INTRODUCTION

Stream water pollution problems associated with acid mine drainage are not new and have been the subject of considerable concern and study both by the mining industry and government agencies for the past fifty (50) years.

Water pollution resulting from acid mine drainage in the anthracite region is similar in character to that of the bituminous regions. The growth of the commercial coal mining industry has greatly accelerated the volumes of mine drainage discharges that are deleterious to the neighboring receiving streams. What was once a localized problem in the early days of the coal industry is now a widespread problem.

Many miles of streams are rendered acid by mine drainage and many more are unfit for some uses. The chemical pollutants in acid mine drainage, including sulfuric acid and the acid salts of iron and other metals, are toxic to aquatic, life. They destroy or reduce the natural alkalinity of the streams, resulting in a permanent sulfate hardness both difficult and expensive to remove at water treatment plants. The presence of dissolved salts of iron, and manganese imparts undesirable properties for many water users. As with other pollutants, the detrimental effects of mine-drainage pollution grow in importance with the water needs of the expanding population, especially in

urban, centers. Increasingly stringent regulatory control must be placed on the mining industry by the controlling agencies. However, most of the mine drainage originates in abandoned mines and the responsibility for abating pollution from this source has fallen to State agencies. Future needs for suitable domestic and industrial water must be met from various surface water sources; the ground water supply will be inadequate,

PURPOSE AND SCOPE

The Department of Environmental Resources of the Commonwealth of Pennsylvania authorized engineering surveys of a number of the major watersheds within the State. The purpose of this survey is to identify and locate the sources of mine drainage pollution stemming from abandoned deep and strip mines and to suggest measures to abate or alleviate the effects. To do this, the quality and flow volume of each located discharge had to be studied for a given period of time. Estimated costs of pollution abatement costs were also developed.

FORMATION OF ACID MINE DRAINAGE

Certain disagreements still exist concerning the formation and the chemistry of acid mine drainage. Acid mine drainage is formed in coal mines from the iron sulfide materials in coal, gob and associated rock, and in coal-refuse storage piles. The pyritic materials are oxidized through exposure to oxygen and water. Water flowing through the mines leaches away the oxidation products and carries them to adjacent water courses. Secondary reactions between sulfuric acid and the acid salts of iron, inorganic minerals, and organic minerals in the mines, in coal storage and coal refuse piles, and in the streams, produce other chemicals often found with acid mine drainage. One of the more common systems yielding ferrous hydroxide and acid is represented by the following reactions:

$$^{2}FeS_2 + 70_2 + 2H20 > SO4 + H2SO4$$

$$FeSO_4 + 2H_20 \text{--->} Fe(OH)_2 + S0_4 + 2H^+$$

$$Fe(OH)_2 + H20 \text{--->} Fe(OH)_3 + H^+$$

The concentration of soluble metallic salts in mine drainage is a function of the amount of minerals, air, and water present. Also, the crystallography, particle size, and the purity of the iron sulfide minerals have been found to play a very important role in reactivity.

Geology also plays an important part in acid mine formation. Formations vary significantly from place to place even within a given coal seam and this variation is due, in part, to differences in the occurrence and form of iron sulfide minerals associated with the coal. Iron sulfide minerals found in the strata above and below the coal are exposed during the course of mining and, when the location is depleted of coal, the acid-forming minerals remain in the roof and sides of the abandoned mine.

The pollution of mine drainage from a mining operation may be either continuous or intermittent. When deep mines are found below the ground water table, acid mine drainage is usually produced on a continuous basis. Discharges from surface mines are often intermittent, generally occurring during the after periods of precipitation, Where strip mines occur, runoff is usually trapped in the abandoned strip mines in huge pools. During periods of intensive rainfall, the pools will overflow and release concentrated "slugs" of acid mine drainage to nearby streams. The other thing that happens is that these pools drain into the deep mines underlying the stripped area, thus increasing the mine drainage flow.

DESCRIPTION OF THE SWATARA CREEK WATERSHED - PART III

This watershed, as designed for study, is located in the western part of Schuylkill County. It includes parts of Tremont, Frailey and Porter Townships, The watershed consists of an area of approximately nine and one-half (9-1/2) square miles and an acreage of approximately six thousand one hundred and twenty (6,120) acres. The greatest area of the watershed (about 4,690 acres or approximately 77% of the total area of the watershed) is located in Tremont Township. The Watershed is bounded on the North by Broad Mountain, on the South by Second Mountain, on the West by more of Broad Mountain and on the East by Sharp Mountain. The Watershed lies between 40° 37' 30" and 40° 33' 45" north latitudes and 76° 30' 00" and 76° 22' 30" west longitudes.

