To the Graduate Council:

I am submitting herewith a thesis written by James Edward Rowe entitled "Land Use Alternatives for Reclaimed Strip Mined Areas in Selected Tennessee Counties." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Planning.

Joseph M. Prochaska, Major Professor

We have read this thesis and recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

LAND USE ALTERNATIVES FOR RECLAIMED STRIP MINED AREAS IN SELECTED TENNESSEE COUNTIES

A Thesis

Presented for the

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ABSTRACT

The purpose of this thesis is to develop a process for determining alternative land uses for reclaimed strip mined areas in the Central Appalachian Region that would be beneficial to both the mine operator and the environment. The process was tested on several selected sites in a five-county area of the Tennessee portion of the Cumberland Plateau.

Eight major physical factors were mapped on transparencies and analyzed in order to identify environmentally critical areas. The factors are: (1) ground water intake areas, (2) major water run-off areas, (3) agricultural and forest soil areas, (4) mineral resource areas, (5) steep land, (6) areas affected by certain air drainage patterns, (7) floodplains, and (8) areas of scenic features and regional landscapes. The analysis followed the methodology developed by Ian McHarg. This procedure was combined with the spatial parameters computed by statistical analysis for unique uses in existence for reclaimed strip mined areas. These parameters and the physical factors studied were employed in the construction of a Reclaimed Strip Mined Site Alternative Land Use Suitability Matrix.

Utilization of the matrix provides a possible use type for the development of a strip mined site. The best possible reuse of the land is not determined by this process, but the matrix helps one to visualize the interaction between the various types of land uses and to model the interactions more precisely. Moreover, the physical and spatial

information can be used to avoid problems of reuse and to determine economically justifiable land uses by reclaimed strip mined sites which will benefit the operator and his neighbors as well as the environment.

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CHAPTER I

INTRODUCTION

The areal extent of surface coal mining is presently a topic of great public debate. Since it is a less expensive technique than deep mining, its use has greatly increased in recent years, and a growing concern has been expressed about the amount of land disturbed by the process and the need to develop effective reclamation procedures. (Surface, or strip, mining is a method of extraction whereby overlying materials (overburden) are removed to expose the mineral being mined. Reclamation is the process of recontouring surface mined land, either to its original slope or to slopes suitable for productive uses other than the original use.)

The purpose of this paper is to develop a process for determining alternative uses for reclaimed strip mine areas in Central Appalachia. The process is based on an analysis of the particular characteristics of individual sites and the relationship of each site to selected factors affecting reuse. No attempt is made to recommend specific land uses for reclaimed land. Instead, a variety of possible uses are identified. Simply stated the process for determining a suitable reuse for a relcaimed strip mined site contains six steps. These steps are as follows:

1. Inventory and map on transparencies the planning data.
2. Point out critical or significant environmental areas on maps.
3. Consider the future plans for the area.

4. Analyze data on overlays and incorporate the spatial parameters developed in order to determine the suitability for the various reuses.
5. Consider the environmental impact of development type chosen.
6. Make a detail engineering and market study for the particular site.

The study area, the Tennessee counties of Anderson, Campbell, Claiborne, Morgan, and Scott, was chosen because its physical characteristics are similar to those of the rest of Central Appalachia, which includes central and southern West Virginia, eastern Kentucky, southwest Virginia, and the Cumberland Plateau portion of Tennessee. A great deal of surface mining has been conducted in the study area in the past. More stripping is expected in the future because of the large amounts of low sulphur coal underlying the region. Although properly reclaimed land can be used for many purposes, including recreation, agriculture, forests, housing, and industrial development, only 42.8 percent of the disturbed land in Central Appalachia has been reclaimed (Table I).

This situation should change in the near future since pending federal regulation of the surface mining of coal will require a significant upgrading of existing reclamation standards. In Central Appalachia, complete backfilling will generally be required. The legislation will require the "utility and capacity of the reclaimed land to support a variety of alternative uses."[1] Moreover, the relationship of these uses

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[1]H. R. 25, sec. 508 (a) (3).

TABLE I

CENTRAL APPALACHIA MINING AND RECLAMATION FROM 1930-1971

Area	Disturbed in Acres	Reclaimed Acres	Percent Reclaimed
Eastern Kentucky	108,000	42,000	38.8%
Tennessee	67,800	23,400	34.5%
Virginia	78,800	28,900	36.7%
West Virginia	210,000	105,000	50.0%
Total	464,600	199,300	42.8%

Source: James Paone et al., Land Utilization and Reclamation in the Mining Industry, 1930-71, Information Circular 8642, U. S. Department of the Interior, p. 11.

to existing land use policies and plans will have to be demonstrated. The Commissioner of the State Department of Conservation will be required to approve or authorize the proposed use of the land following reclamation. If and when such federal legislation is enacted, mine operators, regional planners, and those responsible for postmining reclamation will be required to consider alternative uses.

This research has considered one phase of a three-facet problem. Postmining land use decisions are based upon (1) supply, (2) demand, and (3) a combination or balance between the supply of sites and the demand for the various types of final land uses. This thesis was designed to analyze the supply side of the problem only and not the demand for any proposed reuse. An analysis of this type should be tied into the existing area or state planning systems. Effective regional development demands adherance to the regional plans for the area. If none exist, the regional impact of any postmining use should be considered before implementation.

An area's potential can be achieved if planned or projected future developments, such as a highway or school, are researched and considered before determining any reuse for mined land. Since the State Commissioner of the Department of Conservation will have to approve the postmining reclamation plans for any strip mining site, such eventualities should be taken into account.

To be effective, restoration must be planned at the earliest stages of the mining operation. The process must take into account such factors as economics, aesthetics, revegetation, erosion, water

conservation, and soil type. Long term benefits, future land use, conservation of natural values and beauty as well as many other objectives must be considered.

Potential exists for residential, commercial and industrial land uses in situations where access, water and sewer availability, and load bearing capabilities meet industrial and residential requirements. The highest potential for commercial or industrial uses would be in close proximity to the urban areas in the region and in strip mined sites close to interstates and other major access routes. These potentials will be emphasized by the process developed in this thesis. The process illustrates methods whereby economic benefits may be enhanced through employment of alternative uses of land rather than total reclamation. In areas where the proposed reuse would require reclamation procedures that would make the stripping economically unfeasible, the area in most instances would not be mined. Schlottmann and Abrams' study of the regional impact of a ban on mining coal on slopes in excess of 20 degrees gives adequate coverage to this dilemma.[2] They found that if areas such as Central Appalachia were banned as strip mine sites, other areas such as southern Illinois would increase their production in order to meet the demand for coal.

Overview of the Study Area

The five-county study area contains approximately 80 percent of the total strip mined acreage in Tennessee. The area is situated in the

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[2]Alan Schlottmann and Lawrence W. Abrams, The Regional Impact of a Ban on High Slope Coal Surface Mining, ARP Publication No. 34 (Knoxville, Tennessee: The University of Tennessee Environment Center, March 1975).

northeast corner of the Tennessee portion of the Cumberland Plateau. In Claiborne and Anderson Counties, only the western section are on the plateau and these sections contain the mined sites. The total area occupied by the five counties is 1,480,400 acres. Total area disturbed by strip mining of coal as of July 12, 1973, was 41,320 acres, ranging from a low of 5,155 acres in Claiborne County to a high of 14,229 acres in Campbell.[3]

The study area has a mean annual precipitation of 50 inches. As can be seen in Table II, maximum rainfall occurs in March and August; however, it is well distributed throughout the year with no month averaging less than 2.96 inches.[4] The mean frost-free period is 173 days. The mean seasonal temperatures range from a monthly average of 73 degrees F. in July to 37 degrees F. in January, a range of 36 degrees F. The winters are mild and snow cover seldom remains more than a few days. Temperatures fall at or below 32 degrees F. for an average of 80 days per year.[5]

The study area lies within the Appalachian Highlands Physiographic Region.[6] USGS topographic maps (1:24,000) were used to determine slope

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[3]Reported acreages as determined by actual ground surveys by personnel of the Tennessee Division of Geology.

[4]U. S. Weather Bureau, Climatological Data (Washington, D. C.: U. S. Department of Commerce, 1972), pp. 145-50.

[5]Climatological Atlas of Continental U. S., Vol. I (New York, N. Y.: Weather Trends, Inc., 1964).

[6]Edwin H. Hammond, "Classes of Land-Surface Form in the United States," in The National Atlas of the United States of America (Washington, D. C.: United States Geological Survey, 1970), p. 61.

TABLE II

CLIMATE, RUGBY, TENNESSEE, 1884-1930

	Precipitation	Snow	Prevailing Wind Direction	Average Temper-ature	Avg. Max.	Avg. Min.	Highest	Lowest
Jan.	5.35	5.0	N	36.3	47.2	26.0	73	-17
Feb.	4.80	5.0	N	37.8	48.8	26.4	78	-19
Mar.	6.10	3.3	N	46.5	59.6	34.8	89	- 2
Apr.	4.83	.4	N	55.0	67.9	41.0	96	15
May	4.28	.1	NW	63.7	77.1	49.8	95	26
June	5.07	0	W	71.1	83.7	57.8	101	32
July	5.31	0	NW	74.1	87.1	61.4	103	41
Aug.	4.78	0	NW	72.9	85.8	60.4	102	42
Sept.	3.56	0	N	67.9	81.7	54.5	101	28
Oct.	2.96	.2	N	55.6	71.0	41.5	91	16
Nov.	3.89	1.6	N	45.0	57.8	32.6	83	0
Dec.	4.76	3.8	N	37.5	47.4	26.6	75	-18
Annual	55.69	19.4	N	55.3	67.9	42.7	103	-19

Source: Morgan County Planning Commission, Comprehensive Plan for Morgan County, Tennessee, April 1970, p. 15.

and local relief characteristics of the study area. All or portions of 51 quadrangles cover the study area and a 20 percent sample of ten maps was taken to determine the area's slope distribution and relief features. Since strip mining activities are limited to the plateau portion of the study area, no sample sheets were taken from the eastern sections of Claiborne and Anderson Counties which lie in the Great Valley of the Tennessee River. Slope sampling procedures and sample sizes of 60-100 points were used as outlined by Hammond.[7] The slope distribution was found to be as follows: 7 percent of area in 0-8 percent slopes, 12 percent of area in 8-15 percent slopes, 17 percent of area in 15-30 percent slopes and 64 percent of area in slopes of greater than 30 percent slope. Furthermore, 81 percent of the plateau portion of the study area is in slopes of 15 percent or more. The mean elevation of the plateau portion of the study area is 2,150 feet; local relief of differences range from 700 to 1,300 feet.

The study area is underlain by horizontal strata, resulting in rugged topography. These strata consist of limestones, shales, and sandstones. The area is chiefly drained by the Cumberland River System, although the southeastern portion is in the Tennessee River Valley. The soils of this upland area have developed under warm temperatures and high rainfall. They are characterized by gray brown silt loams and are highly leached. The area's soils are distributed as 20 percent silt

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[7]Edwin H. Hammond, Procedures in the Descriptive Analysis of Terrain, Final Report (Washington, D. C.: Geography Branch, Earth Sciences Division, Office of Naval Research, 1958).

loams, 22-45 percent cherty silt loams, 5-20 percent stony fine silt loams, up to 10 percent fine sandy loams, 5 percent silty clay loams and 11-19 percent miscellaneous soil types.[8]

Approximately 90 percent of the study area is forested. Except for roads, small hamlets, and the strip mined sites, the upland areas are forested. The region is part of a mixed mesophytic deciduous forest.[9] Since the area has been selectively logged over a long period for the largest saw timber, scattered conifer and low grade second growth hardwood stands have become established.

Development of Mining in the Study Area

The study area has been strip mined since World War I. Early stripping was conducted on a small scale, using hand and animal powered machinery. Immediately following World War II, heavy earth handling equipment, including bulldozers and frontloaders were used.[10] The high freight rates for rail movement of coal kept the coal industry in Tennessee from expanding significantly between 1945-1959. New freight rate schedules, much more favorable to the rail shipment of coal, were

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[8]Morris E. Austin, Soil Survey, Claiborne County, Tennessee (Washington, D. C.: U. S. Government Printing Office, 1948), pp. 3-29; Foster Rudolph, Soil Survey, Norris Area, Tennessee (Washington, D. C.: U. S. Government Printing Office, 1953), pp. 3-11.

[9]P. F. Krumpe, H. R. DeSelm, and C. C. Amundsen, "An Ecological Analysis of Forest Landscape Parameters by Multiband Remote Sensing," in Proceedings of the Seventh International Symposium on Remote Sensing of Environment, Vol. I (Ann Arbor, Michigan: The University of Michigan Center for Remote Sensing Information and Analysis, May 17-20, 1971), p. 716.

[10]Tennessee Valley Authority, An Appraisal of Strip Mining (Knoxville, Tennessee: The Tennessee Valley Authority, 1963), pp. 4-5.

adopted in the late 1950's.[11] This factor, along with the growing need to supplement the area's hydroelectric power output with thermoelectric power generation, spurred the Tennessee coal industry to begin rapid expansion, particularly in the area susceptible to surface mining activities. Table III indicates the rapid expansion of disturbed acreage within the study area for the period of 1961-1973.

Strip mine production in the study area rose from 911 million tons in 1959 to 2,539 million tons in 1968, nearly a threefold increase. In 1968, the study area produced 77 percent of Tennessee's total strip mine tonnage. The coal produced is used chiefly in steam power generator plants, most of which are located in the Tennessee Valley Region. Transportation is by rail.[12]

The amount of coal mined by contour stripping has rapidly increased in the past decade. Barring legislation or court intervention, this trend should continue as long as stripping is more profitable than underground methods. Strip mining recovers up to 90 percent of a coal deposit while deep mining removes 60 percent of the resource on an average. Production per man-day can be as high as twenty-five tons for stripping, versus eleven tons by deep mining. Contour stripping in the

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[11] Strip Mining in Kentucky (Lexington, Kentucky: Division of Strip Mining and Reclamation Commission, 1965), p. 21.

[12] Robert C. Johnson and Edward T. Luther, Strippable Coal in Northern Cumberland Plateau Area of Tennessee, Report of Investigations 34 (Nashville, Tennessee: State Department of Conservation, 1972), p. 5.

TABLE III

CHANGES IN TOTAL ACREAGE DISTURBED BY CONTOUR STRIP MINING (1961-1973)

	County Size in Acres	Cumulative Acres Disturbed		
		1961	1966	1973
Anderson	214,400	2,510	4,882	7,759
Campbell	288,600	3,674	8,487	14,229
Claiborne	284,200	1,776	3,405	5,155
Morgan	348,200	3,059	4,290	6,025
Scott	345,000	5,139	6,674	8,152
Total	1,480,400	16,158	27,738	41,320

Source: Tennessee Bureau of Mines files.

study area where coal seams range from 18 to 60 inches yields 2,400 to 8,100 tons per acre.[13]

A study of reclamation effectiveness in Appalachia as of 1965 indicated that Tennessee ranked last of the 13 states surveyed. Of the 26,760 acres disturbed by contour strip mining in Tennessee as of January 1, 1965, only 1,098 acres (4 percent) had been completely reclaimed and only 275 acres (1 percent) had been partly reclaimed; the remaining 25,387 acres of disturbed acreage remained unreclaimed.[14] A 1974 study revealed that 76,800 acres in Tennessee have been disturbed by surface mining from 1930 until 1971.[15] Only 23,400 acres, 34.5 percent of the total acreage, have been reclaimed to some degree.[16] The reclamation has mainly occurred in the post-1967 era and as such, represents tremendous progress. More acreage has been reclaimed in recent years than disturbed due to the orphan mines project of the Tennessee Department of Conservation. An orphan mine can be defined as any abandoned surface mine operated prior to the enactment of comprehensive reclamation laws. Figure 1 is an example of an orphan mine and of the natural vegetation on the site. This particular site, near

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[13]Tennessee Valley Authority, p. 4.

[14]"Study of Strip and Surface Mining in Appalachia," An Interim Report to the Appalachian Regional Commission (Washington, D. C.: U. S. Government Printing Office, 1966), p. 21.

[15]James Paone et al., Land Utilization and Reclamation in the Mining Industry, 1930-71, Information Circular 8642 (Washington, D. C.: U. S. Government Printing Office, 1974), p. 11.

[16]Ibid.



Figure 1. An orphan mine located near Philips Branch.

the Philips Branch, was abandoned in 1962. Figure 2 is an example of an active mining area on Massengale Mountain in Campbell County. The exposed face of the bank is known as the highwall. The scars left by orphan mines were major factors stirring environmentalists and others to seek regulations which would require reclamation.

Tennessee Surface Mining Laws

The surface mining of bituminous coal in Tennessee was unregulated until the enactment of the "The Tennessee Strip Mine Law of 1967." The bill, approved on April 4, 1967, is cited in Chapter 43 of the Tennessee Code (since repealed). The present regulations, which are entitled "The Tennessee Surface Mine Law of 1972," were amended in 1974.

The 1967 law was concerned with and covered all minerals mined except limestone, marble, or dimension stone.[17] The Tennessee General Assembly decided that unregulated strip mining of minerals causes soil erosion, stream pollution, and in general creates conditions inimical to life, property, and the public welfare. This situation required the exercise of the state's police power in the regulation of strip mining. The state justified the regulation of the industry by determining that the public welfare was infringed upon by strip mining. A mining operation located near Woolridge and operated under the 1967 regulations, is shown in Figure 3.

The Act vested the Commissioner of the Department of Conservation with the power to require and prescribe conditions for the issuance of

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[17]Tennessee Code Ann. 43- (2) (b) repealed.



Figure 2. An example of an active mining operation.



Figure 3. A mine operated under the 1967 reclamation standards.

permits for strip mining and to collect bonds and set the conditions for forfeiture of the bonds. The Commissioner was also mandated to create a Strip Mining Fund to be used for the reclamation of orphan mines.[18] Finally, the Commissioner was granted the legal authority to determine the penalties for violations and provide for the enforcement of the Act and its associated regulations. A 1967 mining operation that was bonded and later forfeited is depicted in Figure 4. It is located north of Clearfield, Tennessee. This operation is now an orphan site and is subject to reclamation financed by the Strip Mining Fund.

In order to start or to continue any surface mining operation in Tennessee, permits for strip mining had to be obtained by September 1, 1967.[19] The operators were charged a basic fee of $250 for a permit, plus $25 for each additional acre, to an amount not to exceed $750.[20] Each operator had to post a bond with the Commissioner guaranteeing faithful performance with the provisions of the Act. The bonds ranged between $100 and $200 an acre.[21] The total bond cost was less costly than the price of reclamation. The strip mine reclamation fund created out of forfeited bonds made it possible for the state to establish and carry out a systematic schedule for the reclamation and revegetation of orphan mines.

Bonds are released when the Commissioner determines that all reclamation is completed. The present statute (1974 amendments) call

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[18] Ibid. (4) (b).

