although some legislative proposals would only partially preclude mining on steep slopes, it is not possible to evaluate their impacts because of the wide range of potential administrative discretion in considering such factors as different technologies, soil stability, and the like. Consequently this chapter focuses on a complete ban above a specified slope angle. To the extent legislation is enacted which only partially excludes such mining, the impacts would be reduced.

69 The economic data used in this analysis are derived from a number of sources, including the Bureau of the Census and the Bureau of Economic Analysis of the Department of Commerce, the Appalachian Regional Commission, and the Bureau of Labor Statistics of the Department of Labor. Often the sources use different definitions for such variables as poverty and work force and use different economic regions for aggregating and presenting their data. Furthermore, in many instances, data could not be obtained for 1971 or 1972, and earlier data had to be used. Wherever possible, adjustments were made to eliminate inconsistencies, but conclusions must be considered tentative, particularly because they may not fully reflect current conditions. In all cases, data sources are referenced and the year of the data noted to assist the reader in assessing the results presented.

69 APPALACHIAN ECONOMIC SETTING

69 Appalachia has vast mineral and timber resources and major industries coexisting with poverty and environmental degradation. Coal mining is significant in both the region's economic base and its environmental problems. The impact of strip mining curbs on the Appalachia region should be viewed from two standpoints: the total regional impact and potential local effects.

69 The effects of constraining a basic industry such as coal mining are in part determined by the general economic health and rate of growth in the region where it occurs. A region with a growing and diversified economy is better able to absorb changes and employment dislocations than a static region or one experiencing economic decline.

69 Appalachia has long been one of our Nation's most seriously depressed

economic areas. Although conditions have been improving it still lags behind the rest of the country. While total personal income in the region grew by over one-third from 1965 to 1970, per capita income was only $2,970, compared to the national figure of $3 ,700 (1, 2). The percentage of the Appalachia population below the poverty level declined about 40 percent between 1960 and 1970, but it still remains almost twice the national average (3).

70 During the 1965-1970 period, total employment grew by 9 percent, and by 1970 the unemployment rate in the region approached that of the rest of the nation (see Table 4-1).

*7*TABLE 4-1.

	Unemployment rate (percent)					
	1965	1966	1967	1968	1969	1970
United States	4.5	3.8	3.8	3.6	3.5	4.9
Appalachia	5.1	4.3	4.6	4.2	3.9	5.0

70 Source: Appalachian Regional Commission, 1972.

70 The unemployment figures probably understate the problem, because they do not include individuals so discouraged that they have ceased looking for employment and have dropped out of the labor force. Applying a national labor force participation rate to the Appalachian population indicates that this hidden unemployment may have been as high as 7 percent in 1970, which raises the real total unemployment to 12 percent (4).

70 Other problems - such as inadequate education - also prevail throughout the region. In central Appalachia, 43.1 percent of the population over 25 years of age has not completed elementary school, and 74.0 percent has not completed high school (5). The corresponding figures for the Nation are 15.5 percent and 47.7 percent, respectively (6).

70 The severity of these problems varies widely among local areas within Appalachia. Table 4-2 contrasts the unemployment and poverty levels for the 12 EA's of the Appalachian region. The most serious problems lie in the area formed by eastern Kentucky, western Virginia, northern Tennessee, and southern West Virginia - known generally as central Appalachia. n1 These EA's are designed to represent economically interdependent counties, usually centered on a major urban area or on a city, but there is considerable economic variation within each EA. For example, in one county 55 percent of the families is below the poverty level, while the level throughout the central Appalachian EA's is generally about 20 percent (7).

70 n1 The three commonly used definitions of "central" Appalachia differ in geographical coverage. The smallest, that used by the Bureau of the Census for the 1970 census of depressed regions, includes only eight counties. The four basic Economic Areas (EA) of central Appalachia include over 100 counties. The Appalachian Regional Commission's definition includes 51 counties and 1 city.

71

*3*TABLE 4-2. - UNEMPLOYMENT RATE AND FAMILIES BELOW POVERTY LEVELS

Economic Area	Percent unemployment (March 1970)	Percent families below poverty level (1969)
11. Williamsport, Pa	5.1	9.9
66. Pittsburgh, Pa	4.5	8.8
68. Cleveland, Ohio	3.8	6.8
64. Columbus, Ohio	4.2	9.5
65. Clarksburg, W. Va	4.8	17.1
52. Huntington, W.Va.-Ashland, Ohio	5.9	21.2
53. Lexington, Ky	4.6	24.1
51. Bristol, Va	5.3	21.3
50. Knoxville, Tenn	5.3	23.4
49. Nashville, Tenn	3.8	17.9
48.Chattanooga, Tenn	n(1)	17.0
45. Birmingham, Ala	4.5	20.0
Total United States	4.4	10.7

71 n(1) Not available.

71 Source: Department of Commerce, Bureau of Economic Analysis. 1973.

71 According to Bureau of the Census figures, the real unemployment rate in central Appalachia in 1970 - including those who want a regular job although they were not counted as a part of the labor force - is about 18 percent (8). Per capita income in this region, lower than anywhere else in Appalachia, is approximately one-half of the United States average (9). It was the only area in Appalachia to experience a net population loss (- 10.7 percent) during the 1960's, and it is also the area with the least manufacturing capacity and economic diversity (10). Still, the picture for central Appalachia is not entirely discouraging. Non-mining earnings increased rapidly during the 1960's, and per capita income increased more rapidly than the national average.

71 IMPORTANCE OF COAL MINING TO APPALACHIAN ECONOMY

71 Surface and underground coal mining has always been one of Appalachia's important basic industries. It provides 6.3 percent of all basic earnings and 2.5 percent of total earnings in the region (11). Total earnings include not only basic earnings - from activities such as manufacturing and agriculture - but also earnings from all other secondary activities (residentiary earnings) such as wholesale and retail trade, construction, medical care, and other services serving local populations. Changes in basic earnings are reflected in a multiplied impact on earnings and employment in these other activities. Because of the operation of the earnings multiplier, every permanent dollar reduction in basic earnings may be expected to result ultimately in a reduction

in total earnings of about $1.75.Changes in employment have similar effects. n2

71 n2 The earnings multiplier has been estimated to average 1.75 for the whole region and to range from 1.49 to 2.17 for smaller areas. Preliminary estimates have been made of the employment multiplier, and it is of the same general magnitude.

72 Table 4-3 indicates the local importance of coal mining contrasted with the regionwide average. For example, in the northern West Virginia, northern Kentucky, and southern Ohio area (EA 52 and 65), coal mining earnings, primarily underground, are about 30 percent of basic earnings, compared to the 6.3 percent regional average. Although these data indicate that the central Appalachian area is the one most dependent on coal mining, many counties elsewhere in Appalachia are also highly dependent on coal mining. For example, Table 4-4 shows that although the southeastern Ohio area (EA 64) derives only 0.3 percent of its total earnings from coal mining, Noble County derives almost 20 percent of its livelihood from coal. And in central Appalachian economic areas such as Huntington-Ashland, which are very dependent on coal mining, individual counties such as Pike County derive an even larger share of their total livelihood from coal.

*2*TABLE 4-3. - IMPORTANCE OF COAL MINING EARNINGS, 1970

Economic area	Coal mining as a percent of basis earnings
11. Williamsport, Pa	4.1
66. Pittsburgh, Pa	7.9
68. Cleveland, Ohio	.3
64. Columbus, Ohio	1.0
65. Clarksburg, W. Va	31.4
52. Huntington, W. Va.-Ashland, Ohio	29.7
53. Lexington, Ky	8.8
51. Bristol, Va	26.2
50. Knoxville, Tenn	6.4
49. Nashville, Tenn	.1
48. Chattanooga, Tenn	n(1)
45.Birmingham, Ala	3.5
Total Appalachia	6.3

72 n1 Not available.

72 Source: Department of Commerce, Bureau of Economic Analysis, 1973.

*4*TABLE 4-4. - COAL MINING EARNINGS AS PERCENTAGE OF TOTAL EARNINGS IN SELECTED COUNTIES, 1970

2

Economic area Name	Coal mining as percent of total earnings	County Name	Coal mining as percent of total earnings
45. Birmingham, Ala	3.5	Jefferson	1.9
49. Nashville, Tenn	Nil	Van Buren	4.8
50. Knoxville, Tenn	2.5	Cambell	5.2
		Bell	11.7
		Laurel	.8
51. Bristol, Va	11.8	Buchanan	63.7
52. Huntington, W.Va.-Ashland, Ohio	12.1	Raleigh	31.0
		Kanawha	5.1
		Gallia	2.8
		Carter	.4
		Pike	47.7
53. Lexington, Ky	3.3	Breathitt	19.6
64. Columbus, Ohio	.3	Perry	16.1
		Noble	18.3
65. Clarksburg, W.Va.	13.9	Barbour	40.1
66. Pittsburgh, Pa	3.3	Garrett	3.5
		Belmont	17.0
		Clarion	6.1
		Washington	10.4

72 Source: Department of Commerce, Bureau of Economic Analysis, 1973.

73 Coal mining also represents a significant, although highly variable, employer in Appalachia. There are 21,845 surface miners in the 12 key Appalachian EA's, accounting for about 0.3 percent of total employment. By contrast, underground mining employs over four times as many miners in the same region - over 90,000. Table 4-5 shows the variability of coal mining employment by economic areas. Even in areas such as Huntington-Ashland and Bristol, where coal mining is a significant source of employment, surface mines usually employ less than 1 percent of the total work force. In individual counties, such as Raleigh and Pike, however, the degree of dependence on surface and underground coal employment is significantly greater.

*5*TABLE 4-5. - COAL MINING EMPLOYMENT, 1970

Economic Area	Total employment	Coal mining employment	Surface mining employment	Surface mining as percent of total employment

11. Williamsport, Pa	144,739	2,144	1,483	1.0
66. Pittsburgh, Pa	1,292,238	28,185	4,837	.4
68. Cleveland, Ohio	1,684,838	1,311	1,099	1
64. Columbus, Ohio	638,442	1,582	1,091	.2
65. Clarksburg, W. Va	100,541	9,547	1,527	1.5
52. Huntington, W.Va.-Ashland, Ohio	367,811	35,726	5,027	1.4
53. Lexington, Ky	230,571	7,105	2,080	.9
51. Bristol, Va	232,259	18,245	1,488	.6
50. Knoxville, Tenn	273,408	5,023	1,614	.6
49. Nashville, Tenn	527,528	184	117	n(1)
48. Chattanooga, Tenn	260,268	495	145	n(1)
45. Birmingham, Ala	591,256	5,012	1,337	.2
Total Appalachia	6,343,899	114,559	21,845	.3

73 n1 Nil.

73 Source: Bureau of Mines, Department of the Interior, and Bureau of Economic Analysis, Department of Commerce, 1973.

73 The relative economic importance of coal mining has declined as the employment base has diversified. This decreased dependence on mining is indicated in Table 4-6 for four selected economic regions in central Appalachia. The increased economic diversity contributes to increased economic stability and viability. Consequently, a curtailment of coal mining would be less significant now than in the past when coal mining was a more important part of the earnings base.

*5*TABLE 4-6. - MINING AND MANUFACTURING EARNINGS IN SELECTED ECONOMIC AREAS

Basic economic area	Mining earnings/manufacturing earnings			
	1940	1950	1959	1969
51. Bristol, Va	1.40	1.02	0.60	0.30
52. Huntington, W.Va.-Ashland, Ohio	3.73	4.24	2.17	1.54
53. Lexington, Ky	2.03	1.63	.71	.23
66. Pittsburgh, Pa	1.35	1.12	.58	.35

73 Source: Data supplied by the Appalachian Regional Commission, January 1973.

APPENDIX A
ENVIRONMENTAL EFFECTS OF MINING AND RECLAMATION UNIT OPERATIONS

83 It is useful to determine the environmental impacts of nine individual operations which, when integrated into total operations, comprise all types of surface mining and reclamation. Most area and contour strip mining approaches employ all of them.

83 Each of the nine operations has a different set of effects on the environment. The construction of access roads for moving heavy equipment and hauling coal generally leads to increased erosion, sediment transport, and dust. As a rule, these roads are rarely paved or otherwise significantly improved. If access roads are not carefully constructed in mountainous areas, landslides and slumping (or caving in of fill benches) can occur. Also access road construction can lead to changes in water courses unless adequate provision is made for culverts and bridges.

83 Drilling and Blasting required to fracture overburden prior to removal by draglines, shovels, front end loaders, and bulldozers can result in landslides and slumping in mountainous areas. Such land movement can lead to flooding and disruption of wildlife patterns and ground water flow.

83 Scalping - or clearing of vegetation and removal of topsoil from both the area where the overburden will be removed and the area where the overburden will be placed - destroys the ground cover. This leads to a number of temporary effects, particularly erosion and disruption of wildlife patterns. In mountainous terrain, scalping is often performed downslope from the coal outcrop, so as to allow a better bind between the overburden push downslope and the hillside.

83 Removal and placement of the overburden clearly presents the largest environmental challenge. The problem is minimal with area mining because, except for the first cut, the overburden is placed in previously mined cuts.

Thus the impact of this step is limited primarily to the effects of the first and final cuts. Erosion and sedimentation can occur but, with good water management, these can be minimized. In mountainous terrain, however, the overburden removed has traditionally been cast over the downslope or on the outer edge of the bench. This practice increases markedly the potential for landslides and slumping, erosion, highwall collapse or sloughing, chemical pollution, flooding, ground cover and wildlife pattern disruption and generally precludes future uses of the mined areas. To the extent that significant improvements can be made in preventing damages from placement of the overburden, the total environmental abuse from strip mining will greatly diminish.

84 Coal removal is accomplished by small machinery such as shovels and front-end loaders or by augers. While the impacts of this step are usually quite small compared to overburden removal, chemical pollution and sedimentation can result during the coal removal step. If augering is used, there is the danger of causing ground water pollution as water in the open cavities reacts with the pyritic material and seeps into ground water courses.

84 Reclamation operations are designed to correct the adverse environmental impacts. Spoil rehandling and grading is the most important of the four reclamation steps. Following area mining, the surface can be leveled to allow future productive uses of the land. Following or concurrent with contour mining, the spoil can be returned to the bench and stacked against the highwall and then graded to a stable contour. These operations significantly reduce landslides, slumping and highwall problems. Although they may temporarily increase erosion, sediment transport, and chemical water pollution by exposing new spoils to weathering, their overall impact is to reduce environmental damages.

84 Revegetation with grasses, legumes, trees, etc. tends to stabilize the surface of the exposed material and to improve the aesthetics. Erosion, sediment transport, landslide and flooding potential, and dust are reduced when the ground cover is restored. Previous or new uses of the land can be established.

84 Drainage controls handle the surface water and storm runoff through and around the mined area. Diversion of water from the mined area by cutting drainage ditches above the highwall and by shaping the contour of the hill reduces landslides, slumping, and flooding potential and minimizes erosion and sediment transport. Drainage controls are sometimes accompanied by treatment of chemically polluted water from the mined area.

84 Sediment basins constructed downstream from the mined area trap sediment which would otherwise lead to water pollution and siltation in streams and behind dams and diversions. Unless properly designed and maintained, such basins and their associated check dams can be a flooding hazard to property downstream.

84 The environmental effects of these nine operations are summarized in Table A-1. Each operation is rated according to its tendency to exacerbate or ameliorate adverse environmental effects. The ratings were developed by members

of the Task Force working group on reclamation and, as such, are the subjective judgments of the working group members. Most of the indicators reflect directly the previous description of the operations.

85 [See Table in Original]

85 Differences in the environmental effects resulting from the several surface mining approaches depend upon how each of the nine steps is performed and how they are combined to form a total mining operation.

APPENDIX B.
FOREIGN EXPERIENCE IN RECLAMATION OF STRIP-MINED LANDS

87 Although a number of countries - Belgium, Czechoslovakia, Denmark, Hungary, the Republic of South Africa, and the U.S.S.R. - conduct land reclamation programs, only the Federal Republic of Germany and the United Kingdom have had a fairly long and successful history of land reclamation efforts.

87 FEDERAL REPUBLIC OF GERMANY

87 Strip mining of "brown coal" (lignite) is the largest mining operation in the Federal Republic of Germany. The description below is based on short visits to the lignite mines of the Federal Republic.

87 Historical Background

87 Strip mining of lignite, along the lines which led to modern practice, started shortly before 1900. Improvement of strip-mined lands in Germany dates back to 1789 when the local Duke in the Cologne area ordered that trees be planted in the small surface mines. Large-scale planting of trees was started in 1906.

87 The first reclamation laws leading to current practice date from 1929 and were promulgated as amendments to existing mining laws. In 1940 a new regulation required that all topsoil with a depth of more than 20 inches should be removed separately and spread over spoil banks. Post World War II legislation and regulation (1950, 1951 and 1958) were even more precise in their requirements. The legislation established four basic criteria for all operations to follow:

87 1. Preplanning of future land use and type of reclamation to be employed.

87 2. Soil management and restoration of the surface by mining equipment.

87 3. Reforestation or agricultural cultivation of the restored land.

87 4. Permanent use of the reclaimed land for agriculture, forestry, or recreation.

87 Topographic and Geological Conditions

87 Topographical and geological conditions are favorable for reclamation. The Cologne lignite fields occur in a flat ridge between the Rhine and Erft Rivers. The lignite bed lies under unconsolidated sand, clay, and loess which allow removal by bucket wheel excavators without the use of explosives.

87 The mining area is located in forests and in some of the richest agricultural lands in the country. The high value of the land, the fact that there are many villages in this area, and the generally favorable geological and topographical conditions have made reclamation not only necessary but also economically feasible.

88 Economic Factors

88 A number of economic factors favor strip mining of the lignite and the subsequent land reclamation. The lignite reserves are large and located in a relatively small geographical area, leading to large scale mining with low mining costs. Lignite is the cheapest domestic fuel produced in Germany and competes with other fuels in the production of electricity in a region which has major industrial and domestic power consumers. Reclamation costs compare favorably with the market value of farmland restored to full agricultural productivity. Reclaiming land to this level of productivity is the most expensive type of restoration, with costs ranging from $3,000 to $4,500 per acre (1), or above $0 .24 to $0 .44 per ton of raw lignite. Since lignite has about one-fourth the calorific value of bituminous coal, this is equivalent to $1 to $2 per ton of bituminous coal. n1

88 n1 Based on an average lignite thickness of 50 to 75 feet.

88 Institutional Considerations

88 About 90 percent of the lignite in the Federal Republic is produced by one firm (Rheinbraun), which is a fully owned subsidiary of the largest utility company in West Germany. About 75 percent of the lignite is used for power generation. Twenty percent of all electricity generated in the Federal Republic is obtained from lignite. Because of the size of its operation, Rheinbraun can afford an excellent planning and engineering group. There is close cooperation between the company and the State authorities inlicensing and land use planning. The company also seeks the advice of professional bodies and places great importance on public relations.

88 Production Technology

88 The brown coal operation of the Rheinbraun is probably the largest earth moving operation in existence. Because of the depth of the opencast mines, all the overburden must be removed from the site and stored for later use.

88 Much of the success of land reclamation in the Federal Republic results from (a) preplanning of land use and (b) close supervision of the reclamation program. Prior to mining, careful study is conducted on geological conditions,

soil types and their suitability for agriculture or forestry, volume of the pit which will be created and the overburden which will be available for reclamation and water problems.

88 As mining proceeds, old villages are dismantled and new settlements with amenities (schools, churches and public facilities) are built a few miles away in non-coal bearing areas. The Village of Neu-Berrenrath, with about 3,400 inhabitants, is the largest resettlement. As of 1968, the company had resettled 17,000 people.

88 Stripped land is also turned into agricultural lands and recreation areas with forests and lakes. In 1968, 298 hectares (738 acres) were prepared for agriculture and 162 hectares (400 acres) for forestry.

88 UNITED KINGDOM

88 Historical Background

88 Although land management, restoration and reclamation are first noted in the Lands Clause Consolidation Act of 1845, it was not until the first Mines Act of 1923 that mined-land reclamation became of national importance. The enforcement of the Act was left to local authorities which apparently put pressure on operators for early reclamation of surface-mined land. The Opencast Coal Act of 1958 is now the governing legislation for surface mining.

89 Minerals have long been extracted by opencast mining in the United Kingdom but it was not until 1942 that large scale opencast bituminous coal mining was begun to meet wartime needs. Peak output of opencast coal was 14 million tons in 1958. From 1958 to 1970 the coal tonnage produced by this method declined because of lessened demand. Recently there has been renewed interest in opencast coal as a profitable source of additional output, with the result that there are now 30,000 acres of land in use for opencast sites (2).

89 Topographical and Geological Conditions

89 In contrast to lignite mining in West Germany where the bulk of the output is concentrated in one geographical area, surface coal mines in the United Kingdom are from many diverse regions. Therefore, it is difficult to generalize on the topography of the areas where coal is being surface-mined. But it is certain that some of the mines are in areas of steeper topography than is the case in the Cologne area of West Germany and that successful reclamation has been carried out in these areas.

89 Economic Factors

89 Cost of production per ton of saleable coal from opencast mines is about $ 1 less than the cost of coal mined underground. Reclamation costs of surface mined areas amount to about 4 percent of total production costs, or about [*] .20 per ton, according to National Coal Board (NCB) data for the last four years (3). In times of coal shortages, abandoned surface mines that have not been mined-out or restored for other uses can be brought into production in

relatively short time. At one site, contractors were extracting coal at the rate of 13,000 tons a week within two months of starting work (4). This flexibility is possible if total opencast output is maintained by the NCB at a level that provides a base for expansion.

89 Institutional Considerations

89 The coal industry in the United Kingdom was nationalized in 1947 when the National Coal Board was formed to administer the mines in behalf of the Government. The NCB took over the opencast mining operations from the Ministry of Power in 1952. Since then all lands mined have been fully restored either for agricultural uses or for building land or recreational areas.

89 Advertisement of the Board's intention to apply for a site is published in the local press and a period of 28 days is allowed for any objections to mining by Local Authorities, local residents, and others having an interest in the land. If objections from either Local Authorities or persons with an interest in the land cannot be resolved, a Public Inquiry is arranged at which both the Board and the objectors state their case before an Inspector nominated by the Minister of the Environment. Following the Inquiry the Inspector makes a report to the Secretary of State of Trade and Industry.

89 Production Technology

89 Opencast coal mining practice in the United Kingdom is very similar to area mining in the U.S. In shallow seams the coal is mined in a series of parallel cuts with overburden from each new cut being cast into a void of the previous cut. Deeper sites are worked by a series of box cuts, the final void being filled with overburden from the initial cut.

90 Reclamation Technology

90 The Opencast Coal Act, building on the Town and Country Planning Acts, clearly requires that the restoration of a given area to a usable condition be planned before mining begins, and that it remain under constant supervision from the beginning of coal stripping operations until five years after mining has been terminated. The preplanning phase will indicate whether the area to be mined would best be restored to agricultural use or forest land. Before work begins, a meeting is held between representatives of the NCB, the Ministry of Agriculture, the local Planning Authority and owners and occupiers of the land. Agricultural restoration plans divide a mining project into the following three parts:

90 Stripping.

90 The mine operator is responsible for the maintenance of a program of selective removal of all material overlying the coal to be mined. Topsoil and subsoil are removed and deposited in separate dumps. All remaining overburden must be stockpiled separately to prevent any admixture of topsoil, subsoil or overburden at any time.Particular attention is given to possible disturbance caused by noise, dust and blasting.

90 Contractual restoration.

90 This phase of the program is a part of the coal mining contract and is concerned primarily with backfilling. As the open pit develops to permit backfilling, the overburden, subsoil, and topsoil are placed in the mined-out portion of the pit floor in their original position and each level is graded to conform as nearly as possible to the original contour. NCB excrcises close supervision to ensure that topsoil, subsoil and overburden are not mixed. Provisions must be made for the drainage of the surrounding area at all times, and culverts and ditches supplied where required. The contract is completed when the topsoil has been satisfactorily spread and the sites are given over to the Ministery of Agriculture.

90 Agricultural restoration.

90 After backfilling and regrading, the land is retained under Ministry management for five years. During this time a program is carried out which includes drainage development, cultivation, fertilizing, the selection of crops and appropriate seed mixtures, and above all, the proper management of grassland and grazing.

90 Forestry restoration

90 This phase of restoration follows a plan generally similar to that employed for agricultural restoration except that usually in such instances the mining site is located on a hillside or ridge type terrain. Restoration of the mining site must therefore incorporate the return to hill and dale contouring, permanently terraced and ditched to prevent soil erosion. Management is extended for a five-year period after regrading to insure proper plantings and supervision.

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APPENDIX C
SOIL STABILITY AND LANDSLIDE POTENTIAL

93 With a rich geologic history, Appalachia presents a wide variety of

geologic conditions. The massive mountain range which stretches from Canada to Alabama contains many types of terrain, soil conditions, and vegetation. The land surface in Appalachia is used for many purposes, such as agriculture, forestry, recreation, and of significance to this study, minin. Much of the region is underlain with vast deposits of coal, sand and gravel, clays, stone, and metallic ores - minerals often extracted by surface mining.

