II. GEOLOGY

A. PHYSIOGRAPHY

The project area lies within the Appalachian Mountain Section of the Valley and Ridge physiographic province, (Plate No.1). The land form here consists of a series of northeastwardly trending parallel valleys and ridges cut through in numerous places by streams.

This area lies in the southern Pocono Mountains, in the southwest section of Pennsylvania's Southern Anthracite Field. This Southern Field is one of four fields in eastern Pennsylvania which contain coals of anthracite rank.

There are four towns in the study area. Newtown is located on the extreme easterly border, Tremont and Donaldson are near the center and Good Spring is located on the extreme westerly border.

B. TOPOGRAPHY AND DRAINAGE

Topography in the area is dominated by Broad Mountain trending Northeast - Southwest which marks the northern limit of our study area. Relief can be considered to be moderate to high, being on the order of 835 feet. Our Sampling Station GS-61, located south of the Borough of Tremont, lies at Elevation 750±, while Sampling Station MC-1, located at the headwaters of Middle Creek in the "Otto" strip pit lies at Elevation 1610±.

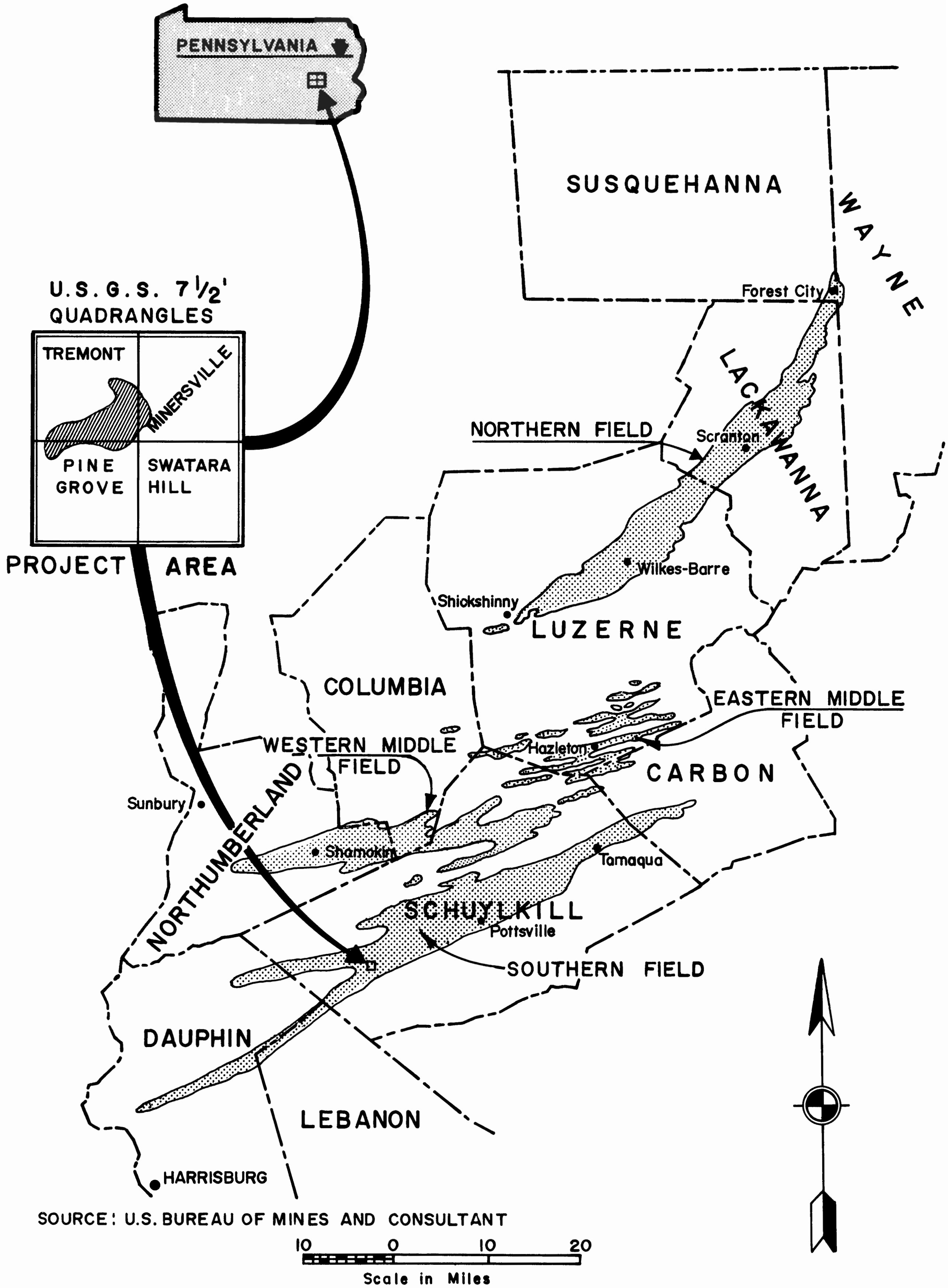
Topography in the area between Donaldson and Good Spring is rather uniform; the low valley represents the axis of the Donaldson Syncline. The area to the north, consisting of the southern slopes of Broad Mountain, rises rather sharply to an elevation of about 1500. To the south the ridge line is somewhat lower and less well defined.

North and east of Tremont the topography is more rugged with a number of small valleys whose origin and location have no doubt been influenced by the rather complex fault system through this area.

Approximately one-third of the surface area has been disturbed by mining. This obviously has drastically altered the original topography and surface-subsurface drainage systems.

Drainage within the study area is provided by Good Spring Creek, originating near the Village of Good Spring and flowing east toward Tremont, and by Middle Creek which originates above the Otto strippings approximately 3.3 miles northwest of Newtown.

ANTHRACITE FIELDS OF NORTHEASTERN PENNSYLVANIA



SOURCE: U.S. BUREAU OF MINES AND CONSULTANT

Good Spring Creek is supplemented by moderate flows from Martins Run and Bailey Run, both near Donaldson, while Coal Run and Gebhard Run contribute considerably to the flow of Middle Creek on the eastern end of the project.

Good Spring Creek, carrying the entire effluent from our study area, joins Swatara Creek approximately one-half mile from the southern boundary of the Borough of Tremont, ultimately discharging into the Susquehanna River near Middletown, Good Spring Creek has two small tributaries, Poplar Creek and Hollenbach Run.

C. STRATIGRAPHY

The youngest naturally occurring deposits in the area consist of Quaternary talus located on the upper slopes of many of the mountains.

Rocks in the study area are of Pennsylvanian Age with the exception of one small area where the older Mississippian Age rocks are encountered.

Pennsylvanian Age rocks consist of materials of the Llewellyn Formation and of the Sharp Mountain, Schuylkill and Tumbling Run members of the Pottsville Formation in stratigraphic order, as shown on the Generalized Stratigraphic Section, Plate No.2.

Mississippian Age rocks are encountered in one small area on an upper reach of Middle Creek, in the vicinity of the intersection of Interstate 81 and Route 25, north of Newtown. These rocks, the Mauch Chunk Formation, generally underlie the area to the north of our study area, on the north slopes of Broad Mountain and in the "Hegins" or "Tri-" Valley as it is known locally. There are no coal measures present below the Mauch Chunk Red Shale.

The Llewellyn Formation, named in 1962 for the town of Llewellyn east of Newtown, comprises those rocks previously referred to as the Allegheny and Conemaugh Formations and, more informally, the "Coal Measures" or "post-Pottsville" rocks. These rocks are composed of shale, siltstone, quartzitic and conglomeratic sandstones, quartz-pebble conglomerate and coals.

The Pottsville Formation is composed chiefly of conglomerate, sandstone, siltstone, shale and coals.

The Geologic Map, Plate No.3, contains the lithology of materials comprising the various Members and Formations previously mentioned.

Approximately 60 coal beds are known to exist in the Pottsville and Llewellyn Formations and 25 of these coal beds are present at one point or another within the limits of the study area.

These coal beds have similar physical as well as chemical characteristics and are therefore quite difficult to correlate.