[19] Ibid. (5).

[20] Ibid. (6).

[21] Ibid. (7).



Figure 4. A 1967 operation that was bonded and later forfeited.

for a minimum per acre bond of $600. Appeal from the agency rulings are heard before the Board of Reclamation Review. In 1972, 65 operators were permitted to mine 5,181 acres in Tennessee and $10,350 in bonds were forfeited.[22]

With the enactment of the law, operators had to prepare and carry out a mining and reclamation plan for the area affected by their operation. These plans had to be approved by the Commissioner before a permit was granted; each plan had to describe all mining operations and give detailed estimations of hydrologic and soil problems.[23] Reclamation and revegetation details were also included.

The Tennessee Surface Mining Law of 1972 is similar but more comprehensive in detailing mining procedure and reclamation. Figure 5 depicts an example of the 1972 law reclamation standards in a mine in Lower Elk Valley. Before filing for a permit, an applicant must now give 30 days' public notice in a newspaper of general circulation of his intent to operate a surface mine and its proposed location.[24] Another provision of the 1972 law states that no operator may mine a coal seam on a slope greater than 28 degrees unless he has obtained a written agreement stating that no overburden will be deposited on the downslope of the cut.

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[22]Jerrold Becker and Susan Collins, Bonding Requirements for the Surface Mining of Coal, ARP Publication No. 25 (Knoxville, Tennessee: The University of Tennessee Environment Center, May 1974), p. 12.

[23]Tennessee Code Ann. 43- (8) repealed.

[24]Tennessee Code Ann. 58- 1544 (h).



Figure 5. A mine operated under the 1972 reclamation standards.

The new laws increased the bonding fee to $1,000 an acre.[25] The basic permit fee remained $250, plus $25 for each additional acre, the total not to exceed $2,500.[26] The state now may exercise the power of eminent domain to purchase any lands which are affected or disturbed by surface mining. These lands may consist of orphan banks or unreclaimed spoil piles, which in their present state are hazardous or otherwise detrimental to the health and safety of any person near such a mining operation.[27] The owners of the unreclaimed lands will have an opportunity to complete the reclamation required before any action is taken by the state.

The present laws also require the filing of an annual report with the Commissioner. This report must detail all mining operations and reclamations accomplished.

The most visible effect of the 1972 law as it differs from the 1967 law is in highwall requirements. Under the 1967 law, operators had to backfill against the highwall to cover completely and permanently the face of the last workable coal seam. They had to strike off the crest of all overburden piles to an average minimum width of 20 feet where it could be done with normal releveling equipment used in the coal industry and to cover the floor of the pit area with a minimum of two feet of available spoil. Highwall reduction was required near residential areas with slopes having a maximum 1:1 ratio.

Under the present law (1974 amendments), the solid bench width is clearly delimited by statute (Table V in the Appendix). In the final

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[25] Ibid., 1545. [26] Ibid., 1546. [27] Ibid., 1553 (a).

grading on cuts where no highwall or a wall of less than 20 feet existed prior to mining, terrace backfilling may be required. Overburden has to be placed against the highwall to at least a 10-foot depth. The highwall must be reduced to no more than 30 feet.[28]

The material on the solid bench must be placed in a wedge against the highwall, sloping to a so-called "Georgia-type V-ditch," and thus upward, at a slope not to exceed 5 degrees, to cover the blossom and blend in smoothly with the newly filled bench as shown in Figure 21 (Appendix). The fill bench has to be graded to roll gently over the edge of the outslope and blend in with the natural ground below the edge of the outslope. Other configures such as shown in Figures 22 and 23 (Appendix) may also be approved if justified in the mining and reclamation plan. A slope, except stable rock highwall, must never exceed 35 degrees. In area mining, complete backfilling approximating the original contours is required.[29]

Pending federal legislation controlling the mining and reclamation of the surface coal mining industry would supersede the state laws where its regulations are inconsistent with the provisions of the 1974 Act.[30] State provisions that are more stringent will still be in effect. The Department of Interior will administer the regulations if and when it is enacted. A national reclamation fund will be enacted

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[28]Tennessee Department of Conservation, Regulations Pertaining to Surface Mining, Regulation 11.23, 1973.

[29]Ibid.

[30]H. R. 25, sec. 505 (a).

similar to the one in Tennessee.[31] President Ford vetoed the latest strip mine bill on May 20, 1975, on the grounds that the energy crisis and the potential unemployment made the bill undesirable.

The pending legislation would permit states to assume exclusive jurisdiction over the regulation of surface coal mining and reclamation operations, except as provided in Section 521 and Title IV of the Act. States must also meet all Environmental Protection Agency standards pertaining to strip mine operations. The federal government will retain the right to enforce any section of the new strip mine controls it deems the state is not enforcing.

The major difference between the proposed federal bill and Tennessee's law are that the performance bond will be at least $10,000 and the proposed reuse of an area must be consistent with adjacent land use and existing state and local land use plans or programs. Instead of allowing a reasonable highwall, depending upon the slope, the new federal legislation demands complete backfilling with spoil material that would completely cover its highwall and return the area back to the approximate original contour in all mining operations.[32] Figure 6 depicts the type of reclamation standards being demonstrated on Massengale Mountain by the Tennessee Valley Authority. This procedure will meet the requirements of the pending federal regulations and will be discussed in detail in Chapter IV.

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[31]Ibid., sec. 401 (a).

[32]Ibid., sec. 515 (d) (2).



Figure 6. "Back to contour" reclamation at Massingale Mountain.

Types of Reclamation

Reclamation procedures are related to the type of mining operation employed. Among the many types of contour mining methods utilized in Central Appalachia, slope reduction, parallel fill, box-cut, head-of-hollow fill, mountain top removal, block cut, multiple seam, lateral movement, and longwall stripping are the most frequently used. Figures 24 through 27 show the physical cross sections of several of the methods. These figures are located in the Appendix. These methods are used in order to minimize the adverse effects on the environment and to maximize the recovery of coal. Some of these methods were developed in response to present and pending legislation.

The slope reduction and parallel fill methods are now illegal in Tennessee due to the overburden being placed on the downslope. However, the parallel fill method may prove useful as an emergency measure in case of slides.[33] The box-cut is a conventional method. It prevents most of the overburden from being placed downslope, but it too will be illegal when the Federal Strip Mine bill is enacted into law.

The head-of-hollow fill improves aesthetics, reduces landslides, allows for more coal recovery, and creates flat land in mountainous areas. This method is useful in reclaiming orphan mines. If constructed properly, the fill area is relatively safe from land slides and erosion.[34]

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[33]Elmore C. Grim and Ronald D. Hill, Environmental Protection in Surface Mining of Coal, EPA-670/2-74-093 (Washington, D. C.: U. S. Government Printing Office, October 1974), p. 60.

[34]Ibid.

Cannelton Industries near Charleston, West Virginia, is using a method which may have merit for alternative land use considerations. It is termed "mountain top removal." All the overburden is excavated and the spoil and top soil are replaced and graded into flat to rolling topography. In this particular instance, a new town is planned for the finished site.

The block-cut method eliminates downslope overburden. The overburden is hauled back and deposited in the pit of the previous cut. In this method the reclamation is integrated with the mining. The aesthetics of the area are improved because the tree line is undisturbed and acts as a screen. Approximately 60 percent less acreage is disturbed by this method. Many studies have been conducted on improving the aesthetic qualities of highwalls which result from the block-cut type methods.[35]

The final surface mining method considered in this thesis is longwall stripping. This experimental method is an alternative or modification between conventional shaft and surface mining methodologies.[36]

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[35]William T. Plass, "Highwalls—An Environmental Nightmare," in Proceedings of the Symposium on Revegetation and Economic Use of Surface-Mined Land and Mine Refuse at Pipestem State Park, West Virginia (Washington, D. C.: U. S. Government Printing Office, 1973).

[36]Surface Mining . . . A Changing Industry (Charleston, West Virginia: West Virginia Surface Mining and Reclamation Association, n.d.), p. 26.

Agencies Affecting the Study Area

The study area lies within the boundaries of six jurisdictions or agencies which deal in some manner with the reclamation of strip mined land and the general development of the area: They are: (1) the Tennessee Department of Conservation; (2) the Tennessee State Planning Office and The University of Tennessee; (3) the various county governments; (4) the East Tennessee Development District; (5) the Tennessee Valley Authority; and (6) the Appalachian Regional Commission. These overlapping jurisdictions are displayed on map form in Figure 7.

The Tennessee Department of Conservation Division of Strip Mine Permits has direct responsibility for regulating strip mining and reclamation in Tennessee. Since 1967, the Department of Conservation has had control over the issuance of strip mining permits and the collection and dispersal of bonds for the assurance of proper reclamation. However, many mines were abandoned and the bonds forfeited due to reclamation costs as was depicted in Figure 4, page 18. Before 1967, operators had a free hand (except for TVA coal contracts) in exploiting the coal. Consequently, they disturbed thousands of acres and left them as orphan or unreclaimed mines as shown in Figure 1, page 13. The 1972 strip mine law strengthened the Commissioner of the Department of Conservation's control over the strip mine operators by the enactment of more stringent reclamation laws.

The general development of the area is the responsibility of the counties. However, the counties involved are poor and rural and lack professional planning staffs to guide their development. The state

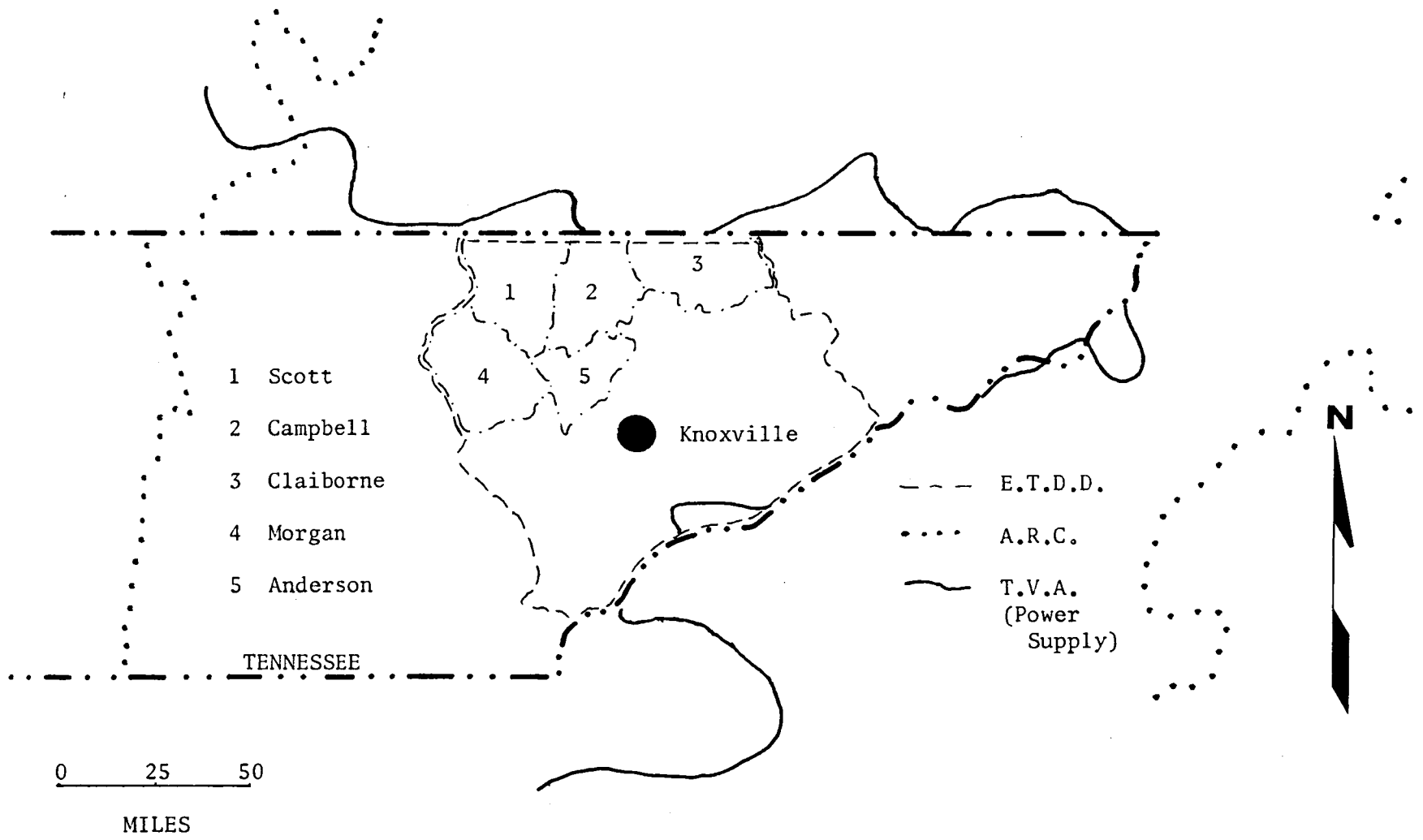


Figure 7. Agencies and units of governments concerned with strip mine reclamation in the study area.

provides local planning assistance through the Tennessee State Planning Office. The local assistance must be requested by the respective counties. Upon request the Tennessee State Planning Office in Knoxville can act as a liaison for securing the assistance needed. Direct planning for reclamation projects has not been attempted by the Knoxville office but could be if the local community requested such a project. The state can also make available the resources of The University of Tennessee for research in strip mine reclamation problems.

East Tennessee Development District (ETDD). At the regional level, the study area is within the confines of the East Tennessee Development District. The agency functions as a regionwide planning and coordinating agency in land use, housing, recreation, transportation, health, social services, environmental quality, law enforcement, and economic development. The District serves as a forum for local governments to formulate regionwide policy and to review and comment on federal, state and local projects of regional significance. It also makes and implements policy decisions.[37] The East Tennessee Development District's staff guides local officials in the decision-making process. The District also provides a unifying mechanism through which adopted goals may be achieved.[38]

The ETDD is not a government. Instead it is a voluntary association of local governments. It does not have powers of enforcement or taxation

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[37]Interview with Robert Freeman, ETDD, Knoxville, Tennessee, April 22, 1975.

[38]Ibid.

for any of its programs. It promotes intergovernmental coordination and cooperation by carrying on regional planning programs. A total of 61 local governments are represented on the agency.

According to Robert Freeman, Assistant Director of ETDD, the agency will address the problems of planning for strip mined areas in the future.[39] A land use plan for the entire 16 county area included in the District will consider the problems of this type of planning in its completed form.

Tennessee Valley Authority (TVA). The Tennessee Valley Authority was established as a regional development agency in 1933. According to the preamble of the enabling legislation, the purposes of TVA are to:

> Improve the navigability and to provide for flood control of the Tennessee River; to provide for reforestation and the proper use of marginal lands in the Tennessee Valley; to provide for the agricultural and industrial development of said valley; to provide for the national defense by the creation of a corporation for the operation of government properties at and near Muscle Shoals in the State of Alabama, and for purposes . . . such as creating power program and to sell excess power to local communities, industry, the Federal government, and private utility companies.[40]

The primary energy source for TVA's thermal electric generating stations is coal. Over the years, TVA has become the nation's largest single consumer of coal. Coal produced by stripping has been significantly cheaper than coal produced by shaft mining. Fifty percent of all

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[39] Ibid.

[40] John H. Cumberland, Regional Development: Experiences and Prospects in the United States of America (Paris: Mouton and Company, 1973), p. 57.

coal purchased by TVA is produced by strip mining. Excavation of the coal has disturbed over 25,000 acres of land.[41]

The rationale for TVA's tacit approval of strip mining in its early years is shown by its supportive statements of strip mining's positive aspects. The agency maintained that haul roads and mountain cuts constituted a resource in fire control and future recreational purposes for the region.[42] TVA maintained that the strip mine regulation was the responsibility of the states. The Authority claimed that the areas involved had little economic impact before the strip mining occurred and were essentially only growing unharvestable trees.[43]

In 1965, TVA adopted a policy of including reclamation provisions in its coal contracts. These provisions set reclamation standards until the state laws equalled and surpassed them.[44] During the 1970's, payments in escrow were added to the reclamation provisions in order to assure that the proper reclamation was completed. In 1973, 4,494 acres of spoil were reseeded. Since 1965, 7,857 acres of strip mined land in Tennessee have been reseeded. A two-step bidding procedure was initiated to further reclamation standards. Mine operators (suppliers) had to obtain an approved postmining reclamation plan before bidding on any coal contract.[45]

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[41] Ibid., p. 59. [42] Ibid. [43] Ibid., p. 60.

[44] "TVA Coal Contracts Set Reclamation Requirements," Coal Age 70 (September 1965), 26.

[45] Annual Report of the Tennessee Valley Authority (Knoxville, Tennessee: Tennessee Valley Authority, 1973), p. 76.

In addition to coal contract provisions for reclamation, TVA initiated several test projects and demonstrations for ideal reclamation procedures. Two of these projects are within the study area, one on Massengale Mountain in Campbell County, the other in Oakdale near Crab Orchard Creek. The Massengale Mountain project will meet all federal reclamation standards if and when they are enacted. This project will be examined in detail in Chapter IV. In the latter, hydraulic seeding and landscaping with large trees for screening purposes are being demonstrated.[46]

Appalachian Regional Commission (ARC). The last organization considered in this thesis is the multistate ARC. ARC was created to deal with the various social and economic problems of the Appalachian Region. One of these problems is the reclamation of strip mine disturbed areas. The Appalachian Development Act, which created the Commission, authorizes the Secretary of the Interior to assist states in filling and sealing abandoned coal mines and the reclamation and rehabilitation of areas damaged by surface mining.[47] Title 11, Section 205 of the Act authorized a $36.5 million grant program to the states to accomplish the needed reclamation.[48]

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[46]Ibid., p. 78.

[47]Cumberland, p. 95.

[48]Advisory Commission on Intergovernmental Relations, Multistate Regionalism, Report Mo. A-39 (Washington, D. C.: U. S. Government Printing Office, April 1972), p. 22.

An example of an ARC funded project in the study area occurred in Jellico, Tennessee. The Jellico project was a demonstration to reclaim and rehabilitate a series of deep strip mine pits into an urban recreational complex of over 300 acres. The project was located entirely within the city limits of Jellico. The project proposal requested $300,000 from Applachian Basic Assistance section of the Appalachian Development Act and another $100,000 from state and local funds.[49] The planning for this project was done by TSPO and TVA; ARC helped to finance part of the total community project.

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[49]Lowell D. Richards, Jellico Strip Mine Reclamation Project, Proposal Submitted to the Appalachian Regional Commission under Section 205 of the Appalachian Regional Development Act (Nashville, Tennessee: State Planning Office, May 18, 1966), pp. 1-6.

