INTRODUCTION

The Pennsylvania State Legislature reflected the feelings of the citizenry by stating its intent in the 1965 Clean Streams Law -

"...to reclaim and restore to a clean, unpolluted condition every stream in Pennsylvania that is presently polluted ... "

It was recognized that in order to accomplish this end, the most serious source of pollution in Pennsylvania - abandoned mine drainage - would have to be abated. In a precedent setting action during December 1967, the Legislature enacted "The Land and Water Conservation and Reclamation Act" (Act 443) which authorized the creation of an indebtedness of $500 million for the conservation and reclamation of land and water resources. $150 million of this sum was allocated for the prevention, control and elimination of stream pollution from mine drainage. The authority for creating this indebtedness was provided by the electorate during May 1967. This report details the findings of a mine drainage watershed study funded under Act 443 of 1967.

The Susquehanna River drains 20,900 square miles of Pennsylvania's 45,300 square mile total area. It is reported that 650 miles of significant tributaries have been rendered essentially sterile of biological

(1)
U.S. Corps of Engineers, "Susquehanna River Basin, Mine Drainage Study", January, 1971.

activity by acid mine drainage discharges. Additionally, some 230 miles of principal streams are seriously degraded or periodically threatened by this mine pollution.

Muddy Run is the principal source of pollution to Clearfield Creek which, in turn, is a principal source of pollution to the West Branch Susquehanna River. A Federal study (1) indicated that Muddy Run contributes over 47% of the acid mine drainage pollution load to Clearfield Creek, although it accounts for only 8% of the watershed area. It was, therefore, obvious that a study of Muddy Run should receive high priority, particularly in view of Clearfield Creek's importance to the West Branch pollution situation.

At the point of confluence with Clearfield Creek, the West Branch is neutral to alkaline and supports a game fishery. For the next thirty-six miles downstream, the West Branch is marginal in quality and supports some vestiges of aquatic life, until Moshannon Creek completely destroys the river's viability. This presents the appealing challenge of reducing Muddy Run's pollution load to the extent necessary to improve the West Branch's quality in that thirty-six mile reach to a level which will return normal uses. This report is the first step in meeting this challenge.

(1) Federal Water Pollution Control Administration, "Mine Drainage in the Susquehanna River Basin", 1970

PURPOSE

Determine the extent and severity of mine drainage in Muddy Run and its tributaries.

Conduct a pollution. source inventory by locating and measuring the specific discharges associated with past and present mining.

Determine the impact of Muddy Run on Clearfield Creek and West Branch Susquehanna River.

Develop remedial measures for each significant source of pollution which would reduce or eliminate the pollution.

Set forth the cost of the remedial measures, including a ranking of the measures according to recommended priority.

Develop and recommend an "abatement plan" for the watershed.