93 Surface mining of coal and other commodities removes the protective vegetative cover and usually mixes the topsoil, subsoil, and broken rock strata - a mixture generally known as spoil material. About two-thirds of the spoil material in Appalachia is finer textured than sandy loam (1). Of course, spoil material with coarser textured materials, large rock fragments, and clays can be found throughout Appalachia. For example, various types of stone are produced in 62 percent of Appalachian counties. Clays are mined in 23 percent of Appalachian counties (1).

93 Instability of spoil material is a major problem associated with surface mining on sloping terrain. This instability causes two basic phenomena - surface erosion of the spoil and slides or slippage of entire masses of spoil (2). Both kinds of spoil material movement occur on surface mined areas and may result in serious environmental problems. Erosion and the resulting sedimentation pollute streams and lakes even at considerable distances from the mine, while slides can seriously damage areas adjacent to the mine.

93 Slope angle is an important element in the stability of slopes affected by or produced by surface mining. However, the severity of likely environmental problems caused by surface mining is strongly influenced by several properties of the spoil material. Spoil materials vary widely in their stability on the same slope angle, depending on the properties of the spoil materials (3). Some kinds of spoil materials are more stable on slopes of 25 degrees than other soil materials on slopes of 10 degrees.

93 EROSION

93 Surface erosion results from the abrading action of moving water on the surface of exposed spoil. In addition to slope angle, other factors that influence the erodibility of spoil materials include the related content of silt, sand, or clay content of organic matter, structure, and permeability (4). Where slope angle, rainfall and other factors are equal, spoil materials that are high in silt and very fine sand will suffer more than twice as much erosion losses as soils that are high in clay (5). Clay serves as an adhesive preventing the dislodging of individual soil particles that are easily eroded. Thus, generally speaking, when the spoil material is derived principally from siltstone and finely grained sandstone, the resulting material will be highly erodible; when it is derived from clay shales, it will be more resistant to erosion.

94 Complete vegetative cover is highly effective in reducing surface erosion and sediment production (6). Close-growing grasses which minimize the exposure of bare soil reduce erosion from sloping lands to only a few percent, or less, of that when the same soil is bare (7). For erosion control, grasses and

legumes are superior to the vegetative cover provided by trees. If small gullies are formed prior to establishment of vegetative cover, however, erosion will continue unchecked.

94 Surface mining spoils vary widely in the relative ease of establishing vegetative cover. Some spoil materials are so acidic that no plants will grow; others are marginal and require several years of careful management to obtain protective vegetative cover. In a few cases, the spoils are high in plant nutrients and have favorable physical properties so that good vegetative cover can be obtained within a few weeks after mining. Requiring that the material most favorable to vegetgrive growth be placed back on the surface after mining is quite effective in accelerating the establishment of ground cover and, hence, in minimizing erosion. The most favorable soil material at any mine site can be identified prior to mining. In fact, topsoil and subsoil properties and the amount of each type of material available per acre can be determined for a potential mining area through the use of existing soil surveys (8).

94 In summary, for a given slope angle, some erodible spoil materials that are difficult to vegetate suffer erosion losses of several hundred tons per acre per year for several years, while others that are resistant to erosion and easily vegetated may lose only a few tons per acre shortly after mining and very little in subsequent years. As the slope angle increases, the erosion from a given type of spoil material generally increases, except that with the prompt establishment of good vegetative cover, the erosion need not be greater than that from undisturbed land of the same type.

94 LANDSLIDES

94 Landslides or slippage also depends on the nature of the spoil material. Properties of bulk spoil and of the natural soil surface beneath the spoil are of critical importance. The major cause of slides and slippage is from overloading - stacking the material in an unstable configuration so that the internal structural strength of the material is exceeded. When this occurs, large masses of the material slide and slip to relieve the internal stress. n1 If the material is stacked on a slope, the sliding material may gain momentum and continue down the slope, destroying trees and ground cover in its path. If the spoil material is stacked on the bench and graded to original contour, the potential for landslides or slippage is negligible because the undisturbed solid bench retards slippage in the backfilled land mass.

94 n1 Technically, when the complements (normal and tangential) of the gravity forces acting on any plane in the spoil bank exceed the shear strength of the spoil material along that plane, failure will occur resulting in creep or slippage (9). If the degree of overloading of slopes and the water regime of critical layers are the same, spoil materials with low shear strength will be more likely to fail than spoils with high shear strength (10).

94 In general, clay materials not only have less shear strength, but are more likely to become saturated from surface water percolation. When this happens, the unstable spoil is susceptible to slippage along the saturated planes, and can result in landslides. Sandier materials, or permeable materials

with more than 50 percent coarse fragments have higher shear strength and are less likely to become saturated to the point where failure occurs. Thus, although clay helps to stabilize the surface against erosion, it may be much less stable against slippage and slides.

95 Vegetation generally does not reduce the tendency of soil materials to slip on slopes; in fact it may tend to increase the prospect for slippage if the reduction of runoff - a primary benefit from the standpoint of erosion control - causes increased infiltration of water into the zone just above a potential failure surface. The root system of large trees stabilizes the upper few feet of soil and removes water from potential failure surfaces by evapotranspiration. However, during the early years after mining, new trees are of little help in stabilizing the bulk of the spoil materials.

95 Included in the reference section is a short bibliography of technical literature on landslides (11), (12), (13), (14), (15).

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APPENDIX D.
RECLAMATION COSTS FOR PREVIOUSLY MINED LANDS

97 There have been a number of cost studies since the mid-1960's of reclaining mined lands after mining has ceased. Many of the earlier estimates were for partial reclamation to reduce off-site damages such as siltation and acid mine drainage. n1 More recently the estimates have included the cost of reducing the potential for landslides, returning the land to productive use, and improving the general appearance of the mined area. Some of the data from these studies are included in this appendix.

97 n1 In the 1967 Department of Interior report Surface mining and the Environment (1), the national average cost of "basic reclamation" was estimated to be $3 23 per acre. Adjusted to 1972 at a cost increase of 5 percent per year, this average would be $4 12 per acre. Another Interior study (2) in 1966 estimated the "basic reclamation" costs for strip mined coal in Applachia to be significantly higher than the national average, $521 per acre or $6 65 per acre adjusted to 1972.

97 Emerging from these studies have been several useful findings which are important in designing surface mining and reclamation plans. First, the costs of restoring the mined area to approximately its original contour or other similarly appropriate conditions can be reduced significantly if the reclamation is done soon after the mining ceases. The reclamation costs are lower because

the spoils have not spread out by landslides, slumping, and erosion. Early reclamation also avoids the cost of removing vegetation which in regions of high rainfall will spring up on the spoil banks. Second, reclamation costs can be reduced significantly if the equipment associated with the mining operation is used for reclamation, rather than having to move heavy equipment back into the area to be reclaimed.

97 In a 1965 comparison of five secondary backfilling methods, Griffiths and others estimated that the cost of contour backfilling could be reduced by two-thirds if done immediately following mining operations (3). Because timber was buried in and vegetation had grown on the spoil banks, the cost of regrading a previously mined area in Pennsylvania to original contour was $2 ,770 per acre (1965 dollars). If the downslope area had been scalped before mining and the reclamation conducted immediately after mining, the cost could have been $923 per acre, or $1 ,300 per acre adjusted to 1972 levels at 5 percent increase per year. If $2 50 per acre were included for revegetation, the incremental production costs for reclamation of this Pennsylvania mine would be 33 cents per ton of coal at 1972 levels.

97 A recent analysis for the Applachian Regional Commission of twenty-one backfilling and grading operations during 1967-1971 in Appalachia revealed that the cost of backfilling could be correlated only with the degree of spoil dispersion in the downslope (4). That is, the more spoil spread over a larger area, the greater the cost of recovering and moving it. Also the steeper the slope angle, the greater the tendency for spoil cast onto the downslpe to slide down it, thus further increasing backfilling costs. This study for the Commission indicated that the cost of terrace backfilling was, on the average 57 percent of the cost of contour backfilling because only 25 percent to 40 percent of the spoils is moved back up the slope for terrace backfilling while 75 percent of the spoils must be moved in contour backfilling. The average costs for a West Virginia operation in this analysis were $5 26 per acre or about 8 cents per ton for terrace backfilling and $9 23 per acre or 13 cents per ton for contour backfilling. These costs do not include revegetation or sediment control which would add 4 cents to 6 cents per ton.

98 The major cost variability in restoring previously mined lands is the intended future use of the land. If the land is to become productive again then the reclamation must restore a stabilized contour with vegetation that is appropriate to the use. With area mining the objectives can be obtained easily and at a reasonable cost if the reclamation follows soon after the mining. If the land is not reclaimed shortly after mining, natural vegetation will become established over time, thus adding to reclamation costs in the future if further reclamation is performed.

98 The passage of time is even more important in restoring previously mined lands on steep slopes. Where the overburden has been pushed to the edge of the bench and down the slope, landslides and erosion will carry the spoils farther down the slope and over a more extensive area.

98 Since the major cost, and the most highly variable one, is the cost of moving the spoil back up the slope to cover the exposed bench and highwall, or

otherwise placing the spoil to both stabilize and revegetate it, spreading of the spoils and new vegetative growth on the spoils increase costs markedly. Thus prompt reclamation is essential both from the viewpoint of reducing environmental damages and reclamation costs.

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APPENDIX E.
COST ANALYSIS OF CONTOUR MINING AND RECLAMATION TECHNIQUES

99 This appendix presents the details of contour mining and reclamation costs. Such analysis is complicated by the proprietary nature of coal production and reclamation cost data, particularly for integrated mining and reclamation operations. This analysis is based on data in a recent Bureau of Mines Study (1), an unpublished study by Delsen of Resources For The Future (2), and an analysis by Saperstein and Secor of Pennsylvania State University (3). Qualitative descriptions of modified block-cut operations by Heine and Gukert (4) and the economics of block-cut operations by Compton (5) were also useful in the analysis.

99 To develop data on the increased costs of alternative reclamation techniques, a uniform set of assumptions was used and then unit operations data were considered to develop total engineering cost estimates for the alternatives. Empirical data were not adequate because they were very limited

and it was impossible to separate costs which truly reflected the differences in techniques from differences in factors such as topography, coal seam thickness or rainfall.

99 Costs were developed for a mining operation on a slope of 20 degrees with a 3 foot coal seam. The bench width was assumed to be 125 feet with a 25 foot undisturbed barrier at the outer edge, resulting in a 9 foot low wall and a 55 foot high wall. These assumptions represent a hypothetical mining operation in southwestern Pennsylvania, but the relative cost differences between techniques are representative of other parts of Appalachia as well.

99 Using these assumptions, total costs for 5 contour mining techniques were estimated: mining with no reclamation; mining with smoothing of the soil bank; mining with terrace backfilling of the bench; mining with contour backfilling of the bench; and mining using a modified block-cut technique.

99 The first 4 techniques are conventional. They all deposit overburden in a spoils pile on the edge of the bench or on the downslope and then go to different levels of effort to recover, reshape and revegetate it. Consequently, the unit operations and equipment they use are similar. In developing costs, this analysis assumes use of a diesel-powered dragline with a 7 cubic yard bucket to pile some of the spoils on the edge of the bench and drop the rest down the hillside. A bulldozer is used to clear the surface of vegetation and to remove topsoil prior to the use of the dragline. In the technique where no spoils are returned to the bench, the bulldozer is also used to compact and shape the spoil bank. This reduces its steepness, serving to reduce the likelihood of landslides. For the terrace backfilling and contour backfilling techniques, the dragline pulls part or all of the spoils back onto the bench, and the bulldozer smooths any remaining soil bank on the down-slope and also shapes the spoils on the bench in terraces or in a shape close to the original contour.

100 The cost differences among these four techniques were derived by first estimating the cost for mining without reclamation, incorporating data on the efficiency of utilization of the various pieces of equipment and standard labor productivity rates. Costs for successively higher degrees of reclamation - smoothing the spoil bank, terrace backfilling, and contour backfilling - were then derived based on the extra unit operations needed, reduced productivity per hour and the resultant overtime labor needed to use equipment most effectively and compensate for some of the lost output.

100 As contrasted with the four conventional techniques, the modified block-cut technique combines mining and reclamation in an integral operation. With this technique, a large 17 cubic yard capacity front end loader is used rather than a dragline. This loader is used to move the overburden along the bench from one block to the next instead of depositing the overburden on the downslope. Bulldozers are still used only to remove surface vegetation and topsoil prior to removing overburden and to shape the overburden back to its original contour. Coal is removed with a 6 cubic yard front end loader and transported off-site by truck. Because of the size of the front-end loader, the modified block-cut method can produce more coal per hour than any of the four

conventional techniques.

100 The cost estimates for the five mining techniques are presented in Tables E-1 to E-5. The data represent direct production costs as well as overhead but do not include any coal cleaning costs, railroad freight charges or profits. Total costs range from $3.90 to $4 .85 per ton depending on the technique. Hence, reclamation can increase costs by up to $0 .95 per ton over the no reclamation case. Because all Appalachian mining States minimally require that the spoil bank be smoothed, it is more realistic that $4. .29 per ton be considered the base cost case, or an incremental cost of $0 .30 per ton.When this is done, it is seen that terrace back-filling increases the cost of a ton of coal by $0 .30. Similarly, contour backfilling represents an increase of $0.56 per ton.

100 The $4 .46 per ton estimate for the modified block-cut technique represents a cost increase of $0.56 over the no reclamation case, or $0 .17 per ton over what is now required in many Appalachian States.

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101

TABLE E-1. - CONTOUR STRIP MINING WITH NO RECLAMATION
Dollars per ton

Dragline	$0.45
Coal loader, 6 cu. yd	.12
Drilling	.33
Blasting	.72
Trucking off site	.20
Bulldozer operations	.28
Union welfare	.65

Administration, marketing, insurance	.35
Mining rights (royalty)	.25
Land rent	.05
Taxes	.20
Tippling costs	.30
Total	3.90

TABLE E-2. - CONTOUR STRIP MINING WITH SMOOTHING OF SPOIL BANK

	Dollars per ton
Dragline	$0.45
Coal loader, 6 cu. yd	.12
Drilling	.33
Blasting	.72
Trucking off site	.20
Bulldozer operations	.49
Replanting	.06
Union welfare	.65
Administration, marketing, insurance	.35
Mining rights (royalty)	.25
Land rent (surface use)	.05
Taxes	.20
Tippling costs	.30
Total	4.29
Incremental cost over no reclamation	.39
Incremental cost over minimum	.00

TABLE E-3. - CONTOUR STRIP MINING WITH TERRACE BACKFILLING OF BENCH

	Dollars per ton
Dragline	$0.60
Coal loader, 5 cu. ft	.15
Drilling	.40
Blasting	.73
Trucking off site	.25
Bulldozer operations	.60
Replanting	.06
Union welfare	.65
Administration, marketing, insurance	.35
Mining rights (royalty)	.25
Land rent (surface use)	.05
Taxes	.20
Tippling costs	.30
Total	4.59
Incremental cost over no reclamation	.69
Incremental cost over minimum	.30

TABLE E-4. - CONTOUR STRIP MINING WITH CONTOUR BACKFILLING OF BENCH

	Dollars per ton
Dragline	$0.74
Coal loader, 6 cu. yd	.16
Drilling	.43
Blasting	.74
Trucking off site	.28
Bulldozer operations	.64
Replanting	.06

Union welfare	.65
Administration, marketing, insurance	.35
Mining rights (royalty)	.25
Land rent (surface use)	.05
Taxes	.20
Tippling costs	.30
Total	4.85
Incremental cost over no reclamation	.95
Incremental cost over minimum	.59

TABLE E-5. - CONTOUR STRIP MINING USING MODIFIED BLOCK-CUT

	Dollars per ton
17-cu.-yd. loader - overburden	$0.65
Coal loader, 6 cu. yd	.13
Drilling	.35
Blasting	.73
Trucking off site	.22
Bulldozers (2 required)	.55
Replanting	.03
Union welfare	.65
Administration, marketing, insurance	.35
Mining rights (royalty)	.25
Land rent (surface use)	.05
Taxes	.20
Tippling costs	.30
Total	4.46
Incremental cost over no reclamation	.56
Incremental cost over minimum	.17

NOTES ON COSTS

NOT INCLUDED IN ESTIMATES

Coal cleaning (mechanical, per ton)	$0.75-$1.50
Railroad freight charges (National average for all coal, ICC, 1971, per ton)	3.70
Profits	

102 INCLUDED IN ESTIMATES

102 Union Welfare

102 Due to the National Bituminous Coal Wage Agreement of 1971, welfare fund payments rose to 60? per ton on Nov. 12, 1971, and to 65? per ton Nov. 12, 1972. Payments are scheduled to rise to 70? May 12, 1973, to 75? Nov. 12, 1973, and to 80? May 12, 1974. If the coal is processed, i.e., part of the coal is discarded as refuse, the charge for union welfare is determined on coal shipped rather than raw coal mined. The fraction of coal mechanically cleaned has dropped from 63% in 1967 to less than 50% in 1971.

102 Mining Rights

102 This charge was taken from a Resources for the Future Study by Jerome Delson and adjusted to 1972 dollars.

102 Land Rent

102 This analysis assumes that the mining company owns neither the mineral nor surface rights. If the mining company owned the surface rights, a charge would have to be assessed against each ton of coal to recover the purchase price and upkeep (property taxes, etc.) associated with holding that property. If not owned, this represents a rental fee for the period when other land uses are precluded.

102 Taxes

102 From "Corporation Income Tax Returns, Statistics of Income-1968," Internal Revenue Service, 1972.The coal mining industry paid state and local taxes of $70 million and Federal corporate income tax of $4 1 million in 1968. This agrees well with the income tax of 19? per ton calculated by Delson, assuming a sale price of $3 .80 per ton (1968 basis), 8% return on investment

and straight-line depreciation.

APPENDIX F. HIGHLIGHTS OF STATE LAWS REGULATING SURFACE MINING OF COAL

103 ALABAMA

103 (Law of 1969)

103 A. Administrative Agency Department of Industrial Relations.

103 B. Requirements and Limitations

103 1. Procedural

103 (a) Permit. - Surface mining requires a permit, valid for one year, which can be obtained by (1) paying a $2 50 filing fee, (2) filing an adequate performance bond and (3) submitting a "statement" of the manner in which the operator intends to reclaim the land (no State approval of this "statement" is called for).

103 (b) Performance Bond. - The bond must be for $1 50/acre. It is released periodically on "any affected land" where the law's reclamation requirements have been met.

103 2. Substantive

103 (a) Drainage. - Water must be diverted from the operation in order to "reduce siltation, erosion, or other damage to streams."

103 (b) Reclamation. - The land must be graded to achieve a "rolling topography," including grading of overburden ridges to a minimum 10 ft. top width and of peaks to a minimum top width of 15 ft. Toxic matter must be covered.

103 The operator must direct seed or plant trees on disturbed land, except that this does not apply to (1) areas likely to fill with water, or (2) areas where soil hardness or toxicity or nutrient deficiency will "seriously inhibit plant growth." A departmental determination that land is "unplantable," made three or more years after the end of the permit term, relieves the operator of "all obligations under . . . [the law] with respect to [the] affected lands." The failure of natural weathering and leaching within 10 years to eliminate the soil's growth-inhibiting characteristics has the same effect. Subject to these exceptions, the operator must complete the reclamation of all affected land within three years from the expiration of the permit.

103 If the land is to be reclaimed for range, agricultural, recreational, or other specified uses, the statutory vegetation requirements may be modified. Survival standards are specified for tree planting.

103 C. Enforcement

103 In cases of violations of the law, the Department may issue a noncompliance notice and must hold a hearing on such notice after 30 days. If the Department's final order, entered after such hearing, is not complied with in the time it prescribes, it may go to court to get the bond forfeited or to get an injunction or other appropriate relief. Any person mining without a permit is guilty of a misdemeanor and liable for a $500-$5 000 fine (no such penalty for permit violations).

104 D. Other

104 Proceeds from bond forfeitures, to the extent that they exceed the costs of reclaiming the lands to which the forfeitures are applicable, may be used by the State to reclaim lands for which there is no private obligation to reclaim.

104 COLORADO

104 (Law of 1969)

104 A. Administrative Agency Department of Natural Resources, Bureau of Mines.

104 B. Requirements and Limitations

104 1. Procedural

104 (a) Permit. - Each mining operation requires a permit, valid for up to one year (all permits expire each June 30), which may be obtained by (1) paying a $50+ $1 5/acre fee and (2) filing an adequate performance bond. No reclamation plan is required prior to issuance of the permit. No permit may be issued to an operator currently violating the law under another permit.

104 (b) Performance Bond. - The amount is based on what the State determines in each case to be necessary to insure compliance with the law. There are no

minimum or maximum amounts. The bond is released periodically for "any affected land" where all reclamation requirements have been met.

104 2. Substantive

104 (a) Drainage. - Earth dams must be contructed where "necessary" and "practical" to impound water, unless they would interfere with mining or damage adjacent property. Acid-forming material must be sufficiently covered by earth or spoil material to prevent pollution from drainage, unless such material is covered by at least 4 ft. of water. Refuse must be disposed of in a way that will "control pollution", and drainage from the mine must be diverted in a way that will "control" siltation, erosion, or other "damage" to streams.

104 (b) Reclamation. - By July 1 of each year operators must submit a reclamation "plan" describing the methods of reclamation chosen by the operator and any results already achieved. The law specifies that "an even or gently undulating skyline will be a major objective" and requires that ridges and peaks must be struck off to a top width not exceeding 15 ft. in all cases.

104 The operator must designate, subject to the Department's approval, the intended use(s) for the land or parts of it. The law specifies certain grading and/or revegetation requirements for each of the major use categories (e.g., range, agriculture).

104 The law defines reclamation as the employment "during and after" mining of procedures "reasonably designed" to "minimize" disruptions and provide rehabilitation.The reclamation must be completed within three years of its commencement, except that no planting is required (1) on land used for deposit of refuse until such depositing is ended or (2) the soil is so toxic, deficient in nutrients, or hard as to "seriously inhibit" plant growth despite use of chemical treatment, fertilizer, replacement of overburden, or similar measures.

105 C. Enforcement

105 If the Department is unable to get violations corrected through informal measures, it may issue a notice of non-compliance and after 30 days hold a hearing. If the operator fails to comply with any order resulting from a hearing, the Department may, after a further hearing, request the Attorney General to initiate court action to forfeit the performance bond. There are no provisions for penalties, permit revocation, or injunctions against illegal operations.

105 ILLINOIS

105 (Law of 1971)

105 A. Administrative Agency Department of Mines and Minerals, Division of Land Reclamation.

105 B. Requirements and Limitations

105 1. Procedural

105 (a) Permit. - A permit, valid for one year, is required for any surface mining operation (1) affecting more than 10 acres during a year or (2) in which overburden exceeds 10 ft. in depth. Permits may be obtained by (1) paying a $50+ $2 5/acre fee, (2) filing an adequate performance bond, and (3) submitting an acceptable reclamation plan.A permit "should not" be issued to an operator against whom bond forfeiture proceedings have been required unless he provides adequate assurance that such proceedings will not again be necessary.

105 (b) Performance Bond. - The bond must be in the amount of $600-$1000/acre, determined by the Department. It is released when grading and covering with materials capable of supporting vegetation have been completed, except for $1 00/acre to be retained until vegetation requirements are met.

105 2. Substantive

105 (a) Drainage. - All requirements of the Illinois Environmental Protection Act (which includes water quality controls) must be met during and after mining and reclamation. Runoff water must be impounded, drained, or treated to reduce soil erosion and pollution. Operators must construct earth dams if necessary to impound water, provided this will not interfere with other mining or other subsequent use of the property or damage adjacent property. Acid-forming material must be covered by 4 ft. of water or by solid material, at a slope not exceeding 30 percent (at 15 degrees), capable of supporting plant and animal life. Accumulations of "toxic waters" are forbidden. Slurry must be confined.

105 (b) Reclamation. - The general rule is that mined land must be regraded to "a rolling topography traversible by machines necessary for maintenance in accordance with [the land's] planned use," with resulting slopes not to exceed a 15 percent (at 8 degrees) grade. Terracing must be done where necessary to prevent excessive erosion.

105 On lands to be used for forestation, "enhancement of wildlife," or recreational sites, the final cut spoil, box cut spoil, and outslopes of overburden; and the side slopes of haulage roads to be used for lake formation, may have grades up to 30 percent (at 15 degrees). In no case must a slope be reduced to less than its pre-mining grade. Where pools or lakes capable of supporting aquatic life may be formed by drainage or rainfall, and where the land is to be used for a Stateapproved sanitary landfill, no reclamation is necessary, according to regulations.Lands used for row crop agriculture within five years before mining and found by the Department to be both capable of being returned to such use and optimally suitable for such use must be graded to its "approximate original grade".

106 The operator must propose post-mining land uses in his reclamation plan. This plan must be given to the appropriate county (governing) board(s) to review. These boards may propose post-mining land uses. The Department must issue a public statement explaining any decision to disapprove either a plan or a county board's land use proposal.