CHAPTER II

McHARG

Ian McHarg is the head of the Department of Landscape Architecture and Regional Planning at the University of Pennsylvania. He is a landscape architect by training and an environmentalist by temperament. His Design with Nature (1969) stimulated the planning world into an awareness of ecological and environmental concerns.[1]

Examination of the McHarg Methodology

The ecologic and environmental considerations recommended by McHarg were applied to the study area. These considerations are based upon site characteristics of the individual strip mines. According to McHarg, regional plans should not be arbitrarily designed. Instead, they should follow the plan nature has already demonstrated. One way to achieve such a plan would be to chart all of the physical resources of the region, especially its drainage network, and notice the resultant pattern. McHarg advocates what is termed "physiographic determinism." Simply stated this means that nature should be considered first. The design indicated by the aquifers, the slopes, and the wetlands should be the core of any plan.[2]

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[1] Ian McHarg, Design with Nature (Garden City, New York: Natural History Press, 1971).

[2] William H. Whyte, The Last Landscape (Garden City, New York: Anchor Books, 1970), p. 207.

To arrive at alternatives, McHarg charts an area's underlying design by analyzing major natural factors such as the water table and geologic elements. One by one, each element is traced to determine where, all other factors being equal, it would be best to built or develop and where development would be unwise. The result is an accumulative plan—as the charts of each element are overlaid on top of the others, the natural design emerges. In order to justify his conclusions on more than aesthetic grounds, McHarg demonstrates his findings with rigorous inductive analysis of the physical and economic factors involved. Increment by increment, nature's case (design) is developed.[3]

The McHarg Methodology and its Relationship to Strip Mined Land Use Alternatives

Land morphology, soils, stream patterns, plant association, wildlife habitats, and land use can be examined through the concepts of the physiographic region. Nature often performs work for man and in many cases this is best accomplished in a natural condition. Many strip mined areas are best reclaimed and revegetated to the original status and left in a wilderness state. Many areas are intrinsically suitable for certain uses while others are less suited. If we accept the proposition and modify it, one can develop families of land uses that can be utilized in strip mining reclamation.[4]

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[3]Ibid., p. 211.

[4]McHarg, p. 57.

McHarg lists eight dominant aspects of the natural process and ranks them in order of both value and intolerance to human use. He then reverses the order to create a gross hierarchy of urban suitability. The rank/order follows:

Natural-Process Value Degree of Intolerance	Intrinsic Suitability for Urban Use
surface water	flat land
marshes	forest or woodlands
floodplains	steep slopes
aquifer recharge areas	aquifers
aquifers	aquifer recharge areas
steep slopes	floodplains
forest or woodlands	marshes
flat land	surface water

Obvious conflicts are apparent in this hierarchy. Flat land, which is often used for urban purposes, is also suitable for agriculture. The study area consists of contour surface mining sites in generally rough topography. Flat land is a premium and its proposed reuse depends upon many factors. Slopes in excess of 12 degrees are not recommended for cultivation by the Soil Conservation Service. Due to erosion, steep slopes are also unsuitable for development. Land uses compatible with these slopes would be mainly forestry and recreation, with low-density housing (second homes) permitted on occasion. The pending federal legislation would demand "back to contour" reclamation and as a result

drastically reduce the number of alternatives available for reclaimed strip mined land.[5]

The natural vegetative cover for most of the study area is forest. Where present, it improves microclimate and it exercises a major balancing effect upon the water regiment. The forest diminishes the occurrence of erosion, sedimentation, flood and drought. The scenic role of woodlands is apparent, as is their provision of a habitat for game. The recreational potential is high, and the forest is low-maintenance, self-perpetuating landscape.[6] Forests can also be employed for timber production, water management, wildlife habitats, airsheds, recreation or for any combination of these uses.

Certain lands serve man best if left in an undeveloped state. These include floodplains, water run-off areas, areas which are highly erodible due to slope and/or soil characteristics, and major aquifers and aquifer recharge areas. These considerations are modified and applied to developing a suitability matrix for determining alternative land use for reclaimed site mined sites in the next chapter.

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[5]Ibid., p. 60.

[6]Ibid., p. 61.

CHAPTER III

JUSTIFICATION OF CRITERIA AND DEVELOPMENT OF THE PROCESS

Postmining redevelopment for certain uses demands accessibility, a population base, an economically viable area, and the physical characteristics essential for the various proposed reuses. Naturally, certain forest and wildlife management areas do not require maximum accessibility. The criteria selected and the use groups formed are based upon the five-county study area's characteristics. The process developed was applied and tested on a few selected sites in the region. They are identified in Chapter IV.

When determining land use many factors must be considered, including competing uses for the same land and the problem of providing for the use of marginal and submarginal land for urban-type development because of population and commercial pressures. For example, it is frequently economical for one to risk building in a floodplain which also happens to be along a major highway or in a resort area.

Alternative Uses

An early study by Limstrom and Merz found that most strip mined lands in Ohio were adaptable to three general uses: forestry, recreation and wildlife, and agriculture.[1] Other uses, such as industrial or

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[1] G. A. Limstrom and R. W. Merz, Rehabilitation of Lands Stripped for Coal in Ohio (Columbis, Ohio: The Ohio Reclamation Association, December 1949), pp. 11-13.

residential purposes, were considered to be of minor importance except near municipalities and along railroads and highways. The authors felt that most of the stripped land in Ohio was best suited for forestry. In addition to the production of wood, forests help control erosion, improve soil, conserve water, and provide recreational opportunities.

More recently, Buckner and Kring have expanded forestry opportunities by determining that Christmas trees are a profitable, short-rotation crop suitable to the extreme site conditions of the study area.[2] The University of Tennessee studies found that Christmas tree crops grown on reclaimed strip mined land have three advantages over other uses: they are not subject to vandalism; mine roads provide year-round use and access; and, due to different site characteristics, exposure, slope and altitude, several species can be utilized.[3] This experimentation will be analyzed further in Chapter IV.

A strip mine site can be reused for many purposes. The alternative uses which fit the regional needs, and at the same time, are environmentally compatible will be developed further. This analysis does not quantify variables such as scenic features and landscape characteristics. Fisher, Krutilla, and Cicchetti have presented an analytical framework for evaluating the benefits of environmental resources that could be

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[2]E. R. Buckner and J. S. Kring, "A Crop for Mine Spoils?" KTG Journal, Vol. 7, No. 1 (Spring 1967), 1-7.

[3]Ibid., p. 1.

appropriately modified for strip mined areas.[4] Their research was based upon recreational areas. Such analysis would remove some of the subjectivity of existing methods.

Urban and Industrial Suitability

An evaluation of the urban and industrial suitability of the study area was based upon several surveys. The surveys considered the degree of slope, soil permeability, and areas subject to flooding. It was assumed that urban development which occurs on poor soils, steep topography, or in areas subject to periodic flooding will be significantly more expensive and restricted than in areas which process favorable soils. It also takes land suitable for agriculture purposes. Urban development on such unsuitable land requires extensive landscaping work and heavy reliance on sewer systems, and demands more expensive site preparation. Industrial and commercial development normally require large tracts of land which is rare in the study area.

Strip mining can create level land that can later be employed for industrial or commercial development. Residential areas offer greater flexibility in design but still must bear the additional, often costly, expense of site improvement. Virtually all of the land in the study area is subject to severe development limitations due to either slope or accessibility. Except for small, isolated areas around Oneida in Scott County and between Wartburg and Petros in Morgan County, the remainder of

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[4]A. C. Fisher, J. V. Krutilla, and C. J. Cicchetti, "Alternative Uses of Natural Environments: The Economics of Environmental Modification," in J. V. Krutilla, ed., Natural Environments: Studies in Theoretical and Applied Analysis (Baltimore, Maryland: The Johns Hopkins Press, 1972), pp. 1-13.

these two counties is not suitable for major urban-industrial development due to the terrain. Campbell County, with the exception of the southeast quarter, is likewise not suitable for major urban-industrial development. Major portions of Claiborne and Anderson Counties also have severe development restrictions.

The suitability for urban and industrial uses will be examined later in this chapter. A particular site's suitability for an urban related use will be determined by the unique characteristics of that site and its relationship to several spatial factors. Koder M. Collison has determined that an industrial site in the Appalachian region should be chosen with consideration given for thirteen factors.[5] The first six important factors listed are: size, ownership, topography, access, utilities, and transportation. An intensive site analysis for the study area has been conducted for the identification of potential industrial sites by the East Tennessee Development District.[6] This analysis considered the factors enumerated in Collison's article.

Existing Urban Development

Urban areas tend to aggregate about the county seat, transportation nodes, or isolated areas of flat, unforested, productive land. Wartburg, Oneida, LaFollette, and Tazewell are typical urban areas in the study

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[5]Koder M. Collison, "A Practical Guide to Site Selection," Appalachia (December 1974-January 1975), 30-36.

[6]East Tennessee Development District, Potential Industrial Areas (April 1971).

area. The northern portion of Anderson County along with the remainder of the study area has been experiencing a population loss and minimal economic development. Some isolated areas within these counties such as Tazewell, Oneida, and LaFollette had experienced modest growth. However, this growth is due to the nature of the town as either a government center for the county or a major retail service center of a large mountainous area. These centers also contain the majority of the area's manufacturing and wholesale establishments. Development of the strip mined areas near these centers will enhance this growth by providing relatively level land for future development. The area as a whole is within the Knoxville sphere of influence.

Examination of the areas of retail gravitation indicates that even small towns within the study area generate relatively large hinterlands as shown in Figure 8. The breaking points between the various urban centers were computed by applying Reilly's Law of Retail Gravitation as explained by Murphy.[7] This visual analysis was included to emphasize the large trade areas of the relatively small towns. The formula employed is as follows:

$$A \text{ to } B = \frac{\text{miles between A and B}}{1 + \sqrt{\frac{\text{population of B}}{\text{population of A}}}}$$

[7]Raymond E. Murphy, The American City, an Urban Geography (New York, New York: McGraw-Hill Book Company, Inc., 1966), p. 62.

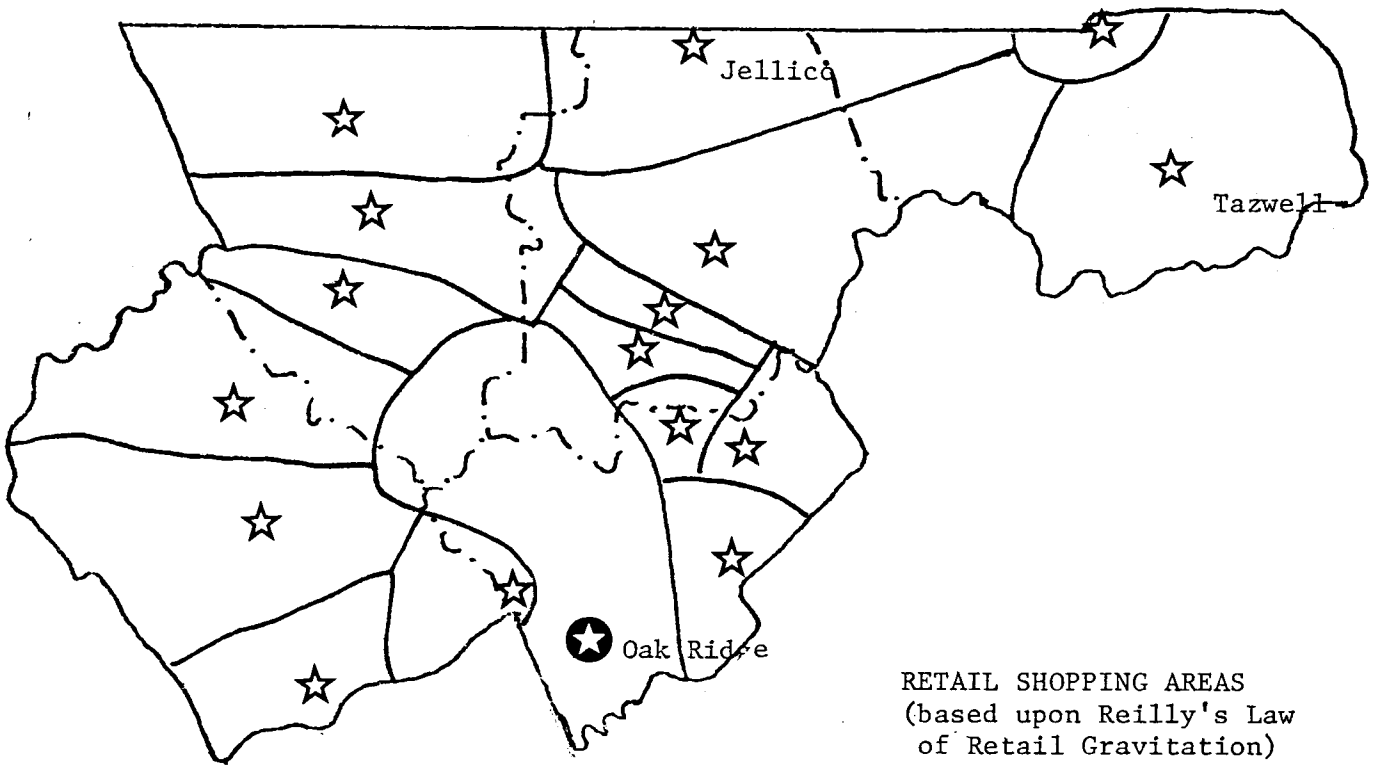


Figure 8. Retail shopping areas (based upon Reilly's law of retail gravitation).

Spatial Parameters

The accessibility and proximity criteria were determined by statistical analysis of 150 unique land uses for reclaimed strip mined sites inventoried by the author.[8] The analysis was computed with the Statistical Analysis System packaged computer program.

The unique reclamation uses by type were tabulated as grouped data by intervals in miles from the nearest interstate highway, and Standard Metropolitan Statistical Area (SMSA) (Table IV). A more general interstate highway/major arterial system variable was also used as a measure of accessibility for potential center-potential market. The grouped data represents the most reliable distance information which was available. With urban related and recreational uses representing over 70 percent of the postmining uses, it seems reasonable to assume that any major future development of mining sites would be in these two categories.

The spatial pattern of unique uses of reclaimed strip mined areas in the Appalachian Region suggests that development occurs near urban areas due to population pressures and the scarcity of easily developed land. Accessibility and demand determine the location and creation of unique developmental uses of reclaimed strip mined sites. Unaccessible strip mined areas are usually reclaimed to the minimum required by law, or before 1967, simply left unreclaimed. From Table IV it can be seen

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[8]James E. Rowe, An Inventory of the Unique Uses for Reclaimed Mined Land in the Appalachian Region, ARP Publication No. 33 (Knoxville, Tennessee: The University of Tennessee Environment Center, March 1975).

TABLE IV

SPATIAL RELATIONSHIP OF POSTMINING USES TO URBAN CENTERS AND INTERSTATE HIGHWAYS[1]

Use	Number of Observations by Miles to Interstate 0-5	5-10	10-15	15-20	20+	Number of Observations Within 10 Miles of a City of 20,000	Number of Observations by Miles to SMSA 0-15	15-25	25-40	40-50	50+	Total Observations
Urban Development[2]	13	8	6	5	13	45	12	11	7	9	6	45
Agricultural Uses	1	3	1	1	11	10	4	1	1	3	8	17
Recreational Uses	11	6	1	7	8	19	6	10	5	7	5	33
Other Uses	6	4	1	6	5	10	6	2	2	0	12	22
Totals	31	21	9	19	47	84	28	24	15	19	21	117

[1]A set of regional maps by both state and land use are available upon request locating the postmining uses.

[2]For urban related observations we were unable to determine the approximate location, thus these have been deleted.

Source: Alan Schlottmann and James E. Rowe, "The Economic Potential for Reclaimed Strip Mined Land." Unpublished article, August 1975.

that recreation uses are quite prevalent within five miles of interstates. Nearness to population centers is also important to recreation and urban related uses. It would appear that postmining planning should not indicate these uses as available alternatives for inaccessible rural areas.

Generalized least squares procedures were applied to estimate the relationship between urban related and recreation uses relative to all other land uses and the distance variables.[9] Urban related/recreational uses were treated as a qualitative dependent variable.[10] The following regressions were estimated:

$$y = a + b_1 x_1 + b_2 x_2 + e$$

where y = 1 if observation was an urban related/recreational use

0 otherwise

x_1 = distance from interstate highway/major arterial system

x_2 = distance from SMSA

e = disturbance term.

The estimated regression equation was as follows:

$$(1)\quad y = \underset{(.05)}{1.225} - \underset{(.02)}{.024} - \underset{(.04)}{.012x_2} \qquad R^2 = .58 \ .$$

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[9]The procedure used in this thesis was a generalized least squares procedure for grouped data as discussed in J. Johnson, Econometric Methods (New York, New York: McGraw-Hill Book Company, Inc., 1972).

[10]See Jan Kmenta, Elements of Econometrics (New York, New York: The Macmillan Company, 1971); or Arthur Goldberger, Econometric Theory (New York, New York: John Wiley and Sons, 1964).

The importance of accessibility and nearness to a regional population center in determining the degree to which alternative land uses are developed as urban related/recreational sites is clearly seen. In particular, the above estimates are significant at the level of 1 percent with relatively small standard errors. Accessibility tends to be the most important variable for recreational uses. If the qualitative dependent variable is redefined as taking the value of 1 for a recreational use, and 0 elsewhere, including the urban related uses, it is estimated that:

$$(2)\quad y = \underset{(.07)}{.800} - \underset{(.03)}{.028}x_1 \qquad R^2 = .57 \ .$$

The SMSA variable is statistically insignificant, due mainly to the presence of the urban related observations which were grouped dichotomously from the recreational uses. Similarly, the analogous estimated regression equation for urban related uses shows that nearness to a regional population center is the most important variable where the dependent variable is redefined as having a value of 1 for an urban related use, and 0 elsewhere, including the recreational uses.[11]

$$(3)\quad y = \underset{(.08)}{.871} - \underset{(.01)}{.016}x_2 \qquad R^2 = .51 \ .$$

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[11]Alan Schlottmann and James E. Rowe, "The Economic Potential for Reclaimed Strip Mined Land," unpublished article, 1975. The sample size was taken from 117 observations.

All of the above regressions were estimated excluding the observations from West Virginia. This state's spatial pattern of alternative land uses, regardless of the particular grouping of observations, has statistically insignificant generalized least squares estimates. Approximately 70 percent of all the urban related/recreational uses in West Virginia have been developed by a single operator. The alternative land use is generally decided even before initial surface mining occurs, and development can occur on a mine site where seam thickness of coal, etc., might not have economically justified a mining operation by itself without a future productive alternative use after mining has ceased. The Starvaggi Industries of Weirton, West Virginia, have been successful with this concept.[12]

The parameters used for the matrix were determined by computing the midpoint of each subclass (0-5 miles, etc.) by the variables:
Y = .800-(.028) (midpoint of subclass) for urban uses and by:
Y = .871-(.016) (midpoint for subclass) for recreational uses. The resulting figures estimate the probability of examples located at the particular distance away from either an SMSA or an interstate highway.