MUDDY RUN

MINE DRAINAGE POLLUTION

ABATEMENT PROJECT

OPERATION SCARLIFT

COMMONWEALTH OF PENNSYLVANIA

MILTON J. SHAPP , GOVERNOR

DEPARTMENT OF ENVIRONMENTAL RESOURCES

MAURICE K. GODDARD , SECRETARY

BASIN DESCRIPTION

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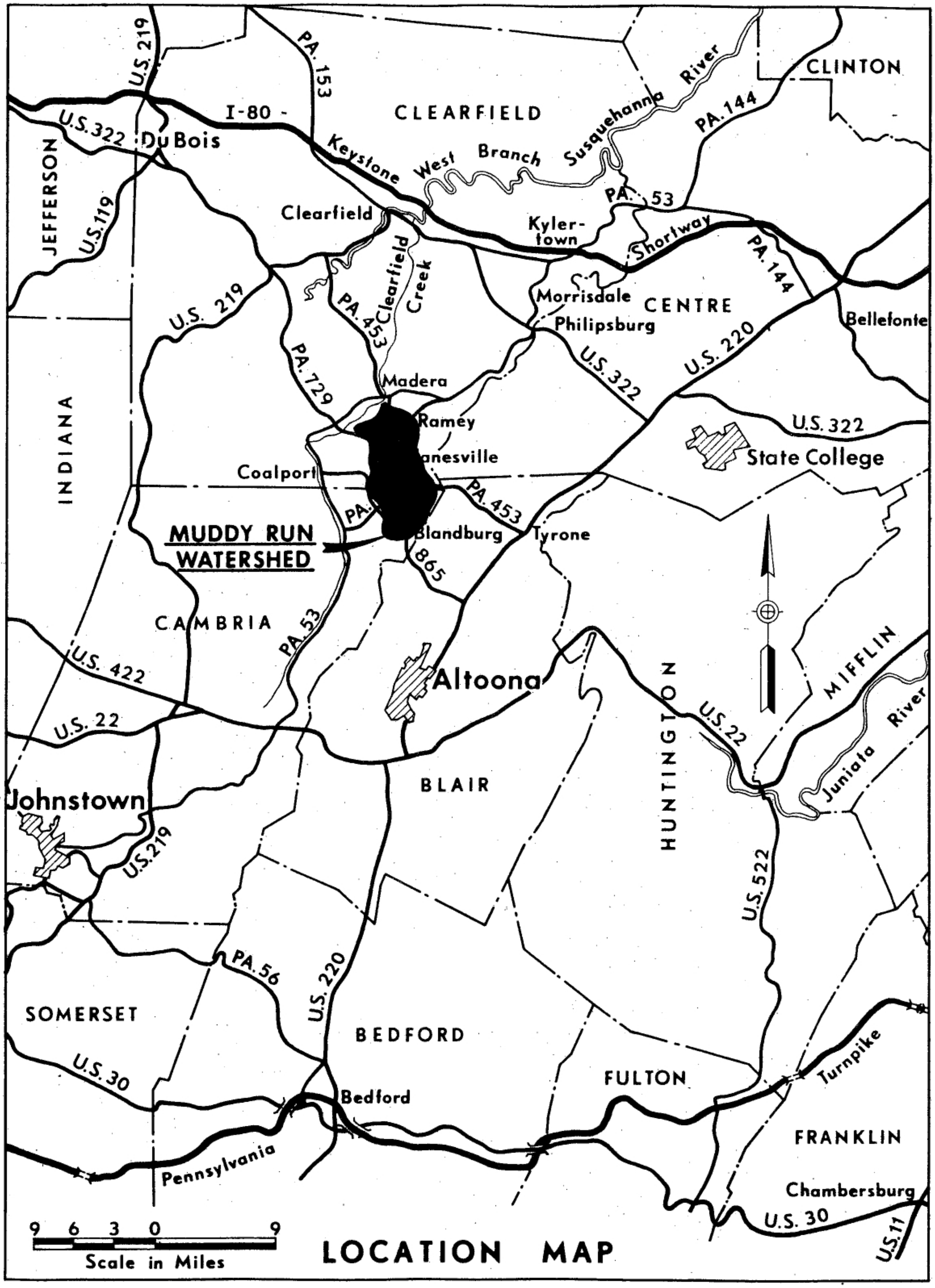
LOCATION

The northern 3/4 of the Muddy Run watershed is situated in the southeast corner of Clearfield County, Pennsylvania; the southern 1/4 of the watershed is situated in the northeast corner of Cambria County, Pennsylvania. The watershed is bounded on the north by Madera, on the south by Blandburg, and is centered about Janesville. The center of the watershed is 17 miles north of Altoona, and 18 miles south of Clearfield. The 37 square mile watershed (48 square mile study area) has a maximum width of 5 miles and a maximum length of 10 miles. Muddy Run flows in a northerly direction to its confluence with Clearfield Creek at Madera. From there, Clearfield Creek flows north to its confluence with the West Branch Susquehanna River near Leonard, Pennsylvania.

Banion Run, Little Muddy Run, East Branch, and Curtis Run are the only named tributaries to Muddy Run. The watershed includes portions of Bigler, Gulich, Reade and Beccaria Townships.

CLIMATOLOGY

The National Weather Service maintains a station at Madera



LOCATION MAP

which records precipitation and temperature data. Madera is situated at the mouth of Muddy Run. The average temperature of 45° for the period June 1970 through May 1971 is considerably below the average temperature for the entire State. Temperature extremes ranged from 90° to -15°. The 78 inches of snowfall during this same period is considerably above the State's 30 year snowfall average of 46 inches.