106 Grading must "proceed in conjunction with surface mining" and must be completed within one year after the end of the permit term. All other reclamation must be completed within three years after the end of the permit term. Extensions necessary to achieve acceptable reclamation may be given at the Department's discretion or the performance bond may be forfeited.

106 Unless the land will within three years support plant growth meeting the Department's vegetation standards as a result of natural weathering and leaching, it must be covered with topsoil or other materials adequate to support such growth.

106 C. Enforcement

106 If an operator violates the law or regulations, the Department may notify him, hold a hearing after 30 days, and then, if still necessary, request the Attorney General to start court proceedings to forfeit the performance bond. The Department may enjoin any operator lacking a permit or violating the law's provision prohibiting mining that threatens subsidence on adjacent lands.Operating without a permit (but not violating a permit) is a misdemeanor, punishable by a $50-$1000 fine for each day of violation.

106 D. Other

106 The permit applicant must prepare a statement on environmental impacts, which the Department must consider before issuing a permit.

106 INDIANA

106 (Law of 1967, as amended in 1972)

106 A. Administrative Agency Department of Natural Resources, Division of Forestry.

106 B. Requirements and Limitations

106 1. Procedural

106 (a) Permit. - Each mining operation requires a permit, valid for one year, which may be obtained by (1) paying a fee of $50+ $1 5/acre (2) filing an adequate performance bond, and (3) submitting a proposal for operations and reclamation that is consistent with the law and regulations. No permit will be issued to an operator who has had a prior permit revoked until the violations have been corrected.

106 (b) Performance Bond. - The bond must be at least $2000 or $3 00/acre, whichever is greater. The bond may be reduced annually as reclamation is completed and/or $1 000 is retained, up to 15 years, until satisfactory vegetation cover is established.

107 2. substantive

107 (a) Drainage. - Operators must construct earth dams in final cuts to impound water unless the lakes would interfere with other mining or damage adjacent property.Acid-forming material in the exposed mineral seam must be covered with non-toxic overburden or impounded water. Grading must "minimize" erosion.

107 (b) Reclamation. - Peaks and ridges must be reduced and depressions diminished to a "rolling, or sloping, or terraced topography" consistent with the reclamation plan's approved land use objectives. Regulations specify maximum slope angles allowed for various intended land uses. In no event may the final cut be graded to a slope exceeding 33 1/3% (approximately 16 degrees) unless it will be filled with water. All debris and refuse must be buried or removed.

107 The area must be revegetated to conform with the approved land use objectives and in accordance with departmental specifications.

107 Reclamation, including revegetation, must be started "as soon as practicable" after mining has started, with the statutory grading requirements carried out "as soon as practicable" after deposit of the overburden. Regulations define this as meaning no more than two spoil ridges behind the mining activity. The portion of the performance bond applicable to revegetation ($75/acre, but no less than $1 000) is held until a "satisfactory vegetative cover" (acceptable for commercial agriculture or forestry) is established, but not to exceed 15 years.

107 C. Enforcement.

107 If an operator violates the law, the Department may revoke his permit and forfeit his bond after written notice and an opportunity after 10 days for a hearing. Violation of the law is a misdemeanor, punishable by a $1000-$5000 fine.

107 KENTUCKY

107 (Law of 1954)

107 A. Administrative Agency. Department of Environmental Protection, Division of Reclamation.

107 B. Requirements and Limitations

107 1. Procedural

107 (a) Permit. - Surface mining requires a permit, good for one year, which may be obtained by (1) paying a fee of $150+ $3 5/acre of land to be affected, (2) filing an adequate performance bond, and (3) submitting an acceptable reclamation plan, provided that the operator has not been in repeated non-compliance with the law, has not had past permits revoked more than three times, does not currently have a permit revoked, and has not left lands

unreclaimed.

107 (b) Performance Bond. - The amount of the bond shall be established after "consideration" of reclamation costs, but shall be between $200 and $1000/acre, with a $2 000 minimum total, unless "circumstances" warrant an exception to the minima. The bond is released periodically as backfilling and grading are completed on portions of the land, except for $1 00/acre which is retained until revegetation is completed.

108 2. Substantive

108 (a) Drainage. - The law contains general requirements that any breakthrough of "hazardous" acid water be sealed off, that runoff water be impounded, drained, or treated "to reduce soil erosion . . . and pollution of . . . waters." Regulations contain specific pH and turbidity discharge limitations for all mine drainage and require that treatment facilities to meet these limits must be kept working until the operator demonstrates that the standards can be met without them. No drainage may be discharged into underground mines.

108 If experience indicates these requirements, or the requirements for reclamation, discussed below, cannot be met on the proposed site, the permit must be denied.

108 (b) Reclamation. - For area mining (i.e., up to 12 degrees slope) complete backfilling to approximate original contour is required, to eliminate all spoil peaks and highwalls. For contour and auger mining, "terrace backfilling" (undefined) is required, with the regulations specifying that no overburden from second or subsequent cuts may be either pushed over the outslope from the first cut or piled on the outer onethird of the fill bench for the first cut. The steepest slope of the reduced or backfilled highwall and of the outer slope of the fill bench must be 45 degrees or less, except where precluded by solid rock conditions.

108 Reclamation must be "kept current," pursuant to departmental regulations commenced "as soon as possible" after mining starts and completed no later than one year after the permit expires. For area mining, departmental regulations define "current" as having grading and backfilling no more than two spoil ridges behind the pit being worked (the spoil from which is the first ridge) completed within 90 days after an area is mined. For contour mining, grading and backfilling must follow coal removal within 15 days and 1500 feet. If augering is also involved, augering must follow stripping within 60 days, with grading and backfilling following the augering within 15 days and 1500 feet.

108 All toxic or acid-producing material and other refuse must be buried.

108 "Suitable vegetative cover" is required by the law and is administratively defined as a 70 percent stand. If prompt planting appears unlikely to be successful, the Department may authorize a deferral until soil conditions are acceptable or may permit the operator to vegetate instead equivalent acreage of previously mined, unvegetated land where soil conditions now permit successful planting. Segregation and replacement of topsoil is not

required by law.

108 (c) Bench Width . - The law authorizes regulations limiting bench width and amount of overburden that may be placed beyond the solid bench. Current regulations limit bench width to 220 ft. and a 12-14 degrees slope, down to 80 ft. at a 27 degrees slope. Beyond 27 degrees, only auger mining is permitted, with a maximum 60 ft. bench at 28 degrees, down to a no-fill bench at 33 degrees or above. (See discussion in (b) above on placement of overburden.)

108 C. Enforcement

108 The Department must issue a notice of non-compliance or order suspension of the permit "where necessary," if an operator fails to comply with the law, regulations, or orders. If the operator does not comply with a notice of non-compliance or reach agreement with the Department within the time specified in the notice, the permit may be revoked and the performance bond forfeited.

109 If a State official fails willfully and deliberately to enforce the law and fails for an unreasonable time after the demand of a citizen to rectify this situation, the citizen may bring a court action to compel the official to perform his duties.

109 The Attorney General must, if requested by the Department, bring a court action to restrain any actual or threatened violation of the law, regulations, or orders and to recover the civil penalties provided for such violations. Such penalties are $100-$1 000 for each day of violation. Willfull violations are a misdemeanor, punishable by a fine of $500-$5000/day.

109 D. Other

109 The State may acquire and restore unreclaimed orphaned lands and spoil piles, but may use only funds from forfeited performance bonds or other funds that become available. (Fees go to the State's general fund.)

109 MARYLAND

109 (Law of 1955, as amended in 1972)

109 A. Administrative Agency

109 Department of Natural Resources, Geological Survey, Bureau of Mines.

109 B. Requirements and Limitations

109 1. Procedural

109 (a) Permit . - Operators must be licensed (at a cost of $1 00+ $1 0 for annual renewal).A license will be denied to anyone who continues to violate the surface mining law or who has forfeited a bond posted for surface mining in any State. In addition, the permit required for each operation, valid for the life of such operation, may be obtained by (1) paying a "reclamation fee" of $3

0/acre, which is matched by the State and placed in a State reclamation fund; (2) submitting an acceptable mining and reclamation plan; and (3) indicating that the operator has not failed to comply with the law under any prior permits.

109 (b) Performance Bond . - After the permit application is approved but before mining, the operator must file a bond of $400/acre but no less than $3 000 total. Unless released earlier (presumably for satisfactory completion of reclamation), liability extends for five years after mining.A separate "revegetation bond" is required, based on estimated revegetation costs, but between $50- $125/acre.

109 2. Substantive

109 (a) Drainage . - The operator must prevent "avoidable" stream pollution in excess of technological-engineering standards set by the Department. Presumably, violation of the water quality laws (standards set by the Health Department) can be restrained by the State as well as by the Federal government. Department regulations specify measures to "prevent" erosion and formation of acid water. Deep mines with impounded water must be bypassed or sealed.

110 (b) Reclamation . - Regulations provide that (1) for area mining (less than a 12 degrees slope) the land must be restored to "approximate original contour" and (2) for contour mining (slope of 12 degrees or more) either terracing or modified terracing is required. Terracing means the steepest slope of the highwall and spoil bank shall not exceed 45 degrees, with bench width limited as indicated in (c) below. Modified terracing eliminates the 45 degrees limit for the highwall when there is insufficient soil for suitable vegetation on the reduced highwall or when reduction or backfilling of the highwall will excessively damage vegetated land above the highwall.

110 Regulations require concurrent reclamation, defined as grading and backfilling no more than two spoil ridges behind the pit being worked and completed within 90 days after mining is completed. Where only one cut is anticipated, backfilling may not follow mining by more than 2000 ft. However, the regulations permit exceptions to be granted for all of the time and distance requirements. For augering, backfilling must be completed as mining progresses and the soil compacted.

110 Unless an exception is granted, regulations require that topsoil be segregated and replaced. Neither the law nor the regulations contain performance standards for revegetation. Areas to be planted must be examined by the State Forester and, "when possible," he is to furnish a report, the recommendations in which are to be "strictly adheared to" by the operator.

110 (c) Bench Width . - Regulations limit the bench width for the first cut as a function of original slope angle and allow additional cuts only if placement of overburden meets the same limits, which range from a maximum of 250 ft. at 15 degrees or less to 60 ft. at 31-33 degrees. Above 33 degrees, no fill material is allowed beyond the cut bench.

110 C. Enforcement

110 If an operator fails to comply with the law or regulations, the Department must notify him and specify a time for compliance; if the violation continues beyond such time, the Department may issue a cease-and-desist order. If the non-compliance persists, the Department may cancel the permit to revoke the bond following a hearing. Mining without a permit or in violation of a permit is a misdemeanor, for which the operator may be fined $500-$5000. After July 1, 1973, the penalty is $1 000-$1 0,000 and/or imprisonment up to two years, and the operator must, in addition, pay a sum sufficient to reclaim the illegally mined area.

110 D. Other

110 Funds from civil penalties, bond forfeitures, and reclamation fees are used by the State to forest and reclaim surface mined lands.

110 MONTANA

110 (Law of 1971)

110 A. Administrative Agency

110 Department of State Lands, State Board of Land Commissioners.

111 B. Requirements and Limitations

111 1.Procedural

111 (a) Permit. - No surface mining operation that will remove more than 10,000 cubic yards of product or overburden may be conducted without a "contract" between the Board and the operator. This contract, which is equivalent to a permit, may be obtained by (1) paying a $5 0 fee, (2) filing an adequate performance bond, and (3) submitting an acceptable reclamation plan. Each contract continues in force indefinitely until terminated by mutual consent.

111 (b) Performance Bond . - The amount is $2 00-$1 000/acre but not to exceed the costs of required restoration.It remains in effect until reclamation is completed and approved, but may be released in part as acreage is restored.

111 2. Substantive

111 (a) Drainage . - Earth dams or other "reasonable devices" must be used to control drainage - unless they would impair other landowners' rights or cause water pollution - whenever needed to prevent acid drainage or sedimentation.

111 Acid-forming material must be covered and refuse disposed of to prevent water pollution.Water from mining must be diverted to control siltation, erosion, or other damage to streams.

111 (b) Reclamation . - The reclamation plan must provide for "the best

possible reclamation procedures available under the circumstances at the time" so that the land is restored to a "productive use." When required by the plan, soil material must be placed on disturbed areas to permit plant growth on slopes up to 2:1. Wastes must be removed or buried.

111 Archaeological and historical values in areas to be mined must be given "appropriate protection."

111 Vegetative cover "commensurate with the proposed [post-mining] land use" must be established "to the extent reasonable and practicable."

111 Reclamation must be "concurrent" with mining "as feasible," and must be completed within a specified "reasonable length of time."

111 C. Enforcement

111 "Disputes" between the Board and an operator may be resolved by "judicial proceedings" but only after a hearing has been held by the Board unless such proceedings need to be started immediately in order to "avoid serious harm to the environment."

111 If reclamation is not carried out as specified in the approved plan, the Board, may, after 30 days' notice, order the operator to stop mining. If the operator disobeys the order, the Board may initiate court action to enjoin further operations and may sue for damages for breach of contract and/or forfeiture of the performance bond.

111 Operating an open cut or strip mine without a permit is a misdemeanor subject to a $500-$1,000 fine.

111 D. Other

111 The Department must prepare an environmental impact statement, under the Montana Environmental Policy Act, for each reclamation contract covering a major coal mining operation.

112 NORTH DAKOTA

112 (Law of 1970)

112 A.Administrative Agency

112 Public Service Commission.

112 B. Requirements and Limitations

112 1. Procedural

112 (a) Permit . - The three-year permit required for surface mining whenever the overburden will exceed 10 ft. may be obtained by (1) payment of a fee n1 and (2) filing of an adequate performance bond. A reclamation plan need

not be submitted for approval until December 1 following the permit issuance.Refusal or willful failure to comply with the law makes an operator ineligible for a subsequent permit.

112 n1 For 10 acres or less, $2 5+$7 .50 x number of affected acres between 2 and 10; for 11-50 acres, $100+$3 .50 x number of affected acres between 11 and 50; for 50 acres or more, $275+$2.50 x number of affected acres in excess of 50.

112 (b) Performance Bond. - The bond amount is $2 00/acre in all cases and is reduced proportionately as reclamation is completed.

112 2. Substantive

112 (a) Drainage. - The reclamation plan that the Commission must approve must "be based on the advice and technical assistance of the State soil conservation committee, the State game and fish department . . . and other agencies or individuals having experience in foresting and reclaiming surface-mined lands. . . . " In addition, earth dams must be constructed where lakes may be formed provided their formation will not interfere with underground or other mining.

112 (b) Reclamation. - Peaks and ridges must be (1) graded to a slope of not more than 20% (approx. 9 degrees) on land to be used for crops; (2) struck off to a minimum top width of 35 ft. on land to be used for pasture or forest; and (3) graded to a "rolling topography," with slopes not exceeding the original slope or 20%, whichever is greater, on land near to and visible from public roads or buildigns.

112 Reclamation need not be concurrent but must be completed within three years after the permit expires, unless extended to five years because the land fails to support plant growth. If further extension is needed, the Commission may grant it or forfeit the bond, but after the second seeding or planting an area shall be deemed reclaimed. There is no requirement to save topsoil.

112 The only performance standard for reclamation is that it must achieve "results appropriate to the use for which the area was reclaimed," and this general standard presumably is subordinated to the more limited, specific statutory standards described above.

112 C. Enforcement

112 The Commission must notify operators of violations of the law or regulations. If approved corrective measures are not commenced or agreed to within 90 days, the Commission may proceed to request bond forfeiture, which will satisfy all of the operator's reclamation obligations.

112 The Commission may seek an injunction against operators mining in violation of the law or regulations or without having a permit. The $50-$1000 minimal penalty applies only to mining without a permit.

113 OHIO

113 (Law effective April 1973)

APPENDIX G.
METHODOLOGY FOR DETERMINING SLOPE ANGLE DISTRIBUTIONS

125 Because physical data on the slope angle distributions of surface mined coal production and strippable coal reserves were not available, new and relatively fast methodologies had to be developed. It also became apparent that state records and mining plans for current mining operations did not provide direct information on slope angles or allow the location of specific mines on a topographic map. A carefully selected sample, stratified to assure a representative cross-section of key variables, was used. Because it was felt that there might be little correlation between current surface mining production and strippable coal reserves, slope angle distributions for production and reserves were determined separately.

125 Sampling was based on selecting counties which were representative of several key factors. First, counties chosen for the sample were in significant coal producing regions. Second, terrain, production and strippable reserves in these counties were representative of the general region, both within a state and in neighboring states (1). Third, a relatively larger number of Appalachian counties in regions of hilly or mountainous terrain were selected to increase the accuracy of statistical estimates of the slope angle distributions of coal production and strippable reserves at relatively steep slope angles. Fourth, wherever possible, sample counties were selected for which U.S. Geological Survey coal outcrop and contour maps were available.

125 Using these criteria and a consensus of the representatives on the working group from the Bureau of Mines, Geological Survey, Appalachian Regional Commission, and Soil Conservation Service, 25 counties were selected.

125 Slope angle distribution of production

125 To estimate the slope angle distribution of the current production, it was necessary to inspect all surface mining operations in the sample counties. This extensive task was undertaken by the Health and Safety Inspectors of the Bureau of Mines. By measuring the slope angle at the site of each mining operation and knowing the annual production of the mine, it was possible to estimate the total production in the sample counties as a function of slope angle. In addition to production and slope angle, the type of mine (strip or auger) and the sulfur content of the coal were determined.

125 The results from this field survey are presented in Table G-1. As the table shows, the sample counties for the Appalachian region account for 67 million tons of surface mine production, or 39 percent of surface mine production in the region.

126

*7*TABLE

G-1. - SLOPE ANGLE DISTRIBUTION OF COAL PRODUCTION IN APPALACHIAN COUNTIES

State/ sample county	1972 surface production (thousand tons per year)	Percentage of current coal production with interval				
		0-9.9 degrees	10 degrees- 14.9 degrees	15 degrees- 19.9 degrees	20 degrees- 24.9 degrees	25 degrees +
PENNSYLVANIA						
1. Butler	870	17	33	14	16	16
2. Clarion	3,110	59	38	1	2	1
3. Clearfield	3,795	37	30	24	7	2
4. Somerset	2,695	39	39	12	4	6
5. Washington	1,065	21	55	23	0	0
MARYLAND						
6. Garrett	775	29	45	0	26	0
OHIO						
7. Belmont	10,575	14	27	30	11	17
8. Gallia	157	33	56	11	0	0
9. Perry	625	0	16	84	0	0
10. Tuscarawas	1,175	10	0	6	63	20
WEST VIRGINIA						
11. Barbour	2,790	0	0	5	95	0
12. Kanawha	3,256	4	6	7	2	81
13. Mingo	2,655	0	0	0	11	89
14. Raleigh	1,895	1	1	4	11	83
KENTUCKY						
15. Bell	2,950	0	0	61	19	20
16. Breathitt	6,765	0	0	0	38	62
17. Carter	159	0	88	0	3	9

18. Laurel	362	0	22	59	19	0
19. Pike	7,780	0	1	0	4	95
VIRGINIA						
20. Buchanan	2,200	0	0	0	4	96
21. Wise	3,220	0	2	5	16	77
TENNESSEE						
22. Anderson	1,290	0	0	4	43	53
23. Campbell	1,780	3	3	17	31	46
24. Van Buren		n(1)	n(1)	n(1)	n(1)	n(1)
ALABAMA						
25. Jefferson	4,895	42	14	16	16	12
Total	66,839					

126 n1 Not available.

126 Since the sample counties were selected to be representative of a number of counties in a geographical subregion, aggregating the county production for each slope angle range (0-9.9 degrees, 10-14.9 degrees, etc.) allowed the calculation of the slope angle distributions of production by states or economic areas. In Table G-2, the county groupings are shown, with the sample counties (used as the model) for the grouping underlined.

126 TABLE G-2. - COUNTY GROUPINGS

126 ALABAMA

126 1. Bibb, Blount, Cullman, Etowah, Fayette, Jefferson n1, Marion, Shelby, Tuscaloosa, Walker, Winston [EA 45] n2

126 n1 Sample counties identified by underlining.

126 n2 The EA in which the county grouping falls is identified by number.

126 2. Jackson, (Jefferson n3) [EA 48]

126 n3 When a sample county for the grouping was not available, the slope angle distribution from the sample county in a nearby grouping was used; those sample counties are identified by the parentheses.

127 KENTUCKY (EASTERN)

127 1.Bell, Knox, Harlan, Whitley [EA 50]

127 2. Laurel, McCreary, Wayne [EA 50]

127 3. Floyd, Johnson, Lawrence, Martin, Pike [EA 52]

127 4. Boyd, Carter, Elliott, Greenup [EA 52]

127 5. Breathitt, Clay, Jackson, Knott, Leslie, Letcher, Magoffin, Morgan, Perry, Pulaski, Rockcastle, Wolfe [EA 53]

127 MARYLAND

127 1. Alleghany, Garrett [EA 66]

127 OHIO

127 1. Gallia, Lawrence, Meigs, Scioto [EA 52]

127 2. Athens, Fairfield, Guernsey, Hocking, Licking, Morgan, Muskingham, Noble, Perry, Washington [EA 64]

127 3. Jackson, Vinton, (Gallia) [EA 64]

127 4. Belmont, Harrison, Jefferson, Monroe [EA 66]

127 5. Carroll, Columbiana, Coshocton, Holmes, Stark, Tuscarawas, Wayne [EA 68]

127 PENNSYLVANIA

127 1. Centre, Clearfield, Clinton, Elk, Jefferson, Lycoming [EA 11]

127 2. Allegheny, Beaver, Fayette, Greene, Washington, Westmoreland [EA 66]

127 3.Armstrong, Cambria, Clarion, Indiana [EA 66]

127 4. Butler [EA 66]

127 5. Somerset [EA 66]

127 TENNESSEE

127 1. Bledsoe, Hamilton, Marion, Rhea, Sequatchie (Jefferson, Ala.) [EA 48]

127 2. Overton, Putnam, Van Buren, White [EA 49]

127 3. Campbell, Claiborne, Cumberland, Fentress, Morgan, Roane, Scott [EA 50]

127 4. Anderson [EA 50]

127 VIRGINIA

127 1. Buchanan, Dickenson, Russell, Tazewell [EA 51]

127 2. Lee, Wise [EA 51]

127 WEST VIRGINIA

127 1. McDowell, Mercer, (Buchanan, Va.) [EA 51]

127 2. Boone, Braxton, Clay, Gilmer, Greenbrier, Kanawha, Nicholas, Pocahontas, Webster [EA 52]

127 3. Fayette, Raleigh, Wyoming [EA 52]

127 4. Mason, Cabell, (Gallia, Ohio) [EA 52]

127 5. Logan, Mingo, Wayne [EA 52]

127 6. Barbour, Harrison, Lewis, Marion, Monongalia, Preston, Randolph, Taylor, Tucker, Upshur [EA 65]

127 7. Brooke, Marshall, Ohio (Washington, Pa.) [EA 66]

128 Slope angle distribution of strippable reserves

128 To estimate the slope angle distributions of the strippable reserves, it was necessary to calculate slope angle distributions of the outcrop of each coal seam in the sample counties using a statistical sampling technique. This task was performed by the U.S. Geological Survey and the Bureau of Mines. Available geologic maps that delineate coal bed outcrop lines on a topographic base were utilized for most slope angle determinations. Coal resource reports provided additional data concerning the areas likely to contain recoverable coal reserves in the selected beds. The angles of slopes along which these coal beds occur were determined by measuring the spacing of topographic contour lines and were assigned to the appropriate slope categories (0-9.9 degrees, 10-14.9 degrees, etc.).

128 The sampling technique used in determining the range of slope angles for coal beds in each sample county consisted of the following steps (2):

128 1. The intersection of latitude and longitude lines were identified and numbered consecutively on a 5-minute grid pattern on the available geologic map coverage for each county. In areas of limited coal bed distribution, a 2 1/2-minute grid was plotted to acquire a sufficient number of sampling points. These intersections or grid points determined the immediate areas of sampling.

128 2. The outcrop lines of coal beds with strippable reserves (2) were identified within a 2 1/2-minute area of the 5-minute grid points or within a 1 1/4-minute area of the 2 1/2-minute grid point.

128 3. Representative slope segments which included the identified coal bed outcrop lines were selected for measurement as close as possible to each grid point. The measured slope segment generally extended between prominent

topographic breaks such as the valley floor and the first prominent upslope bench.Where slope uniformity was evident, about 100 feet of topgraphic relief above and below the the coal outcrop line was included on the measured segment of the slope.

128 4. The angle of a slope segment was recorded for each coal bed near the grid points, and if considerable slope variation was evident within the sample area, several measurements were made and an average slope recorded, The spacing of topographic contour lines, indicative of slope angles, was measured with a template designed for rapid reading of slope angles.

128 5. The number of slope angle measurements was totalled by categories and the percentage distributions were calculated for each coal bed in each sample county. An example of the results of the analyses by the Geological Survey and Bureau of Mines is attached to this appendix. A list of source material used in compiling slope angles, slope distributions tables, and histograms is also included for each county.