The accessibility criteria were determined to be significant for recreational related uses while the proximity criteria were significant for the urban related uses. Proximity criteria were as statistically insignificant for recreation and the accessibility criteria were statistically insignificant for urban uses.

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[12]Rowe, p. 19.

The accessibility criteria are as follows:

0-5 miles from an interstate	=	73 percent chance of example being a recreational use
5-10	=	59 percent
10-15	=	45 percent
15 or more miles	=	24 percent
0-5 miles from a railroad	=	63 percent
5 or more miles	=	47 percent

The proximity criteria are as follows:

0-15 miles from an SMSA	=	75 percent chance of example being an urban use
15-25	=	55 percent
25-40	=	33 percent
40 or more miles	=	9 percent

The suitability matrix was constructed to indicate that nearness to an interstate highway was more important than nearness to an SMSA for a recreational related use than an urban related use. Agricultural and other uses were determined to be more likely to occur in a reverse relationship to recreational and urban uses.

The economic viability of a proposed reuse is estimated by the percentage of existing examples being located within the same general distance from an interstate highway or an SMSA. The spatial parameters and the environmental factors analyzed when used in combination leads one to chose a sound alternative land reuse type. Further on-site engineering analysis and area-wide market studies would help pinpoint the best possible reuse.

Physical Factors Affecting Development

The natural and ecological features of certain sections of the study area dictate that they should be protected as a result of an application of McHarg's principles and methodology. These areas should be placed in low density and open space type uses. The major areas are: groundwater intake areas, major water run-off areas, agricultural and forest soil areas, mineral resource areas, steep land, areas affected by certain air drainage patterns, floodplains, and areas of scenic features and regional landscapes. Factors (Table VI) that were added to the accessibility and proximity criteria established in this thesis to determine a site's suitability for various types of land uses can be found in the Appendix. The physical and spatial factors were mapped onto overlays and the resultant natural pattern emerged.

Groundwater intake areas. Groundwater is chiefly derived from the percolation of moisture into the interpore space of the soil. An estimated one-third of the precipitation falls on steep topography with impervious soils and runs off into river and streams; about one-third is returned to the atmosphere by evaporation and transpiration; and the remaining one-third is filtered down into the soil into zones of saturation and becomes groundwater. In most instances, the groundwater is then slowly moved under the influence of gravity from the intake areas along the water table until it is discharged into springs, wells underground reservoirs, and surface water bodies. Figure 9 depicts the groundwater intake areas of the area are of the Knox dolomite or Knox group, which consist of the subdivisions of Copper Ridge dolomite,

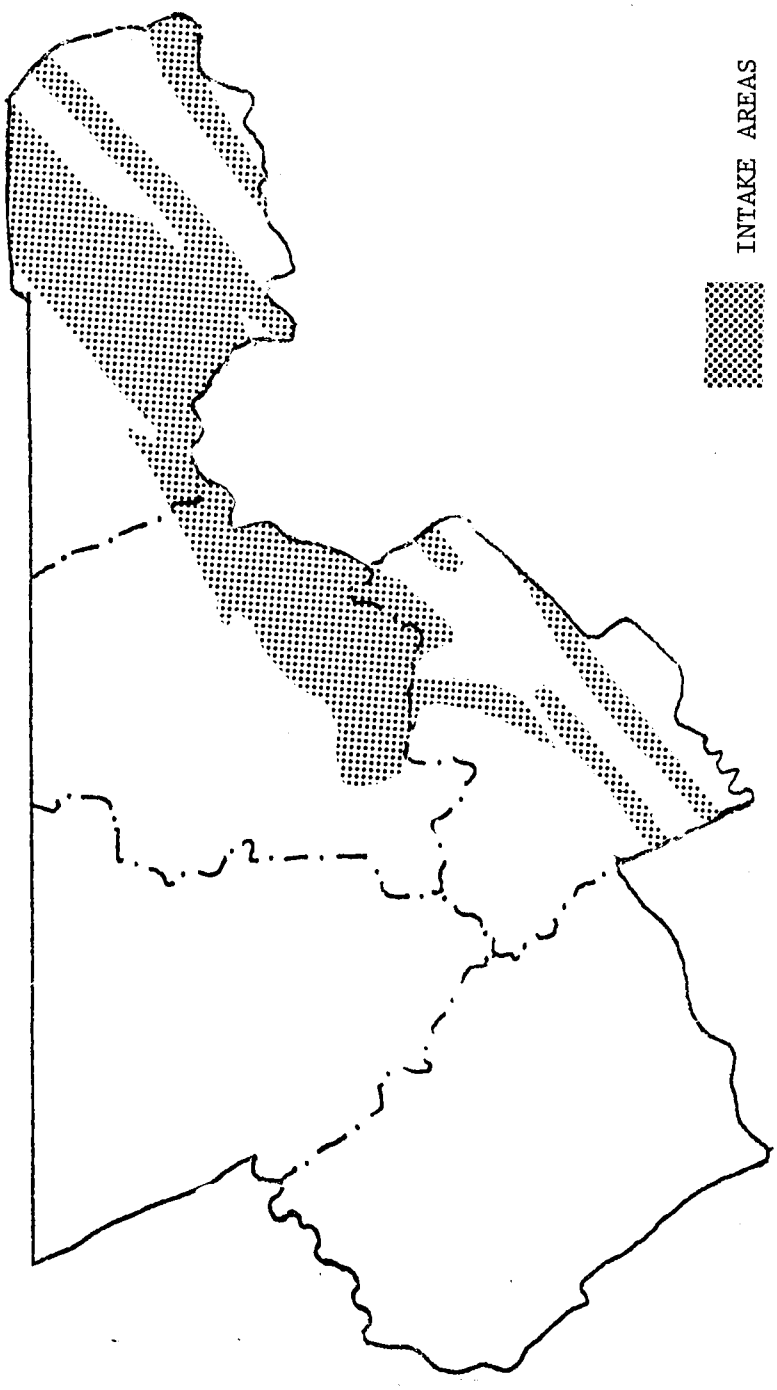


Figure 9. Major groundwater intake areas.

Chepultepec dolomite, Longview dolomite, Mascot dolomite, and the Kingsport formation.

Since the areas are the major collectors of groundwater, which may become surface water, they should be protected from misuse. In this respect, care must be taken to insure that the surface and the topography of the intake areas are not altered to the extent that water collection, absorption, and transmission are impaired, and, more importantly, that the soils and the atmosphere of the intake areas are not substantially polluted since the pollutants can filter into the water table and be dispersed throughout the region. Where feasible, groundwater intake areas should be placed in either adequately sewered urban uses or in open space uses. The strip mine sites do not occur in the intake areas.

Water run-off areas. Areas of significant precipitation are located in portions of Anderson, Campbell, Morgan and Scott counties. The concentric isohyets range from 54 inches in the vicinities of Oakdale, Wartburg, and Oliver Springs to 58 inches near Petros as shown in Figure 10. With the exception of the Petros section, the remainder of the area is conducive to precipitation run-off in that the topography is moderately steep, the soils are of the rather impervious Ramsey-Jefferson-Harsells association, and the parent material is of Pennsylvanian age rock. The run-off of this area is collected by the Emory and Powell Rivers and their tributaries.

Since the bulk of the precipitation from these areas becomes surface water and flows through the area where it may be used for domestic and scenic purposes, it is essential that it be protected. In this respect,

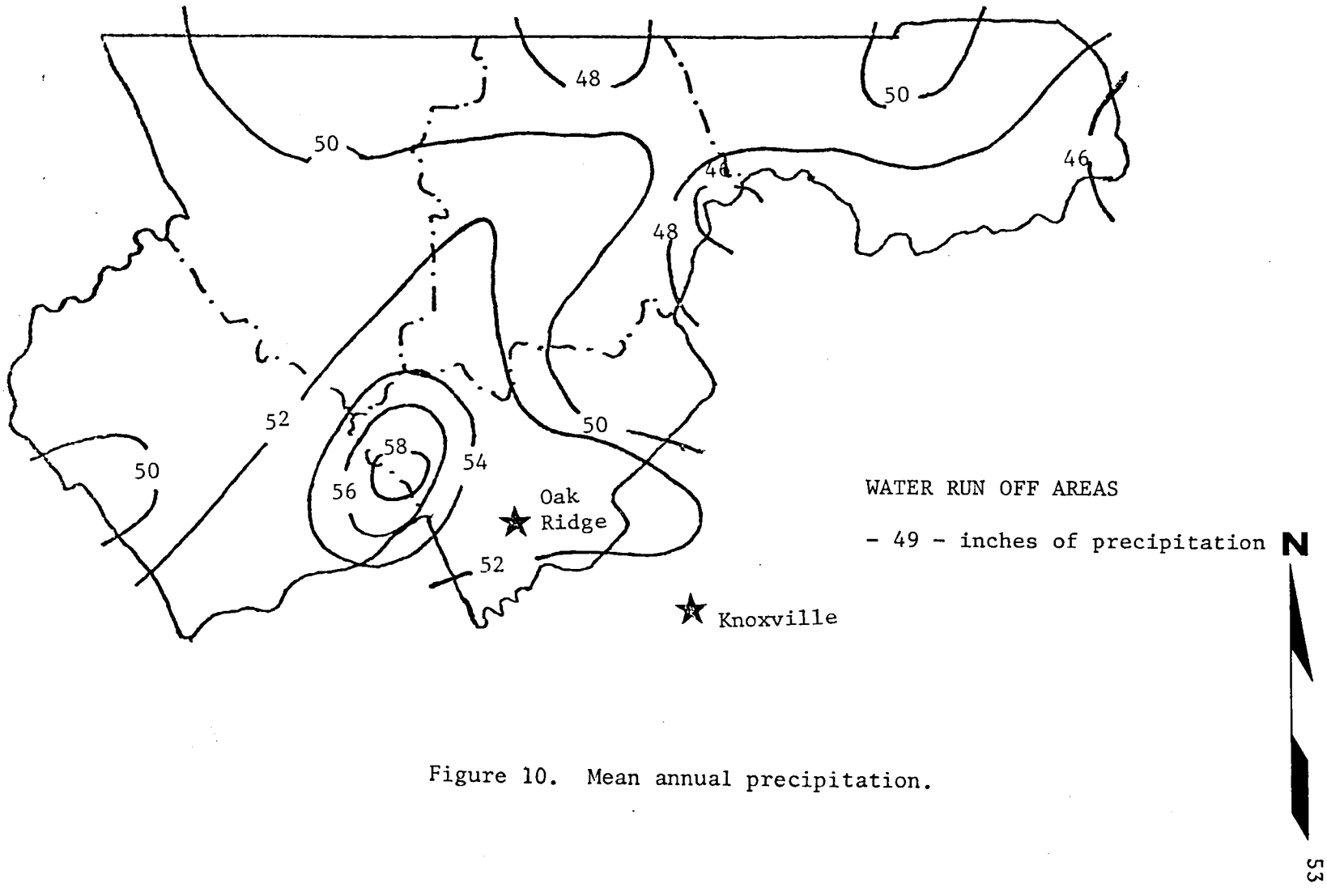


Figure 10. Mean annual precipitation.

two principal types of misuse are possible, that of pollution of the water itself with substances which are slow to decompose or which are toxic through air or soil pollution and pollution caused by the removal of the vegetative cover from the areas which could increase in soil erosion and turbidity. If either of these conditions occur, the cost of treating the water for municipal and industrial uses is increased greatly, and the water becomes less desirable for water-contact sports.

Portions of the areas are protected to a considerable degree because they are largely in public ownership. The lands in public ownership include Morgan State Forest, Brushy Mountain State Prison Farm land, and The University of Tennessee mountain lands. The fact of public ownership of land is, of course, no guarantee that proper conservation practices will be followed; but the usual case is that more comprehensive conservation practices are followed on large public tracts of land.

Agricultural and forest soils. A classification system for soils is based on the fertility, topography, and the conservation hazards found in the area. Six broad classes of soils in this classification system are designed by the letters A through F. Of these, four (A,B,C,D) have significant agricultural potential in that they are inherently fertile, and if properly managed, well suited to cultivated and pasture crops with few or no conservation hazards. Unfortunately, the study area contains only small areas of the more desirable soils in the Powell Valley and the Hinds Ridge areas. The remaining two classes of soils are most suited to forest uses as shown in Figure 11.

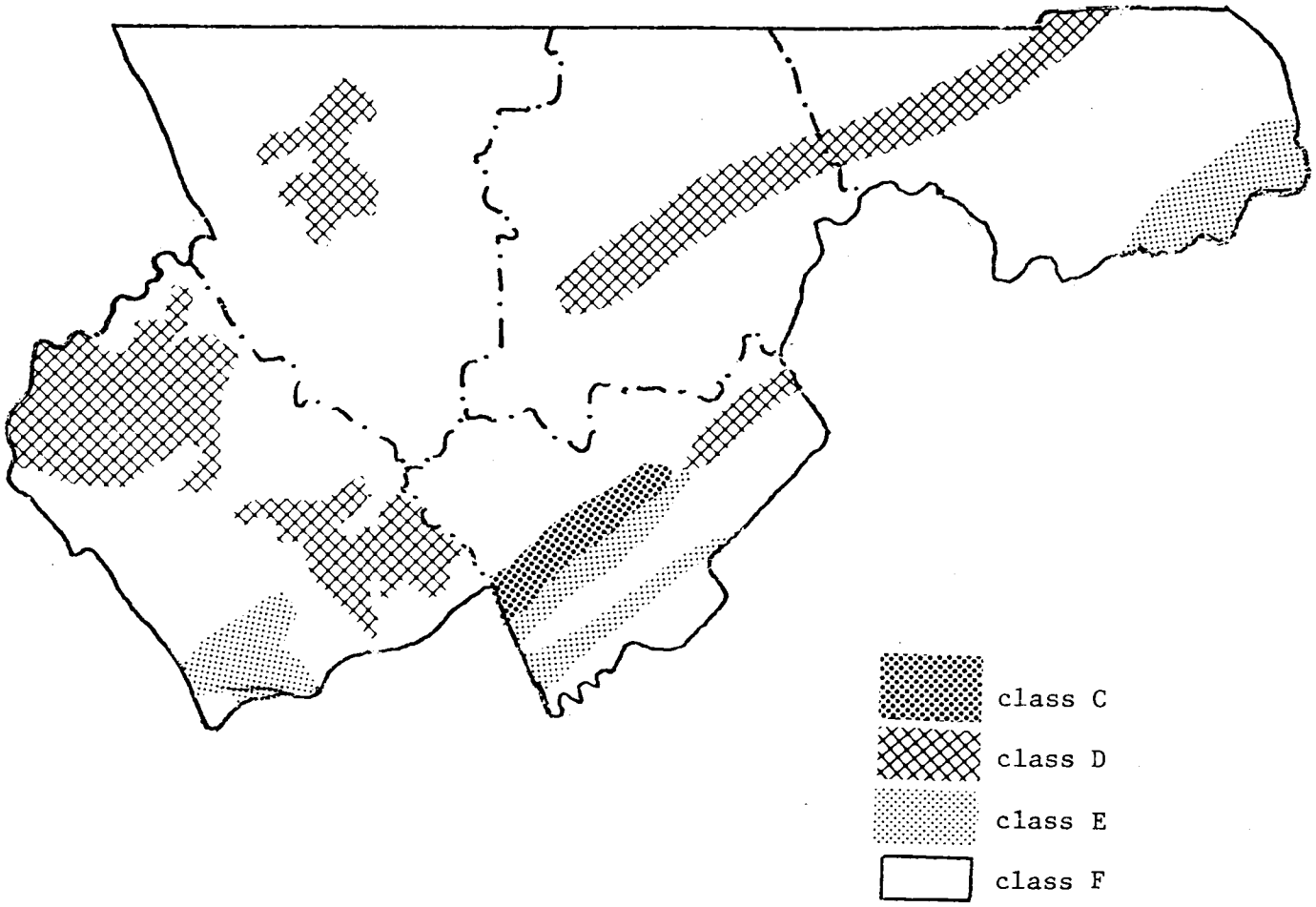


Figure 11. Agricultural and forest soils.

Class C soils require a higher level of management to achieve the productivity of the first two classes. They are also suitable for pasture crops and several varieties of row crops. Class C soils are made up of Jefferson-Philo-Stonyland, Fullerton (Baxter)-Talbott, Dunmore-Dewey-Greendale, Dunmore-Fullerton (Baxter-Talbott, Dunmore-Dewey-Lindside, Colbert-Talbott-Rockland, Sequoia-Armuchee-Teas, and Hartsells-Ramsey associations. These associations are located in the valley corridor sections of the area.

The Class D soils are dispersed generally throughout the lowland sections of the study area and in an area near Oak Ridge. Fullerton (Baxter)-Dewey-Bodine-Clarksville and Dandridge-Needmore-Whitesburg soil associations comprise this classification group. They are predominately rolling to hilly, 5 to 12 percent slope, and are located on infertile upland soils.

Although the soils of these classes are often the best ones for urban type development because of their general suitability for septic tanks and ease for grading, they should, where feasible, remain in agricultural uses. One reason for keeping most of the better soils in agricultural uses is that they are found in limited quantities and if they are employed in nonagricultural uses, less productive soils will be used for production. A greater conservation cost would result which necessitates a greater per acre capital investment to reach a level of productivity comparable to that of the better soils in the valley.

Forest soils are those soils which are generally unsuitable for crops in that they are relatively infertile, found on steep topography

and usually cannot be used for either row or pasture crops. They comprise the two remaining groups, Classes E and F.

The Class E soils occur in areas that are mostly hilly and mountainous with 12 to 30 percent and greater slopes. They are the Fullerton-Bodine-Ennis, Motevallo-Litz-Sequoia, and Tellico-Asmuchee soil associations and are located in both areas of the valley corridor as well as portions of the mountainous areas.

The Class F soils are generally found on land steep and are of the Ramsey-Ranger-Talladega, Ramsey-Jefferson-Hartsells, and Ramsey-Montevallo-Litz soil associations. They are located in the mountainous terrain. These soils are generally poor and as a result produce only marginal timber yields, therefore the Class F soil areas have their greatest potential for scenic and recreational purposes.

Forest areas are also important in that they provide vegetative cover which both reduces water run-off and soil erosion and enhances water absorption, particularly in the groundwater intake areas of the ridge tops. Additionally, forests are important in the production of oxygen through the photosynthesis process as well as in providing wildlife habitats, facilitating recreational opportunities and enhancing or creating the aesthetic and scenic values of the areas. Tables in the Appendix detail the suitability parameters for soil related uses.

Mineral resource areas. Extensive coal deposits, of varying depths, qualities, and quantities, are located in the region. Figure 12 indicates generally where these resources are located.