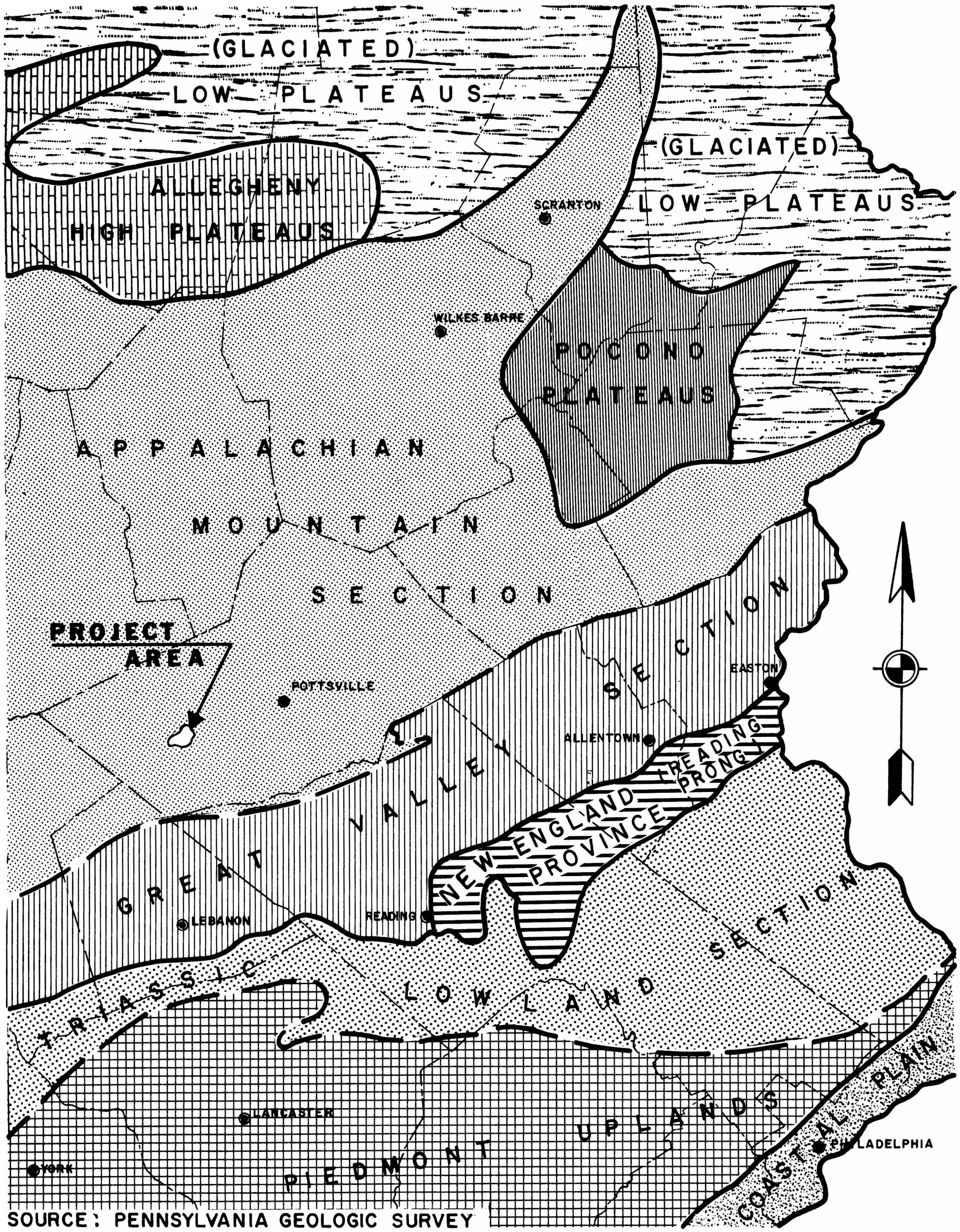
The economically more important coals present in the study area are listed in stratigraphic order. Average thickness of beds was established by U.S.G.S. measurement.

No.	Name		Average Thickness (Feet)
18	Peach Mountain		8.0
16	Tracy		7.8
14	Diamond		6.9
12	Orchard		6.8
11	Primrose		10.0
10	Holmes		8.9
9	Top Split)		8.3
8-1/2	Middle Split)	Mammoth	8.7
8	Bottom Split)		8.2
7	Skidmore		7.0
6	Seven Foot		5.2
5	Buck Mountain		6.9
4	Little Buck Mountain		7.0
Scotty #3			10.9
Lykens Valley #2			9.2
Lykens Valley #4			4.4
Lykens Valley #5			9.3

Coal beds in the Pottsville Formation have floor rocks consisting mainly of shale and siltstone with roof rocks usually consisting of sandstone and conglomerate.

The roof and floor rocks of the coal beds in the LlewellynFormation are mainly shale and siltstone; however, in certain areas they consist of sandstone and conglomerate.

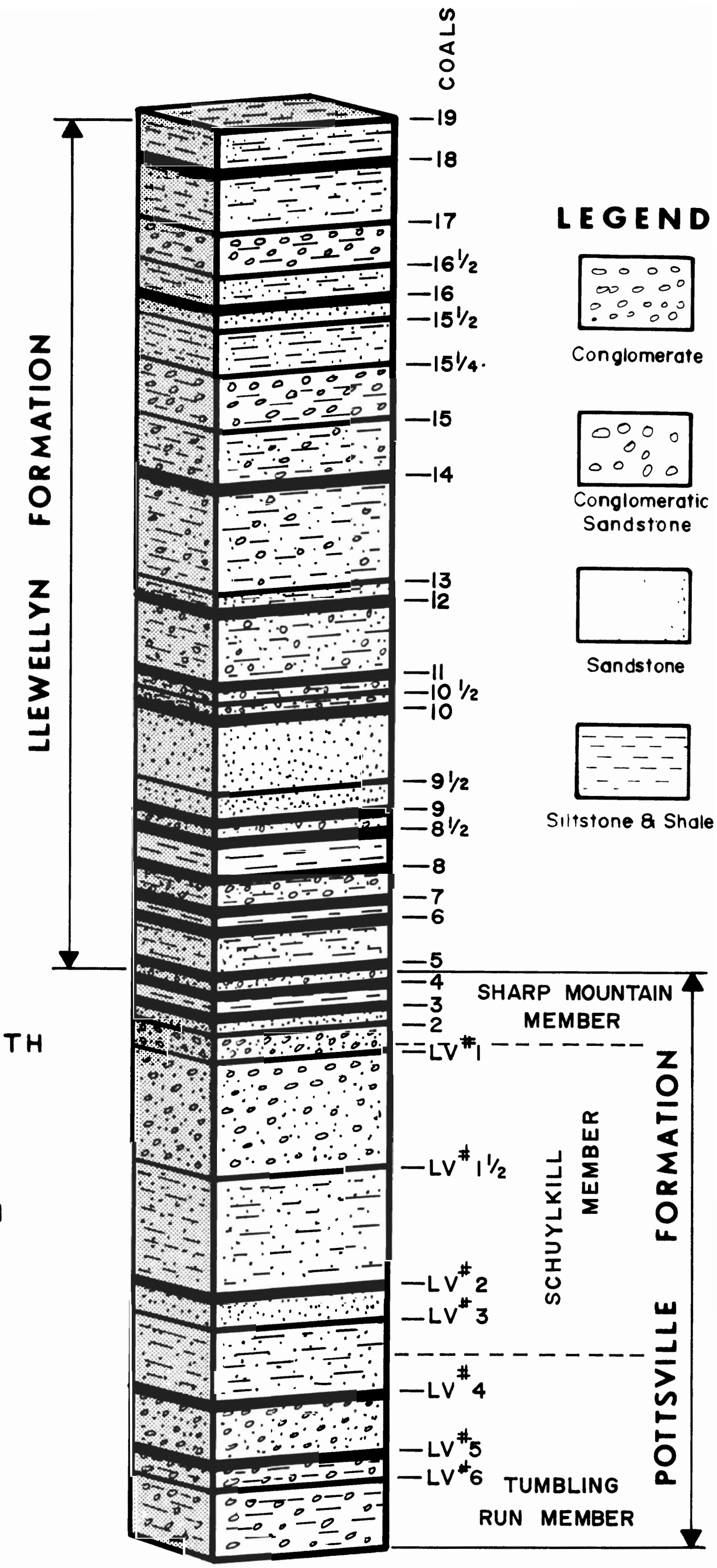
The U.S.G.S. reports that the sulfur content of coals in this area ranges from about 0.5 percent to 2.0 percent, averaging about 0.7 percent.