129 As in the case of the current coal production, it was possible to use the slope angle distributions of the sample counties to calculate the slope angle distributions of strippable reserves in the surrounding counties. However, the procedure is considerably more complicated than for current coal production. Because of the necessity to take into account both the thickness of the coal bed and its slope angle distribution, the procedure consisted of the following steps:

129 1. Using the Bureau of Mines' data for each county, Floss and FBOM factors were calculated (3). Floss is either 0.8 or 0.5, depending on whether the coal would be recovered by stripping or augering, respectively. FBOM is the ratio of "strippable reserves" to "recoverable strippable resource" for each county.

129 2. Using the slope angle distributions for each coal bed in each county, the strippable reserves were allocated to the appropriate slope angle distribution, in each county.

129 3. The strippable coal reserves in each slope angle interval were determined for each county grouping and then aggregated for the state or economic area. The county groupings and model counties used for calculation of reserves were the same as those used for production; i.e., those in Table G-2. These quantities were identified as the "BOM" reserves. (The original county strippable reserves were calculated by BOM assuming an average slope angle of 0 degrees, 11 degrees, or 22 degrees for the entire state).

129 4. To adjust the "BOM" reserves for the actual slope angle distributions in the county or state, the strippable coal reserves in the five slope angle intervals were multiplied by the factors presented in Table G-3 (this can be done at any level of aggregation: county, county grouping, economic area, or state). These factors increase those reserves in slope angle intervals below the average angle for the state assumed by BOM and decreases those reserves above the average angle.

*6*TABLE G-3

State	Average slope angle in State assumed by BOM	Factors to adjust BOM strippable reserve estimates to actual slope angle distribution				
		0-9.9 degrees	10 degrees- 14.9 degrees	15 degrees- 19.9 degrees	20 degrees- 24.9 degrees	25 degrees+
	11 degrees	2.222	0.877	0.646	0.469	0.337
	22 degrees	4.617	1.822	1.344	.975	.700

[See Table in Original]

129 The result of the fourth step is the reclaculation of the strippable reserves for the Appalachian region, taking into account the actual slope angle distributions of the coal deposits. The slope angle distributions are presented in Table G-4.

130

*6*TABLE G-4. - SLOPE ANGLE DISTRIBUTIONS OF STRIPPABLE COAL RESERVES IN APPALACHIAN COUNTIES

State, sample county	Percentage of coal reserves within interval				
	0-9.9 degrees	10 degrees- 14.9 degrees	15 degrees- 19.9 degrees	20 degrees- 24.9 degrees	25 degrees+
Pennsylvania:					
Butler	49	47	4	0	0
Clarion	84	16	0	0	0
Clearfield	74	23	3	0	0
Washington	67	24	3	3	3
Maryland:					
Garrett	81	14	3	2	0
Ohio:					
Belmont	27	34	28	12	0
Gallia	6	65	27	1	0
Perry	85	15	0	0	0
Tuscarawas	64	35	1	0	0
Noble	7	28	63	3	0
West Virginia:					
Barbour	4	68	24	4	0
Kanawha	0	0	2	41	57
Raleigh	9	14	46	24	7

Kentucky:					
Bell	0	3	16	41	40
Breathitt	0	0	0	22	78
Carter	0	9	66	25	0
Laurel	32	34	24	8	3
Pike	0	0	0	28	72
Virginia:					
Buchanan	0	0	10	54	36
Tennessee:					
Campbell	9	6	30	44	11
Van Buren	96	4	0	0	0

[See Table in Original]

130 Although it was felt that slope angle prohibitions would have little effect on surface mining outside Appalachia, several sample counties were selected in the Central and Western coal regions to check this assumption. Using the same procedures previously described, the slope angle distributions of the current coal production and strippable reserves were determined for the sample counties. These data are summarized in Tables G-5 and G-6.

*6*TABLE G-5. - SLOPE ANGLE DISTRIBUTIONS OF COAL PRODUCTION IN CENTRAL AND WESTERN COUNTIES

State, sample county	Percentage of production within interval				
	0-9.9 degrees	10 degrees-14.9 degrees	15 degrees-19.9 degrees	20 degrees-24.9 degrees	25 degrees+
linois:					
Perry	n(1)	n(1)	n(1)	n(1)	n(1)
St. Clair	n(1)	n(1)	n(1)	n(1)	n(1)
Arizona:					
Navajo	100	0	0	0	0
Colorado:					
Routt	83	17	0	0	0
Wyoming:					
Campbell	100	0	0	0	0

[See Table in Original]

130 n1 NA=not available.

*6*TABLE G-6. - SLOPE ANGLE DISTRIBUTIONS OF STRIPPABLE COAL RESERVES

IN CENTRAL AND WESTERN COUNTIES

State, sample county	Percentage in slope angle interval 0-10 degrees	10 degrees-15 degrees	15 degrees-20 degrees	20 degrees-25 degrees	25 degrees+
Illinois:					
Perry	100	0	0	0	0
St. Clair	80	20	0	0	0
Arizona:					
Navajo	40	32	21	6	1
Colorado:					
Routt	44	22	18	14	2
Wyoming:					
Campbell	60	28	7	4	1

[See Table in Original]

131 REFERENCES

131 1. U.S. Department of the Interior, Bureau of Mines, Division of Fossil Fuels. Coal - Bituminous and Lignite in 1971. Washington, D.C., September 27, 1972.

131 2.U.S. Department of the Interior, Geological Survey. Unpublished report "Slope Angle Distribution of Coal Beds with Strippable Reserves." 1972.

131 3. U.S. Department of the Interior, Bureau of Mines. Strippable Reserves of Bituminous Coal and Lignite in the United States. 1971.

131 SAMPLE DATA

131 BELL COUNTY, KENTUCKY

131 Strippable coal reserves in Bell County, Kentucky are present in 14 beds of the Breathitt Formation (Table 5). Parts of fifteen 7 1/2-minute modern topographic quadrangle maps cover Bell County and published geologic maps showing coal bed outcrop lines were available for five quadrangles (see references). Data on coal beds in two other quadrangles were obtained from recently compiled maps now being processed for publication (Froelich, A.J., 1972, written communication). Coal bed outcrop lines in four quadrangles were located on unpublished maps compiled for the preparation of U.S. Geological Survey Bulletin 1120 (Huddle and others, 1963).No data could be located for small areas of the county in the other four quadrangles.

131 Geologic maps used in this study did not always show the same coal bed names as those listed in Table 5. The names of mapped coal beds which probably represent the stratigraphic interval containing the coal bed listed in Table 5 are as follows:

131 Low Splint coal bed - Creech, Amburgy, and Sandstone Parting

131 Jellico coal bed - Straight Creek, Mingo, and Darby

131 Bacon Creek coal bed - Bennett Fork, Hance, Rich Mountain, and Puckett Fork

131 Hagy coal bed - Mason

131 River Gem coal bed - Lily

*6*TABLE 5. - SLOPE ANGLE DISTRIBUTION OF COAL BEDS IN BELL COUNTY, KY.

6[In percent]

Coal bed	Slope angle distribution n1 0-9.9 degrees	10 degrees- 14.9 degrees	15 degrees- 19.9 degrees	20 degrees- 24.9 degrees	25 degrees+
Hazard No. 9	0	0	67	33	0
Hazard No. 8	0	0	25	50	25
Hazard No. 7	0	0	15	40	45
Lower Hignite	0	0	0	44	56
Lower Hamlin	0	0	0	25	75
Stray	0	0	0	31	69
Fire Clay Rider	0	0	0	26	74
Hazard No. 4	0	0	0	30	70
Low Splint	0	0	5	43	52
Jellico	0	4	25	39	32
Harlan	0	0	6	25	69
Bacon Creek	0	4	25	67	4
Hagy	0	0	53	33	14
River Gem	0	8	42	33	17

[See Table in Original]

131 n1 Slope angles determined from topographic contour lines by M. J. Bergin.

132 Topographic slope angles were measured at or near the intersections of the 2 1/2-minute latitude and longitude lines. A total of 272 slope angle measurements indicate that most beds crop out on slopes of more than 20 degrees (Table G-7). Exceptions are the Hazard No. 9 coal bed that underlies more gentle slopes near the ridge tops and the Hagy and River Gem coal beds that underlie more gentle slopes near the valley bottoms. The measured slope angles in Bell County, Kentucky, show the following distribution: 48 percent more than

25 degrees; 37 percent between 20 degrees and 25 degrees; 14 percent between 15 degrees and 20 degrees; and 1 percent between 10 degrees and 15 degrees.

132 [See Graph in Original]

133 REFERENCES CITED

133 Englund, K. J., Geology of the Middlesboro South quadrangle, Tennessee-Kentucky-Virginia: U.S.Geol. Survey Geol.Quad. Map GQ-301. 1964.

133 Englund, K. J., Smith, H. L., Harris, L.D., and Stephens, J. G., Geology of the Ewing quadrangle, Kentucky and Virginia: U.S.Geol. Survey Geol.Quad. Map GQ-172. 1961.

133 Englund, K. J., Landis, E.R., and Smith, H. L., Geology of the Varilla quadrangle, Kentucky-Virginia: U.S.Geol. Survey Geol.Quad. Map GQ-190.1963.

133 Englund, K. J., Roen, J.B., and DeLaney, A. O., Geology of the Middlesboro North quadrangle, Kentucky: U.S.Geol. Survey Geol.Quad. Map GQ-300. 1964.

133 Froelich, A. J., Geologic map of the Wallins Creek quadrangle, Harlan and Bell Counties, Kentucky: U.S.Geol. Survey Geol.Quad. Map GQ-1016. 1972.

133 Huddle, J. W., Lyons, E. J., Smith, H.L., and Ferm, J. C., Coal reserves of Eastern Kentucky: U.S.Geol. Survey Bull. 1120, 247 p. 1963.

APPENDIX H. OCCUPATIONAL HEALTH AND SAFETY IMPACTS OF SLOPE ANGLE PROHIBITIONS

135 The impact of a slope angle prohibition on occupational health and safety can be evaluated by comparing death and injury rates for surface mining with the rates for the major alternatives discussed in the text, i.e. underground mining, mining on less steep slopes, and use of other fossil fuels.

135 According to the National Safety Council, underground coal mining is the most hazardous of all major industries. In 1970 the disabling injury frequency rate per million man-hours worked for underground coal mining was 3.8 times as great as the average of all industries. n1 The severity rate (total number of man-days lost per million man-hours worked) of underground coal mining was also the largest for all major industries - 8.4 times the national average. Further, the average number of man-days lost per injury each year was one of the highest for all industries. By contrast, the surface mining disabling injury frequency rate is only 1.26 times the national average while the severity rate is 3.9 times the national average. These are roughly comparable with rates for the construction industry.

135 n1 Accident Facts, 1971 Edition. National Safety Council, 1971.

135 The injury frequency rates per million man-hours for deep mining as well as for strip and auger mining have remained relatively stable n2 over the

decade from 1961 to 1970. n3 Fatal and nonfatal injury rates from underground mining are approximately double those of strip mining, while injury rates from auger mining are intermediate to strip and underground mining. The severity of the injuries for underground mining has averaged over twice that for strip mining, with the severity of auger mining again representing an intermediate case. The average annual injury frequency and severity rates per million man-hours worked for the decade of the 1960's are summarized in Table H-1.

135 n2 Note that this analysis is based on data prior to the implementation of the Occupational Health and Safety Act (OSHA).

135 n3 Bureau of Labor Statistics.

*4*Table H-1. - Average Injury Frequency and Severity Rates For Coal Mining Based on Hours Worked, 1961-70

Type of mining	Injuries per million man-hours worked		Man-days lost per million man-hours worked
	Fatal	Nonfatal	
Underground	1.35	47.56	10,105
Strip	.49	23.01	4,086
Auger	.87	29.83	6,712

136 To realistically contrast a switch from surface to underground mining, the frequency and severity rates should be calculated on the basis of millions of tons of coal produced rather than millions of man-hours worked. Because the labor productivity in underground mining averages between one-third and one-half that of strip and auger mining, the rates of fatal and nonfatal injuries for underground mining can be about 5 times those for surface mining. For the period 1968-1970, the rates of death, nonfatal injuries and man-days lost per million tons of coal mined for surface and underground mining are presented in Table H-2.

*4*TABLE H-2. - AVERAGE INJURY FREQUENCY AND SEVERITY RATES BASED ON PRODUCTION, 1968-70

4[Per million tons]

Type of mining	Fatalities	Nonfatal injuries	Man-days lost
Underground	.63	24.48	5221.5
Surface (strip and			

auger)	.13	4.80	961.8

136 In summary, shifts to underground mining will result in significantly increased rates of death and injury per ton of coal mined.

136 Alternatively, surface mining prohibited on steep slopes could be replaced by other strip mine production on less steep slopes in northern and southern Appalachia or outside of Appalachia. In general, this probably would have no significant effect on either the death or injury rates because it is believed that they should not vary greatly by the slope of the terrain being mined.

136 This analysis of occupational health and safety considerations must be qualified by several factors. First, the data used are from the period preceding passage of the 1970 Occupational Safety and Health Act (OSHA). It is reasonable to expect that OSHA will bring about significant reductions in injury and severity rates for both underground and surface miners. To the extent that OSHA causes decreases in productivity, however, reductions in injuries and deaths per ton of coal mined will be partially offset.Second, there are distinct differences in the occupational safety data for different mining companies and it is possible that all mining operations can begin to more nearly meet the higher standards of some companies. n4

136 n4 "Coal-Mine Study Shows Record Can Be Improved When Firms Really Try," Wall Street Journal, January 18, 1973, indicated that U.S. Steelmines, virtually all of which are underground, had a fatality rate of 0.28 per million man-hours, roughly half the coal industry average, and an injury rate of 2.72 per million man-hours, or about one-twentieth the industry average. At the same time, several companies whose production came primarily from surface mining had significantly greater fatality and injury rates per million man-hours.

136 Finally, although Bureau of Mines Health and Safety data include injuries and loss of work resulting from pneumoconiosis, some experts estimate that the prevalence of this illness, caused by the inhalation of coal dust, is far greater than these data indicate. Although OSHA sets standards for the levels of coal dust, the new ambinent particulate levels are very likely to remain higher for deep mining than for surface mining. Thus, shifts to deep mining may increase the incidence of this respiratory illness for a fixed level of coal production.

APPENDIX I. IMPACT OF A 20 degrees SLOPE ANGLE RESTRICTION

137 The results of the high, medium and low impact scenarios associated with 15 degrees and 20 degrees slope angle restrictions were presented in Chapters 3 and 4. The assumptions underlying the scenarios for the 20 degrees slope limit case are somewhat different than those used in the 15 degrees case and are discussed below. Because the 20 degrees slope limit case affects different amounts of current production in different areas than the 15 degrees case, the potential for substituting either surface or underground mining is changed.

137 Table I-1 indicates that total coal reserves physically recoverable by

underground mining in many of the major economic areas would last several hundred years even with a shift from surface mining on slopes above 20 degrees to underground mining. Hence, as in the 15 degrees case, a shift from surface to underground production in the economic areas discussed would not necessarily lead to a coal production curtailment in the long run. However, to make up for lost production on steep slopes, as indicated in the last column of the table, current underground production would need to expand significantly.

*5*TABLE I-1

Economic Area	Production lost on steep slopes for 20 degrees restriction (million tons per year)	Years remaining for underground mining at current production levels	Years remaining for underground if all production above 20 degrees goes to underground	Percent increase in annual underground production if all steep slopes production lost is recovered by underground mining)
11. Williamsport, Pa	0.77	NA n1	NA	46.7
66. Pittsburgh, Pa	6.33	915	827	10.7
68. Cleveland, Ohio	5.75	NA	NA	728.0
64. Columbus, Ohio	0	NA	NA	0
65. Clarksburg, W.Va	7.26	NA	NA	29.9
52. Huntington, W.Va.-Ashland, Ohio	24.70	529	384	37.7
53. Lexington, Ky	15.56	542	209	159.0
51. Bristol, Va	9.81	171	133	28.1
50. Knoxville, Tenn	6.69	487	180	171.0
49. Nashville, Tenn	0	NA	NA	0
48. Chattanooga, Tenn	.29	NA	NA	0
45. Birmingham, Ala	2.81	NA	NA	41.6

(See Table in Original)

137 n1 NA=not available.

137 As shown in Table I-2, the potential for shifting surface mining to less steep slopes is somewhat different for a 20 degrees ban than for the 15 degrees ban discussed in Chapter 3 of the report. Outside central Appalachia, there continue to be sufficient reserves to absorb all displaced production. In Central Appalachia, the situation is somewhat better than that presented for the 15 degrees ban. In contrast to essentially no reserves in the four key EA's in central Appalachia below 15 degrees, some reserves are available on slopes under 20 degrees in all the areas except in eastern Kentucky (EA 53). Although not sufficient to absorb all displaced production, limited substitution would be possible.

138

TABLE I-2

Economic Area	Production lost on steep slopes with 20 degrees slope prohibition (million tons per year)	Years remaining for steep slope mining at current production levels	Years remaining for surface mining below 15 degrees at current levels of production	Years remaining for surface mining if less steep slopes recover all production loss by slope limitation
11. Williamsport, Pa	0.77	0	30.5	27.7
66. Pittsburgh, Pa	6.33	2.8	33.6	28.8
68. Cleveland, Ohio	5.75	0	361.6	59.8
64. Columbus, Ohio	0	8	48.2	48.2
65. Clarksburg, W.Va	7.26	1.8	1,544.6	76.8
52. Huntington, W.Va.-Ashland, Ohio	24.70	48.3	360.6	34.1
53.Lexington, Ky	15.56	17.8	0	0
51. Bristol, Va	9.81	27.5	158.4	4.4
50. Knoxville, Tenn	6.69	18.3	28.9	12.8
49. Nashville, Tenn	0	0	141.7	141.7
48.				

Chattanooga,
Tenn .29 10.0 38.3 28.0
45.
Birmingham, Ala 2.81 5.1 19.8 14.3
(See Table in Original)

138 ALTERNATIVE SCENARIOS

138 Table I-3 summarizes the assumptions used to derive the impact of a 20 degrees slope angle limitation.

138 TABLE I-3. - IMPACT SCENARIOS - 20 degrees SLOPE ANGLE BAN

138 1. High Impact Case

138 All production lost

138 No substitution deep or strip mining

138 2. Medium Impact Case

138 Outside central Appalachia -

138 Shift to less steep slopes

138 Lose production from small mines (under 50,000 tons/year)

138 No increase in underground mining

138 Central Appalachia -

138 in EA 50-75 percent of surface production above 20 degrees is lost

138 in EA 52-50 percent of surface production above 20 degrees is lost

138 in EA's 51 and 53 all production above 20 degrees is lost

138 5 percent increase in underground mining

138 3. Low Impact Case

138 Outside Central Appalachia - Shift to less steep slopes

138 Central Appalachia -

138 10 percent increase in underground

138 in EA 52-100 percent shift to less steep slopes

138 in EA 50-50 percent shift to less steep slopes

138 in EA's 51 and 53 - no shift to less steep slopes

139 High impact case

139 The high impact case assumes that all mining employment and earnings precluded by a 20 degrees slope limitation are not replaced by surface or underground mining in the same economic area or in the rest of Appalachia. Although this case is considered unlikely, it nevertheless reports what would be the worst condition that could result. It is exactly the same scenario used with the 15 degrees slope restriction.

139 Low impact case

139 The low impact case assumes that outside central Appalachia, all surface mining over 20 degrees shifts to less steep slopes. Inside central Appalachia, the impact varies, ranging from no shift to less steep slopes in EA's 51 and 53, a 50 percent shift in EA 50, to a complete shift in EA 52. The shifts in EA's 50 and 52 are greater than in the 15 degrees low impact case because of the reserves available between 15 degrees and 20 degrees in these areas. The reason for variations in the shifting in these areas is that the Huntington - Ashland EA has considerable strippable reserves between 15 degrees and 20 degrees, whereas the Lexington EA has none. In addition, a 10 percent increase in underground mining is assumed throughout central Appalachia to compensate for some of the surface mining lost in the region.

139 Medium impact case

139 In this case, steep slope production is assumed to shift to less steep slopes outside central Appalachia, with the exception of small mines. As discussed in the text, the viability of small mines is marginal and their capacity for shifting operations is considered minimal. In central Appalachia production on steep slopes is considered lost in EA's 51 and 53, with 25 percent and 50 percent shifts to less steep slopes in EA's 50 and 52, respectively. Again, this case assumes greater shifting in EA's 50 and 52 than the 15 degrees case because of the availability of more reserves. Furthermore, it assumes a 5 percent increase in underground mining in central Appalachia.

139 Impact on production

139 As can be seen in Table I-4 the loss of production as a result of a 20 degrees slope prohibition ranges from about 17 to 18 million tons per year depending on the impact scenario used, compared to a range of 42 to 108 million tons annually with a 15 degrees slope limit. The impact is most severe in central Appalachia, which has the highest quality low sulfur coal, with a minimum of 80 percent of the loss coming from this area. The reason for an increase in production in the Huntington-Ashland EA in the low impact case is that no surface production is lost, while underground mining is assumed to grow by 10 percent.

140

*4*TABLE I-4. - NET PRODUCTION LOST IN 3 SCENARIOS, 20 degrees SLOPE ANGLE BAN

4[In millions tons per year]

Region and economic area	High impact case	Middle impact case	Low impact case
NORTHERN APPALACHIA			
11. Williamsport, Pa	0.77	0.20	0
66. Pittsburgh, Pa	6.33	1.39	0
68. Cleveland, Ohio	5.75	1.15	0
64. Columbus, Ohio	0	0	0
65. Clarksburgh, W.Va.	7.26	.29	0
Subtotal	20.11	3.03	0
CENTRAL APPALACHIA			
52. Huntington, W.Va.-Ashland, Ohio	24.70	9.08	n1 (6.55)
53. Lexington, Ky	15.56	15.07	14.58
51. Bristol, Va	9.81	8.06	6.32
50. Knoxville, Tenn	6.69	4.82	2.96
Subtotal	56.76	37.03	17.31
SOUTHERN APPALACHIA			
49.Nashville Tenn	0	0	0
48. Chattanooga, Tenn	.39	.01	0
45. Birmingham, Ala	2.81	.08	0
Subtotal	3.20	.09	0
Total for 20 degrees limitation	80.07	40.15	17.31
Total for 15 degrees limitation	107.95	64.23	41.95

140 n1 Gain.

140 Direct economic impacts

140 The direct economic effects of the 20 degrees slope limit are shown for Basic Economic Areas and selected counties in Tables I-5 and I-6, respectively.The impacts are most significant in central Appalachia - the region that is already most depressed economically. The impacts range from a 4.8 percent loss of basic earnings in one EA in the high impact case to a gain of 2.6 percent in basic earnings in another EA in the low impact case. In many areas outside central Appalachia the effects are negligible.In some counties,

such as Wise, Va., the effects, even in the best situation, are significant.

141

13
TABLE
I-5. -
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11. Williamsport, Pa	5.1	9.9	84	0.3	0.1	134	0.1	n(3)	35	0	0	0	
66. Pittsburgh, Pa	4.5	8.8	97	.2	.1	729	n(2)	n(3)	153	0	0	0	
68. Cleveland, Ohio	3.8	6.8	105	.2	.1	917	n(2)	n(3)	183	0	0	0	
64. Columbus, Ohio	4.2	9.5	92	.0	0	0	0	0	0	0	0	0	
65. Clarksburg, W.Va	4.8	17.1	73	4.8	1.4	1,451	.2	.1	58	0	0	0	
52. Huntington, W.Va-Ashland, Ohio	n(4)	n(4)	n(4)	3.7	1.2	4,487	(2.6) .6	(.8) .2	(3,070 709	n3	n3	) n3	
53. Lexington, Ky	4.6	24.1	68	2.6	.9	2,080	2.3	.8	1,828	2.0	.7	1,578	
51. Bristol, Va	5.3	21.3	71	2.1	.6	1,450	.9	(.3) .3	(.1) 612	(226) n3	n3	n3	
50. Knoxville, Tenn	5.3	23.4	67	1.0	.3	818	.6	.2	444	.1	n(2)	68	
49. Nashville, Tenn	3.8	17.9	78	0	0	0	0	.0	0	0	0	0	
48. Chattanooga, Tenn	n(4)	17.0	n(4)	n(4)	(2)	41	n(4)	n(2)	1	0	0	0	
45. Birmingham, Ala	4.5	20.0	75	.3	.1	374	n(2)	n(2)	11	0	0	0	

[See Table in Original]

141 n1 Earnings and employment changes do not include secondary impacts.

141 n2 Nil.

141 n3 Gain.

141 n4 Not available.