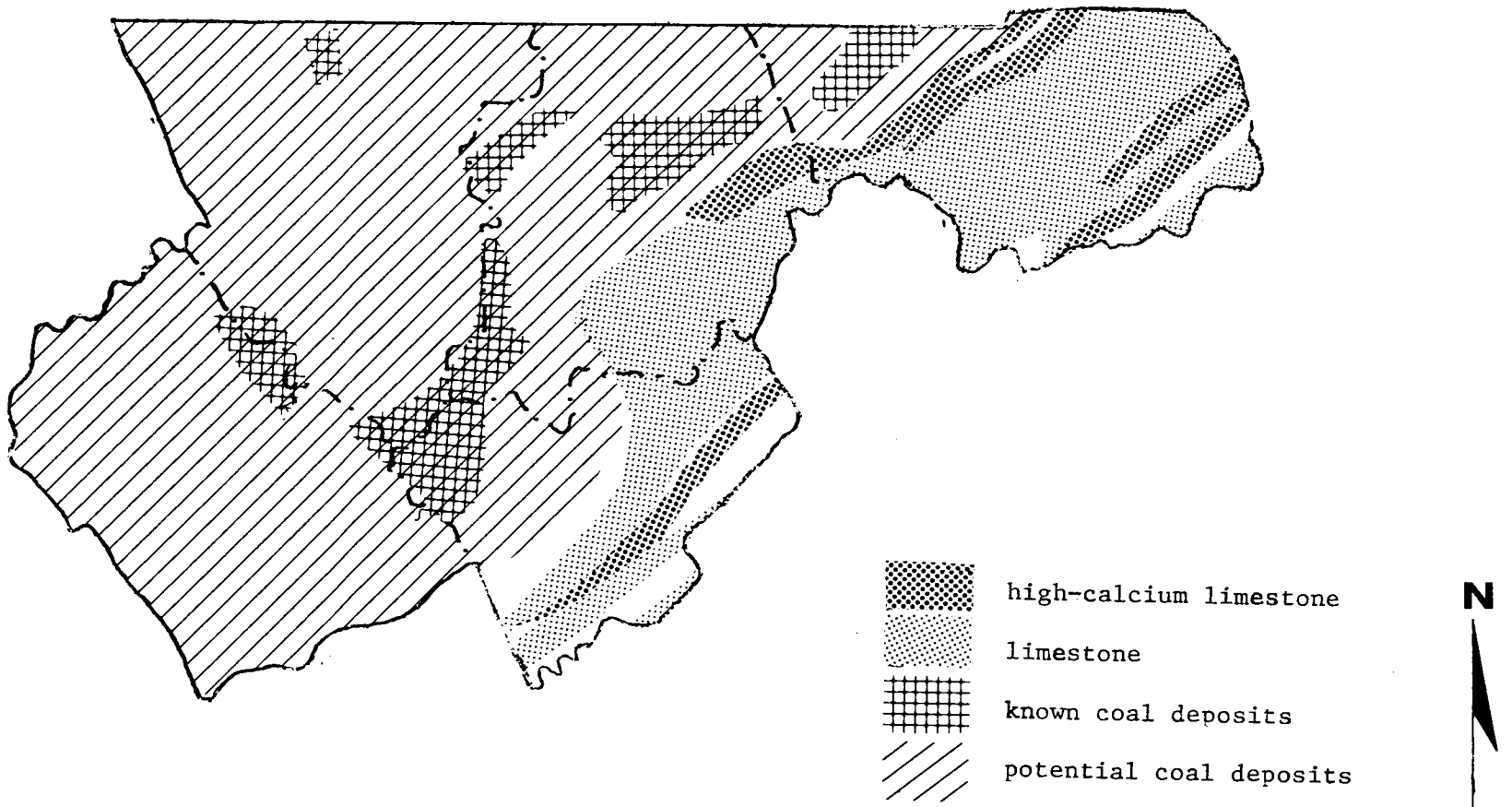


Figure 12. Major mineral resources.

Steep land. Much of the area's lands are of steep topography with 20 percent or greater slopes as determined earlier in the study area overview (Figure 13). The major steep areas are located throughout the Cumberland Plateau. The soil associations of the major steep areas are primarily those of the Ramsey-Ranger-Talledega, Ramsey-Jefferson-Hartsells, Ramsey-Montevallo-Litz, Fullerton-Bodine-Ennis, Montevallo-Litz-Sequoia, and Tellico-Neubert-Amuchee soil associations. Generally, they are shallow, stony, and relatively infertile.

Currently the majority of the steep areas are in open space related uses such as forestry, limited agriculture, and recreation. Strip mined site restoration in most instances in these areas would demand reclamation back to contour. Therefore, the major reasons for retaining steep areas in open space uses are: steep areas are easily eroded when their vegetative cover is removed, urban development often destroys the scenic values of steep areas, and many of the steep areas would have severe development limitations.

Air drainage patterns. Air pollution is either an existing or potential problem in the lower elevations of the area, particularly in the urban areas of the valley corridor. It is a result of several inter-related ecological and man-made factors. Of primary importance are the pollutant type and source, the topography, and the climatic phenomena of air drainage patterns and temperature inversions. The topography of the area consists of the nearly level central valley corridor penetrated by ridges and surrounded on the northwest side by mountainous terrain

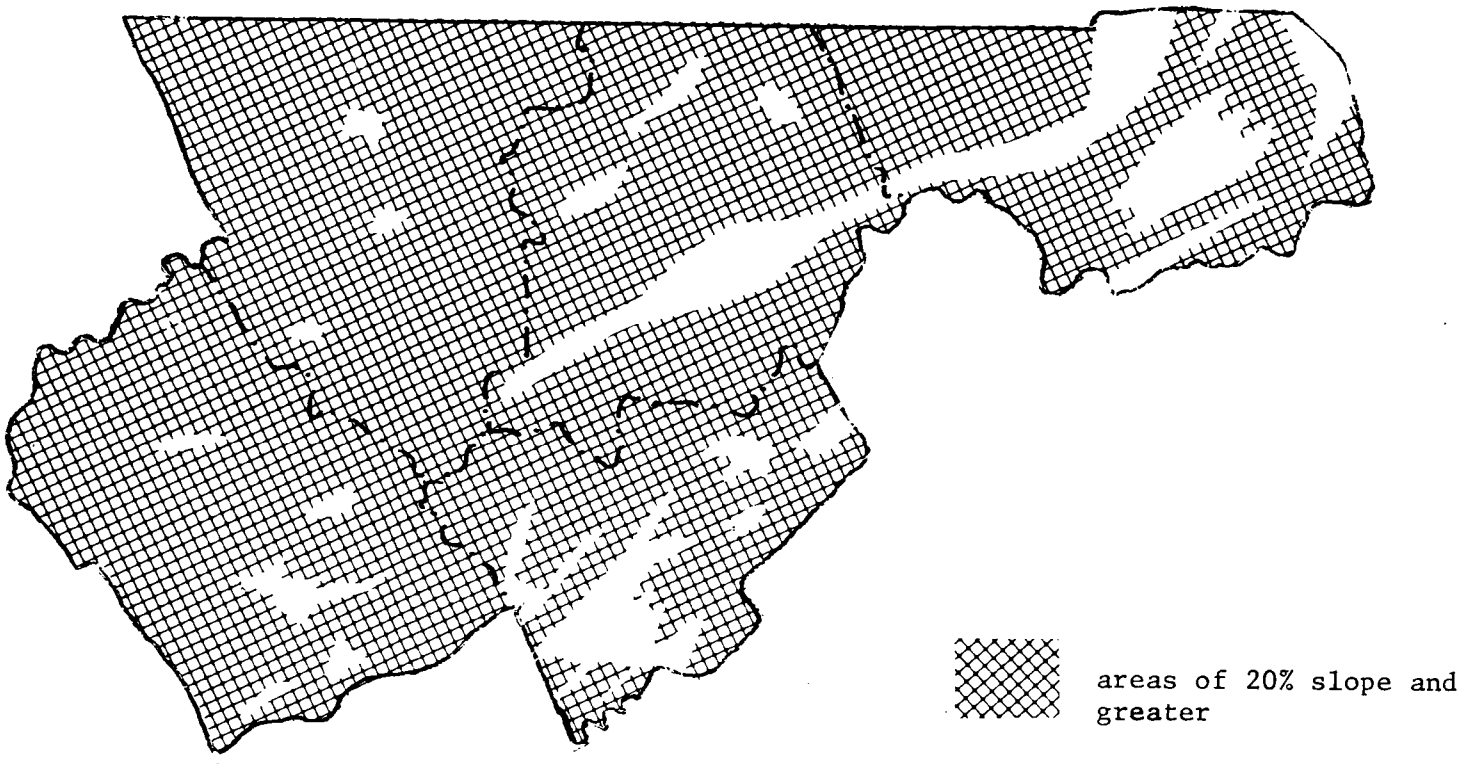


Figure 13. Topography.

and mountain valleys. The prevailing winds are from the northeast at an annual average of 7.4 miles per hour and the air drainage currents normally flow into the valleys in the morning hours and out of them in the afternoon. Combinations of both of these types of currents move air into, around, and out of the valleys. When temperature inversions occur, which are relatively frequent in the valleys of the area in the winter and spring months, the air drainage patterns are altered. The upper layer of warm air prevents the colder layer near the valley floor from moving out; thus, creating a stagnated condition. This condition remains until the inversion is broken up by the gradual warming of the colder layer of air and the reoccurrence of the normal air drainage patterns. When temperature inversions occur in valleys containing a source of air pollution, the condition is worsened and the common result is smog.

Floodplains. Floodplains are the natural easements of rivers and streams. Their purpose is to transport excessive volumes of water during periods of abnormally heavy rainfall and run-off. The delineation of a plan is based upon past historic records as well as flood potential. However, most strip mined sites are not in flood prone locations.

Scenic features and regional landscapes. The study area is abundant in scenic features and resources and has three major distinct regional landscapes:

1. Plateau landscape consisting of the area extending from the northwesterly slopes of Pilot, Griffith, and Rivet Mountains, in Scott and Morgan Counties.

2. Mountain landscape, which includes the area from Walden Ridge and the Cumberland Mountains northwesterly to the northwestern slopes of Pilot, Griffith, and Rivet Mountains adjoining the plateau,
3. Urban valley corridors, which consist of the developed and developing areas around and between Oak Ridge and Knoxville.

All of the previously listed physical features have a definite scenic potential as shown in Figure 14 and described in Table 18 (Appendix). Where feasible, they should be protected from misuse. They can best be protected through their placement in low density open space uses, particularly recreation (both public and private), forestry, and agriculture. In limited instances, more mining and lumbering operations could be permitted when proper reclamation planning is employed. The reasons for protecting these areas are twofold: scenery and recreation are important to the region's economy, and the demands for recreational areas are expected to increase with increasing population pressures. Large areas with open space type uses are called for by the McHarg methodology.

Suitability Matrix

The function of a matrix is to demonstrate the degrees of suitability among several variables. As shown in Figure 15, four generalized types are considered: urban, recreational, agricultural, and other unrelated uses. These land use types have been placed in a matrix with eight main categories of the major physical and spatial characteristics of the area. They are: water intake areas, water

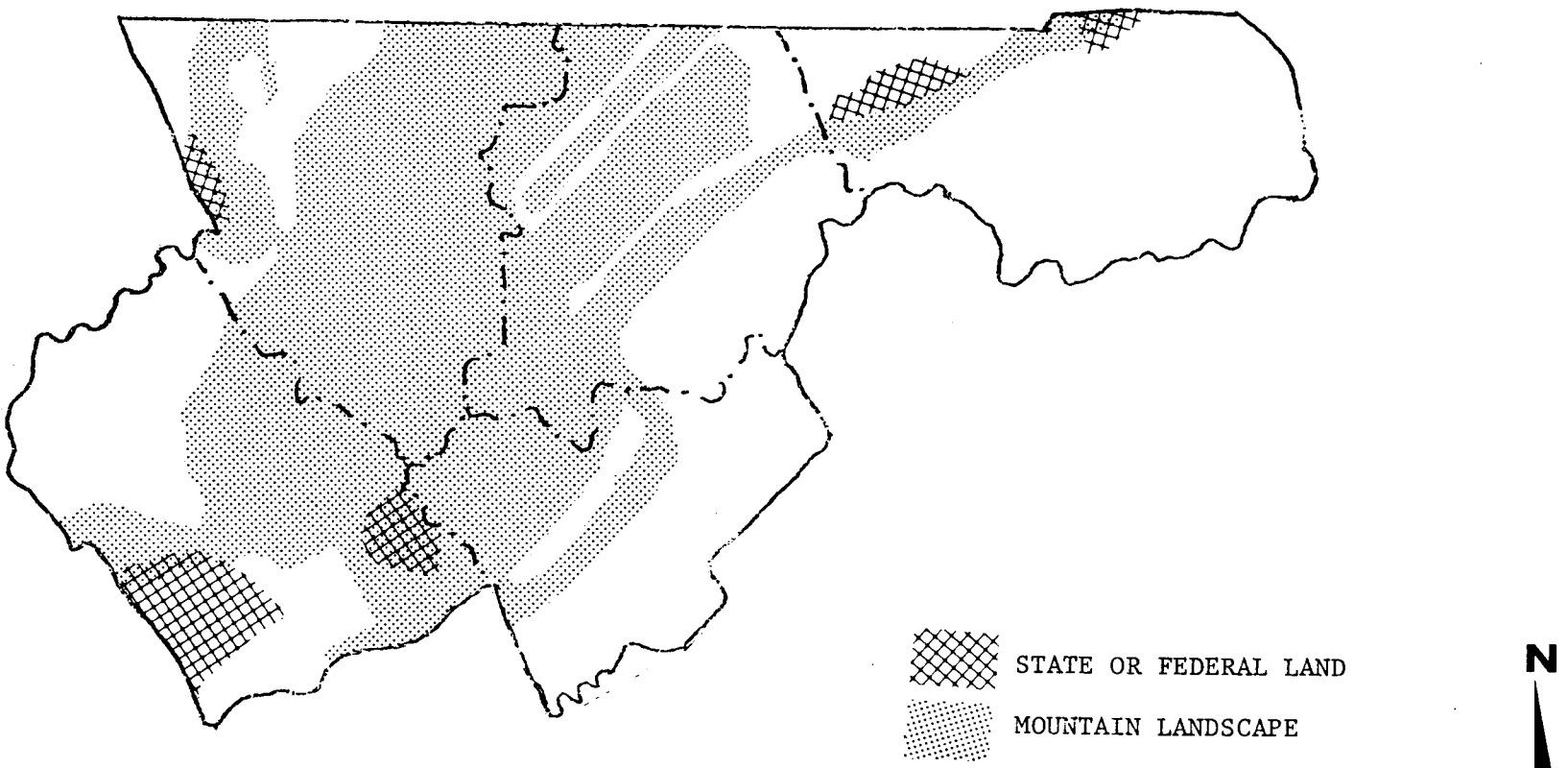


Figure 14. Scenic features and historic sites.

Legend

X possible use

\+ moderate limitations

□ severe limitations

Alternative uses	Accessibility Criteria 0-5 miles from interstate	5-10	10-15	15 or more miles	0-5 miles from railroad	5 or more miles	Juxtaposition to Urban Areas	0-15 miles from SMSA	15-25	25-40	40 or more miles	Topography over 20% Slope	Soil Class C	Soil Class D	Soil Class E	Soil Class F	Water Intake Areas	Scenic Areas	Water Run-Off Areas
	Physical and Functional Constraints																		
Urban related uses																			
residential	X							X					+	+			+	+	
commercial	X							X					+	+				+	
educational	X							X					+	+			+	+	
industrial	X							X					+	+				+	
transportation	X							X					+	+			+	+	
Agricultural uses																			
intensive		+	+	X					+	X	X		X	+			X	+	
extensive		+	+	X					+	X	X	+	X	+	+		X	+	X
Recreational uses																			
intensive	X	+						X				+	X	+	+	+	+	+	
golf courses	X	+						X				+	X	+	+	X	X	+	
campgrounds	X	+						X				X	X	+	+	+	X	+	
etc.	X	+						X				+	X	X	X	X	X	+	
extensive		+	+	X				+				X	X	X	X	X	X	X	
forest		+	+	X				+				X	X	X	X	X	X	X	X
camping		+	+	X				+				X	X	X	X	X	X	X	X
hunting		+	+	X				+				X	X	X	X	X	X	X	X
fishing		+	+	X				+				X	X	X	X	X	X	X	X
timber		+	+	X				+				X	X	X	X	X	X	X	X
Other uses		+	+																
Refuse disposal		+	+																
other nonspecified		+	+															+	

Figure 15. Reclaimed strip mined site alternative land use suitability matrix.

run-off areas, soils, scenic areas, steep areas, areas in juxtaposition to urban areas, and areas that are accessible to an interstate highway or railroad. The proposed innovations in transporation routes were not considered but should have been. The degree of suitability, ranked as possible, moderately limited, and severely limited (each of the opposing variables were determined by considering both the real and potential economic and social costs involved in an area's use). These three categories of suitability are as follows:

Possible use: includes areas with slight limitations. All or nearly all the component areas are favorable for the intended use. Any unfavorable factors are relatively easy to overcome.

Moderate limitations: areas of this classification are only reasonably favorable for the intended use. The unfavorable sites may be overcome through correct planning, careful design, good management, or moderate expense.

Severe limitations: areas of this classification are unfavorable for the intended use. Adapting the environmental and spatial criteria components in question to the intended use may be accomplished only with difficulty and considerable expense.

Where feasible, strip mined sites should be placed in either a single or multiple land uses which have the greatest degree of compatibility with the area's predominant physical characteristics. Generally, these would be those of either the possible or moderately limited ratings. The physical suitable criteria were enumerated in the soils discussion.

Application of Process

In order to determine the best alternative land use for a reclaimed strip mine site, each of the predominant physical/envoronmental and spatial features of the study area were identified and depicted on maps. Based on the findings of the suitability index and of the features shown on the overlays, a map of the area was prepared which showed the possible type of land use and its suitability to the area in generalized terms. Certain areas which are expected to continue to their present uses were identified and not considered from a suitability standpoint. These areas consisted of land in public ownership and areas presently in urban-type uses. The land use suitabilities map suggests what major groups of land use could be implemented rather than its specific use. For example, low density residential development could (and perhaps should) be permitted in an area shown in "agriculture" with the exception of areas of high agricultural value. The generalized land suitability map for the study area is depicted in Figure 16.

The procedure described above is a modification of the land capability analysis developed by the Ohio Department of Natural Resources.[13] Land capability analysis can be defined as a methodology for evaluating the physical components of the environment in terms of their ability to support, withstand, or tolerate various land uses. This analysis is an application of McHarg's methodology to strip mine

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[13]Ohio Department of Natural Resources, Land Capability Analysis: The Wolfe Creek Project (Columbus, Ohio: Ohio Department of Natural Resources, February 1974), pp. 1-55.