PHYSIOGRAPHIC PROVINCES OF EASTERN PENNSYLVANIA

PLATE NO. I

No.	NAME (COALS)	
19	TUNNEL	
18	PEACH MOUNTAIN	
17	LITTLE TRACY	
16-1/2	UPPER FOUR FOOT	
16	TRACY	
15-1/2	LITTLE CLINTON	
15-1/4	CLINTON	
15	LITTLE DIAMOND	
14	DIAMOND	
13	LITTLE ORCHARD	
12	ORCHARD	
11	PRIMROSE	
10-1/2	ROUGH	
10	HOLMES	
9-1/2	FOUR FOOT	
9	TOP SPLIT	MAMMOTH
8-1/2	MIDDLE SPLIT	MAMMOTH
8	BOTTOM SPLIT	MAMMOTH
7	SKIDMORE	
6	SEVEN FOOT	
5	BUCK MOUNTAIN	
4	LITTLE BUCK MOUNTAIN	
3	SCOTTY STEEL #3	
2	SCOTTY STEEL #2	
LV1	LYKENS VALLEY # 1	
LV1-1/2	LYKENS VALLEY # 1-1/2	
LV2	LYKENS VALLEY # 2	
LV3	LYKENS VALLEY # 3	
LV4	LYKENS VALLEY # 4	
LV5	LYKENS VALLEY # 5	
LV6	LYKENS VALLEY # 6	



SOURCE: U.S. GEOLOGICAL SURVEY AND CONSULTANT

GENERALIZED STRATIGRAPHIC SECTION

PLATE NO. 2

D. STRUCTURE

The geologic structure in the area is rather complex consisting of a series of generally asymmetrical northeast-southwest striking anticlines and synclines whose structure is modified by a series of faults. M of these individual structural features, appearing as somewhat separated to the west-southwest, converge in the area near Tremont. The synclinal axes branch out from Tremont toward the west and southwest, resembling the tail of a fish, and collectively form the most important structural feature in the area which is known as the Minersville Synclinorium. These synclinal troughs are referred to informally as the "Northern and Southern fishtails", and are separated by the Joliet Anticline which is the crestal fold of the New Bloomfield Anticlinorium and the most significant anticlinal structure in the area.

The North Trough, or "Northern Fishtail" trends s 80° W from Tremont to the west border of the area near Lykens. The South Trough, or "Southern Fishtail", trends S 50° - 60° W from near Tremont,

The more important anticlinal and synclinal structures are discussed individually as follows:

1. Anticlinal Structures

The Joliet Anticline, mentioned previously, trends N 55° - 77° E terminating in the southeast corner of the Tremont quadrangle. The amplitude on the base of the Pottsville Formation is reported as ranging from 0 feet near Tremont to 12,000± feet outside our study area. The dips of both limbs range from 1° to 70°, averaging about 30°. The anticline plunges northeastward at 9^0 to 16°. The nearest crested exposure is in the Valley of Lower Rausch Creek.

The Big Lick Mountain Anticline trends N 60° - 75° E terminating in the high angle Newtown reverse fault in the south-central part of the Minersville quadrangle. Between Tremont and Donaldson and near Newtown the north limb is overturned. The dips of the overturned north limb range from 75° N to 80° S while the dips of the upright south limb range from 50° - 60° S. Strongly asymmetrical to the north, it plunges to the east-northeast and has an amplitude averaging 1000± feet on the Primrose (No.11) Coal bed.

The West West Falls Anticline trends N 80° - 85° E appearing in our study area near the headwaters of Middle Creek, In this area the anticline divides into a more complicated anticlinal - synclinal structure ultimately becoming a part of the complexly folded north limb of the Minersville synclinorium. The fold is asymmetric and the dips of the limbs range from about 1^0 to 80°, averaging near 45°.

Amplitude of the anticline on the base of the Mauch Chunk Formation is reported to range from 0 to 6,000 feet, averaging about 3,500 feet.

2. Synclinal Structures

The Tremont cline trends N 75^0 - 85° E and its limbs dip from 8° to 80^0, averaging about 60°. The fold plunges eastward at about 3° to 5°, and the amplitude ranges from 0 feet to 5,000 feet, averaging about 2,500 feet,

This syncline is the southernmost syncline in the coal field whose south limb is not overturned.

The Donaldson Syncline trends N 65^0 to east-west and is the north trough or "fishtail' of the Minersville Synclinorium through the western part of our study area. The south limb is overturned near Donaldson and at other locations outside the study area. Dips on the north limb range from 10^0 to 70°, averaging 45°; dips on the south limb range from about 5^0 N to 57° S overturned.

Amplitude is on the order of 4,000 feet to 7,800 feet from near Lykens to Donaldson, then decreases rapidly to less than 1000 feet to the east of our study area.

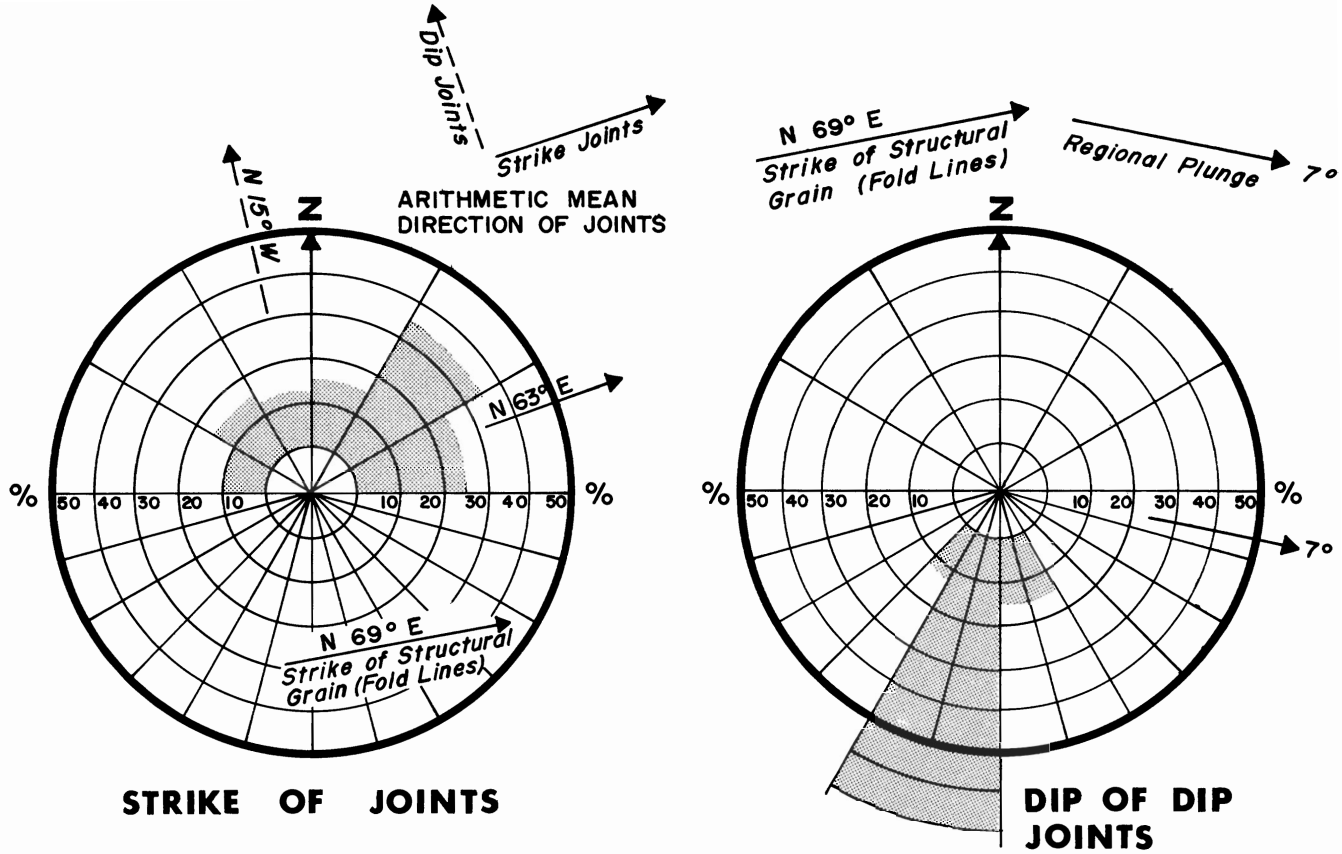
The Fisher Syncline trends N 70°± E and is known as the "Fisher in" in the area. A cross section developed along the No.2 Tunnel at the Indian Head Colliery, Plate No.8, indicates that the syncline is overturned in the Mammoth workings and that both limbs dip about 40° S.