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51.
Bristo (0.3) (0.1) (188)
l, Va 5.3 26.2 2.0 0.9 1,488 1.7 0.4 1,150 n2 n2 n2
Buchan (3.1) (1.6) (169)

an, Va	6.0	95.0	5.8	3.1	321	1.4	.7	76	n2	n2	n2
Dickinson, Va	8.0	95.0	4.3	4.3	149	3.1	1.8	62	(1.3) n2	(.7) n2	(25) n2
Wise, Va	4.6	75.0	12.6	3.5	349	8.9	2.4	245	5.1	1.4	142
52. Huntington, W.Va.-Ashland, Ohio	5.9	29.7	3.8	1.2	4,703	2.6	.9	3,168	.4	.1	457
Kanawha, W.Va	4.8	15.8	1.6	.3	318	.1	n(4)	19	1.4	(.3) n2	(280) n2
Pike, Ky	7.7	93.2	7.8	3.1	484	3.4	1.4	213	(.9) n2,n3	(.4) n2,n3	(59) n2,n3
Carter, Ky	7.7	1.0	.1	n(4)	2	.1	n(4)	1	0	0	0
66. Pittsburgh, Pa	4.5	7.9	.7	.1	1,588	.2	n(4)	344	0	0	0
Allegheny, Pa	4.3	1.4	0	0	0	0	0	0	0	0	0
Belmont, Ohio	4.9	41.8	4.1	.8	207	.6	.1	31	0	0	0
Clarion, Pa	5.1	15.0	.5	.1	15	.1	n(4)	2	0	0	0

[See Table in Original]

142 n1 Earnings and employment changes do not include secondary impacts.

142 n2 Gain.

142 n3 No shift to less steep slopes.

142 n4 Nil.

143 The differences in direct economic impact between the 15 degrees and 20 degrees restrictions are significant in central Appalachia. This is mainly because of increased opportunity for mining in the 15 degrees to 20 degrees range resulting from greater reserves or current production. Except for the Lexington, Ky. EA, the severity of the impact is considerably less with the 20 degrees limitation. Outside of central Appalachia the impacts are reduced, although they are not great in either case. In each case, total economic impacts on employment and earnings, including secondary impacts, would be larger

by a factor which depends upon the employment and earnings multiplier for each area.

CHAPTER 1.
SURFACE MINING AND RECLAMATION TECHNIQUES

25 ENVIRONMENTAL IMPACTS

25 The previous sections discuss the environmental impacts of discrete surface mining operations as well as those from a combination of operations for total mining and reclamation techniques. Table 1-1 compares the environmental impacts resulting from use of these ten mining and reclamation techniques. It characterizes their impacts on air and water, land use, health and safety, wildlife habitat, and esthetics. n3 It should also be pointed out that variations in site conditions and in how well the techniques are planned and applied will result in wide variations in the environmental impacts of each technique.

25 n3 These rankings were initially developed by the Task Force working group on reclamation. Comments on the rankings were then solicited from a number of experts. These rankings are necessarily subjective but do reflect a general consensus on the relative impacts of the ten methods.

25 Although area mining can cause a variety of environmental damages, these effects can be minimized with good planning and management. Most area mines are large and at least temporarily affect large surface areas. Impacts on surface water can be minimized even when water

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TABLE
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ESTIMAT
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Scale
for

severity of environmental indicators n1
3 = Severe Adverse Impact
0 = Negligible Adverse Impact

Mining Technique n2	Surface Water Pollution	Ground Water	Changed Water Courses	Air Pollution (dust)	Land Use (adj. land impact & precluded land use)	Health & Safety (landslides & flooding)	Wildlife Habitat Disruption	Aesthetics (highwall & veg.)	TOTAL n4
Area Mining									
- Without Reclamation	1-2	0-1	1-3	2-3	2-3	0	1-2	2-3	9-16
- With Reclamation n3	0-1	0-1	0-1	1	0	0	0	0	1-4
Contour Mining (Spoils on Downslope)									
- Conventional Contour Strip	3	0-1	2-3	2-3	3	3	1-3	3	17-22
- Contour Strip									

with Spoils Shaping	1-3	0	2-3	2-3	2-3	1-3	1-2	2-3	11-20
- Contour Strip with Terrace Backfilling	1-2	0	0-2	1-2	1-2	1-2	1-2	0-1	4-13
- Contour Strip with Contour Backfilling	1	0	0-1	1-2	0-1	0-1	1	1	3-8
- Augering from Narrow Bench	1-3	1-3	0-1	0-1	1-2	0-1	0-1	1	3-12
Contour Mining (No Spoils on Downslope)									
- Modified Block Cut	1	0	0	1	0	0	0-1	0-1	2-4
- Long Wall Surface	0-1	1-2	0	0-1	0-1	0	0	0	1-5
- Augering with Backfilling	0-1	1-2	0	0-1	0	0	0	0	1-4

[See Table in Original]

25 n1 Indicators are for both temporary and pervasive impacts.

25 n2 Head of Hollow Fill technique is not rated here because its environmental effects also depend on the techniques(s) for which it serves as a supplemental method for spoil disposal.

25 n3 This ranking is for area mining in the Eastern and Central coal regions with adequate rainfall for vegetation. Area mining in the Far West may

well be unacceptable unless vegetation can be re-established.

25 n4 Aggregating environmental parameters into a single index is difficult and often involves value judgments with respect to relative importance of the factors involved. These totals assume equal weighting of environmental impacts. Use of other weights could alter the ranking of the techniques. courses are disturbed. Dust is endemic in all large earthmoving operations. Esthetic impact is related to the imperfect restoration of land to blend with the surrounding topography and vegetation.

26 Conventional contour strip mining, in which all or a substantial portion of the overburden is initially cast over the downslope, does the most damage. One of the best ways to reduce damage is to return most of the overburden to the bench and stabilize it against erosion and weathering. When the overburden is not returned to the bench but is spread over vegetation on the downslope, a variety of serious impacts often result, particularly landslides, sedimentation, and acid mine drainage. Shaping and stabilizing the spoils on the downslope can reduce most of these impacts under favorable conditions. However, when the highwall and bench are exposed, environmental damage can still occur.

26 Terrace and contour backfilling reduce the environmental impacts significantly. The main difference between the two is the greater amount of spoil material left on the downslope with terrace backfilling. It is worthwhile noting, however, that a "good" terrace backfill may lead to less environmental abuse than a partially successful contour backfill. For example, a terrace backfill may result in better storm water management than a contour backfill.

26 Augering from a narrow bench may lead to small environmental damage, such as ground water contamination but, when the benches are not reclaimed, erosion, sedimentation, and acid mine drainage may result.

26 As pointed out previously, head of hollow fill may be used in connection with most other techniques. Thus, major variations in environmental damage will depend on whether the fill is adequately stabilized and revegetated and whether exposed highwalls and unfilled benches, which are unstable or acid producing, remain in the mined area.

26 The modified block-cut technique rates very well because the overburden removal and spoil handling are integrated, i.e., reclamation is integrally associated with extraction. Overburden is deposited in another location on the bench, usually with the same equipment used to remove it. Environmental damage from erosion and water pollution can be minimized by prompt grading and revegetation.

26 Long wall surface mining would appear, conceptually, to have about the same effects as augering with back-filling of the bench. Both could lead to potential ground water pollution; otherwise their effects are minimal. Although long wall mining may result in higher resources recovery than augering, the method could cause minor land subsidence effects.

26 Because most environmental damage - such as landslides, erosion, and

water pollution - stems from deposition of spoils on unsuitable lands adjacent to the mined area, the greatest benefits will usually accrue from properly planning and controlling or instead, avoiding such deposition. For both area and contour mining, this translates into restoration to the original or a similarly appropriate land contour and vegetation.

27 The reclamation plan must, of course, take into account possible future uses of the area, such as agriculture, range, forestry, wateroriented recreation, etc. In any case, good water management practices are required to minimize downstream impacts from erosion, sediment, and chemical pollution.

27 SURFACE MINING RECLAMATION COSTS

27 The costs of surface mining reclamation can vary widely, depending primarily on the objectives of the reclamation activities, the topography, how the mining operation is performed, and whether the reclamation is part of the mining operation. Other important variables are the rainfall and the type of soil or spoil material available for the surface layer.

27 There are, of course, differences in reclamation costs for area strip mining versus contour strip mining and area strip mining in the Eastern and Central coal regions versus the Western coal region. There are differences in reclamation costs at sites which have exactly the same contour, soil, rainfall, and vegetative conditions but which lie on opposite sides of a state line; these differences arise from both state regulations and enforcement.

27 One major cost difference depends on whether reclamation is performed subsequent to or as an integral part of the mining operation. There are numerous data on the costs of reclaiming lands after mining from reclamation projects on abandoned or "orphan" lands conducted by public groups. Because this report focuses on high levels of reclamation performed concurrent with mining, some of the more important data on reclamation costs after completion of mining are summarized in Appendix D. The remainder of this chapter deals with the costs of integrated mining and reclamation.

27 Reclamation costs may be calculated both as land rehabilitation costs in dollars per acre or as incremental costs of coal production in cents per ton. Although variations in coal seam thickness, slope angle, method of overburden removal, and other factors affect costs, it is useful to estimate broad averages of incremental production costs in the major mining States as a function of reclamation costs.

27 In Table 1-2, average incremental production costs in cents per ton of coal are given for reclamation costs of $1,000, $2,000, $3,000, and $4 ,000 per acre. Because an average coal seam thickness and recovery in each state has been assumed, the data should be used only for rough comparison.

28

*6*TABLE 1-2.
 - ESTIMATED

INCREMENTAL PRODUCTION COSTS FOR VARIOUS RECLAMATION COSTS

	Calculated production per acre mined n1	Costs of reclamation, cents/ton			
		$1,000 per mined acre	$2,000 per mined acre	$3,000 per mined acre	$4,000 per mined acre
Appalachia Region:					
Alabama	4,030	24.8	49.6	74.4	99.2
Kentucky (eastern)	4,460	22.4	44.8	67.2	89.6
Ohio	5,330	18.8	17.6	56.4	35.2
Pennsylvania	4,610	21.8	43.6	65.4	87.2
Tennessee	4,180	24.0	48.0	72.0	96.0
Virginia	5,900	17.0	34.0	51.0	68.0
West Virginia	7,060	14.2	28.4	42.6	56.8
Average	5,080	20.4	40.8	61.2	81.6
Central Region:					
Illinois	7,200	13.8	27.6	41.4	55.2
Indiana	6,620	15.0	30.9	45.0	60.0
Kentucky (western)	7,340	13.6	27.2	40.8	54.4
Average	7,050	14.2	28.4	42.6	56.8
Western Region:					
Colorado	12,100	8.2	16.4	24.6	32.8
Montana n2	66,100	1.6	3.2	4.8	6.4
Wyoming	66,100	1.6	3.2	4.8	6.4
Average	48,000	3.8	7.6	11.4	15.2

[See Table in Original]

28 n1 Based on density of 1,440 tons of bituminous coal per acre-foot at 80 percent recovery, based on 1960 data.

28 n2 Montana entry changed to reflect mining of sub-bituminous coal in Powder River Basin.

28 Source: Adapted from Surface Mining and Our Environment, Department of Interior, 1967, p. 114.

28 From Table 1-2, one can see that the incremental production costs for the equal level of reclamation in the Western coal regions are but a small fraction of those in the Appalachia and central regions. They differ because the coal

seams in Montana and Wyoming run 25 to 100 feet thick, with only 50 to 200 feet of overburden, while coal seams in the Central and Appalachian regions run 3 to 6 feet with overburden thicknesses of up to 200 feet. In both the Western and Central regions, area mining predominates. With large efficient draglines and shovels, the cost of overburden handling is relatively low. In addition, because most of the overburden in area mining is initially deposited in its final location, the cost of reclamation is limited to grading and revegetating the spoil banks.

28 Integrated Mining and Reclamation

28 This comparison of reclamation costs focuses on mining and reclamation practices in the Appalachian region. Thus most of this section concerns the costs of reclaiming lands disturbed by contour strip and auger mining.

28 Integration of mining and reclamation steps in contour strip mining operations promises significant cost reductions. In an analysis of the incremental costs of integrated mining and reclamation, two problems are confronted: separation of reclamation costs from overburden stripping costs and proprietary nature of such costs in an integrated mining and reclamation project. Several recent efforts, however, provide some useful cost data.On the basis of data in a recent Bureau of Mines study (13), an unpublished study by Delsen of Resources For The Future (14), and an analysis by Saperstein and Secor (11) as well as other information, estimates of costs for several contour strip mining approaches have been developed.

29

*4*TABLE 1-3. - ESTIMATED COSTS OF CONTOUR STRIP MINING AND RECLAMATION APPROACHES n1

4[In dollars per ton]

Type and degree of reclamation	Production costs n2	Incremental reclamation costs	Incremental reclamation costs above minimum now required n2
No reclamation (conventional)	$3.90		
Shaping of spoil bank n3	4.29	$0.39	
Terrace backfilling	4.59	.69	$0.30
Contour backfilling	4.85	.95	.56
Modified block-cut	4.46	.56	.17
Augering from narrow bench	3.45		
Augering from			

narrow bench with
backfilling n4 3.51 .06 .03
[See Table in Original]

29 n1 These cost estimates are for a hypothetical mine, using common assumptions with respect to key variables such as slope, bench width, coal seam thickness, etc. See ch. 1 and app. E for details.

29 n2 Does not include coal cleaning, freight or profits.

29 n3 Shaping of spoil bank required in all major Appalachian mining states.

29 n4 Assumes complete backfilling of bench, but only plugging of the first few feet of the auger hole.

29 Source: See app. E.

29 Cost estimates are presented in Table 1-3 for seven contour mining and reclamation techniques as applied on a 20 degrees slope. The hypothetical mining operation considered in these calculations is on a 3-foot thick seam. The bench width was assumed to be 125 feet with a 25-foot undisturbed barrier at the outer edge of the bench (resulting in a 9-foot low wall) and a 55-foot highwall. This case would be similar to typical mining operations in southwestern Pennsylvania. To the extent site specific factors such as slope angle or bench width change, absolute reclamation costs and possibly the relative costs among techniques will vary. Combination of augering with the first five techniques may reduce production costs and incremental reclamation costs per ton, and possibly change relative costs among techniques. Details of this analysis are given in Appendix E.

29 Cost estimates of reclamation following narrow bench auger mining were recently compiled (11). Based on a 220,000-ton auger mine operating in a 4-foot seam with a 42-inch auger in southern West Virginia, the costs, including depreciation of equipment, for partial backfilling, regrading, and revegetating the mined area were about $5 2 per acre, or 2 cents per ton. The reclamation did not return the surface to the original contour; a residual highwall 14 feet high was left. The spoils from the 35-foot wide bench extended 30 to 40 feet down the 30 degrees slope.

29 Complete reclamation of the disturbed area, including backfilling to the original contour, could cost twice as much, 4 cents to 5 cents per ton for the conditions described above. Data are not available for calculating the costs of an integrated auger mining and reclamation operation. It appears, however, that the incremental costs of integrated mining and reclamation for auger mining should be comparable to or less than those for contour backfilling, i.e. 4 cents to 5 cents per ton.

30 In summary, for the model operations evaluated, the costs of advanced reclamation techniques are small compared to the market value of the coal, e.g., only 3 to 9 percent of the price of the coal at the mine. In fact, since coal can be produced by surface mining in Appalachia for $0.75 to $2 .50 per ton less

than by underground mining, the competitive position of surface mined coal would not deteriorate even at the highest range of reclamation costs. n4

30 n4 See Chapter 3 for details of Appalachian coal cost data. For typical 3-and 4-foot Appalachian coal seams, these differential production costs mean that from $3,000 to $14,000 per acre could be spent on land reclamation.

31 SUMMARY

31 The least environmental damage usually results when the deposition of overburden on adjacent lands is minimized and carefully planned and carried out. Further, concurrent reclamation coupled with good water management practices causes much less erosion, sedimentation, and surface water pollution.

31 The modified block-cut method and narrow bench augering with backfilling both minimize disturbance of adjacent lands. In the block-cut approach, reclamation is integrated with extraction so that the overburden is removed from above the coal and deposited in another location on the bench with the same equipment. This method minimizes the disturbance of adjacent lands (except during the first cut), restoring soil stability and vegetative cover to the mined areas concurrently with the mining. Backfilling after augering, which also can be done concurrently with mining operations, minimizes the impacts from a narrow bench even more. These two methods significantly reduce the potential for landslides, both during and after mining and reclamation.Although the integrated operation of removing the overburden and depositing it in its final location is more costly than conventional operations for removing overburden, the costs are more than offset by handling the spoil only once.

31 Contour and terrace backfilling and augering from a narrow bench without backfilling are other methods which result in considerable reduction of overall environmental damage. These methods, however, disturb adjacent lands and can result in serious transient effects during the mining operation. For this reason reclamation to restore soil stability and vegetation should be done as nearly concurrently with the mining operation as possible. In addition, the costs of reclamation to original contour can be considerably higher when the spoils must be pulled up the slope.

31 Head of hollow fill methods may or may not result in environmental protection, depending upon the condition in which the mined area is left. If head of hollow fill is used only for permanent storage of excess spoil material from a modified block-cut or contour back-filling operation, the combination could ensure environmental protection. On the other hand, if all the overburden is placed in a head of hollow fill, leaving the bench and highwall unreclaimed, serious environmental damages such as sedimentation and chemical pollution may result. Other measures such as sediment basins and drainage controls can reduce these impacts. However, only when head of hollow fill supplements an otherwise satisfactory mining and reclamation technique does it offer environmental protection. The costs of head of hollow fill depend substantially on the technique with which it is combined, so that it is not possible to generalize costs for this method.

31 Shaping of spoils on the downslope is, as expected, considerably less costly than any of the techniques requiring backfilling, but causes a wide variety of environmental problems, including sedimentation and landslides. The unreclaimed bench and highwall may also result in sedimentation and chemical pollution. Measures such as sediment basins and drainage controls can reduce these impacts. Because all major mining States now regulate strip mining to avoid the abuses of such practices, the cost of shaping spoil banks is included simply to indicate the relative cost of providing any reclamation.

32 The estimated environmental effects of these several surface mining techniques (see Table 1-1) as well as the estimated incremental production costs associated with each of the techniques (see Table 1-3) are compared in Table 1-4 under the conditions assumed previously.

*3*TABLE 1-4. - SUMMARY RATING OF CONTOUR STRIP MINING AND RECLAMATION TECHNIQUES AND ASSOCIATED COSTS

Environment effects rating	Dollars per ton	
	Incremental reclamation costs n1	Incremental reclamation costs above minimum now required
Minimal impact:		
Modified block cut	$0.56	$0.17
Long wall surface	n(2)	n(2)
Augering with backfilling	.06	.03
Significantly reduced to minimal impact: n3		
Contour backfilling	.95	.56
Augering from narrow bench	0	0
Terrace backfilling	.69	.30
Head of hollow fill	n(4)	n(4)
Reduced impact: Spoils shaping	.39	0
Serious impact:		
Conventional contour strip with no reclamation	0	0

[See Table in Original]

32 n1 Incremental costs for hypothetical mining and reclamation operations.

32 n2 Not available because long wall surface mining is only in experimental stages.

32 n3 Depending on site specific conditions.

32 n4 Not available because head of hollow fill is used in connection with other contour strip mining techniques, making cost allocations very difficult.

32 Our findings in this report indicate that at the least three elements of regulatory programs are necessary to protect environmental quality during surface mining operations. First, adequate planning, through the careful preparation and analysis of mining and reclamation plans, is required. These plans should be prepared and analyzed before mining begins, to assure that operations will result in the achievement of minimal environmental damage. If difficulties are indentified, then the plan can be appropriately modified. Second, specific performance standards are necessary so that miners can choose the most effective techniques to meet them. This section has examined ten different methods and has elaborated on their general strengths and weaknesses. It is clear that there are methods which can reduce environmental abuse at costs that are small relative to total coal production costs, when reclamation is performed concurrently with mining. Third, there must be sufficiently vigorous enforcement of regulatory programs. Often, in the past, the results of enforcement programs were not satisfactory, either because the performance standards did not require an adequate level of reclamation, because earlier reclamation requirements were subject to such broad interpretation that their achievement was often a matter of unnecessary contention between the mine operator and the inspector, or because enforcement was not backed up by adequate performance bonds, manpower or program funding. With stringent, unambiguous performance standards that require reclamation concurrent with mining, it will be easier to judge the adequacy of reclamation performance in each particular case.

33 In the absence of any one of these three components - adequate planning, adequate performance standards and adequate enforcement - experience indicates that efforts to curb environmental and other damages from surface mining will not be truly successful.

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CHAPTER 2
STATE REGULATORY PROGRAMS

44 ENFORCEMENT PROGRAM

44 A number of the State statutes reviewed in this survey provide substantial authority to control the adverse environmental consequences of surface mining. However, implementation of the statutory requirements is contingent upon both the adequacy of enforcement authority and the adequacy and commitment of the administrative enforcement program. This section briefly reviews the statutory enforcement authority available to the 16 survey States and their enforcement capability in terms of manpower and funding.

44 AUTHORITY

44 Operating Without a Permit

44 All of the States surveyed have provisions for penalizing surface mining operators for mining without a valid permit or license. Such a violation is generally a misdemeanor, subjecting the offender to fines ranging from $500 to $5 ,000 per day and/or 30 days to a year imprisonment. It appears that operators relatively rarely fail to obtain a permit before mining, but that unauthorized mining beyond the boundaries established in the permit is more common.

44 Denial of a Permit

44 One very important enforcement authority is the administrative agency's power to refuse to issue a license or permit for a mining operation. All of the States can refuse a license or permit on the basis of noncompliance with application requirements, such as providing insufficient or invalid information or failure to post the required performance bond.

44 Although nearly all States appear to have some authority to deny a permit to operators presenting unacceptable reclamation plans, a number of these States do not have authority to disapprove a plan for environmental reasons. Only Illinois, Tennessee, Ohio, Kentucky, West Virginia, Virginia, and Pennsylvania have explicit statutory authority to deny a permit for environmental reasons, such as nonfeasibility of reclamation or incompatibility of mining with the area's land use values. For example, if land use on the proposed mine site in Illinois is "unique", a permit may be denied. Ohio may designate as unsuitable for strip mining: natural areas; wild, scenic, or recreational river areas; publicly owned or dedicated parks; and other areas of unique and irreplaceable natural beauty.

44 To some extent, states have in fact denied permits for environmental reasons. Since March 1971, West Virginia has denied a total of 341 surface mining applications for various reasons, including environmental. While Kentucky has formally denied only 33 permit applications since 1970, additional permit applications reportedly have been informally denied by field inspectors in cases where the slope angle was over 33 degrees. Tennessee has denied permits for surface mining that would adversely affect a scenic river area.

45 Of 12 permits denied in 1972 in Virginia, seven were denied because the slope angle was considered unsafe for mine workers or posed a landslide threat. As discussed previously, in the section on Bench Width Limitations, the laws of Tennessee, Kentucky, West Virginia, and Maryland may preclude most surface mining on slopes exceeding designated maximum slope angles.

45 Non-Compliance with Permits

45 As indicated previously, the occurrence of environmental damage is most pronounced during the mining operation. All of the 16 State agencies have authority to issue non-compliance citations when the law or the provisions of a permit are being violated. Most of the states have authority to revoke permits

and forfeit bonds when noncompliance notices are not heeded. Usually, an administrative hearing must be held prior to these actions. All States except Colorado, Indiana, Maryland, and Wyoming have explicit authority in their surface mining laws to seek court injunctions against illegal operations. Only half of the States provide for monetary penalties in addition to bond forfeitures.

45 Only Pennsylvania and West Virginia provide explicit statutory authority for the regulatory agency to require an immediate cessation of a mining operation when necessary to achieve immediate corrective action. Kentucky and Tennessee have authority to suspend permits summarily when necessary.

45 The limited data on the number of noncompliance citations issued over the past four years in several of the States surveyed are shown in Table 2-5.

*5*TABLE 2-5. - NON-COMPLIANCE CITATIONS ISSUED IN SELECTED STATES

State	1969	1970	1971	1972
Illinois	5(41)	2(43)	0(41)	0(36)
Indiana	0(41)	0(36)	0(38)	9(46)
Kentucky n2	82(652)	322(1,117)	484(1,098)	480(633)
Ohio	78(157)	15(163)	13(140)	35(252)
Pennsylvania	(n3)	2,400 n4 (551)	3,300 n4 (562)	3,400 n4 (568)
Tennessee	2(301)	0(330)	1(341)	43(306)
Virginia	0(151)	0(251)	0(346)	29(504)
West Virginia n5	6(400)	24(616)	125(343)	318 n4 (246)

45 n1 The numbers in parentheses are the total active mining operations in the State, except as noted below.

45 n2 Data in parentheses show the number of surface mining permits issued for coal.

45 n3 Not available.

45 n4 Multiple citations for individual mining operations caused the number of citations to exceed the number of operations.

45 n5 Data from West Virginia show successful prosecutions and, in parentheses, the mining permits issued.

45 With the exception of Pennsylvania and West Virginia, many of the citations were for administrative rather than environmental problems. For example, most of the orders issued in Ohio were for delinquent reports due annually from the operators. The citations in Pennsylvania were issued for several types of violations including acid mine drainage, improper disposal of

acid material, inadequate water treatment facilities, and failure to keep backfilling current with the mining operation.

46 In West Virginia, data for 1972 revealed that 117 individual operators were prosecuted for a total of 318 separate violations. The bulk of these violations was for failing to construct or maintain adequate water drainage systems or facilities. In both West Virginia and Pennsylvania, the violations were temporary in nature and upon correction the mining operation was allowed to continue.