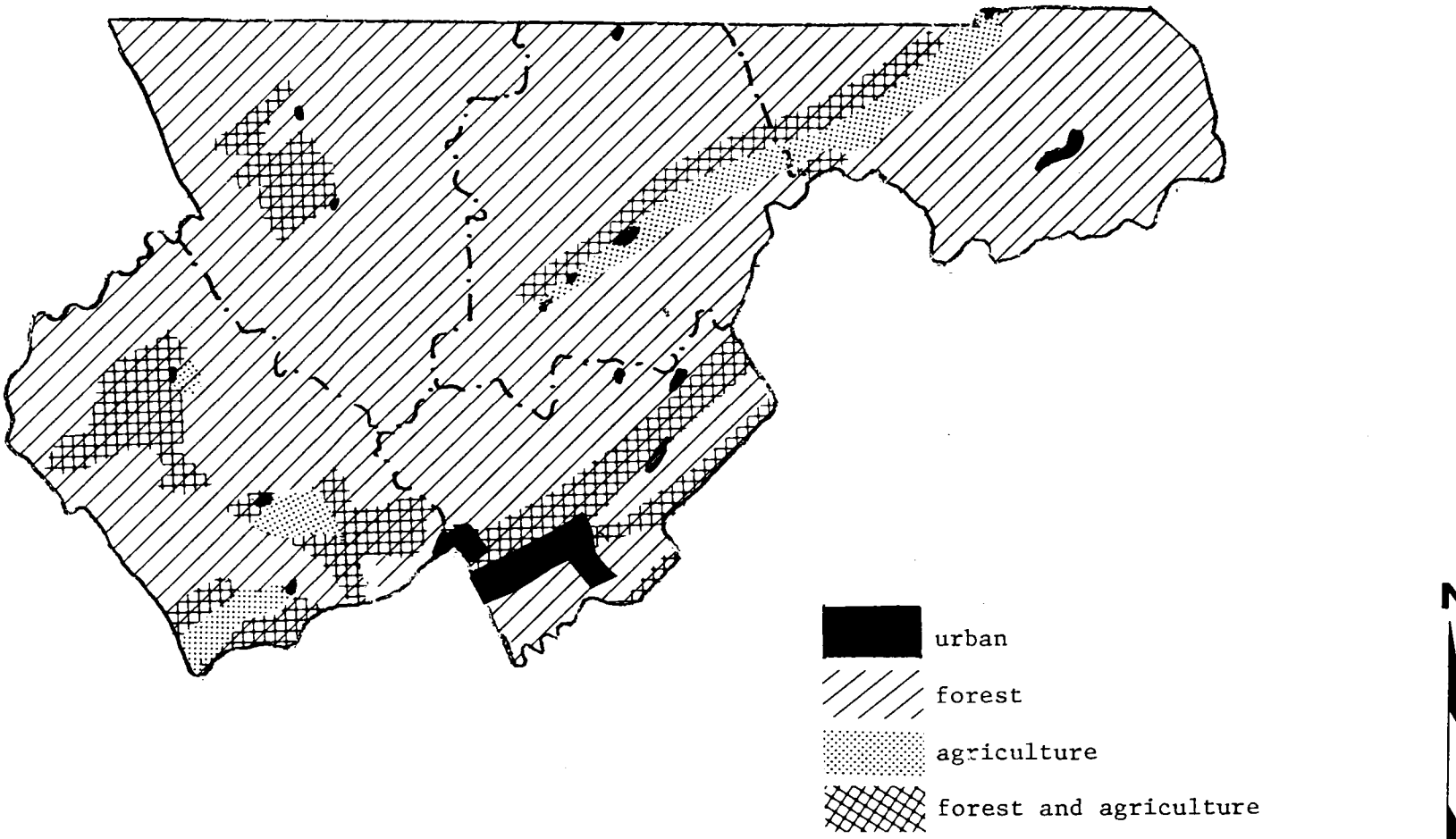


Figure 16. Land use suitabilities.

sites and their possible alternative land use after reclamation. The analysis is based on an inventory of the physical variables in an area and an assessment of how their inherent properties can be affected by different types of land use. The overall objective of this procedure is to establish a methodology for the employment of physical and economic data as an integral part of the comprehensive planning process in order to avoid significant environmental and economic problems. The physical land capability analysis was modified to include the statistical parameters developed to measure the land use suitability of a site in relationship to its distance from an interstate highway, railroad, and an urban area.

Four steps are involved in executing the procedure developed for the study area:

1. The inventory and mapping of physical and spatial planning data.
2. The delineation of all hazard areas, areas of critical environmental concern, and areas of environmental significance.
3. Future plan—objectives plus planned public facilities by state, region, or localities.
4. The analysis of the data to determine the suitability of the land for uses of the four major groups.

Input from the suitability analysis process can, at this point, be combined with a suitability analysis based on socioeconomic and cultural

data to determine the overall ability of a site to support various kinds of proposed reuses.[14]

Subsequent to the analysis of the data, the process was carried two steps further:

5. The environmental impact of proposed major development such as subdivisions, industrial parks, etc. on the physical environment was evaluated.
6. A detailed analysis of several proposed land use types on selected strip mined sites was conducted.

The physical data were collected and mapped on transparent overlays which were more suitable than others for a variety of land uses. Specific sites proved more suitable for various reuses when studied in detail.

Values were assigned for each factor considered. These were separated into three classes: possible use, moderate limitations, severe limitations. For example, depth to the water table is one component of the residential function. Based on criteria developed by the Soil Conservation Service, if the depth is greater than five feet, it is considered a good possibility for residential use; if it is between two and one-half and five feet it is considered to have moderate limitations for residential purposes; and if it is less than two and one-half feet, it is considered to have severe limitations.

The final product of the modified suitability analysis for the study area is a set of data maps and an alternative land use suitability matrix

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[14]Ibid., p. 4.

for reclaimed strip mined sites. The suitability for any strip mined site for the various proposed reuses can be ascertained from the matrix. Structural on-site problems involve such things as the ability of the subsoil to support foundations, while nonstructural problems would include landscaping. Secondly, there are area-wide environmental problems that land use development could present. A housing development, for instance, might seriously affect the run-off and result in flood hazards elsewhere in the drainage basin. Thirdly, resource loss problems which affect the general public as well as an individual or a group must be considered. If a housing development is built on prime agricultural land, or if it destroys an important wildlife habitat, then the problem affects more than the individual homeowner or his neighbors. It is important to identify resource loss areas in the suitability analysis process.[15] Regional planning would help eliminate some of these potential problems.

A matrix helps to portray the interactions between the various types of land uses and to model the interactions more precisely. After the analysis is complete, an attempt should be made to verify the results to determine if the model has correctly identified problem areas. For example, after mapping an area as severely limited for residential development, it would be valuable to check with people living in the area to see if they, in fact, have severe problems with their homes.

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[15] Ibid., p. 17.

While the methods used for land suitability anaysis are being continually improved, the basic process remains the same. Foremost among these underlying ideas is the assumption that physiographic data can provide a sound and logical basis for comprehensive planning. By taking physical and economic information into consideration, problem areas can be avoided and economically justifiable land uses can be ascertained for reclaimed strip mined sites to the benefit of the strip mine operator, his neighbors, and the environment. A strip mine site can be developed into economic as well as an environmentally sound project.[16]

Incorporating physical and economic data into the planning has been a problem because of the expense and the difficulty of collecting and analyzing it. Local and regional planners who have desired physical input for their plans and have considered strip mined areas can utilize the methodology developed in this thesis.

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[16]Ibid., p. 19.

CHAPTER IV

TEST OF THE PROCESS

The process developed in Chapter III was tested and applied to two specific strip mine sites in the study area, Massengale Mountain and Little Brushy Mountain. The selected sites were chosen because of data availability.

Massengale Mountain

In the TVA Office of Engineering, Design and Construction developed plans and cost estimates for a surface mine on its coal property on the south side of Massengale Mountain in Campbell County. Included in the operation was a demonstration reclamation project. The plans provided for limiting the overburden material placed downslope to a predetermined amount, with the remainder of the overburden moved with off-highway trucks, either along the pit, for backfill into the approximate original contour, or to an off-site disposal area.[1]

Longpit Mining Company, which was already mining for TVA on the back side of the mountain, was chosen to mine the experimental area. Before 1970, the company had been primarily engaged in the road construction business. The area contained four seams: the Red Ash, Walnut

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[1]Thomas Pitts, "Surface Mine Reclamation in East Tennessee," in Proceedings of the Symposium on Surface Mine Reclamation and Land Use Planning (Lee's College, Kentucky: Scientists and Engineers for Appalachia, October 26-27, 1973), p. 41.

Mountain, Pewee, and Pewee Rider Coal Seams, which contained approximately 13 1/2 feet of coal. The same seams had been mined previously on the north side of Massengale Mountain by the same company. Mining on this project has adhered to the following guidelines: Permanent spoil banks have been created only below the outcrop of the lowest seam, the Red Ash Seam, where the moutain slope is 28 degrees from the horizontal or less. Spoil placement is limited to an area extending 20 feet vertically below the coal elevation. When a mountain slope exceeds 20 degrees, most spoil material is deliverately placed on a mountain slope and an attempt is made to minimize the unintentional movement of overburden downslope. All material below the coal elevation was compacted by dozer back blading to an approximate 1 1/2 to 1° grade.[2] Mining processed in all seams, thereby permitting the back fill of the lower seam pit by dozers pushing from seams, rather than hauling back fill material by trucks. At the sides, the pit bottom and exposed coal face were covered with nontoxic material. The outer 20-30 feet of each bench was retained for access and as water checks. Out slopes were back-bladed and hydroseeded with a mixture of wood fiber, fertilizer, and grass seeds within a week of the final back-fill placement. Rockline drainage was constructed across the reclaimed mine area extending from the diversion ditches above the mining to the woods line below the mining. Siltation structures were located in natural drainage-ways below the mining area to control damaging siltation.[3]

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[2]Ibid., p. 42.

[3]Ibid., p. 44.

Massengale Mountain is located within five miles of Interstate 75 and is approximately 45 miles from the nearest SMSA. According to the accessibility criteria established in this thesis, the mining site could be utilized for a recreational or agricultural use. Examination of the physical restraints would further restrict its possible reuses. The site is very close to the major groundwater intake area. Water run-off is not a major consideration, and the site is within the Class F soil belt. The topographic characteristic of the site is very steep with slopes over 20 degrees. The area has good scenic vistas and it is located in a mountain landscape.

Overlays of the various physical factors indicate that the site has a forest related land use suitability. As the operators of the mining operation, TVA would plan to utilize the site for its recreational potential if following this procedure. Due to its nearness to the interstate and the existence of good secondary roads in the area, the site would possibly be used for intensive recreation such as a camping area or some form of extensive forest related use.

Little Brushy Mountain

The University of Tennessee owns an area of orphan mines in Morgan County which includes Little Brushy Mountain. The site is known as Wilson Mountain to University personnel; however, it is listed as the west section of Little Brushy Mountain on the Petros and Camp Austin U.S.G.S. Quadrangles in Morgan County (Figure 17). Various research projects have been conducted on the mountain. Figure 18 depicts a photo from a high altitude (60,000 feet) RB-57 aircraft photographed the site

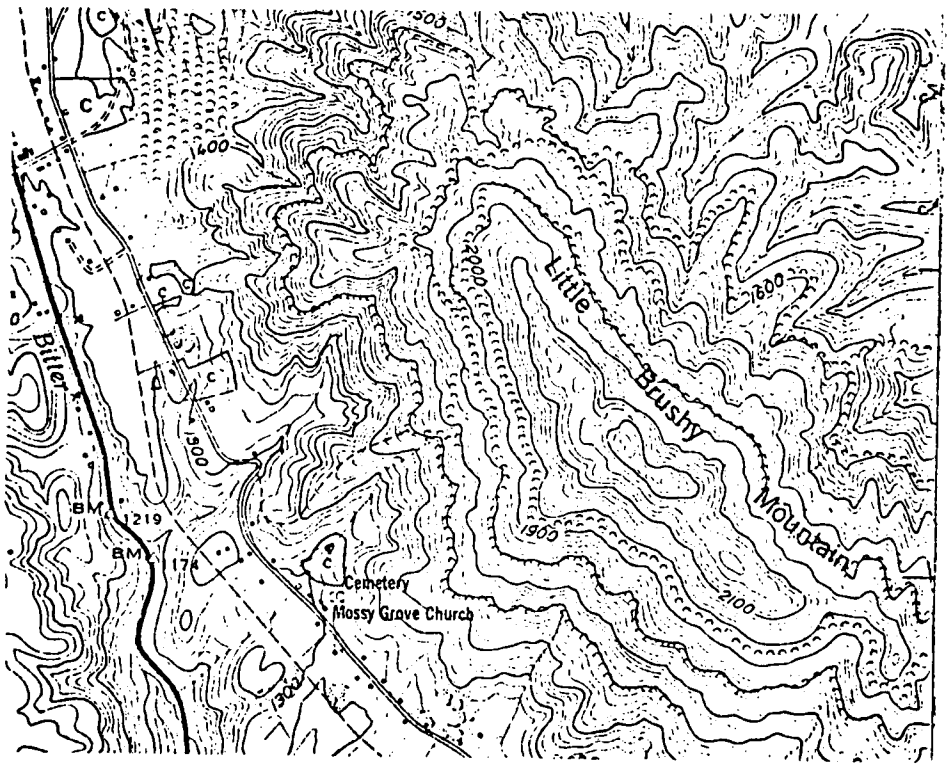


Figure 17. Wilson Mountain, U. S. G. S. quadrangle.



Figure 18. Wilson Mountain as viewed from 60,000 feet by a RB-57.

as part of a government project. This vantage point indicates the proximity to Petros. In Figure 19, Wilson Mountain is revealed from a low altitude oblique view that shows one the scenic potential of the site.

The site was described by Buckner and Kring in their article on the Christmas tree silviculture as shown in Figure 20.[4] Research of this nature will have positive effects upon strip mine reclamation planning. The area is in need of viable economic alternatives for strip mine restoration and experimentation of this type is pointing the way to future developmental potential.

Elevations range from 1,300 to 2,260 feet on the mountain. Little Brushy Mountain is part of the Cumberland Mountain section of the Appalachian Plateau Province. The soils have been designated as the Muskinghum series, but doubtless such series as DeKalb and Skelokta also exist. Slopes are steep and cliffs are common. Soils are shallow to deep, sandy and rocky. The climate is temperate continental with moderately cold winters and warm summers. The nearest weather station reports a mean annual temperature of 55.1 degrees F. and a mean annual precipitation of 54.6 inches.

The forest vegetation of the Cumberland Mountains is part of the mixed mesophytic deciduous forest. Tree size on the mountain indicated that the forest was secondary, although recent lumbering operations have been small.[5]

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[4]Buckner and Kring, p. 2. [5]Krumpe, DeSelm, and Amundsen, p. 717.



Figure 19. Low oblique view of Wilson Mountain.



Figure 20. Christmas tree silviculture on Wilson Mountain.

The site of the experiment is at an elevation of 1,900 feet on a dry southeast facing ridge. Raw spoil was left in a series of mounds and depressions with a maximum relief of approximately 15 feet before tree planting began. The upper portions of the mounds were free of vegetation. Black Locust (Robinia pseudoacacia) and poke weed (Phytolacca americana) were present in the depression. Spoil at the planting site is silty shale material removed as overburden from the coal. This "shale interval" forms the cap of Little Brushy Mountain and contains thin interbedded sandstone seams. Generally, the shale disintegrates rapidly upon exposure.[6]

Two separate mining cuts were made in this area. The spoil from the second cut is partially supported by the thick sandstone bench that was exposed by the first cut. The remainder was pushed off the sandstone bench creating a steep downslope spoil slide. The spoil bank covering the first cut ranges from 15 to 30 feet higher than the depression created by the second cut. Spoil depth over the sandstone base in the second cut ranges from a few inches to three to five feet. Occasional sandstone boulders from a thin interbedded sandstone layer several feet above the coal seam were scattered over the surface.

Buckner and Kring found that analysis of 35 soil samples randomly selected from the planting area gave the following values:[7]

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[7]Ibid., p. 3.

	Average	Range
pH	4.7	4.2 to 5.2
P	14 lbs./acre	2 to 90 lbs./acre
K	161 lbs./acre	100 to 280 lbs./acre

When pH values drop below 4.0, sites are generally considered too toxic for the growth of most tree species. Only four of the 35 soil samples were 5.0 or above (pH 4.0 to 5.0 is considered strongly acid). Phosphorus was low to very low according to agronomic standards. Only eight of the samples tested above 15 lbs./acre. Potassium tested higher, and there was less variation among samples than was the case for phosphorus. Although tests were not made for nitrogen, levels were obviously low as there was no visible organic content in the spoils.[8]

Application of the process developed in this thesis to the strip mined land on Wilson Mountain would reveal that the site would best be used as extensive recreation only. The site is over 15 miles from an interstate highway and over 40 miles from the nearest SMSA. These parameters would place urban and intensive recreational uses within the severely limited rating category. The agricultural related uses would have to be discounted due to the site's soil and topographic conditions. The site has scenic potential and is not within the water intake area, although it is situated in the water run-off area. Since the site is already being employed as a Christmas tree test project, it is assumed that the mountain should be utilized for extensive forest related uses.

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[8] Ibid.

CHAPTER V

CONCLUSIONS

The purpose of this thesis was to develop a process for determining postmining land use alternatives for reclaimed strip mined areas. The process developed was greatly influenced by the works of Ian McHarg.

The Central Appalachian area contains vast amounts of low sulfur bituminous coal. Much of this coal can best be extracted by surface mining. The process of strip mining disrupts the area to a startling degree. This thesis has developed a process for determining the most suitable land reuse for the disturbed areas. Physical land capability analysis was modified to include spatial parameters for the determination of the most suitable reuse of the land.

Restated, the process contains the following six steps:

1. Inventory and map on transparencies the planning data.
2. Point out critical or significant environmental areas on maps.
3. Consider the future plans for the area.
4. Analyze data on overlays and incorporate the spatial parameters developed in order to determine the suitability for the various reuses.
5. Consider the environmental impact of development type chosen.
6. Make a detail engineering and market study for the particular site.

However, the process developed would be of little value unless the demand side of the problem is considered along with the supply. A balance between

the two will have to be established before the true economic viability of a proposed reuse can be ascertained. This research can be pursued further by analyzing the second and third phase of the total problem. As stated in the introduction, this work only attempts to consider one-third of the problem.

The study area of five Cumberland Plateau counties of Tennessee was chosen and analyzed due to the similarities and homogeneity of the area to the Central Appalachian region. The Tennessee counties are relatively underdeveloped and contain an expanding strip mining industry. The traditional McHarg methodology of analysis by overlays was employed for the area. The important physical factors were mapped onto transparencies and studied on a light table to produce a generalized land suitability map. This map and the spatial parameters developed by the author were combined to produce a reclaimed strip mined site alternative land use suitability matrix.