3. Faults

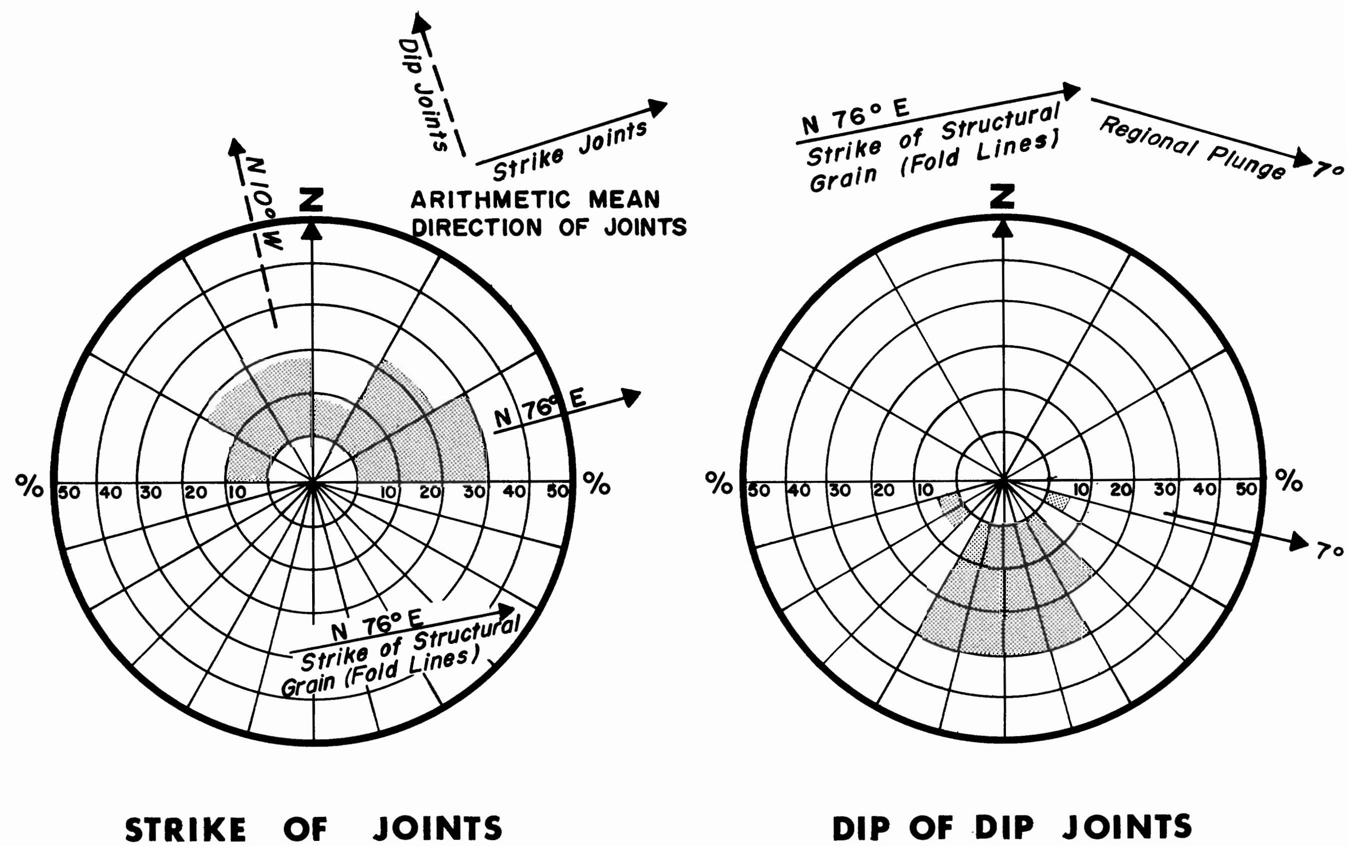
Numerous faults of various kinds have had a significant effect on the anthracite mining industry. The fault system in the study area is dominated by a series of thrust faults. Other types of faults are present in various localities, however their effect has generally been less significant.

Folding and faulting has increased the amount of coal available since the anthracite coal beds probably would have been eroded had they not been protected in the large synclinal basins which now contain the anthracite fields.

The most significant faults within the study area are the Pottchunk fault and the Mine Hill fault complex, a Mine Hill fault complex consists of a single fracture at some locations and at other locations appears as closely spaced interlaced branches.



EASTERN PART



SOURCE: U.S. GEOLOGICAL SURVEY

WESTERN PART

JOINT ROSETTES - TREMONT QUADRANGLE

PLATE NO. 4

The fault bundle, or group of faults making up the Mine Hill complex, is comprised from the base up of the Lower Mine Hill, Hentzes, Middle Mine Hill, and Upper Mine Hill faults.

The Pottchunk fault and the Upper Mine Hill fault enter the project area from the southwest on the south limb of the West West Falls anticline. At a point approximately mid-way between the Villages of Good Spring and Donaldson, on the north slope of Broad mountain, the Pottchunk fault branches into the Middle Mine Hill, the Hentzes, and the Lower Mine Hill faults.

This fault complex, trending northeast, approximates the crest of Broad Mountain, skirting the Fisher "Basin" to the north. It then turns northward crossing the complex crestal folds of the West West Falls anticline approximately one-half mile east of the point where Pennsylvania Route 25 crosses the upper reaches of Middle Creek.

Most of these fault systems, although not readily visible at the surface, have had very significant effects on topography, structural competence, stratigraphy, and surface/sub-surface drainage.

The industry has benefited from the results of these structural disturbances which have provided the duplication of thick economically important anthracite beds at or near the surface.

Folding and faulting has also had many adverse effects on the mining industry. Large faults have macerated some of the desirable coals and have displaced some of the beds to such an extent that their subsurface location is open to speculation. Probably the most adverse effect has been to bury vast reserves in synclinal troughs too deep to be mined using present day methods.

4. Jointing

Joint systems in the sub-surface rocks have a marked effect on their structural competence and their ability to accept and transport ground water. The rocks in o study area have developed such systems which apparently have been greatly affected by the folding which resulted in the basic ridge and valley type topography. The orientation of the joints do not seem to have been noticeably affected by their proximity to the thrust faults.

In this region the fact that the strike joints are exactly parallel to the structural grain (fold lines) and that the dip joints are exactly perpendicular to it is indication that both types were formed by orogenic processes associated with the structural grain, A jointed structure increases the potential retention capacity and permeability of a given aquifer, as wellhaving the capability to alter the flow routes of ground water, joint rosettes illustrated on Plate No, graphically depict the occurrence of the major joint systems in this area.

III. MINING

A. HISTORY OF AREA MINING

The earliest records indicate that anthracite was used prior to 1755, however it was not until 1808 that it was fired in a furnace. Judge Jesse Fell, of Wilkes-Barre, discovered that anthracite could be burned with a forced draught, on a grate of his own invention. Difficulty in igniting anthracite hindered its early use as a fuel. There is no positive record of who discovered anthracite in the Southern Field, but its presence is noted on Schul's map of 1770.The first important discovery of anthracite in the Southern Field was by Necho Allen, a hunter.