46 Reclamation

46 All of the States surveyed have the authority to require forfeiture of the bonds of operators who fail to reclaim according to the State reclamation requirements, and most of the States have the authority to deny a new permit to an operator who has failed to reclaim a previous site.

46 Several laws explicitly provide for the release of portions of the performance bond in stages as regrading and backfilling are completed and approved, with the State retaining a portion to cover final revegetation costs in case of default. For example, Ohio releases onehalf of the bond upon completion of grading and replacement of topsoil, retaining the rest until the State agency approves the remainder of the reclamation and revegetation work. The Maryland and Pennsylvania laws extend all or part of the bond liability for 5 years beyond the completion of reclamation work to ensure satisfactory results. In Pennsylvania, 5% of the bond is retained for this period to cover the contingency that the reclamation work may prove to have been faulty.

46 Some States have adopted laws or regulations that are merely procedural in nature, such as those requiring only a specified number of seeding attempts. These laws sometimes afford inadequate assurance that adequate reclamation will occur. Under the "standard" reclamation requirement, the surface mining operator may have little incentive to ensure that his reclamation efforts produce acceptable results since the law and regulations do not specify results that must be achieved. This is especially true if there is a 2 to 3 year time lag after mining before the reclamation work must be completed, or if the performance bond has been set at an amount that is less than the actual cost of reclamation.

46 In those States requiring concurrent reclamation, however, the backfilling and regrading activities are integrated into the mining process. An operator failing to meet the specified time or distance limits shown in Table 2-3 may be stopped from further mining until he has backfilled and regraded the area where mining is completed. This type of reclamation requirement has helped to improve the physical quality of reclamation work and has significantly facilitated enforcement. For example, in Pennsylvania of $8.1 million in bonds held by the State in 1972, only $1 0,000 was forfeited compared to $543,000 in forfeitures out of a total of $6 .4 million held in 1965, prior to the State's adoption of concurrent reclamation requirements. This appears to represent a significant improvement in reclamation performance.

47 Resources

47 The manpower and funding levels of the agencies responsible for the administration and enforcement of the State surface mining laws can be an important indicator of the effectiveness of reclamation programs. With the exception of Kentucky, Pennsylvania, and West Virginia, most of the State agencies employ less than 25 people (including field inspectors, technical and clerical personnel) and were funded at less than $2 00,000 annually. As seen in Table 2-6, however, funding and employment have generally increased throughout the 1969-1972 period, with the largest increases occurring generally in the Eastern States. The Western States, with newer regulatory programs and generally less surface mining up to the present time, have lower manpower and funding levels.

*9*TABLE 2-6
*9*EMPLOYMENT AND FUNDING *
*9*STATE SURFACE MINING REGULATORY AGENCIES

State	Fiscal Year 1969		Fiscal Year 1970		Fiscal Year 1971		Fiscal Year 1972	
	Funding	Employment	Funding	Employment	Funding	Employment	Funding	Employment
Alabama **	NA ***	NA	22.3	2	22.0	2	na	2
Colorado **	NA	NA	180.0	22	244.3	22	240.4	22
Illinois	41.0	3	67.0	3	67.0	3	142.0	7
Indiana	39.1	4	32.8	4	31.5	4	41.2	4
Kentucky	495.7	43	628.9	51	1,066.4	59	1,280.3	75
Maryland	85.8	7	79.5	7	92.5	7	93.5	7
Montana	na ***	na	na	na	2.0	2	83.8	5
N. Dakota	NA	NA	1.5	1	1.5	1	11.3	1
Ohio	101.2	13	109.9					

				13	108.8	13	147.3	24
Oklahoma **	74.2	6	83.2	6	95.8	6	103.7	6
Pennsylvania	na	62	na	65	800.0	65	993.0	72
Tennessee	61.3	4	65.3	5	67.9	6	176.1	12
Virginia	68.0	7	65.8	12	170.9	18	167.2	20
Washington	NA	NA	NA	NA	96.3	4	133.2	9
W. Virginia	225.8	25	268.2	34	372.2	50	665.6	50
Wyoming	NA	NA	15.0	1	15.0	1	18.7	1

47 * Funding in thousands of dollars.

47 ** Surface mine reclamation program is conducted jointly with mine safety inspection program. Separate funds and manpower for surface mine reclamation activities were not available for Colorado and Oklahoma.

47 *** NA=surface mine reclamation authority not enacted; na=not available.

47 Corresponding to the general increase in the level of funding and manpower, there has also been a general reduction in the workload of State employees as measured by the number of active operations per employee. The limited amount of data obtained from several of the States is shown in Table 2-7. With the exception of Oklahoma and Wyoming, there has been a noticeable reduction for several of the States since 1969. However, even with this reduction in workloads, field inspections of the mining and reclamation operations are still quite infrequent in many of the States. Survey information received from Kentucky, West Virginia, and Pennsylvania indicates that their inspection policy calls for an inspection of each operation at least twice a month and, in the case of Kentucky, at least weekly inspections for auger mining. This contrasts to field inspections of once a month or less in Illinois, Indiana, and Wyoming.

48

*5*TABLE 2-7 -
ACTIVE SURFACE
MINING

OPERATIONS (ALL MINERALS) PER FIELD EMPLOYEE IN REGULATORY AGENCIES FOR SELECTED STATES n1

State	Fiscal year 1969	1970	1971	1972
Illinois n2	13.7	14.3	13.7	5.1
Indiana	16.4	14.4	15.2	18.4
Kentucky	27.6	35.7	27.0	14.9
Ohio n2	19.6	20.4	27.1	14.9
Oklahoma	15.3	15.2	15.0	36.3
Pennsylvania n2	(n3)	22.0	22.5	22.7
Tennessee	75.3	66.0	56.8	25.5
Virginia	45.7	54.5	50.0	39.4
Washington	(n3)	(n3)	146.8	70.1
West Virginia n2	45.0	72.6	34.3	17.3
Wyoming	29.0	83.0	117.0	139.0

48 n1 This table covers surface mining for all minerals except where otherwise indicated.It is useful in indicating the attention that field employees can give to any individual mining operation, whether for coal or other minerals.

48 n2 Coal mining only.

48 n3 Not available.

48 SUMMARY

48 A number of the States surveyed have turned from requiring only post-mining reclamation to requiring concurrent reclamation. Two of these states require the land to be reclaimed to its approximate original contour unless an environmentally satisfactory alternative can be justified by the operator. Several States now require the topsoil to be saved or have adopted specific revegetation survival standards, but reclamation and other requirements are still limited in many cases. Although some performance bond requirements have been increased, many are still not based upon actual reclamation costs. Further, bonds in most States are released upon completion of reclamation activities even though adverse environmental effects from inadequate reclamation may continue for an extended time or first appear at a later time. In many States, it appears that funding and manpower levels permit little more than an administrative-clerical program rather than an enforcement program with skilled field personnel.

48 The ultimate test of surface mining regulatory programs is the condition of reclaimed mined lands. It is too early to determine the effects of some of

the newest laws and programs. However, from the standpoint of both probable performance and the provisions of many current State laws, a clear need exists for strengthening the individual State programs.

CHAPTER 3
IMPACT OF SLOPE ANGLE PROHIBITIONS ON COAL PRODUCTION AND RESERVES

59 SUBSTITUTION OF OTHER SURFACE PRODUCTION FOR SURFACE PRODUCTION ON STEEP SLOPES

59 Physical Availability

59 The regions in central Appalachia where contour mining on steep slopes predominates have very little production from surface mines on slopes below 15 degrees. (See Tables 3-3 and 3-4). Although there are some reserves underlying less steep slopes in southern West Virginia and northeastern Tennessee, there appears to be virtually no coal reserves on the less steep slopes in eastern Kentucky and western Virginia. Thus, only a fraction of the mining activity precluded by a steep slope limitation could be physically accommodated on less steep slopes in central Appalachia.

59 Table 3-11 summarizes the potential for surface mining on less steep slopes if surface mining is prohibited on slopes of over 15 degrees.The potential for mining on less steep slopes is estimated by contrasting the longevity of current reserves underlying less steep slopes if all mining on steep slopes were in fact shifted to these reserves. For example, in northeastern Ohio (EA 68), current reserves on slopes of less than 15 degrees would last about 60 years regardless of whether they absorbed the production that would be prohibited on steep slopes. Similarly, the rest of northern Appalachia (EA 11, 64, 65, and 66) and southern Appalachia (EA 45, 48, and 49) also have sufficient reserves to absorb a shift.

60

*5*TABLE 3-11. - IMPACT ON STRIPPABLE RESERVES FROM A SHIFT FROM STEEP SLOPES TO LESS STEEP SLOPES

Economic Area	Production lost on steep slopes with 15 degrees slope prohibition (million tons per year)	Years remaining for steep slope mining at current production levels	Years remaining for below 15 degrees surface mining at current levels of production	Years remaining for surface mining if less steep slopes recover all production loss by slope limitation

11. Williamsport, Pa	2.81	0.8	41.0	27.4
66.Pittsburgh, Pa	15.10	3.9	42.3	27.8
68. Cleveland, Ohio	6.20	.3	594.9	59.6
64. Columbus, Ohio	9.03	5.8	165.3	44.1
65. Clarksburg, W. Va	7.64	15.4	(n1)	63.2
52. Huntington, W.Va.-Ashland, Ohio	25.45	64.6	264.9	17.8
53. Lexington, Ky	15.56	17.8	0	0
51. Bristol, Va	10.01	31.4	0	0
50. Knoxville, Tenn	11.60	15.3	252.9	8.0
49. Nashville, Tenn	0	0	141.7	141.7
48.Chattanooga, Tenn	.46	11.7	45.2	25.6
45. Birmingham, Ala	4.42	6.0	23.2	13.0

60 n1 No mining on slopes below 15 degrees now.

60 The major problem of shifting to less steep slopes would exist in central Appalachia.Both in eastern Kentucky and Virginia (EA 53 and 51), there are no strippable coal reserves underlying less steep slopes. In southern West Virginia, northeastern Kentucky, and northeastern Tennessee (EA 50 and 52), the impacts of such levels of existing reserves below 15 degrees seem large relative to current levels of mining.

60 Even in areas where there are coal reserves on less steep slopes, it is also likely that mining these reserves will not substitute entirely for the displaced production. Mining economics may lead to the exploitation of reserves outside the impacted areas. Capital and, to a lesser extent, mining equipment are highly mobile, Other areas may have considerably greater potential for expanding their surface mining operations. For example, although eastern and western Kentucky each produce about 33 million tons of surface mined coal annually, the western part of the State has significantly less steep slopes (most under 20 degrees), thus allowing the development of large, efficient area mines.

60 In northern and southern Appalachia, there appears considerable potential

for shifting surface mining production from steep to less slopes. In central Appalachia, however, there appears very little potential for such a shift; reserves on the less steep slopes just do not appear adequate.

60 Technical Constraints

60 Although lack of reserves is not a problem in many areas, other constraints do exist. There is some equipment incompatibility.Contour mining on steep slopes is characterized by small operators using small draglines, shovels, or front-end loaders. As slopes become less steep, a technique more akin to area mining is used, and a larger operation becomes economically more desirable. The smaller front-end loaders and draglines used on steep slopes are not optimally suited for the most economic production on less steep slopes. Nevertheless, mining of less steep slopes might not necessitate abandoning this equipment. Rather, the smaller equipment might be used until it is depreciated, when it might be replaced by larger equipment.

61 Fabrication and delivery of larger equipment, costing hundreds of thousands of dollars or more, depending on size, sometimes requires a lead time of 2 years (15). Further, because this equipment has such large material handling capabilities, it requires considerable peripheral equipment - loaders, trucks, bulldozers, etc. The necessary capital may not be available to many of the smaller contour mining operators, now working steep slopes.

61 Another constraint to increased surface mining on less steep slopes, particularly in northern and southern Appalachia, is that such mining would have to compete with current land uses. Flatter land often supports agriculture as well as more intense local development. In moving to less steep slopes, coal mining may displace relatively valuable land uses, at least temporarily, thus incurring additional costs.

61 Problems of Small Mines

61 Shifts of surface mining to less steep slopes may be constrained not only by physical availability and equipment but also by economic instability of the operators forced out of the steep areas. In many industries, it is the small companies that are least able to adapt to adverse market changes or changes in the way they must operate. This statement may also be true of the surface coal mining industry.

61 Of the approximately 5,600 surface and underground coal mines in operation in the United States in 1970, almost 4,000 produced annually 50,000 tons or less (16). Of these, 3,726, or 93 percent, are located in Appalachia (17).Many of these, however, are underground mines.Table 3-12 points up the importance of the small surface mine in this region.

*4*TABLE 3-12 - IMPORTANCE OF SMALL SURFACE MINES, 1971

	Percent of total	Percent of total surface mine

State	Number of surface mines	surface mines which are small n1	production from small mines n1
Kentucky	878	75	18
Ohio	267	52	7
Pennsylvania	584	71	23
Tennessee	108	53	21
Virginia	315	87	56
West Virginia	426	62	19
Maryland	45	78	31

61 n1 Produce less than 50,000 tons per year.

61 Source: U.S. Department of the Interior, Bureau of Mines, Division of Fossil Fuels. "Coal - Bituminous and Lignite in 1971." Washington, D.C.: Department of the Interior, Sept. 27, 1971. pp. 16-18.

61 For several decades, the number of small coal mines (both surface and underground) has been declining, although their contribution to total coal output has been relatively constant as the average small mine has grown larger (18). Between 1967 and 1971, however, the number of new small surface mines rose rapidly - increasing about 50 percent and keeping pace with the larger surface mines (19).

62 Small mines appear less economic than larger mines and tend to enter the coal industry rapidly when prices are high and perhaps to drop out just as quickly under adverse conditions. An analysis conducted for the Appalachian Regional Commission by Mathematica, Inc., confirms the relatively less stable position of smaller companies. The data in Table 3-13 relate to 40 companies in eastern Kentucky of the 302 surface mining operators active in the State in 1971. Nonetheless eastern Kentucky is characteristic of steep slope areas, and the sample data may indicate relative economic viability of small firms elsewhere in Appalachia. As indicated in the table profits before taxes average over 10 times higher for large firms than for small ones. Similarly, the average profit margin on sales is over 6 percent for large firms but below 1 percent for small ones. Returns on equity and liquidity ratios (the ability to pay current debts with current assets) are also less favorable for smaller companies. It should be noted that the average production from a small operator is 79,000 tons per year, still relatively large. Of the 40 studied, the 8 smallest appear even less profitable, averaging a loss of almost $8,000 annually (compared to an average profit of $2 4,000 for all small firms in the survey) (20). Further, the smallest firms show current debts exceeding current assets by a factor of almost seven.

*6*TABLE 3-13. - ECONOMIC VIABILITY AS A FUNCTION OF COMPANY SIZE, A SAMPLE OF

EASTERN KENTUCKY SURFACE COAL MINES

Size	Number of companies	Number of mines	Average production (tons per year)	Average fixed assets (thousands of]	Average total assets (thousands of]
Large	11	59	913,000	$834	$1,347
Medium	17	58	271,000	584	858
Small	15	37	79,000	237	237

Size	Average before tax profits (thousands of]	Average after tax return on sales (percent)	Average after tax cash flow on sales (percent)	Average return on assets (percent)	Liquidity ratio
Large	$307	6.33	25.9	20.0	1.3
Medium	107	4.19	24.1	8.4	.9
Small	24	.92	17.5	4.1	.9

62 Source: Unpublished data and analysis by Mathematica, Inc., Princeton, N.J., for the Appalachian Regional Commission, based on data provided by Department of Revenue, Commonwealth of Kentucky, 1973.

62 Not all small firms are financially unsound or are unable to adjust to changes such as slope limits. Their numbers have increased and, although profits are low, they do have a positive cash flow. However, as a group they will have more trouble adjusting to restrictions because of generally higher costs of production and low capitalization. Perhaps most important may be their inability to pass on increased costs because they operate within a price ceiling set by the larger, more efficient coal companies.

63 If small operators have trouble adjusting to increased costs, such as would be imposed by slope limitations, they may also have trouble meeting more stringent reclamation requirements. Cost data for comparing economic problems of slope limits and more stringent reclamation are not available.

CHAPTER 3.
MPACT OF SLOPE ANGLE PROHIBITIONS ON COAL PRODUCTION AND RESERVES

63 SUBSTITUTION OF OTHER FUEL SOURCES FOR SURFACE PRODUCTION

63 As stated earlier, most of the coal produced in central Appalachia has a sulfur content below 1 percent. An immediate slope angle ban would cause a significant shortfall in low sulfur coal production, with current and expected high market demand for the coal. Because northern and southern Appalachia produce only 25 percent of the low sulfur coal produced in the East and Central coal regions and probably have only limited low sulfur reserves, there would not be adequate alternative sources of low sulfur coal in the eastern half of the country, unless underground mining could expand rapidly.

63 To meet air quality standards in many areas, stack gas cleaning systems or the processes to desulfurize coal would be needed to reduce the sulfur oxides emitted from burning high sulfur coal. Development of low sulfur western coal may also be accelerated, although not significantly, because central Appalachia does not now provide much coal to the midwestern markets that western coal might economically serve.

63 It can be expected, however, that any slope angle constraints will raise delivered coal prices, either because of increased average production costs or because of longer shipping distances. Higher prices will create an incentive for some increases in underground mining in central Appalachia. Higher prices will also increase demands for other fuels, particularly imported residual fuel oil.

63 POTENTIAL IMPACTS OF SLOPE LIMITATIONS ON COAL PRODUCTION

63 Effects of a slope angle limitation on production will depend on the mix of alternatives which results. The three alternatives - discontinued surface mining on steep slopes, underground mining, or mining on less steep slopes - are not really mutually exclusive. Rather, the degree to which each occurs will vary not only according to general economic and technical considerations but according to local conditions that may constrain selection of one or more of the possibilities.

63 To give the reader a sense of the range of possible effects from a 15 degrees slope angle prohibition, Table 3-14 summarizes the impacts by basic economic areas of three possible scenarios representing a mix of the alternatives.

63 Table 3-15 summarizes the sulfur content of the coal production affected by a 15 degrees slope angle prohibition. The assumptions used cannot be considered definitive but are designed to indicate the constraints within each economic area and their effects on alternatives if mining on steep slopes is prohibited.

64

*4*TABLE 3-14. - NET PRODUCTION LOST IN 3 SCENARIOS FOR A 15 DEGREES SLOPE ANGLE PROHIBITION

4[In millions of tons per year]

Region and economic area	High impact case	Medium impact case	Low impact case
NORTHERN APPALACHIA			
11. Williamsport, Pa	2.81	0.72	0

66. Pittsburgh, Pa	15.12	3.11	0
68. Cleveland, Ohio	6.20	1.24	0
64. Columbus, Ohio	9.03	1.80	0
65. Clarksburg, W. Va	7.64	.31	0
Total	40.80	7.18	0
CENTRAL APPALACHIA			
52. Huntington, W.Va.-Ashland, Ohio	25.45	22.18	12.54
53. Lexington, Ky	15.56	15.07	14.58
51. Bristol, Va	10.09	8.26	6.52
50. Knoxville, Tenn	11.60	11.40	8.31
Total	62.60	56.91	41.95
SOUTHERN APPALACHIA			
49. Nashville, Tenn	0	0	0
48. Chattanooga, Tenn	.46	.01	0
45. Birmingham, Ala	4.42	.13	0
Total	4.88	.14	0
Grand total	108.28	64.23	41.95

*5*TABLE 3-15. - DISTRIBUTION OF NET PRODUCTION BY SULFUR CONTENT PRECLUDED BY 15 DEGREES PROHIBITION

5[In millions of tons per year]

Scenario	Less than 1 percent sulfur	1 to 2 percent sulfur	Greater than 2 percent sulfur	Total
High impact	41.56	30.74	35.98	108.28
Medium impact	35.46	21.09	7.68	64.23
Low impact	25.77	14.55	1.63	41.59

64 These scenarios assume no increase of production in areas with significant reserves beyond that needed to offset the production losses from prohibitions, nor do they take into account how Appalachian deficits would be made up by coal mining in other areas of the country or by other energy sources.

64 High Impact Case

64 The high impact case assumes that all production from terrain with slopes

of more than 15 degrees is not replaced by other surface or underground mining in the same economic area or in the rest of Appalachia. This case, although probably unrealistic, bounds the worst condition that could result: loss of 108.28 million tons of surface mining production in Appalachia, of which 41.56 million tons is low sulfur coal.

64 Low Impact Case

64 The low impact case assumes that coal production precluded by slope limits can be shifted to less steep areas. Because outside central Appalachia there are considerable strippable reserves underlying less steep slopes, this alternative assumes that all mining could conceivably be shifted, resulting in no net loss of production. In central Appalachia, however, no shift to less steep slopes is possible in EA 51 and 53, and it is assumed that only a 25 percent shift would occur in EA 52 and 50, which have marginal reserves. In addition, a 10 percent increase in underground mining is assumed to make up for some of the coal production lost from slope restrictions.The impetus for this increase in underground mining may stem from the quality of coal (low sulfur content) in central Appalachia and increased demand for it as a result of the Clean Air Act. The net effect of these shifts is a loss of 41.95 million tons of production in Appalachia, which includes 25.77 million tons of low sulfur coal.

65 Medium Impact Case

65 In the medium impact case, steep slope production is assumed to shift to less steep slopes outside central Appalachia, with the exception of small mines. The small mine operations (less than 50,000 tons per year) have marginal economic positions and may not adjust to this new constraint. Production from these small mines is assumed lost, totaling about 6 million tons annually. Further, this case assumes that new underground mining will not increase in either northern or southern Appalachia.

65 It is assumed that the surface production precluded by a 15 degrees slope angle prohibition would be lost within central Appalachia. Because of the limited reserves on less steep slopes in central Appalachia, there may be little opportunity for mine operators to relocate on less steep slopes within the region. Slightly offsetting this loss is an assumed 5 percent expansion of underground mining in the central Appalachia region. The net impact of this case is a loss of 64.23 million tons throughout Appalachia, of which 35.46 million tons is low sulfur coal.

65 For ease of understanding, the preceding analysis and discussion focused on the loss of production caused by a 15 degrees slope angle prohibition. A similar analysis was also undertaken for a 20 degrees slope angle ban and is summarized in Table 3-16. The assumptions underlying the high, medium, and low impact scenarios vary somewhat from those discussed above for the 15 degrees slope angle ban and are discussed in detail in Appendix I. As indicated in the table, lost production ranges from 17 to 80 million tons annually, with a medium impact forecast at 40 million tons. This range is lower than in the 15 degrees slope angle case because of significant existing production between 15 degrees

and 20 degrees and because more shifting to less steep slopes is possible because of the reserves between 15 degrees and 20 degrees. Further, the medium impact and low impact cases are much lower because in 2 of the 4 central Appalachia EA's (52 and 50) significant switching to less steep slopes is possible with a 20 degrees ban.

66

*4*TABLE 3-16. - NET PRODUCTION LOST IN 3 SCENARIOS FOR A 20 DEGREES SLOPE ANGLE PROHIBITION

4[In millions of tons per year]

Region and economic area	High impact case	Medium impact case	Low impact case
NORTHERN APPALACHIA			
11. Williamsport, Pa	0.77	0.20	0
66. Pittsburgh, Pa	6.33	1.39	0
68. Cleveland, Ohio	5.75	1.15	0
64.Columbus, Ohio	0	0	0
65.Clarksburgh, W. Va	7.26	.29	0
Total	20.11	3.03	0
CENTRAL APPALACHIA			
52. Huntington, W.Va.-Ashland, Ohio	24.70	9.08	n1 (6.55)
53. Lexington, Ky	15.56	15.07	14.58
51. Bristol, Va	9.81	8.06	6.32
50. Knoxville, Tenn	6.69	4.82	2.96
Total	56.76	37.03	17.31
SOUTHERN APPALACHIA			
49. Nashville, Tenn	0	0	0
48. Chattanooga, Tenn	.39	.01	0
45. Birmingham, Ala	2.81	.08	0
Total	3.20	.09	0
Total	80.07	40.15	17.31

66 n1 Gain.

66 Table 3-17 summarizes the impact of this production loss by sulfur content of the coal. Of the 17 to 80 million tons impacted, between 10 and 37 million have a sulfur content of less than 1 percent.

*5*TABLE 3-17.
- DISTRIBUTION OF NET PRODUCTION BY SULPHUR CONTENT, PRECLUDED BY 20 degrees PROHIBITION
5[In million of tons per year]

Scenario	Less than 1 percent sulfur	1 to 2 percent sulfue	More than 2 percent sulfur	Total
High impact	36.68	24.76	18.63	80.07
Medium impact	22.98	13.44	3.73	40.15
Low impact	10.51	5.95	.86	17.32

66 Air Quality Impact

66 In the short run only two alternative fuels would be available to substitute for the lost low sulfur (1 percent S) coal: medium sulfur oil (2.2 percent S) and high sulfur coal (3 percent S). Desulfurized residual oil (1 percent S) would probably not be available in sufficient quantity until 1976-77. In most cases, it is the only alternative to the low sulfur coal that would meet the requirements of the Clean Air Act.