Four general land use groups were formed—urban, recreational, agricultural, and other related uses—for the purpose of testing the matrix and mapping techniques. The process only suggests possible post-mining land uses. The three categories of suitability for a strip mine site are: use groups that are possible and would have only slight physical limitations, use groups with moderate limitations, and uses that would experience severe limitations if implemented.

The final product of the modified suitability analysis for the study area is a set of data maps and an alternative land use suitability matrix for reclaimed strip mined sites. The suitability for any strip mined site

for the various proposed reuses can be ascertained from the matrix. The matrix helps to illustrate the interactions between the various types of land uses and to model the interactions more precisely. Once this generalized process has been applied for a strip mine site, the economic realities of the situation must be considered. For example, if the site is ideally suited for an industrial park but there is already an industrial park in the area, another proposed use within the urban classification might be chosen.

The data presented for the five counties indicated that most of the strip mined sites within the area would best be returned to their original condition and enjoyed for open space qualities. This process indicates possible land uses that meet the suitability criteria established in this thesis and does not intend to pinpoint the best reuse. However, by taking physical and spatial information into consideration, problems of reuse can be avoided, and economically justifiable land uses can be ascertained for reclaimed strip mined sites to the benefit of the strip mine operator, his neighbors, and the environment. A properly planned strip mined site can be developed into an economic as well as an environmentally sound project. Local and regional planners who have desired physical and spatially derived economic input for their plans for areas affected by strip mining can utilize the methodology developed.

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APPENDIX

TABLE V

SLOPE OUTCROP AND BENCH WIDTH STANDARDS

Slope Below Outcrop (Degrees)	Maximum Solid Bench Width (Feet)
Less than 15 degrees	No restrictions
15.0° - 18°	125
18.1° - 20°	106
20.1° - 22°	94
22.1° - 24°	82
24.1° - 26°	71
26.1° - 28°	55
More than 28.0°	No fill bench allowed

Source: Tennessee Department of Conservation, Regulations Pertaining to Surface Mining, Regulation 11.23 (a) and (b).

TABLE VI

FACTORS AFFECTING SUITABILITY ANALYSIS

On-site problems

- Structural: light load foundation, heavy load foundation, land slides, parking lots, streets, utilities
- Nonstructural: slope, flood plain, landscaping, septic tanks, surface stability, drainage, water supply

Area-wide problems of environmental quality:

- erosion hazard
- runoff changes
- aquifer pollution
- stream pollution

Resource loss problems:

- prime agriculture
- wetlands
- wildlife habitat
- natural areas
- economic minerals
- vegetation

Topographic patterns:

- access capability
- scenic and viewing quality
- slope dominance
- soil limitations

Upland wildlife:

- character of wildlife
- wildlife habitat

Landforms:

- access capability
- scenic quality
- uniqueness

Recreation lodging:

- access capability
- developable land
- potable water
- nuisance elements
- scenic quality
- slope of land
- soil limitations
- tree cover

Organized camping:

- access capability
- developable land
- nuisance elements
- potable water
- scenic quality
- slope of land
- soil limitations
- tree cover

Vegetation:

- access capability
- scenic quality
- slope
- soil limitation
- uniqueness of vegetation (in terms of size, appearance, rarity)

TABLE VII

SOIL LIMITATION RATINGS FOR THE STUDY AREA

Dominant Soil Series	Residential		Industrial	Recreational		Transportational	Agricultural
	With Central Sewerage System	With Septic Tank		Developed	Natural		
Muskingum-Ramsey very rocky-Lehew	Very severe (slope; shallow soils)	Very severe (slope; shallow soils)	Very severe (slope; rock)	Very severe (slope; rock)	Severe (slope)	Very severe (slope; rock)	Very severe (slope; moisture supplying capacity)
Armuchee-Talbott very rocky-Montevallo	Very severe (slope; shallow soils)	Very severe (slope; slow percolation)	Very severe (slope; rock)	Very severe (slope; rock)	Severe (slope)	Very severe (slope; rock)	Very severe (slope; moisture supplying capacity)
Talbott-Caylor-Jefferson	Moderate to slight (rock outcrop)	Very severe to slight (slow percolation; shallow soils)	Moderate to severe (rock outcrop; sinkholes)	Moderate (rock outcrop; sinkholes)	Slight	Severe (rock; sinkholes	Slight to severe (rock; clayey soil areas)
Stonyland-Talbott	Very severe (rock; shallow soils)	Very severe (very slow percolation; shallow soils)	Very severe (rock; slope; sinkholes)	Very severe (rock; slope)	Severe (rock; slope)	Very severe (rock; sinkholes)	Very severe (rock; sinkholes; moisture supplying capacity)

TABLE VII (continued)

Dominant Soil Series	Residential		Industrial	Recreational		Transportational	Agricultural
	With Central Sewerage System	With Septic Tank		Developed	Natural		
Fullerton-Clarksville-Claiborne-(hilly to steep)	Severe to very severe (slope)	Moderate to very severe (slope)	Moderate to very severe (slope)	Moderate to very severe (slope)	Moderate (slope)	Severe (slope)	Severe to moderate (slope)
Fullerton-Claiborne-Clarksville (rolling to hilly)	Moderate to severe (slope)	Slight to moderate (slope)	Slight to moderate (slope)	Slight to moderate (slope)	Slight	Slight to moderate (slope)	Slight to moderate (slope)
Monongahela-Jefferson-Philo	Slight to severe (flood hazard)	Severe to slight (seasonal high water table; low percolation	Severe to moderate (flood hazard)	Moderate (flood hazard; seasonal high water table)	Moderate (flood hazard; season-al high water table)	Severe to slight (flood hazard; seasonal high water table)	Moderate (flood hazard; fragipan)
Jefferson-Philo-Stonyland	Slight	Slight	Slight to moderate	Slight to moderate	Slight	Slight	Moderate
Hartsells-Ramsey	Slight	Slight	Slight	Moderate	Slight	Slight	Moderate
Ramsey-Jefferson-Hartsells	Severe to very severe	Severe	Very severe	Very severe	Slight	Severe to very severe	Very severe

Source: U. S. Department of Agriculture, Soil Conservation Service.

TABLE VIII

SUITABILITY PARAMETERS, SEPTIC TANKS

Variables Uses	Most Suitable	Moderately Suitable	Not Suitable
Slope	0-9%	10-15%	16+
Depth to Bedrock	> 6'	4-6'	< 4'
Depth to Watertable	> 6'	4-6'	< 4'
Permeability	> 1"/hr	1.0-0.6"/hr	< 0.6"/hr
Flooding	None	Rare	Occasional Frequent
Stoniness	0 & 1	2	3, 4, & 5
Rockiness	0	1	2, 3, 4, & 5

Source: Ohio Department of Natural Resources, Land Capability Analysis: The Wolf Creek Project (Columbus, Ohio: Ohio Department of Natural Resources, February 1974), p. 40.

TABLE IX

SUITABILITY PARAMETERS, RESIDENTIAL DEVELOPMENT

Variables Uses	Most Suitable	Moderately Suitable	Not Suitable
Drainage Class	ED, SED, WD	MWD	SPD, PD, VPD
Depth to Watertable	> 5'	2 1/2-5'	< 2 1/2'
Depth to Bedrock	> 5'	3 1/3-5'	< 3 1/3'
Flooding	None	Rare	Occasional or Frequent
Shrink-Swell Potential	Low	Moderate	High
Potential Frost Action	Low	Moderate	High
Stoniness	0, 1	2	3, 4, 5
Rockiness	0	1	2, 3, 4, 5
Vegetation	Cropland Pastureland	Deciduous Coniferous Orchards	———
Groundwater Availability	> 10 GPM	5-10 GPM	(-)
Hazard Area (Flood Plain)	No	(-)	Yes
Unified Classification	GP, GW, SW, SP, GM, GC, SM, SC	ML or CL	CH, MH, OL, OH, Pt
Slope	4-9%	0-3% 10-15%	> 15%

Source: Ohio Department of Natural Resources, Land Capability Analysis: The Wolf Creek Project (Columbus, Ohio: Ohio Department of Natural Resources, February 1974), p. 41.

TABLE X

SUITABILITY PARAMETERS, COMMERCIAL, INDUSTRIAL, INSTITUTIONS

Variables Uses	Most Suitable	Moderately Suitable	Not Suitable
Slope	0-6	6-9	9
Shrink-Swell Potential	Low	Moderate	High
Shear Strength (Unified)	GW, GP, SW	GM, GC, SP, SM	SC, ML, CL, MH, CH, OH
Depth of the H_2O Table	> 5'	3-5'	< 3'
Depth to Bedrock	> 5'	3-5'	< 3'
Flooding	None	Rare	Occasional or Frequent
Hazard Area (Flood Plain)	No		Yes
Vegetation	Cropland Pastureland	Deciduous Coniferous Orchards	(-)
Rockiness	0	1	2, 3, 4, 5

Source: Ohio Department of Natural Resources, Land Capability Analysis: The Wolf Creek Project (Columbus, Ohio: Ohio Department of Natural Resources, February 1974), p. 42.

TABLE XI

SUITABILITY PARAMETERS, AGRICULTURE

Variables Uses	Most Suitable	Moderately Suitable	Not Suitable
Available H_2 Capacity	> 8"	4-8"	< 4"
Slope	< 6	7-17	> 12
Consistence	Very Friable, Friable	Loose, Firm	Very Firm, Extremely Firm
Drainage Class	WD, MWD	ED, SPD	PD, VPD
Depth to Bedrock	> 3 1/3'	3 2/3'-3 1/3'	< 1 2/3'
Permeability	.2-5 in/hr	> 5.0 & .05-.2	< .05
Flooding	None	Rare	Occasional or Frequent

Source: Ohio Department of Natural Resources, Land Capability Analysis: The Wolf Creek Project (Columbus, Ohio: Ohio Department of Natural Resources, February 1974), p. 43.

TABLE XII

SUITABILITY PARAMETERS, PUBLIC UTILITIES

Variables Uses	Most Suitable	Moderately Suitable	Not Suitable
Frost Hazard	Low	Moderate	High
Drainage Class	ED, SED, WD	MWD	SPD, PD, VPD
Depth to H_2O Table	> 5'	2 1/2-5'	< 2 1/2
Flooding	None	Rare	Occasional or Frequent
Slope	0-9	10-15	> 15
Texture	FSL, SL, L, SIL, SICL, SCL	SI, CL, SC, All Gravelly Types	C, SIC, S, LS Organic Soils, Very Gravelly
Depth to Bedrock	> 5'	3 1/3-5'	< 3 1/3
Stoniness	0, 1	2	3, 4, 5
Rockiness	0	1	2, 3, 4, 5
Shrink-Swell	Low	Moderate	High
Corrosion Potential-Steel	Low	Medium	High
Corrosion Potential-Concrete	Low	Medium	High

Source: Ohio Department of Natural Resources, Land Capability Analysis: The Wolf Creek Project (Columbus, Ohio: Ohio Department of Natural Resources, February 1974), p. 44.

TABLE XIII

SUITABILITY PARAMETERS, RECREATION—TRAILS AND PATHS

Variables Uses	Most Suitable	Moderately Suitable	Not Suitable
Drainage Class	ED, SED, WD, MWD	SPD	PD, UPD
Depth to Watertable	> 1 2/3'	(-)	< 1 2/3'
Flooding	None, Rare	Occasional	Frequently
Slope	< 15	15-25	> 25
Texture	SL, L, SIL	SICL, SCL, CL, LS	SC, SIC, C Sand, Organic Soil
Rockiness	0, 1	2	3, 4, 5
Vegetation	Deciduous Coniferous Orchards	Cropland Pastureland Other	(-)

Source: Ohio Department of Natural Resources, Land Capability Analysis: The Wolf Creek Project (Columbus, Ohio: Ohio Department of Natural Resources, February 1974), p. 46.

TABLE XIV

SUITABILITY PARAMETERS, TRANSPORTATION

Variables Uses	Most Suitable	Moderately Suitable	Not Suitable
Drainage Class	ED, SED, WD, MWD	SPD	PD, VPD
Flooding	None	Rare	Occasional or Frequent
Slope	0-9	10-15	> 15
Depth to Bedrock	> 3 1/3'	3 1/2-1 2/3'	< 1 2/3'
Unified Classification	GW, GP, SW, SP, GM, GC, SM, SC	(-)	CL, CH, MH, OH, OL, PT
Shrink-Swell	Low	Moderate	High
Potential Frost Action	Low	Moderate	High
Stoniness	0, 1, 2	3	4, 5
Rockiness	0	1	2, 3, 4, 5
Hazard Area (Flood Plain)	No	(-)	Yes

Source: Ohio Department of Natural Resources, Land Capability Analysis: The Wolf Creek Project (Columbus, Ohio: Ohio Department of Natural Resources, February 1974), p. 45.

TABLE XV

SUITABILITY PARAMETERS, RECREATION—GOLF COURSE

Variables Uses	Most Suitable	Moderately Suitable	Not Suitable
Drainage Class	ED, SED, WD, MWD	SPD	PD, VPD
Depth to Watertable	> 1 2/3	(-)	< 1 2/3
Flooding	None	Rare	Occasional or Frequent
Slope	0-6	7-12	> 12
Texture	SL, L, SiL	SiCL, SCL, CL, LS	SL, SiC,C, Sand, Organic Soils
Rockiness	0	1	2, 3, 4, 5
Permeability	> .08	.05-.08	< .05
Vegetation	Deciduous Coniferous Orchards	Cropland Pastureland Other	(-)

Source: Ohio Department of Natural Resources, Land Capability Analysis: The Wolf Creek Project (Columbus, Ohio: Ohio Department of Natural Resources, February 1974), p. 47.

TABLE XVI

SUITABILITY PARAMETERS, RECREATION—PICNIC AREAS

Variables Uses	Most Suitable	Moderately Suitable	Not Suitable
Drainage Class	ED, SED, WD	MWD, SPD	PD, VPD
Depth to Watertable	> 1 2/3'	(-)	< 1 2/3'
Flooding	None	Rare	Occasional or Frequent
Slope	< 9	10-15	> 15
Texture	SL, L, Sil	CL, SCL, SiCL LS, & Sand (Not Loose)	SC, SiC, Loose Sand, Organic Soils
Vegetation	Deciduous Coniferous Orchards	Cropland Pastureland Other	(-)
Rockiness	0, 1	2	3, 4, 5

Source: Ohio Department of Natural Resources, Land Capability Analysis: The Wolf Creek Project (Columbus, Ohio: Ohio Department of Natural Resources, February 1974), p. 48.

TABLE XVII

SUITABILITY PARAMETERS, RECREATION—CAMP AREAS

Variables Uses	Most Suitable	Moderately Suitable	Not Suitable
Drainage Class	ED, SED, WD	MWD	SPD, PD, VPD
Depth to H_2O Table	> 2 1/2'	1 2/3'-2 1/2'	< 1 2/3
Flooding	None	Rare	Occasional or Frequent
Permeability	> .80	.05-.8	< .05
Slope	< 9	9-15	> 15
Texture	SL, L, SiL	CL, SCL, SiCL, LS, Sand (Not Loose)	Organic Soil, SC, SiC, Loose Sand
Rockiness	0	1	2, 3, 4, 5
Vegetation	Deciduous Coniferous Orchards	Cropland Pastureland Other	(-)

Source: Ohio Department of Natural Resources, Land Capability Analysis: The Wolf Creek Project (Columbus, Ohio: Ohio Department of Natural Resources, February 1974), p. 49.

TABLE XVIII

SCENIC AND GEOGRAPHIC FEATURES

Scenic Streams:		Pastoral Float Streams:	
Campbell County-	Hickory Creek	Anderson County-	Clinch River
Morgan-	Obed River	Morgan-	Emory River
	Clear Creek		Clear Fork
	Clear Fork		
	Crab Orchard		
	Crooked Fork		
Scott-	Williams Creek	Claiborne-	Powell River
	Laurel		Clinch
	White Oak		
	Pine		
White Water Float Streams:		Waterfalls:	
Morgan-	Obed River	Morgan-	Laman Falls
	Clear Creek		Potters
	Daddy's Creek		
	Clear Fork River		
	South Fork Cumberland River		
Scott-	South Fork Cumberland River		
		Scott-	Angel Falls
Lakes:		Historic Sites:	
Campbell-Claiborne-Anderson		Anderson-	Oak Ridge
	Norris		
Anderson-	Melton Hill	Morgan-	Rugby
		Claiborne-	Cumberland Gap
		Scott-	Paint Rock Creek
			Covered Bridge

Source: Tennessee's Outdoor Recreation Resources, 3 Vols. (Nashville, Tenn.: Tennessee Department of Finance and Administration, April 1968), Vol. 3: Tennessee: Its Resources and Economy, Publication No. 331c.

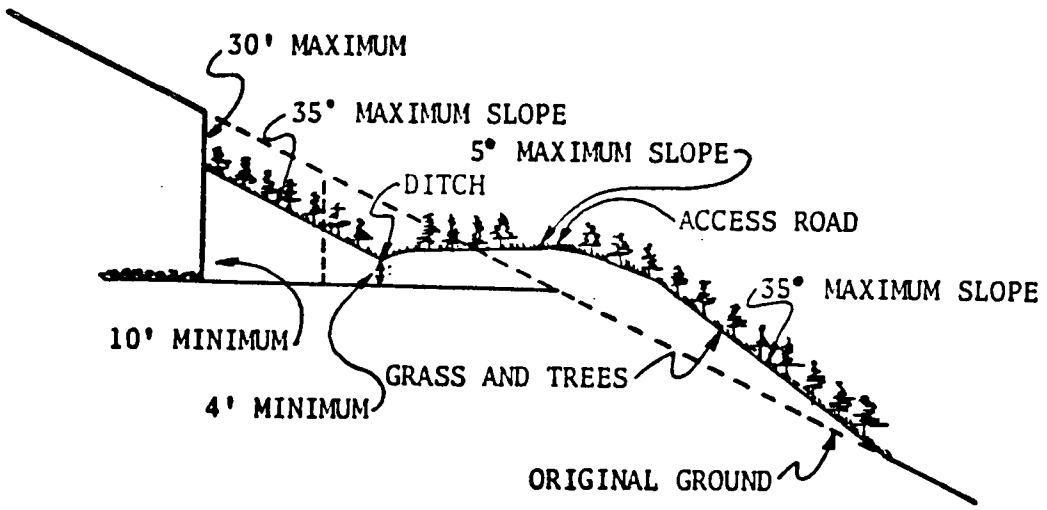


Figure 21. Tennessee strip mine regulations, I.

Source: Tennessee Department of Conservation, Regulations Pertaining to Surface Mining, Regulation 11.23 (a) and (b).