In the next decade anthracite began to be used in the forges of the blacksmiths in Pottsville. William Morris, of Pottsville, is credited with introducing anthracite to other areas. In 1800 he took a wagonload of it to Philadelphia, but no one would buy it from him! Further development of uses of anthracite and the improvement of systems of transport led to the rapid expansion of the industry after about 1825.

Expansion of the industry led to increased land values, the development of a system of canals and later railroads, and the expansion of the steel industry which to that time had been dependent upon bituminous coal imported from Great Britain.

The Schuylkill Canal followed the Schuylkill River and was entirely completed in 1825 from Port Carbon to Philadelphia. Its chief use was in hauling coal from the Southern Field to Philadelphia with first shipments occurring as early as 1814.

The Union Canal, completed in 1827, extended from Reading on the Schuylkill River to Middletown and followed two streams - Tulpehocken Creek and Swatara Creek. A tunnel and lock system near Lebanon joined the two streams at this point where they are only six miles apart. A branch canal, completed in 1830, extended from the Water Works near Lebanon to Pine Grove.

The Schuylkill Canal eventually became the property of the Philadelphia and Reading Railroad and later was abandoned when the railroads assumed the major task of hauling anthracite to eastern markets. However, thousands of tons of coal were hauled prior to this by the canals. Many small railroads existed in the region. The Mine Hill & Schuylkill Haven Railroad extended from Schuylkill Haven, on the canal, to the collieries on the north and south of Broad Mountain. The Philadelphia and Reading Railroad Company built a railroad between the same two cities, completed in 1972. By acquisition of the Mount Carbon Railroad the company's line was extended to Pottsville.

In the Southern Field most of the large mining companies, having come into existence during the period of 1825-75, continued to operate until the 1930's and some of these large mine companies continued to operate until the mid 1960's.

During this period, Pennsylvania Anthracite provided the chief fuel for the United States. Production in the Southern Field during the period from 1769 - 1960 has been estimated at about 755 million net tons.

Available records indicate that the production of anthracite for the entire anthracite region reached a peak of approximately 100 million net tons per year in 1917. A general strike of anthracite workers in 1926 so crippled the industry, through loss of markets, that a gradual decline of coal production commenced including the abandonment of many collieries. After declining to approximately 46 million net tons in 1938, the advent of World War II marked an increase in production to 55± - 64± million net tons/year during the period of 1942-1948. Following the war years production steadily decreased to a reported 10+ million net tons in 1969. Production in 1970, reflecting a continued decrease, was reported to be 9.25 million net tons.

The general project area has been extensively mined using both the deep (underground) method and the stripping (surface) method.

1. Deep Mining

The above ground evidence of a large colliery plant was a breaker which segregated coal, rock, slate and other matter. The earlier breakers were "dry" breakers which did not employ water in cleaning coal. In 1913 there were approximately 300 coal breakers in the anthracite region.

Four types of entries to the deep mines were used, depending on the terrain and dip of the coal veins. These were tunnels, slopes, drifts and shafts. Tunnels were nearly horizontal penetrations through rock and coal to the mineable coal veins, and served as passageways for men and coal, as well as for drainage purposes. Tunnels were usually at or near the base of a mountain and were sometimes as much as 2,000 feet in length. In the workings below this point, pumping of water was required.

Slopes were inclined openings extending downward at an angle of $_{450}$ or more to a fixed landing point.

Drift mines were driven directly into the coal veins where the coal outcropped, and extended upward at a slight angle to facilitate drainage. Shafts were vertical entries used when the desired point was too deep for tunnel or slope. Gangways were driven horizontally in the coal veins in the mine development and were used as haulage ways.

Two methods of deep mining, the room and pillar and the chute, have been used in this area. In the larger mines the room and pillar method was used where the dip of the coal beds was less than about 20^0, and the chute method where the dip exceeded 20^0±. In both methods the rooms are driven parallel to each other and coal is removed leaving pillars or ribs in place to support the roof. Considerable timbering was usually necessary to provide roof support.

This stage was usually referred to as "first mining", wherein approximately 50 percent of the coals were removed. Where the roof was capable of being adequately supported by timbers, or could be induced to collapse at a controlled distance from a pillar, sometimes pillar coal was removed.

During the "second stage", or "robbing", the pillars were usually partly or completely removed which resulted in the removal of approximately 10 percent to 20 percent additional coal, and in a maximum extraction of approximately 60 percent to 70 percent. This stage resulted in the maximum profit since most <u>mine</u> development had already been completed. Sometimes when the fire boss could be persuaded, the difficult coal to extract near the top of the chutes was not taken. In this case sometimes "third" mining was employed, although this stage has no official or legitimate recognition.

In most cases the roof could not be supported adequately by timbering and sagged after the removal of part of each pillar, whereupon mining was discontinued.

2. <u>Anthracite Strip</u> <u>Mining,</u>

"Anthracite" strip mining is normally somewhat different from "area" and "contour" strip mining employed in "Bituminous" strip mining. In "area" strip mining a trough or box-like cut is made through the overburden to expose the coal seam. This cut <u>may</u> extend to the property line or to the limits of the coal seam. As each succeeding parallel cut is made the spoil from it is deposited in the cut previously completed. The last cut leaves an open trench equal in depth to the thickness of overburden plus the thickness of the coal, bounded on one side by a recently deposited spoil material and on the other by an undisturbed highwall.

"Contour" strip mining consists of removing hillside overburden above the cropline, proceeding along the hillside. After exposure and removal of the coal bed additional cuts are made into and along the hillside until the height of the highwall (ratio of overburden to coal) renders the operation impractical or uneconomical. This type operation leaves a bench on the hillside which normally coincides with the topographic contour.

"Anthracite" strip mining is normally conducted on hillsides where the crop lines parallel the mountain crest. Although the surface slopes are usually moderate the coal beds often dip steeply, sometimes to zero degrees. In "Anthracite" strip mining also, the depth of extraction is controlled by the economic limit and/or the capability of the mining equipment being used. Stripped beds are much thicker than those in the bituminous fields and, since the beds tend to "stand on edge" on the synclinal flanks, can be mined economically to much greater depths.

Depending upon the geologic setting the anthracite strip pits may resemble open pits or quarries or may appear as long, narrow canyons with steeply dipping sides. Because of the varying dips and spacing of the outcrops of the mineable coal beds the methods employed in this type of mining may not be classified as either "area" or "contour" mining but rather a combination of both.

No strip mining was conducted in the study area between 1967, when the area near the headwaters of Middle Creek was completed, and 1970 when stripping operations in a limited area south of Good Spring were started. Generalized cross sections showing the coal beds at three locations within the study area are presented on Plate Nos. 6 through 8.