June 1970 through May 1971 was considered the climatological year, even though the sample year was June 1970 through June 1971. Climatological data were not available for June 1971 at the time this report was written. The total precipitation of 43 inches is slightly below average for this area.

Monthly Precipitation and Temperature at Madera

Precipitation (Inches)			Average Temperature (°F)
June	1970	3.87	62.5
July	1970	5.37	66.7
Aug.	1970	5.65	66.9
Sept.	1970	2.23	62.1
Oct.	1970	4.75	51.3
Nov.	1970	4.10	40.1
Dec.	1970	3.50	28.3
Jan.	1971	2.53	19.7
Feb.	1971	4.29	24.5
Mar.	1971	2.72	28.6
Apr.	1971	0.88	41.1
May	1971	3.05	51.1

PHYSIOGRAPHY

The topography of the Muddy Run watershed is influenced by structural features imposed by two physiographic provinces of Pennsylvania - the Allegheny Plateau and the Valley and Ridge Province. The entire watershed, however, lies within the gently folded Allegheny Plateau.

This situation is responsible for a total relief of approximately 1, 300 feet as well as varying stream maturity regimes. In the south, the steadily rising flank of the Allegheny Mountains imposes steep gradients and the accompanying vertical downcutting results in relatively deep V-shaped valleys. The valleys broaden and local relief decreases toward the northern end of the watershed as the gradient imposed by the Allegheny front decreases. The highlands are generally capped by resistant sandstones contained within the coal measures and the valley bottoms are alluvial/colluvial fill. Farming is mostly confined to the flat upland regions while the valley sides and bottoms are forested.

The stream courses in the watershed are influenced by both the northeasterly trending folds and the northwesterly trending wrench faults.

Both the stratigraphically high position of the Allegheny Group and the fluvial dissection are responsible for the many coal outcrops above surface drainage in the area. The surface drainage system was mainly fed by springs at both the coal outcrops and the intervening sandstone aquifer outcrops; however, the original hydrology of the watershed has been extensively altered by coal mining.

GEOLOGY

Surface formations in the Muddy Run watershed range from the upper 350 feet of the Mississippian Pocono Formation to the lower 2OO feet of the Pennsylvania Conemaugh Group, comprising a stratigraphic thickness of nearly 1,000 feet. The valley bottoms are filled with up to 25 feet of Quaternary alluvium.