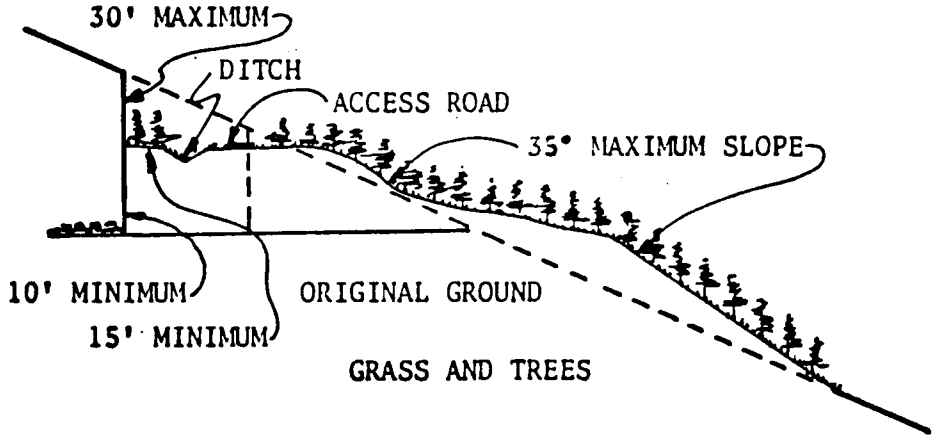


Figure 22. Tennessee strip mine regulations, II.

Source: Tennessee Department of Conservation, Regulations Pertaining to Surface Mining, Regulation 11.23 (a) and (b).

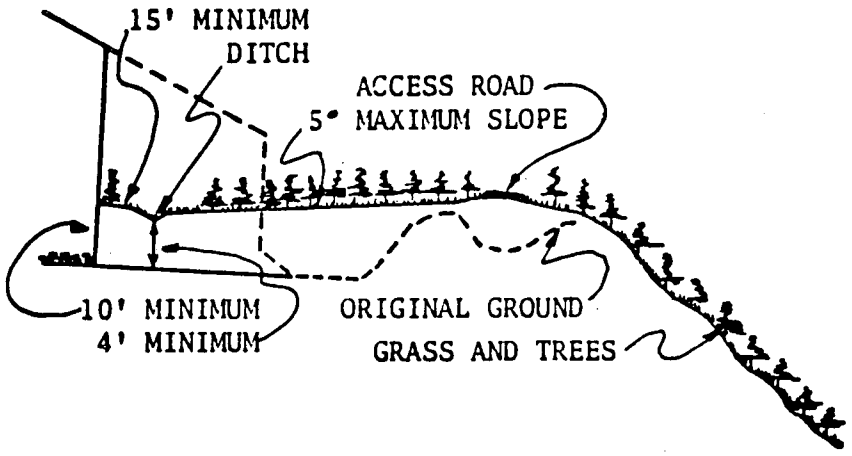


Figure 23. Tennessee strip mine regulations, III.

Source: Tennessee Department of Conservation, Regulations Pertaining to Surface Mining, Regulation 11.23 (a) and (b).

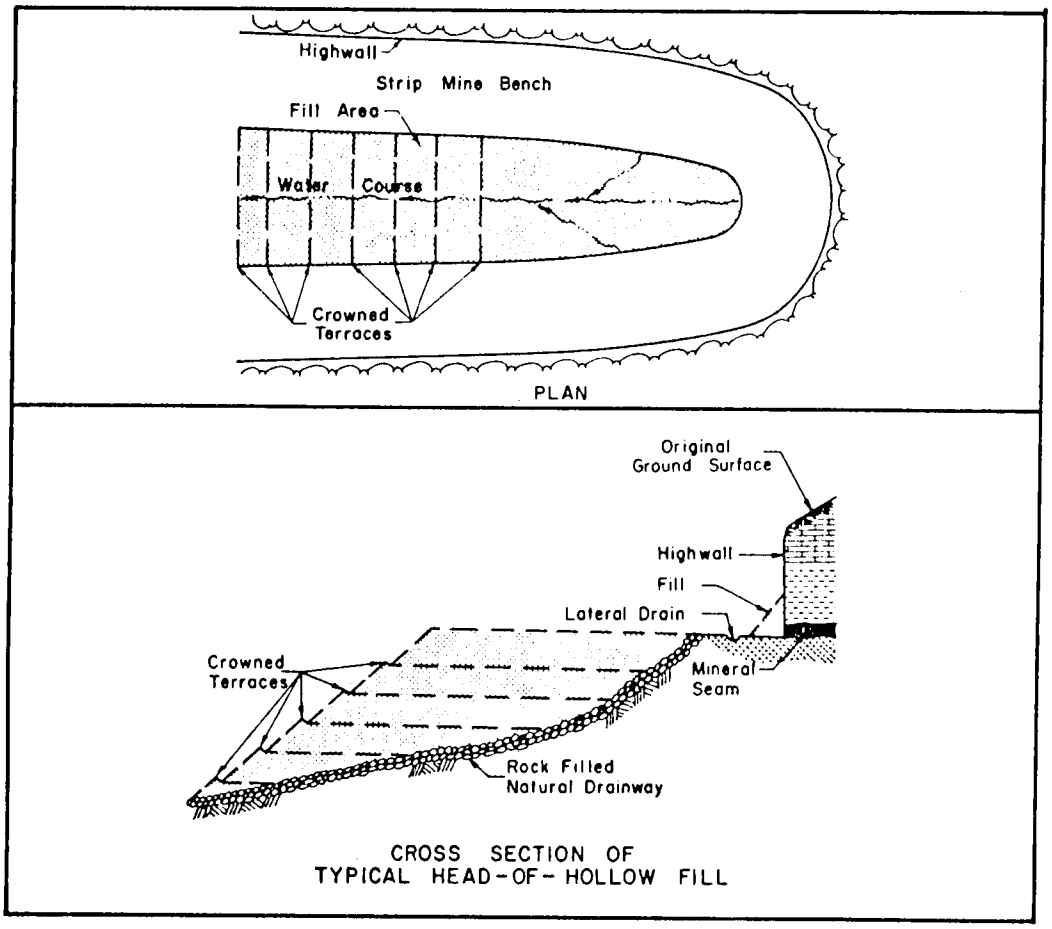


Figure 24. Head-of-hollow fill.

Source: Surface Mining . . . A Changing Industry (Charleston, West Virginia: West Virginia Surface Mining and Reclamation Association, n.d.), p. 19.

Note: The head-of-hollow or valley fill is utilized by mine operators for disposal of excess spoil material. As the diagrams shown, the basic idea is to deposit the material into the valley in a well-constructed fill, that will not be subject to sliding. Most of these fills utilize a rock core that allows for proper drainage and stabilization.

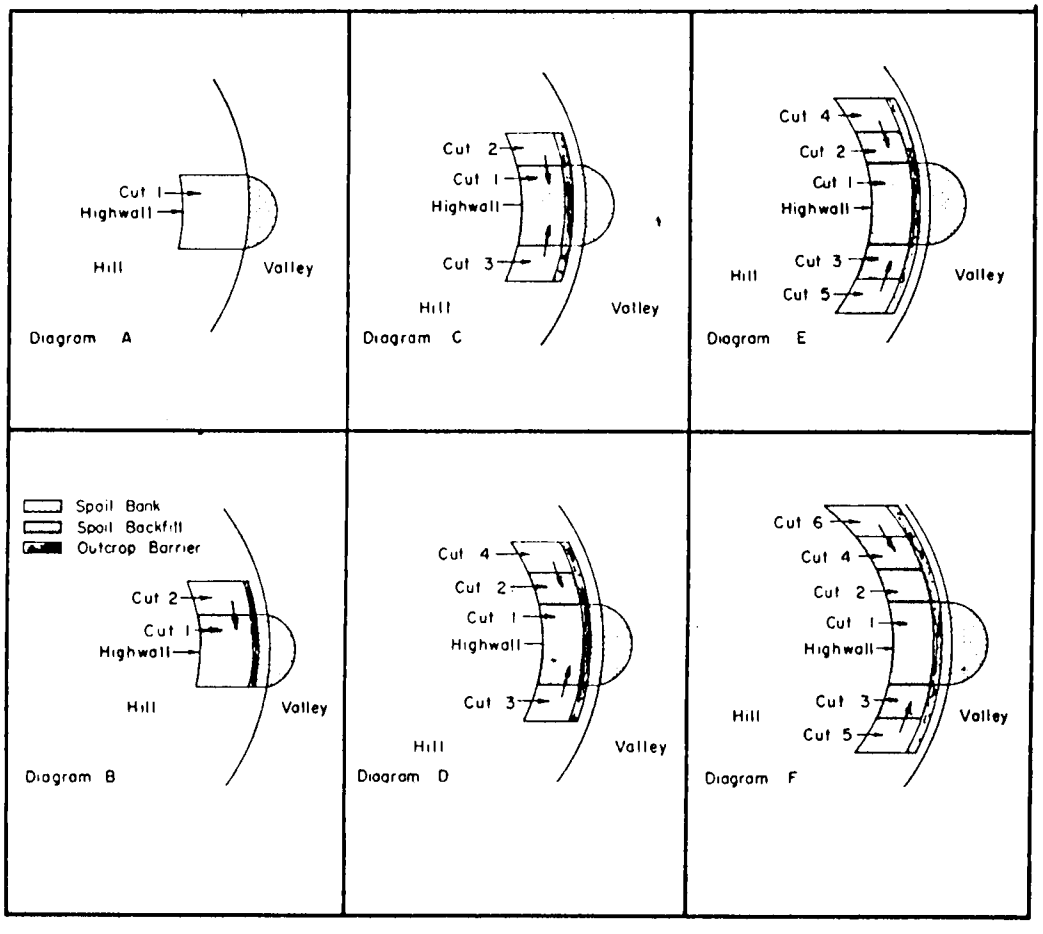


Figure 25. Modified block cut.

Source: Surface Mining . . . A Changing Industry (Charleston, West Virginia: West Virginia Surface Mining and Reclamation Association, n.d.), p. 18.

Note: The block cut method of surface mining has been in use for many years. It simply involves placement of the overburden around a box shaped cut. Following coal removal, the spoil is pushed back into the pit to make way for the second block cut. The modified block cut simply involves pushing the overburden with dozers and has been adapted to steep slope areas.

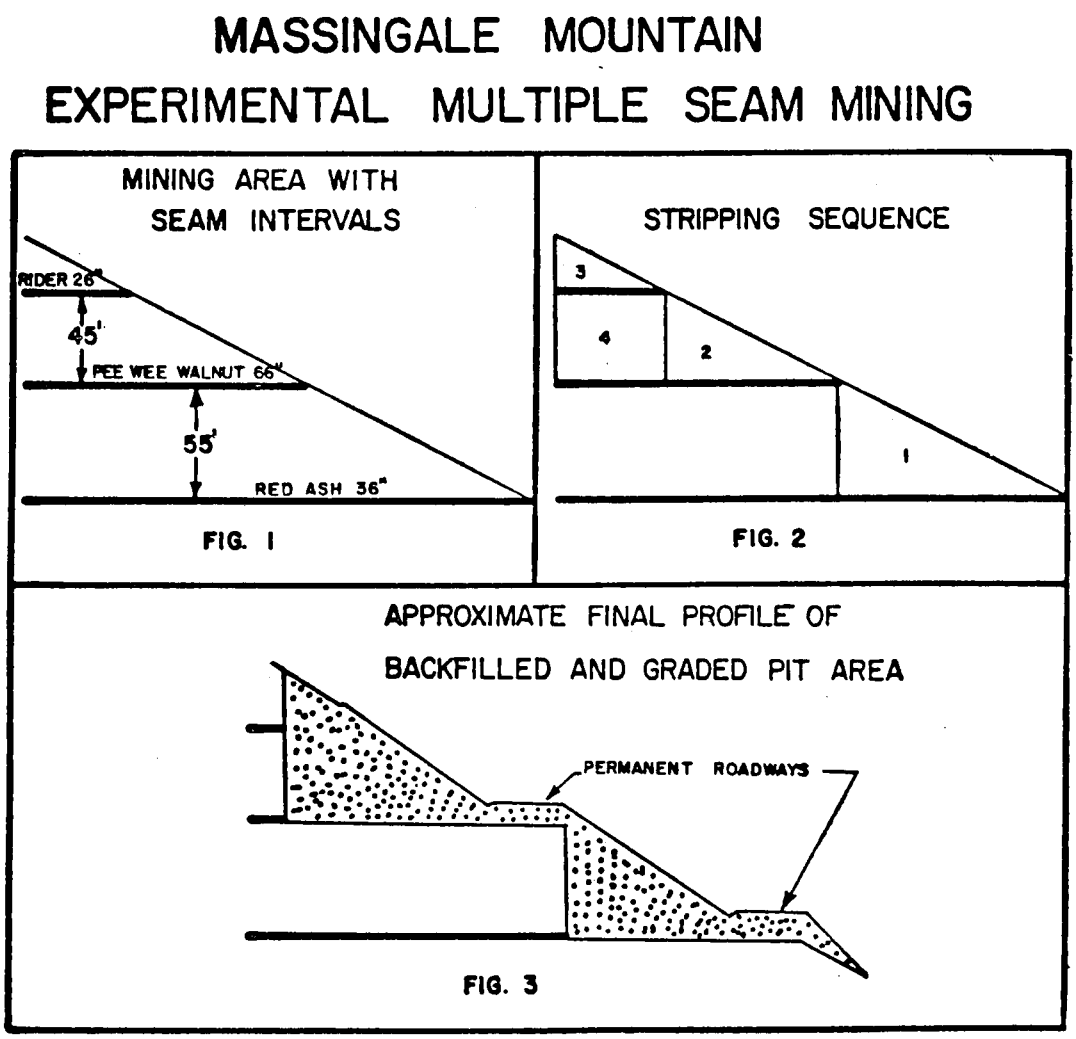


Figure 26. Experimental multiple seam mining.

Source: Surface Mining . . . A Changing Industry (Charleston, West Virginia: West Virginia Surface Mining and Reclamation Association, n.d.), p. 18.

Note: The experimental multiple seam mining project being conducted by the Tennessee Valley Authority has proven that this type mining can be conducted on steep slopes, without causing long-range damage to the environment. This triple seam project has achieved elimination of both the highwall and spoil pile on each seam. The equipment used for mining and reclamation on this complicated project included three front-end loaders, two large dozers, one vertical highway drill, one auger and three dump trucks.

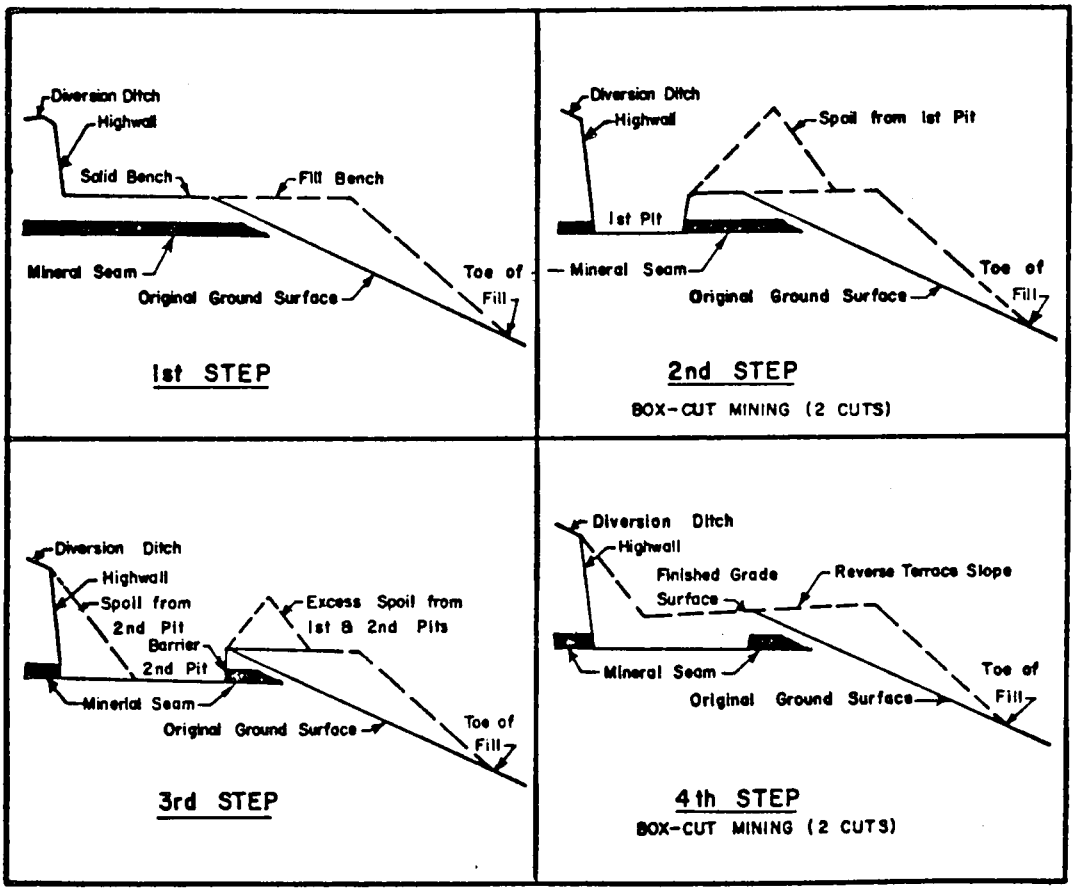


Figure 27. Box-cut mining (2 cuts).

Source: Surface Mining. . . A Changing Industry (Charleston, West Virginia: West Virginia Surface Mining and Reclamation Association, n.d.), p. 19.

Note: This sequence of drawings depicts the intricate phases of box-cut mining in two cuts. First the overburden is removed down to the solid bench and placed on the downslope. The first pit is then cut into the coal seam with overburden being maintained partially on the bench and fill bench. Following coal removal, the second cut is made, with that material being placed against the highwall. The fourth step mirrors the final product after regrading.

VITA

James Edward Rowe was born in Easton, Pennsylvania, on September 28, 1946. He attended the Belvidere, New Jersey, public schools and was graduated from Belvidere High School in 1965. The following fall, he entered Appalachian State University, and on June 6, 1969, he received a Bachelor of Science degree in Geography-Geology. He served two years in the U. S. Army as a Combat Engineer. Upon his honorable discharge, he taught in the public schools in two New Jersey cities. While teaching, he enrolled in Trenton State College. He received a Master of Arts degree in Social Studies Education from Trenton State College on May 23, 1973.

He entered the Graduate School of Planning at The University of Tennessee in September 1974, and will receive a Master of Science Degree in Planning. He is a member of the American Institute of Planners (Associate Member), the American Society of Planning Officials, and the Association of American Geographers.

He is presently employed by the Mount Rogers Planning District Commission in Marion, Virginia, as a Community Development Planner. He is married to the former Clara Anita Pepper and they have a daughter, Lisa.