B. EXTENT AND CONDITION OF MINE WORKINGS

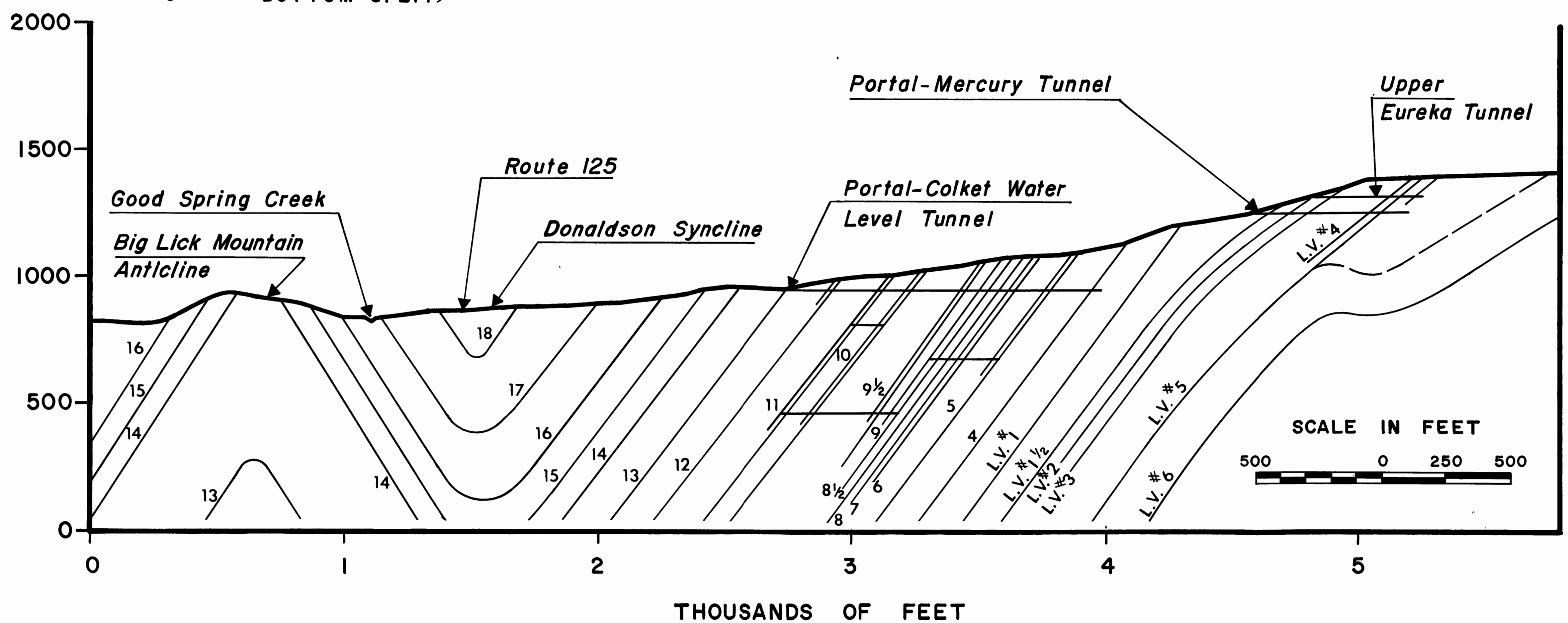
Numerous underground mines have been operated in this area for at least the past 125 years and much of the coal outcropping above these underground mines has been stripped. It is estimated that 32 percent of the study area surface has been disturbed by mining.

No.	NAME (COALS)
18	PEACH MOUNTAIN
17	LITTLE TRACY
16-1/2	UPPER FOUR FOOT
16	TRACY
15-1/2	LITTLE CLINTON
15-1/4	CLINTON
15	LITTLE DIAMOND
14	DIAMOND
13	LITTLE ORCHARD
12	ORCHARD
11	PRIMROSE
10-1/2	ROUGH
10	HOLMES
9-1/2	FOUR FOOT
9	TOP SPLIT } MAMMOTH
8-1/2	MIDDLE SPLIT } MAMMOTH
8	BOTTOM SPLIT } MAMMOTH

No.	NAME (COALS)
7	SKIDMORE
6	SEVEN FOOT
5	BUCK MOUNTAIN
4	LITTLE BUCK MOUNTAIN
3	SCOTTY STEEL #3
2	SCOTTY STEEL #2
LV1	LYKENS VALLEY # 1
LV1-1/2	LYKENS VALLEY # 1-1/2
LV2	LYKENS VALLEY # 2
LV3	LYKENS VALLEY # 3
LV4	LYKENS VALLEY # 4
LV5	LYKENS VALLEY # 5
LV6	LYKENS VALLEY # 6