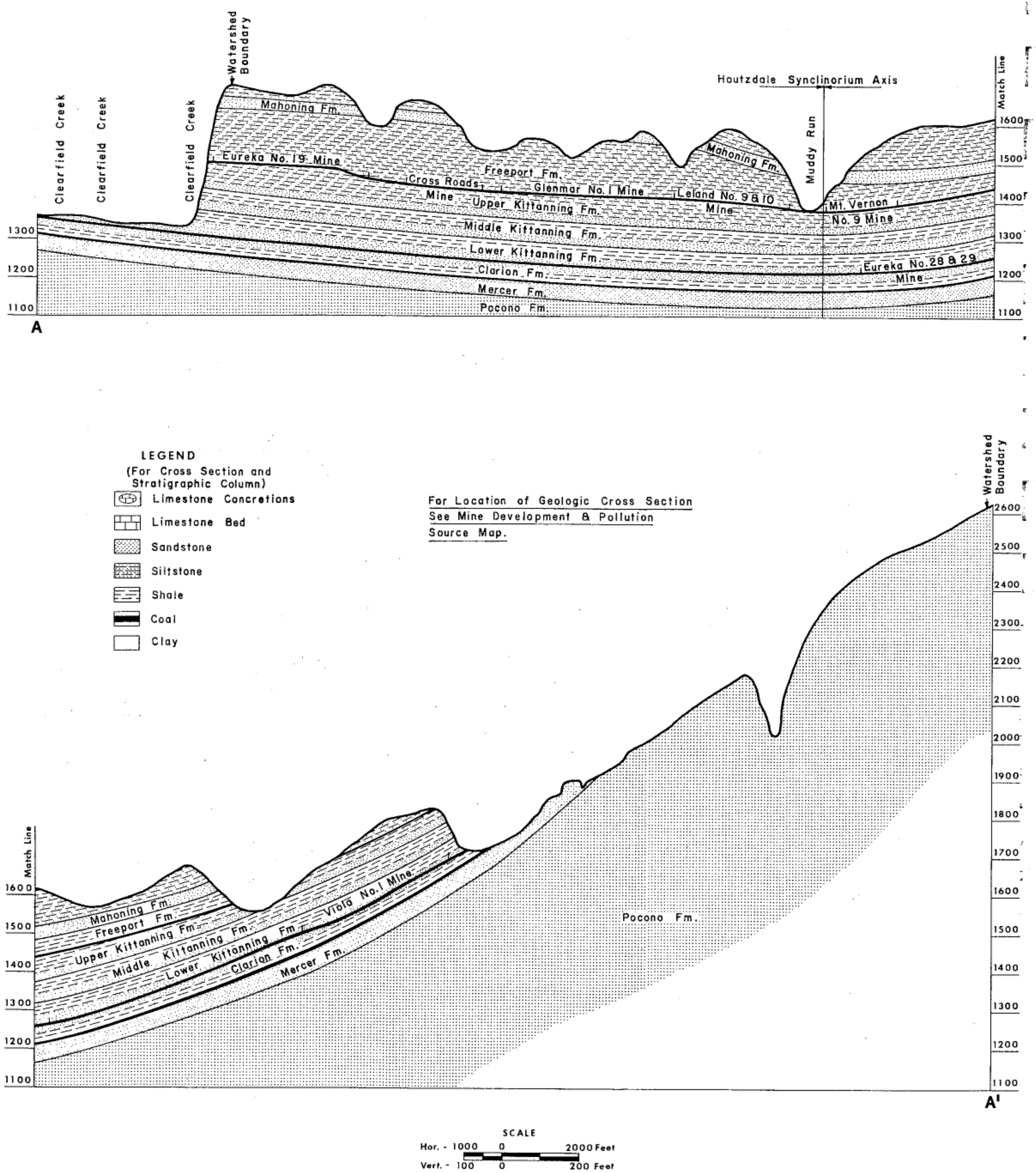
The Allegheny group contains the most important formations in the watershed. These are the coal measures ranging vertically from the Clarion formation to the Freeport formation. The Pottsville group contains some coal in the Mercer formation, as does the Conemaugh group's Mahoning formation, but these have been sparsely developed due to their unreliable thickness and lateral discontinuity within the watershed. The formations comprising the Allegheny group consist of erratic cyclic sequences of underclay, coals, claystones, shales and sandstones deposited during a period of fluctuating mild tectonic activity.

This varying paleoenvironment is also responsible for a set of seemingly incongruous conditions existing today. The drainage from the mines on the Clarion, Lower Kittanning and Middle Kittanning seams is predominantly acidic with large concentrations of iron and sulfate. The mine drainage from the Upper Kittanning, Lower Freeport, and Upper Freeport seams is predominantly alkaline with relatively high concentrations of iron (generally in the ferric state) and sulfate. This may be explained by the association of fresh water limestone in the form of thin beds or concretions within the underclays of these three latter formations. The mildly fluctuating rate of subsidence and the subsequently variable base level resulted in an open water to swamp to fluvial-deltaic depositional sequence responsible for the complex stratigraphic nature of the coal measures. Such an environment of deposition often contains areas of restricted water and high biochemical oxygen demand, resulting in a reducing atmosphere. The coal seams and adjacent strata reflect this condition by their high content of sulfuritic compounds such as pyrite and marcasite. Limestone was occasionally deposited/precipitated in back swamp areas during periods of the sedimentary cycle. The acidity caused by the oxidation and hydrolysis of these iron disulfides in the mine drainage is neutralized to various degrees when this limestone occurs below a coal seam. The resultant higher pH causes the ferrous iron to be precipitated as ferric hydroxide (yellowboy).