66 If the low sulfur coal affected by these scenarios were to be replaced by high sulfur coal from the Central (or Midwestern U.S.) region, there would be an air quality penalty of an additional 88 pounds of sulfur dioxide (above a base of 32 lbs.) per ton of low sulfur coal displaced. For the 15 degrees prohibition, the total yearly increase in emissions of sulfur oxide for the high, medium, and low impact cases would be 1.8, 1.6, and 1.1 million tons per year.For the 20 degrees prohibition, the yearly increase in emissions of sulfur oxide would be 1.5, .94, and .43 million tons for the three cases, respectively.

67 If the low sulfur coal were to be replaced by medium sulfur residual oil, there would be an air emission penalty of an additional 28 pounds of sulfur dioxide per ton of low sulfur coal displaced.For the 15 degrees prohibition the total yearly increase in emissions of sulfur oxide for the three scenarios would be .58, .50, and .36 million tons. For the 20 degrees prohibition the increase in emissions would be .50, .32, and .15 million tons.

67 SUMMARY

67 Because mining on steep slopes is extensive in Appalachia, the impact of a slope angle prohibition on production and reserves is greatest in that area. Central and Western coal reserves and production generally underlie relatively flat terrain.

67 In Appalachia 41 percent and 30 percent of total strippable reserves would be lost with 15 degrees and 20 degrees slope angle prohibitions, respectively. Because the overwhelming majority of U.S. resources is recoverable only by underground mining and because of large and as yet untapped resources in the West, the loss of reserves from a slope angle prohibition represents only about 1 percent of the Nation's total recoverable coal.

67 The impact of a slope prohibition on production is more difficult to determine because a number of alternatives exist that can mitigate the production loss from steep slopes. Prohibition of surface mining on slopes greater than 15 degrees would preclude production of between 42 and 108 million tons annually, representing between 11 percent and 29 percent of total Appalachian production, or 7 percent and 18 percent of total U.S. production. A 20 degrees slope angle prohibition would affect between 17 and 80 million tons annually, representing 5 percent to 21 percent of total Appalachian production or 3 to 14 percent of U.S. production. None of these cases takes account of increased coal production in other areas of the country, increased production of other fossil fuels, or increased imports.

67 An important amount of the coal production that would be precluded by slope limits is low in sulfur and ash content, making it valuable for meeting air quality standards, as well as for coking and exports. Central Appalachian surface mines, for example, produce 23 percent of all low sulfur coal consumed in the nation's electric plants, and virtually all of this production is mined on slopes greater than 20 degrees. Prohibition of surface mining on slopes greater than 15 degrees would preclude between 26 and 42 million tons of low sulfur coal production annually. A 20 degrees slope angle prohibition would affect between 10 and 37 million tons of low sulfur production.

67 REFERENCES

67 1. U.S. Department of the Interior, Bureau of Mines, Division of Fossil Fuels. Coal - Bituminous and Lignite in 1971 Washington, D.C.: Department of the Interior, September 27, 1972, p. 8; and, Dupree, Walter G., Jr. and James A. West, United States Energy Through the Year 2000. Washington, D.C.: Department of the Interior, December 1972. p. 22.

67 2. Dupree, Walter G., Jr. and James A. West. United States Energy Through the Year 2000, Washington, D.C.: Department of the Interior, December 1972. p. 21.

67 3.U.S. Department of the Interior, Bureau of Mines, Division of Fossil Fuels. Coal - Bituminoue and Lignite in 1971. Washington, D.C.: Department of the Interior, September 27, 1972. p. 7.

68 4. These less steep slopes are characteristic of surface mining in the Southwest.

68 Oklahoma, Missouri, the North Central states, southern Illinois, Indiana and the western regions of Ohio and Kentucky.

68 5. U.S. Department of the Interior, Bureau of Mines, Division of Fossil Fuels. Coal - Bituminous and Lignite in 1971. Washington, D.C.: Department of the Interior, September 27, 1972, p. 63.

68 6. Ibid., pp. 63, 65.

68 7. Ibid., pp. 63, 65 and extrapolations using preliminary 1972 export data provided by the Bureau of Mines.

68 8. Based on communications with the Bureau of Mines, Department of the Interior, February, 1973.

68 9. Committee on U.S. Energy Outlook, National Petroleum Council. November 1971. U.S. Energy Outlook: An Initial Appraisal 1971-1985. Volume Two. Summaries of the Task Group Reports. Washington, D.C.: National Petroleum Council.November, 1971. p. 136.

68 10. Ibid., p. 136.

68 11. Based on data in U.S. Department of the Interior, Bureau of Mines, Division of Fossil Fuels. Coal - Bituminous and Lignite in 1971. Washington, D.C.: Department of the Interior, September 27, 1972. pp. 29-36. Also, see footnote 17.

68 12. Based on communications with the United Mine Workers, Washington, D.C.

68 13. Based on communications with the Peabody Coal Company, St. Louis, Missouri.

68 14. Dupree, Walter G., Jr. and James A. West. United States Energy Through the Year 2000. Washington, D.C.; Department of the Interior, December 1972. p, 21.

68 15.Based on communications with the Bureau of Mines, Department of the Interior, February, 1973.

68 16. Arthur D. Little, Inc. Initial Economic Impact Analysis of Water Pollution Control Costs Upon the Coal Mining Industry. Report to Environmental Protection Agency. Cambridge, Massachusetts: A. D. Little. 1972, p. I-1.

68 17. Ibid., p. I-1.

68 18. Ibid., pp. I-2, I-3, I-4.

68 19. Based on data supplied by the Bureau of Mines, Department of Interior, February, 1973.

68 20. Calculations by CEQ based on data supplied by Mathematic, Inc., 1973.

CHAPTER 4
REGIONAL ECONOMIC IMPACT OF SLOPE ANGLE LIMITATIONS

73 IMPACT OF SLOPE LIMITATIONS ON APPALACHIAN ECONOMY

73 Determining the impacts of slope limitation on the employment and economy of Appalachia is difficult. Although the number of employees impacted by slope limitation and their associated earnings can be estimated, the figures represent only one possible scenario. As discussed in Chapter 3, a number of alternative scenarios could result from a ban on surface mining on steep slopes - ranging from complete loss of high slope production to shifts to underground mining or mining on less steep slopes. Each of these possible outcomes has a very different effect on the employment and economy of Appalachia. This section, as in the analysis of Chapter 3, will quantitatively estimate the impact of the several scenarios.

74 The most severe, and the most unlikely, impact on employment and hence on earnings, would result if the mining precluded by slope limitations were not offset by increased surface or underground mining anywhere in the region. Table 4-7 summarizes the distribution of coal mining employment as a function of slope angle. A 15 degrees slope angle limitation on surface mining would result in a loss in surface mining employment of about 15,800, or 14 percent of total mining employment in Appalachia. Operation of the employment multiplier could increase the total to almost 30,000, which would increase the unemployment rate about 0.5 percent. Although not significant regionally, local effects are more severe.

*8*TABLE 4-7. - SURFACE MINE EMPLOYMENT IN APPALACHIA AS FUNCTION OF SLOPE ANGLE, 1970

Economic area	Surface mine employment	Surface mine employment as function of slope angle					Underground mine employment
		0-9.9 degrees	10 degrees-14.9 degrees	15 degrees-19.9 degrees	20 degrees-24.9 degrees	25 degrees +	
11. Williamsp							

	ort, Pa	1,483	548	445	356	104	30	661
66.	Pittsburgh, Pa	4,837	1,505	1,765	838	335	394	23,348
68.	Cleveland, Ohio	1,099	112	0	70	693	224	212
64.	Columbus, Ohio	1,091	70	258	763	0	0	491
65.	Clarksburg, W.Va	1,527	0	0	76	1,451	0	8,020
52.	Huntington, W.Va. Ashland, Ohio	5,027	127	202	211	532	3,955	30,699
53.	Lexington, Ky	2,080	0	0	0	790	1,290	5,025
51.	Bristol, Va	1,488	0	11	27	125	1,325	16,757
50.	Knoxville, Tenn	1,614	13	38	745	378	440	3,409
49.	Nashville, Tenn	117	112	5	0	0	0	67
48.	Chattanooga, Tenn	145	61	20	23	23	18	350
45.	Birmingham, Ala	1,337	562	187	214	214	160	3,674
	Total	21,845	3,110	2,931	3,323	4,645	7,830	92,714
	Percentage	100.0	14.2	13.4	15.2	21.3	35.8	3,675

[See Table in Original]

74 If, in fact, the surface mining precluded by a slope angle limitation is replaced by underground mining, the employment and economic impacts are likely to be positive, rather than negative, because labor productivity is much lower in underground mines than in surface mines. Consequently, to maintain coal production levels following a reduction of almost 16,000 miners at steep slope contour mines could require perhaps 45,000 underground miners; this estimate is based on national labor productivity. n3 The potential underground reserves needed to support such a shift are indicated in Table 3-10. While many areas have the reserves to absorb such a shift, underground production would need to expand significantly to make up for lost production on steep slopes. As

Chapter 3 indicates, different labor and equipment requirements, the heavy capitalization required, and economics preclude a significant shift from surface to underground mining in a short time frame. Even then, underground reserves are not always located in the same areas as surface mining.

74 n3 The possibility of increased employment and economic activity from a switch to underground mining is confirmed by an analysis conducted by William H. Miernyk. Using an input-output technique, Dr. Miernyk analyzed the impact of phasing out strip mining by the year 1975 and substituting underground mining in West Virginia. His analysis showed a net increase in total employment in the state. As expected, however, some sectors of the economy experience job losses while others show gains. Although a number of assumptions critical to this study need further analysis, the results confirm the general direction of employment and economic activity indicated by the crude assumptions about labor productivity. (Miernyk, William H. Environmental Management and Regional Economic Development, vironmental Management and Regional Economic Development, paper delivered November 6, 1971, Miami Beach, Florida). paper delivered November 6, 1971, Miami Beach, Florida).

75 Another alternative is to continue surface mining in the same areas but on less steep slopes. To the extent that this is possible, no measurable effects on either employment or the general economy will occur. This result may be likely in many areas given the existing investment in equipment suited for these types of operations, the desire to remain in a locality, and the availability of personnel.

75 Alternative Scenarios

75 Chapter 3 discusses results of three scenarios in terms of impact on production and reserves if a 15 degrees slope limitation were imposed. This section evaluates their effects on employment and earnings. Table 4-8 restates the assumptions of the three cases discussed in detail in Chapter 3, and Table 4-9 indicates their impacts on basic earnings and total employment. Employment impacts are only those directly associated with surface coal mining. An employment multiplier is not used because it was not available on a county basis.

75 TABLE 4-8. - SUMMARY OF KEY ASSUMPTIONS FOR SCENARIOS (15 DEGREES SLOPE PROHIBITION)

75 High Impact Case

75 All production lost.

75 No substitution of underground or strip mining.

75 Medium Impact Case

75 Outside central Appalachia:

75 Shift to less steep slopes.

75 Lost production from small mines (less than 50,000 tons per year).

75 No increase in underground mining.

75 Central Appalachia:

75 No replacement of production lost on steep slopes.

75 5 percent increase in underground mining.

75 Low Impact Case

75 Outside central Appalachia: Shift to less steep slopes.

75 Central Appalachia:

75 10 percent increase in underground.

75 EA 52 and 50 - 25 percent shift to less steep slopes.

75 EA 51 and 53 - no shift to less steep slope.

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TABLE
4-9. -
THE
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area Scenarios

	Baseline economic data			High impact			Medium impact			Low impact		
	Unemployment rate (Mar. 1970)	Percent of families below poverty level (1969)	Percent of national per capita income (1967)	Percent basic earnings loss	Employment loss		Percent basic earnings loss	Employment loss		Percent basic earnings loss	Employment loss	
Percent basic earnings loss*2 * Employment loss					Percent	Number		Percent	Number		Percent	Number
11. Williamsport, Pa	5.1	9.9	84	0.9	0.3	490	0.2	0.1	126	0	0	0
66. Pittsburgh, Pa	4.5	8.8	97	.4	.1	1,588	.1	(n3)	344	0	0	0
68. Cleveland, Ohio	3.8	6.8	105	.2	.1	987	(n3)	(n3)	177	0	0	0
64. Columbus, Ohio	4.2	9.5	92	.5	.1	763	.1	(n3)	160	0	0	0
65. Clarksburg, W. Va	4.8	17.1	73	5.0	1.5	1,527	.2	.1	55	0	0	0
52. Huntington, W.Va.-Ashland,												

Ohio	5.9	21.2	73	3.8	1.2	4,698	2.6	.9	3,168	0.4	.1	457
53. Lexington, Ky	4.6	24.1	68	2.6	.9	2,080	2.3	.8	1,829	2.0	.7	1,577
51. Bristol, Va	5.3	21.3	71	2.1	.6	1,477	.9	.3	640	(0.3) n2	(.1) n2	(199) n2
50. Knoxville, Tenn	5.3	23.4	67	1.9	.6	1,523	1.7	.5	1,339	1.0	.3	801
49. Nashville, Tenn	3.8	17.9	78	(n3)	0	0	0	0	0	0	0	0
48. Chattanooga, Tenn	(n4)	17.0	(n4)	(n4)	(n3)	64	(n3)	(n3)	2	0	0	0
45. Birmingham, Ala	4.5	20.0	75	.4	.1	588	(n3)	(n3)	15	0	0	0
Total						15,785			7,855			2,636

[See Table in Original]

76 n1 Earnings and employment changes do not include secondary impacts.

76 n2 Gain.

76 n3 Nil.

76 n4 Not available.

76 Source: Based on data supplied by the Bureau of Economic Analysis, Department of Commerce, 1973.

77 Although the results vary greatly depending on the scenario, some general conclusions are possible. Even in the high impact case, a number of basic economic areas remain virtually unaffected. The northern Appalachian economic areas (currently the most economically healthy areas relative to the rest of Appalachia) would experience essentially insignificant impacts. Similarly, the southern Appalachian areas, although significantly depressed economically, are affected very little by the slope angle limitations. The potential for serious impact is highest in central Appalachia - Huntington-Ashland, Lexington, Bristol, and Knoxville. They account for over 40 percent of Appalachian surface mining and about 17 percent of all Appalachian coal mining. These four have the highest percentage of families below the poverty level in Appalachia - over double the national average - and the unemployment rate is higher than the rest

of Appalachia and the nation. Although the maximum direct impact n4 does not represent more than 4 percent of basic earnings, in areas where over 20 percent of the families are below the poverty level, additional erosion of the earnings base is important.

77 n4 Does not include secondary earnings effects.

77 For ease of understanding, the preceding analysis and discussion focused on the impacts of a 15 degrees slope angle prohibition. A similar analaysis was also undertaken for a 20 degrees slope angle ban and is summarized in Table 4-10. The assumptions underlying each case vary somewhat from the 15 degrees case and are fully explained in Appendix I. In northern and southern Appalachia, the direct economic impacts are even further reduced and are not severe. In central Appalachia, the impacts are still appreciable but are significantly less than the 15 degrees case in two of the four key economic areas (EA 50 and 52). A more detailed discussion of the 20 degrees slope angle ban is included in Appendix I.

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TABLE
4-10.
- THE
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OF 20
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AREAS
n1

Econom ic area	Scenarios					
	Baseline Economic Data			High impact	Medium impact	Low impact
	Unempl	Perce nt famil ies below pover	Perce nt of natio nal per capit	Perce nt	Perce nt	Perce nt

	oyment rate (March 1970)	ty level (1969)	a incom e (1967)	basic earni ngs loss	Employment loss Perce nt	Numbe r	basic earni ngs loss	Employment loss Perce nt	Numbe r	basic earni ngs loss	Employment loss Perce nt	Numbe r
11. Williamsport, Pa	5.1	9.9	84	0.3	0.1	134	0.1	(n3)	35	0	0	0
66. Pittsburgh, Pa	4.5	8.8	97	.2	.1	729	(n3)	(n3)	153	0	0	0
68. Cleveland, Ohio	3.8	6.8	105	.2	.1	917	(n3)	(n3)	183	0	0	0
64. Columbus, Ohio	4.2	9.5	92	0	0	0	0	0	0	0	0	0
65. Clarksburg, W. Va	4.8	17.1	73	4.8	1.4	1,451	.2	.1	58	0	0	0
52. Huntington, W.Va.-Ashland, Ohio	5.9	21.2	73	3.7	1.2	4,487	(2.6) .6	(.8) .2	(3,070) 709	n2	n2	n2
53. Lexington, Ky	4.6	24.1	68	2.6	.9	2,080	2.3	.8	1,828	2.0	.7	157
51. Bristol, Va	5.3	21.3	71	2.1	.6	1,450	(.3) .9	(.1) .3	(226) 612	n2	n2	n2
50. Knoxville, Tenn	5.3	23.4	67	1.0	.3	818	.6	.2	444	.1	(3)	68
49. Nashville, Tenn	3.8	17.9	78	0	0	0	0	0	0	0	0	0
48. Chatta												

nooga,
Tenn (n4) 17.0 (n4) (n4) (n3) 41 (n4) (n3) 1 0 0 0
45.
Birmin
gham,
Ala 4.5 20.0 75 .3 .1 374 (n3) (n3) 11 0 0 0
12,48
Total 1 4,034 3,071

[See Table in Original] 78 n1 Earnings and employment losses do not include secondary impacts.

78 n2 Gain.

78 n3 Nil

78 n4 Not available.

78 Source: Based on data supplied by the Bureau of Economic Analysis, Department of Commerce, 1973.

79 The direct economic impact data on EA's may be somewhat misleading. Although they do represent an assessment of subregional impacts, local effects may be even more severe. Unfortunately, detailed and current data on a county-by-county basis are not available, but selected county data indicate the potential for more severe local effects.

79 Tables 4-11 and 4-12 summarize the direct impact of the high, medium, and low impact scenarios of 15 degrees and 20 degrees slope angle bans for selected counties within the Appalachian region. Although the data may somewhat overstate impacts because they assume no employment opportunities or employee mobility between adjacent counties, it is clear that throughout Appalachia even more severe local impacts than indicated by the EA data are possible.

80

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TABLE
4-11.
- THE
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OF 15
DEGREE
S
SLOPE
ANGLE
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ON

SELECTED COUNTIES n1

Economic Area / County	Baseline economic data: Unemployment rate (percent) (1970)	Baseline economic data: Coal as a percent of basic earnings (1970)	High impact: Percent, basic earnings loss	High impact: Employment loss, Percent	High impact: Employment loss, Number	Medium impact: Percent, basic earnings loss	Medium impact: Employment loss, Percent	Medium impact: Employment loss, Number	Low impact: Percent, basic earnings loss	Low impact: Employment loss, Percent	Low impact: Employment loss, Number
51.											
Bristol, Va	5.3	26.2	2.1	.6	1,477	.9	.3	640	(0.3) n2	(0.1) n2	(199) n2
Buchanan, Va	6.0	95.0	5.8	3.1	321	1.4	.7	76	(3.1) n2	(1.6) n2	(169) n2
Dickinson, Va	8.0	95.0	7.5	4.3	149	3.1	1.8	62	(1.3) n2	(.7) n2	(25) n2
Wise, Va	4.6	75.0	13.6	3.7	375	10.5	2.9	290	7.5	2.0	206
52. Huntington W.Va.											
Ashland Ohio	5.9	29.7	3.8	1.2	4,698	2.6	.9	3,168	.4	.1	457
Kanawha, W.Va.	4.8	15.8	1.7	.3	343	1.0	.2	203	.3	.1	63
Pike, Ky	7.7	93.2	7.8	3.1	489	3.5	1.4	218	(.9) n2	(.3) n2	(54) n2
Carter, Ky	7.7	1.0	.1	n(3)	2	.1	n(3)	2	n(3)	n(3)	1
66.											
Pittsburgh, Pa	4.5	7.9	.4	.1	1,588	.1	n(3)	344	0	0	0
Allegheny, Pa	4.3	1.4	n(3)	n(3)	20	n(3)	n(3)	3	0	0	0

Belmont, Ohio	4.9	41.8	8.6	1.8	437	1.3	.3	66	0	0	0
Clarion, Pa	5.1	15.0	.6	.2	20	.1	n(3)	3	0	0	0

[See Table in Original]

80 n1 Earnings and employment changes do not include secondary effects.

80 n2 Gain.

80 n3 Nil.

80 Source: Based on data supplied by the Bureau of Economic Analysis, Department of Commerce, 1973.

81

12

TABLE 4-12. - THE DIRECT ECONOMIC IMPACT OF 20 DEGREES SLOPE ANGLE PROHIBITION ON SELECTED COUNTIES n1

Economic Area County	Baseline economic data		Scenaries					
			High impact		Medium impact		Low impact	
	Unemployment rate (percent)	Coal as a percent of basic earnings (	Percent, basic earnings	Employment	Percent, basic earnings	Employment	Percent basic earnings	Employment

1970) 1970) loss loss loss loss loss loss
Percen Percen Numbe Perce Numbe
t Number t r nt r

51.
Bristo (3.0) (0.1) (226)
l, Va 5.3 26.2 2.1 0.6 1,450 0.9 0.3 612 n2 n2 n2
Buchan (3.1) (1.6) (169)
an, Va 6.0 95.0 5.8 3.1 321 1.4 .7 76 n2 n2 n2
Dickin
son, (1.3) (.7) (25)
Va 8.0 95.0 4.3 4.3 149 3.1 1.8 62 n2 n2 n2
Wise,
Va 4.6 75.0 12.6 3.5 349 8.9 2.4 245 5.1 1.4 142
52.
Huntin
gton
W.Va.
(
Ashlan (2.6) (.8) 3,070
d Ohio 5.9 29.7 3.7 1.2 4,487 .6 .2 709 n2 n2) n2
Kanawh
a, W. (.3) (280)
Va 4.8 15.8 1.6 .3 318 .1 n(3) 19 1.4 n2 n2
(.4) (59)
Pike, (.9) n2, n2,
Ky 7.7 93.2 7.8 3.1 484 3.4 1.4 213 n4 n4 n4
Carter
, Ky 7.7 1.0 .1 n(3) 2 .1 n(3) 1 0 0 0
66.
Pittsb
urgh,
Pa 4.5 7.9 .2 .1 729 n(3) n(3) 153 0 0 0
Allegh
eny,
Pa 4.3 1.4 0 0 0 0 0 0 0 0 0
Belmon
t,
Ohio 4.9 41.8 4.1 .8 207 .6 .1 31 0 0 0
Clario
n, Pa 5.1 15.0 .5 .1 15 .1 n(3) 2 0 0 0
[See Table in Original]

81 n1 Earnings and employment changes do not include secondary impacts.

81 n2 Gain.

81 n3 Nil.

81 n4 No shift to less steep slopes.

CHAPTER 4
REGIONAL ECONOMIC IMPACT OF SLOPE ANGLE LIMITATIONS

82 SUMMARY

82 Although a prohibition of strip mining on steep slopes will probably not have a major impact on Appalachia as a whole, it would have a significant to severe impact in certain areas of Appalachia. The most significant impacts are in central Appalachia and in those counties throughout Appalachia where surface coal mining is a major employer. This is true in both the high and medium impact alternatives; only when a large shift to underground mining is possible would impacts be minimal or even positive. In the areas that would be most heavily impacted, there are generally few alternative employment opportunities. Because adjacent areas, already depressed economically, may be experiencing the same dislocations, the opportunities for jobs outside these selected counties may also be limited. From the data available, however, it is not possible to gain more than a qualitative picture of the employment and earnings impacts from a 15 degrees or 20 degrees slope limitation. More detailed data and analysis by county would be necessary for a definitive understanding.

82 REFERENCES

82 1. Appalachian Regional Commission. Appalachia - An Economic Report, July 1972, p. 3. (This report is hereafter referred to as ARC (1972).)

82 2. Ibid., p. 97.

82 3. Ibid., p. 107.

82 4. Ibid., p. 18.

82 5. U.S. Department of Commerce, Bureau of the Census, General Social and Economic Characteristics, 1970 Census of Population, state reports for Kentucky (PC(1)-C19), Tennessee (PC(1)-C44), Virginia (PC(1)-C48), West Virginia (PC(1)-C50), (Washington, D.C.U.S. Government Printing Office, 1972).

82 6. U.S. Bureau of the Census. Statistical Abstracts of the U.S., 1970, Washington, D.C., p. 11.

82 7. ARC (1972), p. 107.

82 8. U.S. Department of Commerce, Social and Economics Statistics Administration, Bureau of the Census, Employment Profiles of Selected Low-Income Areas; Selected Rural Counties in Appalachia, PHC(3)-70 1970 Census of Population and Housing (Washington, D.C.U.S. Government Printing Office, May 1972).

82 9. ARC (1972), p. 97; and U.S. Department of Commerce, Social and Economics Statistics Administration, Bureau of the Census, Employment Profiles of Selected Low-Income Areas; Selected Rural Counties in Appalachia, PHC(3)-70 1970 Census of Population and Housing (Washington, D.C.U.S. Government Printing

Office, May 1972).

82 10. ARC (1972), p. 12.

82 11. Bureau of Economic Analysis, U.S. Department of Commerce, "The Incidence of Coal Mining in Selected Counties and BEA Economic Areas," unpublished paper, January 1973.