N

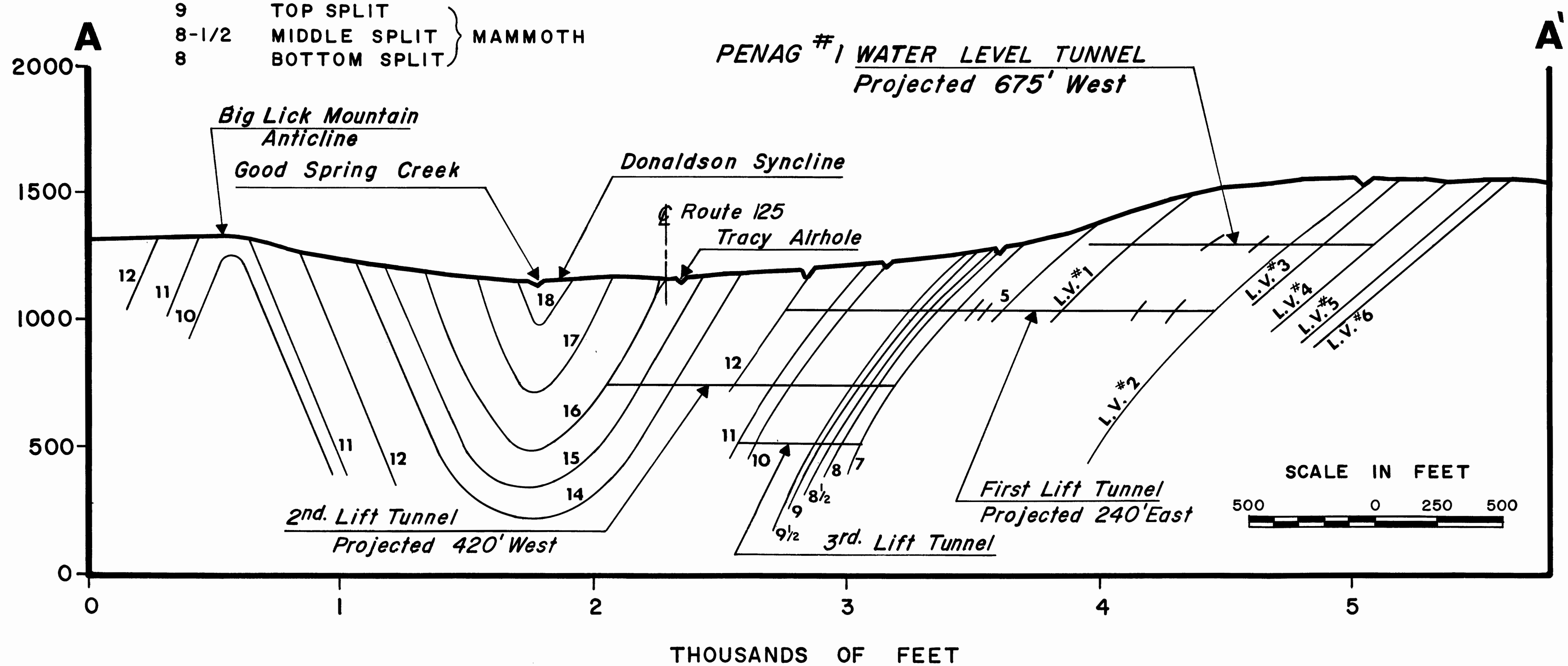
B B′



CROSS SECTION-COAL BEDS NEAR COLKET WATER LEVEL TUNNEL

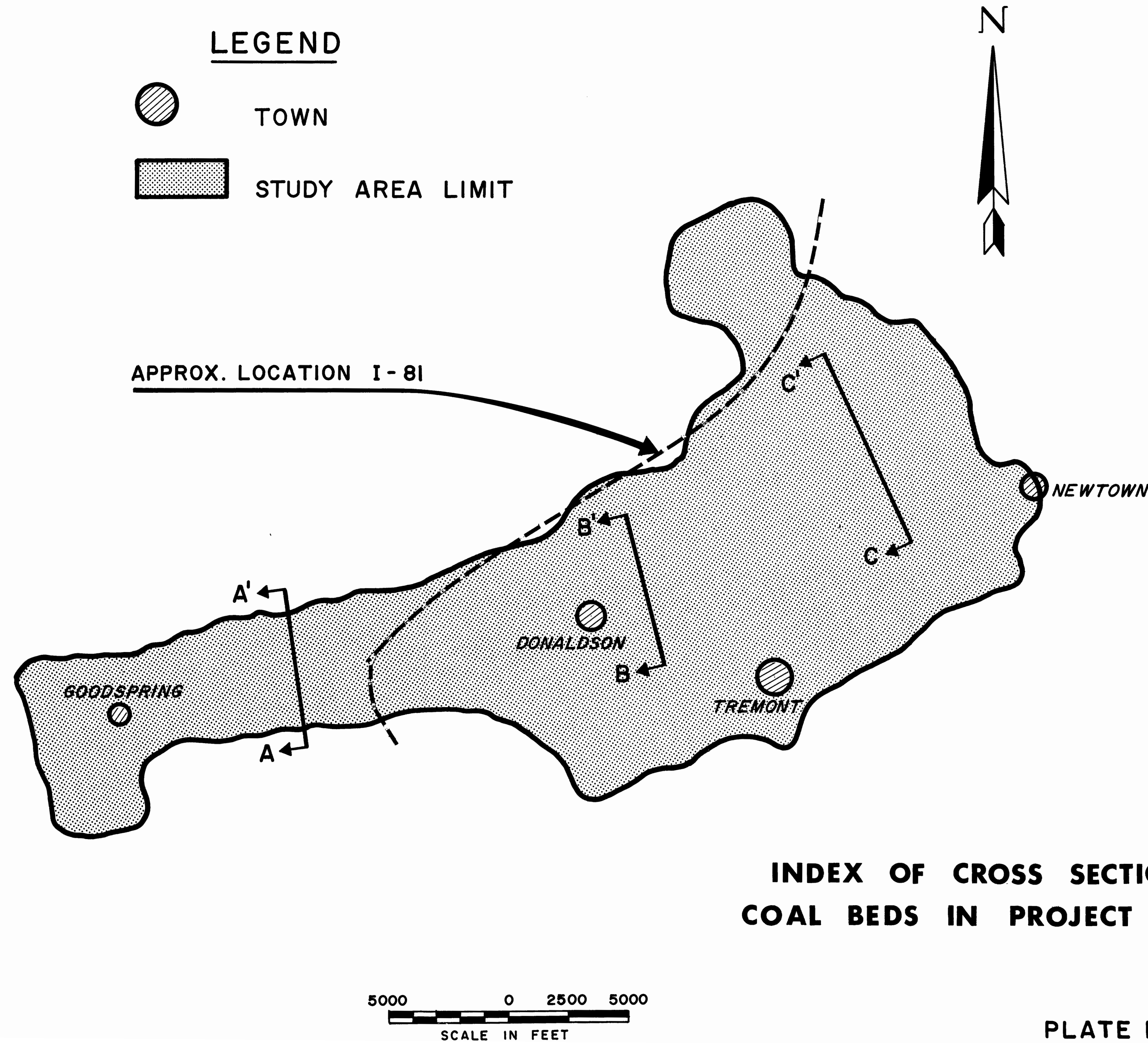
PLATE NO. 7

No.	NAME (COALS)		No.	NAME (COALS)
18	PEACH MOUNTAIN		7	SKIDMORE
17	LITTLE TRACY		6	SEVEN FOOT
16-1/2	UPPER FOUR FOOT		5	BUCK MOUNTAIN
16	TRACY		4	LITTLE BUCK MOUNTAIN
15-1/2	LITTLE CLINTON		3	SCOTTY STEEL #3
15-1/4	CLINTON		2	SCOTTY STEEL #2
15	LITTLE DIAMOND		LV1	LYKENS VALLEY # 1
14	DIAMOND		LV2	LYKENS VALLEY # 2
13	LITTLE ORCHARD		LV3	LYKENS VALLEY # 3
12	ORCHARD		LV4	LYKENS VALLEY # 4
11	PRIMROSE		LV5	LYKENS VALLEY # 5
10-1/2	ROUGH		LV6	LYKENS VALLEY # 6
10	HOLMES			
9-1/2	FOUR FOOT			
9	TOP SPLIT	MAMMOTH		
8-1/2	MIDDLE SPLIT	MAMMOTH		
8	BOTTOM SPLIT	MAMMOTH		



CROSS SECTION-COAL BEDS NEAR PENAG # 1 WATER LEVEL TUNNEL

PLATE NO. 6



INDEX OF CROSS SECTIONS
COAL BEDS IN PROJECT AREA

PLATE NO. 5

There have been unknown numbers of small underground "bootleg" operations of which no record has been maintained. Many of these were small, independent mines operated for "house coal" for the miners personal use, and. were never mapped. The majority of deep mining was done by two large interests. Their workings were extensive and apparently well documented. Broad Mountain, bounding the north of the project area, has been extensively mined and contains sections where the interconnected workings extend for miles. More than 20 coal beds have been mined at one point or another in the study area.

A great deal of the mine pillar system was "robbed" during second phase mining and the existing condition of such mines, although assumed to have been at least partially collapsed, can only be speculated upon without the benefit of a specific program of drilling performed to verify such condition.

The abandoned underground mine workings are deteriorating rapidly. Large scale mining ceased some years ago and most if not all abandoned mines are now unsafe to enter due to roof collapse, rotting timbers, gas, water and caving of the openings.

The areas of stripping are extensive, especially in the Middle Creek Watershed near its headwaters and on Gebhard Run in the "Fisher Basin" area.

Some of the strippings near the headwaters of Middle Creek have been partially backfilled and graded, although acid lakes have been allowed to form in the remainder of the strip. The strippings (Lykens Valley No.2 and 4 Veins) near the crest of Broad Mountain between Good Spring and 1-81 have also been regraded. The above remedial works are only isolated cases and most of the older strippings remain in essentially the same condition as when they were abandoned.

Except for the very old spoil areas which have partially re-seeded themselves naturally after a period of time, vegetation is sparse to non-existent. This condition is the result of various factors including (a) generally granular, acidic soil; (b) insufficient ground water; (c) steep slopes, and (d) lack of any effective programs of reclamation by the owners.

C. COAL PRODUCTION IN STUDY AREA

The total reported production of coal, listed by operator, from underground mines which discharged water to the surface within the study area is as follows (Based upon production figures reported in "Pennsylvania Department of Environmental Resources' Annual Report" for the year 1970):

OPERATOR	PRODUCTION (1970) TONS	
Wolfgang Brothers Coal Company (formerly G. & T. Coal Company) (Little Tracy Slope)	8,458	
Colket Coal Company (No.2 and 3 Slopes)	4,939	
Starr & Williamson Coal Company (formerly H & S Coal Company) (No.1 Slope)	12,829	
Hatter Coal Company (No.1 Slope)	21,097	
Herring Brothers Coal Company (Herring Slope)	2,937	
Mercury Coal Company (No.4 Slope)	22,965	
Renninger Coal Company (Buck Mountain Slope)	3,424	)Production)stopped in)June, 1970
Senawaitis Brothers Coal Company (formerly S. B. K. Coal Company) (Buck Mountain Slope)	260	
J. Federovich Coal Company (formerly S. & F. Coal Company) (Primrose Slope)	11,799	
TOTAL PRODUCTION, NET TONS (1970)	88,708	

These figures indicate that production from the underground mines in the study area represented approximately 1 percent of the total production in the anthracite region for the year 1970.

Some of the underground mines in the study area operated sporadically in 1971 therefore it is assumed that total production from them will be below that recorded for 1970.

A discussion of the effects of acid/alkaline discharges for active deep mines can be found in Section VI-C of this report.

The study area falls within the limits of two anthracite deep mine inspection districts. District Number 13 includes the study area east of Gebhard Run and the balance of the study area falls within District Number 14.

Underground mine water pools, which have a drastic effect on present and future anthracite deep mining, are discussed in detail in the following section.

D. UNDERGROUND MINE WATER POOLS

This area, as well as the anthracite region in general, is confronted with the crucial problem of inundation of the mine workings by water which has been impounded in extensive underground pools, and by the continued infiltration of surface water through various connections to the underground system.

Mine water has always been a problem to the producer and has become progressively more difficult and expensive to handle as more coal is extracted from deeper underground and surface stripping allows the infiltration of more water to the underground workings.

These underground mine water pools sometimes fill the workings. In other cases they are isolated in only a portion of the mines.

As the mines are abandoned and pumping ceases the workings are filled with surface water entering through some of the original openings, through surface crop falls and strip pits, and with ground water percolating through undisturbed aquifers.

Most of the mine water pools are contained to various elevations by a system of barrier pillars. The mine water pool levels are governed by the elevation of points of overflow to the surface or the elevation of breaches in these barrier pillars. It should be noted that the existing condition of these barrier pillars is largely unknown. Breaches may have been created in the pillars due to un-mapped "robbing" and/or structural failure.