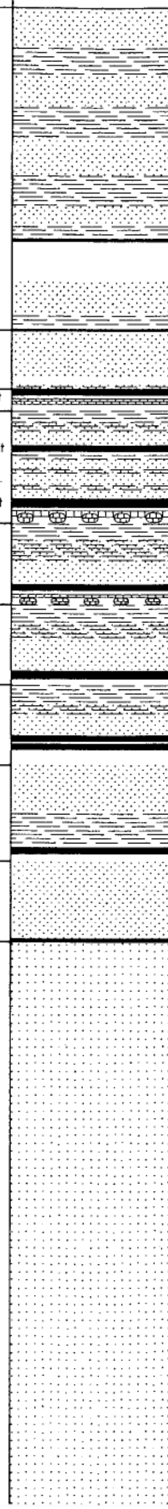
Structurally, the area is controlled by a series of northeast striking folds. These folds are doubly plunging and the strike of the bedding approximates their axial trend. The axis of the Houtzdale-Snowshoe Syncline passes through Utahville, Beccaria, Ramey and Houtzdale with the trough being bounded on the southeast by the Allegheny front and on the northwest by the Laurel Hill Anticline. The coal measures of the Allegheny group, and portions of the Mahoning coal of the Conemaugh group have been protected from erosional processes by this structural low, while the up dip approaches to the Laurel Hill anticline and the Allegheny front expose the lower lying Mercer and Pocono formations.

A series of northwesterly trending wrench faults cross the watershed in a pattern roughly perpendicular to the fold axis and parallel to the stress vector responsible for the folding. The largest fault in the area is the Tipton Fault, which separates the Eureka Mine No. 28 from the Brookwood Shaft Mine on the Lower Kittanning coal seam. It has, along with its splay faults, displaced the Lower Kittanning in this area with such intensity that coal extraction was impossible. This same area is complemented with similar faults, and in general their intensity increased toward the southeast.

Jointing, a characteristic associated with deformation, is well



GEOLOGIC CROSS SECTION



SYSTEM	SERIES	GROUP	FORMATION	COAL MEMBER	CHARACTERISTICS OF COAL MEMBER	GENERAL STRATIGRAPHY OF GROUP
CARBONIFEROUS	PENNSYLVANIAN	CONEMAUGH		Brush Creek	Very thin. Laterally discontinuous. No mining.	Erratic cyclic sequences of sandstone, siltstone, shale and thin coals. Lower 235 feet of group.
				Mahoning	Average thickness = 1 foot. Thin and laterally discontinuous. Strip mined locally.	
			Mahoning			
		ALLEGHENY	Freeport	Upper Freeport	Average thickness = 30 inches. Laterally continuous. Extensively strip mined with some deep mining.	Variable cyclic sequence of clay, claystone, carbonaceous shale, siltstone, sandstone, and mineable coals. Average thickness = 295 feet.
				Lower Freeport Lower Freeport	Split into 2 benches with a 30 foot separation. Both are laterally continuous with average thickness of 30 inches and are extensively strip mined and deep mined.	
			Upper Kittanning	Upper Kittanning	Average thickness = 24 inches. Laterally discontinuous but locally strip and deep mined.	
			Middle Kittanning	Middle Kittanning	Average thickness = 36 inches. Fair persistance. Mostly strip mined with some deep mining.	
			Lower Kittanning	Lower Kittanning	Average thickness = 58 inches, including a 10 inch shale parting. Laterally continuous and extensively deep mined with some strip mining.	
			Clarion	Clarion	Average thickness = 42 inches. Laterally continuous. Deep mined and strip mined.	
		POTTSVILLE	Mercer	Mercer	Very thin and laterally discontinuous. Locally strip mined.	Poorly developed cyclic sequence of shales, siltstones, sandstones, and thin coals. Thickness = 50 feet.
	MISSISSIPPIAN		Pocono			Fine-grained to conglomeratic sandstone up to 350 feet thick.

VERTICAL SCALE
50 0 100 Feet

STRATIGRAPHIC COLUMN OF SURFACE ROCK

developed in the watershed. Generally, the strata associated with coal measures would provide a fair water supply for the nearby communities. The sandstone units within the coal measures would provide perched aquifers, contained by the impermeable underclays and shales that were utilized for domestic water supply. The development of mines along the coal seams, however, tends to open the joint spacing by subsequent roof failure. This decreases the water retention capacities of the rocks, thereby depleting individual home wells of water for domestic use. This was extremely evident when the communities of Janesville, Ginter, and Morann had to install public water supply systems. These communities pipe in water from unaffected areas to combat the loss of well water caused by the development of the underlying coal.

The stratigraphic column and geology cross section shown here illustrate the characteristics described. The actual location of the cross section within the watershed is shown on the mine development drawings in the back of this report.