APPENDIX F. HIGHLIGHTS OF STATE LAWS REGULATING SURFACE MINING OF COAL

113 A. Administrative Agency

113 Department of Natural Resources, Division of Forestry and Reclamation.

113 B. Requirements and Limitations

113 1. Procedural

113 (a) Permit. - Operators must have a license, valid for one year, which is issued to those who (1) pay a fee of $150+ $3 0/acre, (2) submit an acceptable mining and reclamation plan, (3) provide an adequate performance bond of at least $5 000 as determined by the administrative agency, and (4) have not previously violated the surface mining law.

113 (b) Performance Bond. - The bond amount is to be determined by the Department based on the estimated cost of reclamation but not less than $5 000. Upon completion of mining or at the expiration of the license, whichever occurs first, the bond or the portion thereof applicable to adequately reclaimed land will be released.

113 2. Substantive

113 (a) Drainage. - Operators must prevent "pollution" of State waters (that is, contrary to water pollution control standards or otherwise determined to be harmful), "substantial erosion and deposition of sediment, accumulation or discharge of acid water, and flooding, and must prevent acid water from draining or accumulating into the pit".

113 (b) Reclamation. - Land must be restored to its approximate original contour and condition unless the State determines that (1) an alternative such as terracing will permit equal or greater "economic or public use of the land," (2) natural conditions will not permit such restoration, or (3) contouring would cause soil erosion or acid water conditions precluding vegetative growth, in which case the State specifies reclamation by terracing with no slope greater than 35 degrees except where necessary for the land's approved future use.

113 Reclamation must begin within three months after overburden is first removed and must be completed within one year (1) after the operation terminates or (2) after the license year, whichever occurs first. Reclamation, including planting, must take place "as mining progresses . . . whenever possible." Planting, in any case, must take place no later than the planting season

following completion of backfilling, grading, and resoiling unless the time is extended to permit removal of clay or shale uncovered by the coal mining. The operator's plan must provide for "immediate establishment" of grass or other plant cover to prevent soil erosion.

113 Topsoil must be separately removed and replaced unless other procedures "necessary to sustain vegetation" are approved. Refuse and hazardous materials must be suitably buried.

113 The operator's performance bond is returned only after an inspection to ensure that the foregoing requirements are met.

114 No license may be issued if there is not "reasonable cause" to believe that the required reclamation will be accomplished, and the license must be denied if experience with similar operations on similar land shows that the measures which the operator proposes will not prevent water pollution, "substantial" erosion and sediment deposition, landslides, accumulation or discharge of acid water, and flooding.

114 C. Enforcement

114 The Division Chief must revoke the license of any operator who willfully misrepresents or omits material facts in his license application. Any person who violates the law, permits, or orders issued thereunder is subject to court-ordered fines. For most offenses, the fine is $100-$1000 for the first offense and $200-$5 000 for subsequent offenses. For willful misrepresentations or omissions of facts in applications and hearings, and for third and subsequent violations of the law, imprisonment up to six months may be added. In addition, for third and subsequent offenses, the court shall revoke the operator's license and preclude him from obtaining another one for five years. The Attorney General and persons adversely affected by an operation may go to court to enjoin violations or require compliance. If State officials fail to enforce the law, any State resident may petition a court to order them to do so.

114 D. Other

114 The State severance tax of 4 cents/ton of coal generates revenues for State "environmental protection activities" and reclamation of surface mined lands.

114 OKLAHOMA

114 (Law of 1972 as amended)

114 A. Administrative Agency

114 Department of Mines and Mining.

114 B. Requirements and Limitations

114 1. Procedural

114 (a) Permit. - A permit, valid for one year, is required for each mining operation and may be obtained by (1) paying a $5 0 fee, (2) filing an adequate performance bond, and (3) submitting an adequate reclamation plan. No permit may be issued to an operator who has had a prior permit revoked.

114 (b) Performance Bond. - The bond amount is $350- $650/acre with a $5 000 minimum total, except where circumstances warrant an exception to the minimum or maximum amounts. The amount is to be established after considering the likely cost of reclamation. The bond is released when reclamation work is completed, except that up to 80% of the bond may be released as land is graded.

114 2. Substantive

114 (a) Drainage. - The operator may construct earth dams to form lakes in pits if the lakes will not interfere with other property or mining. Operations conducted in flood plains are exempt from the usual grading requirements (in (b), following). There are no statutory provisions for drainage over or from the mined area or for related sediment and acid problems.

115 (b) Reclamation. - The operator is authorized to determine the future uses for which the land will be reclaimed. Ridges and peaks must be reduced to such "rolling topography" as will make them traversible by any machines and equipment associated with the future land uses. Slopes need not be reduced to less than the original grade, and the slope of the overburden ridge resulting from the first cut need not be reduced to less than 25 degrees.

115 Coal seams with significant concentrations of acid-forming material must be covered to support plant life or made into a water impoundment.

115 All affected land must be revegetated as appropriate for its intended use unless it is to be covered with water or used for residential or industrial sites. However, no planting may be required while the soil is sufficiently toxic, deficient in nutrients, or hard to seriously inhibit plant growth. There is no statutory requirement for segregation and replacement of topsoil.

115 Grading and backfilling must follow mining by no more than two spoil ridges. Grading must be completed within one year after mining is completed. Initial planting or seeding must be done at the first "appropriate time" after grading is completed unless an extension is granted for unavailability of planting stock. There is no requirement for concurrent reclamation.

115 C. Enforcement

115 The Department must notify operators of alleged violations of the law or regulations and, if such allegation is denied, hold a hearing after 30 days following the notice. If the Department concludes after the hearing that there was a violation, it must issue a detailed order specifying a reasonable time for corrective actions. If the operator fails to take such actions, the Department may contract to have the work done, and the Attorney General may recover resultant damages and expenses for the Department not to exceed the face amount

of the bond.

115 The Department also has authority to revoke permits, after a hearing, in cases of violations. The Department has general authority to seek in court injunctive or other relief to enforce the law.

115 PENNSYLVANIA

115 (Law of 1945, as amended in 1972)

115 A. Administrative Agency

115 Department of Environmental Resources, Bureau of Land Protection and Reclamation, Division of Mine Reclamation.

115 B. Requirements and Limitations

115 1. Procedural

115 (a) Permit. - Surface mining may not be conducted without an operator's license ($500 fee + $3 00 annually to renew) and a permit for each operation, issued after an acceptable reclamation plan and adequate performance bond are received.

115 (b) Performance Bond. - The amount of the performance bond, guaranteeing compliance with the surface mining law and the State water quality law, is determined by the State on the basis of the total estimated cost to the State of completing the operator's approved reclamation plan if he defaults, with a $5 000 minimum. The State may release portions of the bond as portions of the reclamation plan are completed and approved, but may retain 5 percent for 5 years after reclamation is completed to cover the contingency of later discovered faulty work. No permit or license will be issued to an operator who continues to violate the State surface mining or water quality laws.

116 2. Substantive

116 (a) Drainage. - Operators must, prior to getting a mining permit, obtain a water quality permit, compliance with which will ensure that applicable water pollution control standards are met.In addition, regulations under the surface mining law contain detailed provisions controlling drainage into and from mines.

116 The law provides explicitly that no reclamation plan may be approved unless it provides a "practicable" method of "avoiding acid mine drainage" and "preventing avoidable siltation or other stream pollution," and failure to achieve this is cause for permit revocation.

116 (b) Reclamation. - The reclamation plan must provide for (1) return of land to approximate original contour (contouring); or, if conditions do not permit contouring, (2) terracing (grading to a contour not exceeding 35 degrees), or (3) another alternative which does not pose a water pollution threat and which is not "unreasonable" or "impractical" and does not involve

"unreasonable delay in . . . implementation." In practice, original contour is required whenever the prior slope was under 12 degrees.

116 The law does not explicitly require concurrent reclamation, but once every 90 days after mining starts, a progress report must be provided on "reclamation work performed in pursuance of the approved reclamation plan." Regulations explicitly require backfilling to be accomplished "as mining progresses." They also require burial of acid-forming materials at a high elevation.

116 The law requires topsoil and "adequate subsoil" to be segregated and restored and requires a planting program "best calculated to permanently restore vegetation," unless conditions do not permit, in which case the plan will not be approved without alternative procedures that will obviate any "actual or potential threat of soil erosion or unavoidable siltation." Regulations for coal mining flatly require preservation of topsoil and adequate subsoil to provide at least a 12-inch cover over.

116 C. Enforcement

116 If an operator fails to comply with the law or regulations beyond thirty days after notification, the Department may - after hearing - suspend the operator's license and require the operation to cease and desist. Inspectors may order immediate cessation of operations where "public welfare or safety" requires or where there is no permit. In addition, the Attorney General may request a court to restrain violations of, or enforce compliance with, the law or regulations. Citizens may request a court to order State officials to enforce the law if such an official fails to do so for an unreasonable time after a citizen has so demanded. There are apparently no penalty provisions other than bond forfeitures.

117 D. Other

117 All fees from licenses and bond forfeitures are to be used for reclaiming mined lands.

117 TENNESSEE

117 (Law of 1972)

117 A. Administrative Agency

117 Department of Conservation, Division of Surface Mining.

117 B. Requirements and Limitations

117 (1) Procedural

117 (a) Permit. - Each surface mining operation requires a permit, valid for one year, which may be obtained by (1) paying a fee of $250 plus a per-acre fee of $2 5 that may not exceed $2 500, (2) filing an adequate performance bond, and

(3) submitting an acceptable mining and reclamation plan. No permit may be issued to an operator who has had a prior permit revoked or suspended and bond forfeited, unless the area covered by such permit has been completely reclaimed by the operator.

117 (b) Performance Bond. - The bond must be at least $6 00/acre, with liability continuing until all reclamation requirements are met. The absence of a maximum amount indicates authority to base the amount on actual estimated reclamation costs. The bond is released upon initial planting of land being reclaimed, except for $2 00/acre that is retained until the vegetation has survived or the Department determines that further revegetation effort is impractical.

117 (2) Substantive

117 (a) Drainage. - The operator must apply for a separate water quality permit from the Department's Division of Water Quality Control whenever surface drainage is necessary or the chemistry or turbidity of active streams may be affected. No mining permit will be issued if the Department determines that the operation will not meet water quality standards. The mining and reclamation plan must "strictly control" erosion and pollution.

117 (b) Reclamation. - Reclamation for area mining (i.e., on slopes up to 15 degrees) must achieve "approximately the original contour or rolling topography" and eliminate highwalls, spoil piles, and water-collecting depressions. For contour mining (i.e., on slopes exceeding 15 degrees), there is no overall performance standard for reclamation, but the resulting slopes, except for stable rock highwall, may not exceed 35 degrees, and the highwall must be reduced to a height of no more than 30 ft. unless the pre-existing highwall exceeded 20 ft., in which case the highwall need not be eliminated.No overburden from second or subsequent cuts may be permanently placed beyond the solid bench from the first cut.

117 Reclamation must be concurrent with mining and completed on each acre within one year after mining. For area mining, grading and backfilling must be no more than two spoil ridges behind the pit being worked and must be completed within 90 days after mining is completed and within 180 days after initial land disturbance. For contour mining, grading and backfilling must be completed within 180 days after initial soil disturbance and must follow coal removal within 15 days and 1500 ft. If augering is included, it must follow stripping within 60 days and 2500 ft. and the grading and backfilling must follow augering within 15 days and 1500 ft.

118 Toxic and acid-forming materials must be covered and other refuse removed or covered.

118 Soil must be prepared to provide "favorable conditions for revegetation." The plan must provide for planting that will achieve "quick and permanent" soil stabilization. The regulations contain detailed specifications, with requirements for 80 percent ground cover (60 percent survival of woody plants) except in areas too stony to support vegetation.

118 The plan must provide for conserving topsoil, but only in area mining do the regulations require that it be segregated and restored.

118 (c) Bench Width. - The law calls for regulations to limit bench widths and control the overburden placed beyond the solid bench. Current regulations limit bench width to 125 ft. on slopes between 15-18 degrees, down to 55 ft. on slopes between 26-28 degrees. Beyond 28 degrees, no fill bench is allowed. Terrace backfilling is required whenever the pre-existing highwall is less than 20 feet. Exceptions may be granted from these rules where mining methods such as slope reduction or head-of-hollow-fill have been approved.

118 C. Enforcement

118 Whenever any requirement of the law, regulations, or departmenta orders are not met within applicable time limits, the Department must issue a non-compliance notice and, "where necessary," suspend the permit.If the operator fails to comply with the notice or suspension order, the permit may be revoked and the performance bond forfeited.

118 Both the Department and the Attorney General may request a court to enjoin actual or threatened violations, with the Department being relieved of the normal obligation in such an equity proceeding of showing that there is no adequate remedy "at law" (i.e., non-injunctive relief).

118 Violators are liable to a civil penalty of $1 00-$5000 day and a criminal penalty of $1 000-$5 000 and/or imprisonment up to one year for willfull violations.

118 D. Other

118 Funds from permit fees and bond forfeitures are put in a special account, to be used for administration of the law, including reclamation of abandoned lands, which the State may acquire.

118 VIRGINIA

118 (Law of 1966, as amended in 1972)

118 A. Administrative Agency

118 Department of Conservation and Economic Development, Division of Mined Land Reclamation.

118 B. Requirements and Limitations

118 1. Procedural

118 (a) Permits. - A permit, valid for one year, is required for each operation. Obtaining a permit requires (1) payment of a $6/acre fee and $2 /acre annual renewal fee for undisturbed land, (2) acceptable operations,

reclamation, and drainage plans, (3) a performance bond, and (4) assurance that no prior permit for the operator/applicant has been revoked or security forfeited.

119 (b) Performance Bond. - The amount of the required bond is based on the estimated reclamation cost but must be between $200-$1000/acre with a minimum total of $2500 ($1 000 if total acreage is less than 5). The bond is released only after the Department approves a final reclamation report.

119 2. Substantive

119 (a) Drainage. - Regulations require (1) sediment dams or ponds to keep sediment out of streams and drainage areas, (2) adequate treatment and proper drainage of acid water, (3) protection of permanent streams from spoil, and (4) if the Division deems necessary, (a) diversion ditches to intercept surface drainage above the highwall and (b) interception and treatment of spoil slope surface drainage.

119 If proper drainage is not feasible or spoil would adversely affect a water course, the permit must be denied.

119 (b) Reclamation. - There is no prescribed standard for reclamation other than restoration of the land to a "stable condition" that "minimizes or prevents adverse disruption" and affords a "reasonable opportunity for further productive use." The Division is directed to "encourage adoption of more productive land use, such as pasture, agricultural use, recreational areas, sanitary landfills, industrial and building sites."

119 Reclamation must be "simultaneous" with the mining, defined in regulations as grading and backfilling that follows coal removal by no more than 60 days and 700 feet in distance (or, if augering is also used, within 30 days and 350 feet of augering.

119 Spoil is to be retained on the bench "insofar as feasible" and used for backfill to reduce the ultimate highwall "to the maximum extent practicable." The restored slope must divert surface water from the disturbed area, and terraces may be required for this purpose.

119 The pit must be covered by at least four feet of material suitable for growing vegetation. Prior to this, all acid-producing and toxic spoil must be buried in the pit.

119 The regulations state an "objective" of stabilizing the disturbed area as soon as possible in order to "achieve quickly" a "permanent and protective vegetative cover." Planting and seeding must be done in the first planting season after grading.A very specific per-acre seed mixture for grasses and legumes is specified, subject to modification if the Division agrees. Where excessive erosion is likely, rapid "establishment" of cover is required, and annual vegetation may be used for this.If inspectors find inadequate cover, they must require follow up work.

119 C. Enforcement

119 The Division may issue a non-compliance notice to any operator failing to obey a Division order to comply with the law, regulations, or approved plans. If the operator fails to comply within the reasonable time specified in the notice, the Division must revoke the permit and forfeit the entire bond.

119 The Division must seek a court injunction against further operations whenever "adverse ecological disruptions . . . seriously threaten . . . health, safety and property rights . . . and abatement is not feasible by the application of control techniques." (Presumably, an injunction may be sought against an operator whose permit has been revoked [see prior paragraph].)

120 It is a misdemeanor (punishable by a fine of up to $1 ,000 and/or up to one year in jail for each day of violation) to mine without a permit, to fail willfully to follow approved plans, or to disobey or willfully disregard regulations or orders.

120 D. Other

120 All fees collected under the law go into a fund for reclaiming orphaned lands.

120 No permit may be granted for an operation that would "adversely affect a public park, historic landmark, or recreational area."

120 WASHINGTON

120 (Law of 1970)

120 A. Administrative Agency

120 Board of Natural Resources, acting through the Department of Natural Resources.

120 B. Requirements and Limitations

120 1.Procedural

120 (a) Permit. - Each mining operation requires a permit, which may be obtained for the life of the operation by (1) paying a fee of $25/year + $5 /acre disturbed in the prior year, (2) depositing an adequate performance bond, and (3) filing an acceptable reclamation plan. The State may, but need not, deny a new permit to a continuing offender of the surface mining law and regulations.

120 (b) Performance Bond. - The bond must be filed and maintained in an amount equal to the estimated cost of completing the reclamation plan on the land to be mined in the next year and previously mined land under the permit on which reclamation has not been completed and approved. The bond must be between $100 and $1 ,000/acre. Each year, the bond is reduced to reflect the

number of acres still to be mined during the following year and/or reclaimed.

120 2. Substantive

120 (a) Drainage. - The law prohibits allowing stagnant water to collect on the mined area and requires grading of the final surface cover to make surface water drain away from the area where acid-forming refuse has been buried. Any mining that will affect State streams must be approved by the Department of Ecology under its water quality law. Regulations require establishment, and maintenance until mining and reclamation are completed, of diversion ditches and channels to control runoff, erosion, and siltation under established standards. Overburden must be deposited and graded to avoid erosion.

120 (b) Reclamation. - Peaks and depressions of spoil banks must be reduced to a "gentle rolling topography" in "substantial conformity" with the surrounding land area. The law's policy declaration states that "the very character of many types of surface mining operations precludes complete restoration of the land to its original condition." However, the Department can designate (and has designated) areas in which surface mining is prohibited as unsuitable. In addition, many local jurisdictions require special zoning approval for surface mining; this may hinge on the type of reclamation.

121 Reclamation must be simultaneous with mining "to the extent feasible" and in any event "at the earliest possible time after completion" of "any segment [undefined] of the permit area." State officials have interpreted this provision to make concurrent reclamation "recommended" but not mandatory. Reclamation must be completed within two years after completion of each segment of the permit area.

121 All acid-forming refuse must be buried under at least two feet of fill.

121 Vegetative cover is required only where it is appropriate to the intended subsequent use of the land or needed temporarily to prevent erosion or provide screening. There is no general requirement that topsoil be segregated and replaced.

121 C. Enforcement

121 The Department may cancel an operator's permit and refuse to issue a new one, and may proceed to reclaim all or part of the permit area whenever (1) the operator is failing to follow his approved plan and has failed within 30 days of notification to remedy his violations or (2) reclamation is not completed within two years after completion of mining. If the operator's surety does not pay the State's costs within 30 days of notice, the Attorney General must file a court claim.

121 The Department may order an operator who is violating the law, regulations, or his plan, to suspend operations until compliance is achieved or assured. The Attorney General must seek a court order to stop surface mining in violation of any such order.

121 WEST VIRGINIA

121 (Law of 1967, as amended in 1971)

121 A. Administrative Agency

121 Department of Natural Resources, Division of Reclamation.

121 B. Requirements and Limitations

121 1. Procedural

121 (a) Permit. - A permit, which must be secured for each mining operation and is valid for one year, may be obtained by (1) payment of a $500 fee ($100 for each annual renewal) and a reclamation tax of $6 0/acre, (2) filing an adequate performance bond, (3) submitting an acceptable reclamation plan, and (4) providing assurance that the operator has not had a prior permit revoked and bond forfeited (if this occurred before July 1, 1971, it is not a bar to a permit if the operator paid for necessary reclamation). The Department must notify the public of permit applications and allow 30 days for filing of written "protests," which it must "consider."

121 (b) Performance Bond. - The bond, based on estimated reclamation costs, may be up to $1000/acre, with a minimum total of $1 0,000. Portions may be released as work is completed, but the portion for backfilling and grading may not be released until acidic spoil has been adequately treated, and at least $5 000 must be retained until planting and revegetation are properly done and approved.

122 2. Substantive

122 (a) Drainage. - A drainage system meeting departmental regulations must be established before any mining and maintained thereafter. Regulations require diversion of surface drainage and adherence to specific standards for pH, iron, and turbidity for drainage leaving the permit area. Any breakthrough of acid water must be sealed.

122 (b) Reclamation. - For area mined lands (original slope less than 15 degrees), complete backfilling is required, not to exceed the approximate original contour, with highwalls and spoil peaks eliminated. For contour mining, the highwall must be reduced or, where this would damage vegetated lands above the highwall or there is insufficient soil to provide vegetative cover on the reduced highwall, the highwall must be backfilled with soil from the operation instead. The fill must meet maximum slope limits and must cover toxic and acid-producing material as well as support vegetation and divert surface water from flowing over the outer slope. No overburden in excess of the first cut may be placed over the fill bench. Bench width limitations are described in (c) below.

122 Reclamation must be kept current with mining. Regulations provide that for area mining, reclamation must follow mining by no more than two spoil ridges

and be completed within 90 days after mining ends, with linear feet of open pit never exceeding 3000. For contour mining, reclamation must follow mining within 60 days and 3000 ft. Any augering must follow stripping within 60 days, with reclamation following augering within 30 days and 1000 ft.

122 The regulations contain detailed specifications for stabilizing the disturbed area "as quickly as possible" in order to achieve "a quick, permanent and protective vegetative cover." Whenever the overburden is acid-producing, topsoil or "upper horizon" segregation and replacement is required. Inspection of vegetative cover for approval may be done only after the planting has survived for two growing seaons.Legumes and perennial grasses must provide at least 80 percent ground cover, or if combined with woody plants must provide at least 60 percent cover, with the woody plants achieving 60 percent survival.

122 Areas that are impossible to reclaim and that, if surface-mined, would cause an "imminent and inordinate peril to the welfare of the State" may not be mined and are to be designated by the Department.

122 (c) Bench Width. - The law limits bench width to 250 ft. on slopes of 15 degrees or more, with a reduction to 60 ft. at 33 degrees. Beyond 33 degrees, no fill material is allowed beyond the cut section, i.e., no fill bench.

122 C. Enforcement

122 Inspectors may order immediate cessation of operations whenever the law, regulations, or orders are being violated or when public welfare or safety otherwise so requires. (Added in 1971.) The normal and more lengthy enforcement device is a notice of non-compliance that orders cessation of operations or suspension of the permit. Failure by the operator to reach agreement with the Department or to comply with requirements in the notice or order may result in revocation of the permit and forfeiture of the bond.

122 "Willful" violation of the law is a misdemeanor punishable by a fine of $100-$1 000 and/or up to six months' imprisonment for each day of offense. A "deliberate" violation is a misdemeanor punishable by a fine of $100-$1 0,000 and/or up to six months' imprisonment for each day of offense.123 The Department, the Attorney General, and county prosecuting attorneys may seek a court injunction to stop violations and compel compliance. Such relief may be granted even though administrative remedies have not been exhausted.

122 D. Other

122 Proceeds from permit fees, the reclamation tax, and bond forfeitures go into a State fund for the reclamation of unreclaimed land for which bonds were either not collected or are uncollectible.

122 WYOMING

122 (Law of 1969) A. Administrative Agency

122 The Commissioner of Public Lands. B. Requirements and Limitations

122 1.Procedural

122 (a) Permit. - All surface mining operations require a permit, of indefinite duration, which may be obtained by (1) paying a $5 0 fee and (2) filing an adequate performance bond. The operator may at any time, but need not, propose a reclamation plan. Compliance with an approved reclamation plan fulfills the requirements of the law as set forth in the regulations.

122 (b) Performance Bond. - The bond must be in an amount equal to the cost of the restoration required by the law, as determined by the Commissioner. The bond is released as parts of the mined land are reclaimed.

122 2. Substantive

122 (a) Drainage. - An earth dam must be constructed in the final cut of an operation where lakes may be formed if a dam is needed to impound effluent that is sufficiently toxic or radioactive to endanger man or other life.

122 (b) Reclamation. - Grading must be done to reduce peaks and ridges to a "rolling topography." If "practical," the exposed coal seam must be covered with earth or spoil if acid-forming material is present. "Where practicable, reasonable effort must be made to encourage . . . revegetation . . . ." Regulations provide that topsoil "may" be segregated and replaced and that reclamation may be done concurrently with mining, in which case the cost of any such procedures shall be excluded from the performance bond.

122 C. Enforcement

122 The Commissioner must notify an operator of any violations of law and hold a hearing after 30 days. After the hearing, if the Commissioner still determines there is a violation, he shall request the Attorney General to initiate bond forfeiture proceedings. Any such forfeiture is deemed to fully satisfy the operator's reclamation obligations.A minimal fine of up to $1 000 applies only to those guilty of mining without a permit.

122 D. Other

122 Proceeds from all fees and forfeitures go into a State fund for reclamation.