The U. S. Bureau of Mines indicates that the abandonment of mines in the Southern Anthracite Field has resulted in the flooding of 34 percent of the field and that the largest tonnage of anthracite reserves lies here where mining conditions are the most difficult. Large reserves underlie the abandoned workings and before most of these can be mined they must be de-watered. However some of these reserves may be "lost" to future mining since the adjacent pools must, in many cases, also be de-watered due to the unknown stability and effectiveness of the barrier pillars separating the pools when they must act as dams. The problem becomes then one involving both economics and safety.

The depth to which mining extended was variable to a maximum of perhaps 1500 feet, and averaging 400 to 500 feet in depth in most cases. It is reasonable to assume that the available reserves lie further down the flanks near the axes of the synclines. The Southern Anthracite Field has the greatest reserves, although it is also the most difficult to mine.

Five mine water pools have a significant effect upon our study area. The Good Spring No.3, Colket and Indian Head Pools lie entirely within the limits of the study area. Approximately 60 percent of the Good Spring No.1 and two-thirds of the Middle Creek Pools lie within the study area, the balance falling outside our area to the west and east, respectively. The northeast corner of a sixth pool, the Bausch Creek - East Franklin mine water pool, lies in our study area. This water pool discharges to the surface to the south (Lower Bausch Creek), outside the study area.

The location of underground mine water pools is shown on a special plan "Underground Mine Water Pools Study Area and Vicinity" and also the Mine Development and Pollution Source Map. Both of these plans are located in an Appendix pocket folder on the back cover of this report.

U. S. Bureau of Mines estimates of water contained in these pools and adjacent pools are as follows:

Mine Water Pool Number	Name	Estimated Volume(1) (Gallons)	Average Recorded Acid Load At Mine Pool Overflow (lbs/day)
20	Otto (2)	2,265,000,000	(6)
21	Middle Creek (3)	700,000,000	4,294
21-A	Indian Head	(6)	399
23	Colket	513,000,000	382
24	Good Spring No.3	471,000,000	794
25	Good Spring No.1 (4)	915,000,000	(7)
28	Rausch Creek - East Franklin (5)	890,000,000	(6)

(1) U. S. Bureau of Mines (1948)
(2) Adjacent to study area.
(3) Approximately two-thirds within this study area
(4) Approximately 60 percent within this study area
(5) Only northeast corner within this study area
(6) Unknown
(7) 40 at Sampling Station GS-96. Remainder to East Branch Rausch Creek which is the main discharge

The mine water pool elevations are assumed to be equal to the elevation of the pool discharge points although it is known that some variation does occur particularly after periods of extended rainfall. The effective elevation of the barrier pillars is assumed to be equal to the mine water pool elevation.

The Middle Creek Pool elevation was maintained at 798 feet by pumping when the mines were operating. However, since the mines were abandoned in May, 1956, the pool elevation has risen to 885± feet and presently discharges through a trench constructed for that purpose and known locally as the "Tracy Overflow".

It is assumed that the water surface elevation in most mine pools has risen since the workings were completely abandoned.

E. <u>COAL REFUSE</u> <u>BANKS</u>

In 1966 the U. S. Bureau of Mines estimated there were 148 refuse banks in the Southern Field containing approximately 186,080,000 cu. yds. and covering 3,502 acres.

Solid wastes associated with anthracite coal preparation plants are a source of stream and air pollution and impaired esthetics.On fire they create an additional health hazard. There is also a consider able waste of surface areas which might be put to other uses. The dip of anthracite coal beds is usually rather pronounced with the result that all material dislodged during mining operations must be brought to the surface without the opportunity of underground separation or storage, as sometimes occurs in bituminous coal mining. De-silting basins from fine coal preparation plants having a cleaning operation have retained many thousands of tons of coal silt in refuse banks locally known as "slush dams". Other refuse banks consisting of mostly coarse material can be found adjacent to other coal preparation breakers.

In the early period of deep mining as refuse banks were formed there was only limited means in which to segregate the various component materials. Hence these piles contain varying amounts of impurities and coal.

The pyritic materials occur generally throughout the refuse banks, and at the pile surface are exposed to both moisture and oxygen as a result of the normal weathering process. During periods without precipitation, the pyrite in surface materials is oxidized. Subsequent rain and/or snow melt washes the mantle of these banks resulting in the production of significant quantities of sulfuric acid and ferrous sulfate, most of which enters nearby streams. In-stream aeration permits the ferrous iron to change to the ferric state, which is less soluble, and to precipitate in the streams as "Yellow Boy".

Most of the refuse banks in their present state are too acidic to support any form of plant growth and this absence of desirable vegetative ground cover compounds the problem in that the banks are subject to continual erosion. Existing conditions result in a high sediment laden run-off and the fresh bank surface thus exposed promotes a renewal of the acid producing process. Such recent efforts as the experimental planting of portions of the Westwood Bank in this study area may eventually show that with proper addition of fertilizer and lime vegetative growth can be achieved.

However, it is doubtful if vegetative growth can be maintained without the addition of some 8" to 12" of soil, including grading the slopes to a maximum 3 : 1 to retain soil moisture and prevent erosion. In Britain refuse has been planted without the addition of a soil layer but it is stated that reliming may be required for up to ten years.

Coal silt transported by water, and to a much lesser degree by wind, enters the stream to be deposited in varying degrees throughout its length. During periods of dry weather acid continues to be formed from this coal silt lying adjacent to the stream flow. Therefore, in certain instances, coal silt previously deposited in a stream continues to produce acid at a relatively uniform rate while being supplemented by "slugs" of acid/silt laden water with each rainfall.

Test results, by others, indicate that about 70 percent of the acid salts in the mantle of such piles enters the streams as run-off, the balance infiltrating the bank to later reappear around the perimeter of the bank. Contrary to early general published information on the subject, our studies confirm the above that refuse banks do produce a significant amount of AMD.

The ownership of refuse banks in the anthracite region is often complex with ownership vested in multiple owners of a number of leased coal properties. Subject to the agreement between these parties, the refuse material might belong to the owner of the coal preparation plant or to the individual owners of the mine properties. The least complex situation occurs where one individual entity owns the mineral, including the rights to mine it and the surface upon which the refuse is deposited.

The refuse material is generally undesirable material rejected in the mining and coal preparation:

1. Material rejected in a breaker or preparation plant designed to reclean the smaller sizes (generally called a fine coal preparation plant). Material from these plants can be further divided into coarse refuse and fine refuse (slush dams). Higher quality material often exists in the center of the refuse banks since this material was placed when equipment and methods of screening were less exact.

2. Material brought directly from the mines and deposited on refuse banks. There is also a further division between mine refuse and tunnel rock.

These silting basins (slush dams) and refuse banks are discussed individually in Section IV, under the sub-watershed within which they are located, and in Section VI.

ESTIMATES

FOR REFUSE BANKS IN STUDY AREA

BANK	LOCATION	TYPE	AREA (Acres)	VOLUME (CY x 1,000)	STATUS
Good Spring No.1	0.2 mile west of Good Spring	Mixture	13.2	750	Inactive
PenAg - Good Spring No.3	1.0 mile East of Good Spring	Mixture	43.0	1,362	Current Storage
Westwood Refuse Bank and Slush Dam	Adjacent to I-81 between Routes 125 and 209	Mixture	106.0	6,700	Current Storage
Donaldson Slush Dam (Includes adjacent refuse north and west of main bank)	S.W. of Village of Donaldson	Breaker refuse and silt	69.8	2,750*	Inactive
Indian Head Slush Dam (Includes adjacent refuse north of main bank)	1-1/2 miles West of Tremont and just north of Route 209	Breaker refuse and silt	144.0	5,658	Inactive
Indian Head "Rock Pile"	1-1/2 miles West of Tremont and just north of Route 209 (East of above banks)	Breaker refuse and silt	44.3	1,540	Inactive
		TOTALS	420.3	18,760	

* 460,000 cubic yards have been burned (there were no burning banks in the study area during the study period).

Source: U. S. Bureau of Mines Survey (1966) and Consultant