MINING HISTORY

Mining was begun in Clearfield County in order to supply coal to the eastern Pennsylvania market. The first load of coal was shipped down. the Susquehanna River in 1804. (1)

Coal mining has been a major factor in the economy of the Muddy Run area since the development of the Moshannon Coal Basin in the 1860's. Towns such as Madera, Smith Mills (now Janesville), Beccaria, and Smoke Run owe their existence to this initial surge of mining. As the major seam was exhausted, towns such as Allemans, Glasgow and Blandburg were economically boosted by the development of other seams.

The Moshannon Basin or Houtzdale-Snowshoe Syncline has preserved most of the Allegheny Group from erosion. Its axis passes through the watershed in a north-northeast direction along Muddy Run and breaks to the east-northeast at Smoke Run, passing through Ramey and Houtzdale. Deep mining has been performed on both limits of this trough, with the Lower Freeport (locally termed Moshannon) being extracted first. The Lower Freeport is split in this vicinity, and most of the deep mining (within the watershed) has taken place on the lower bench which averages 36 inches in thickness. The seam rejoins at the northeast boundary of the watershed where it averages 44 inches in thickness.

The Lower Freeport's lateral continuity and persistent mineable thickness and quality attracted many small private entrepreneurs, as well as large interests, such as Berwind-White Coal Mining Company, Standard Moshannon Coal Company, Moshannon Smithing Coal Company,

(1) Bituminous Coal Fields of Pennsylvania, Part II James D. Sisler, Pa. Geol. Surv. Pub.

and Liberty Coal Mining Company. As the Lower Freeport seam was exhausted in the watershed around the 1920's, some of these same companies turned to the Clarion and Lower Kittanning seams.

The Lower Kittanning seam was extensively deep mined along the southeast limb of the basin by Berwind-White Coal Company, and by the Hale Coal Company. It represented a profitable venture because of its lateral continuity, good quality, and persistent lateral thickness averaging 54 inches, including a 10 inch parting. Major deep mining activity on the Lower Kittanning coal lasted from the early 1900's to the early 1950's.

The Clarion coal was also deep mined during the same period as the Lower Kittanning. It is well developed along the northwest limb of the basin and averages 42 inches in thickness in this area. Liberty Coal Company, Middle Penn Coal Company, and Margaret McGlynn performed most of the mining on this seam. The southeast limb has also been explored somewhat, with Harbison-Walker Refractories performing most of the mining.

Deep mining is still being performed today on a limited basis by Scott Brothers Coal Company on the Lower Kittanning seam, and by Elliot Coal Company on the Clarion seam. Most of the mining activity since World War II, however, has been confined to stripping methods as a result of changing coal economics. Along the axis of the syncline the Upper and Lower Freeport seams have been extensively strip mined by the Flango Brothers Coal Company and others while on either flank, the Clarion and Lower, Middle, and Upper. Kittanning seams have been strip mined by S. J. Mountz and Powell Company.

REGULATION OF MINING

Muddy Run was polluted prior to passage of effective mine drainage control legislation. This pollution emanates largely from deep mines which have been abandoned for many years, and were not affected by the 1965 amendments to the Clean Streams Law regulating deep mine drainage.

There is evidence that some surface mines have created additional pollution sources by intercepting deep mine workings, thereby releasing acid water. Some major sources of pollution are apparently surface clay mines which, to this date, are not regulated by State law.

The Commonwealth's first Clean Streams Law, passed in 1937, specifically exempted control of mining operations. In 1945, the law was amended to disallow pollution from active mines located on clean streams. Lack of proper funding delayed effective implementation of this amendment for several years. By that time, Muddy Run was not considered a "clean stream", so mining was allowed essentially without restriction. The technical requirements developed under this law were also weak (complete strip mine restoration and effective mine sealing were seldom required).

It was not until 1963 that control of active surface mines was effectively strengthened, and not until 1965 that active deep mines were required to control pollution regardless of the quality of the receiving streams. None of the present conservation laws can require a coal company to undertake any reclamation work or pollution abatement on mines operated and completed prior to enactment of regulatory legislation.

During July 1970, the Clean Streams Law was again strengthened to require bonding of deep mine operators. This will assure that pollution is prevented during and after completion of mining.