The area described in this report lies within the Appalachian Valley and Ridge Province, a subdivision of the Appalachian Highlands. Geologically this is a region of alternating hard and soft sedimentary rocks, which have been bent by lateral compression from the southeast into folds or waves - anticlines and synclines, From the North to the South, one finds, in order the North Trough of the Minersville Synclinorium, the New Bloomfield Anticlinorium and the South Trough of, the Minersville Synclinorium. There are numerous faults that bisect the Watershed; the general trend of the faults being of a northeast-southwest direction. After the rocks had been folded, the entire area was slowly baseleveled (peneplained) by erosion, and hard and soft layers alike were finally reduced to a nearly uniform surface (peneplain). Then a general uplift of the region gave the streams renewed vigor and began another cycle of erosion, which is still operating at the present time. During this last cycle of erosion, the softer rocks have been gradually worn down and carried away and the more resistant rocks stand out as ridges.

The effect of the pitch of the folds has had a marked influence on the present-day topography and has resulted in a series of canoe-shaped

synclinal valleys in which are located the principal anthracite coal fields. The rock formations in the area of the Watershed are all of sedimentary origin and range in geologic age from the Quaternary to the Devonian periods. The Llewellyn and Pottsville formations are the predominant strata found in the. Watershed.

The Pottsville formation crops out as a high ridge encircling all the coal basins. In most places its strata dip steeply, but is also occupies large flat areas.. The Pottsville is noted for its great thickness (1100 to 1475 feet), the coarseness of its materials, and the number and size of the coal beds it contains. It predominantly hosts the Lykens Valley coal beds. The fractured beds of hard sandstone and conglomerate are very good water producers, and in general the Pottsville may be expected to yield large supplies of water. When coal mines are opened, these strata are usually penetrated, thus forming a flow path into the mines for the water which presents a problem for the operators in pumping it to the surface.

The geologic structure is extremely complex within the Watershed area. The strata have been sharply folded along northeast-southwest axes and the truncated hard and soft beds now form an intricate system of long, narrow ridges and valleys. The area has been subject to intense faulting, the major fault being the Blackwood Fault, and accompanied by the minor Pottchunk, Sharp Mountain, Lorberry, Red Mountain, Beuchler, East Georges Head and Sweet Arrow faults.

The Llewellyn and Pottsville formations are the host beds for the anthracite coal measures within the Watershed. The members of the Pottsville formation within the Watershed are the Sharp Mountain, the Schuylkill and the Tumbling Run. There are approximately thirty (30) different workable beds and seams of anthracite coal. The geologic formation contain numerous beds of conglomerate, sandstone, slate and coal measures, which, owing to the severe folding and faulting, contain innumerable fractures that transmit water readily. The depths of deep mine workings within the Watershed average between 1,300 feet and 2,300 feet, so that in the vicinity of the coal mines, the strata are drained to great depths by. means of pumping installations 'within the deep mines. It was reported in the past, by one of the coal company's chief engineers, that after ten (10) years of study, he stated that an average of twenty-one (21) tons of water was pumped out for every ton of coal shipped. He also stated that an average of fifteen (15) tons of water is pumped out for every ton of material removed from the mines.

The removal and processing of anthracite coal causes many changes in the hydrology of the Watershed. Stream-flow is affected by diversions necessitated by strip-mine operations as well as the consumptive use of water for the processing of the mined coal. Ground water flows are altered by artificial drainage in deep mines and also strip mines. The character of the water is greatly altered by the introduction of silt and soluble materials. Water from anthracite coal mines and coal preparation plants is acidic, culm-laden, and highly mineralized. Changes in the topography of the land, caused by strip-mining operations, modifies the hydrology of the watershed more than any other factor. The amount of water consumed by the land increases or decreases and affects the runoff reaching the streams. When the soil cover is removed, the runoff increases and makes possible the increased erosion of the soil cover in adjacent areas. The concentration of the mining activities within the Watershed area requires diversion of flows of streams in order to satisfy man's needs in the mining industry.

DRAINAGE

There are five (5) distinct drainage areas in Schuylkill County, and, in the area of the Watershed, in the southwestern part of the County, the drainage is by Swatara Creek and its tributaries. Swatara Creek is a tributary of the Susquehanna River.

The important streams in the area of the Watershed are the Lorberry Creek, the lower Rausch Creek and the Swatara Creek. The Swatara Creek does not play an important part in the study of this Watershed, but plays the predominant part in the study of the adjoining watershed. The stream enters and leaves in the extreme southeastern corner of this Area of study. There are other small streams within the Watershed, namely, Stumps Run Creek and Goodspring Creek.

The headwaters of Lorberry Creek are found at Rowe Tunnel. It is characterized by small rapids at frequent intervals from its headwaters at Rowe Tunnel in its southward path to its confluence with lower Rausch Creek. Stumps Run Creek flows from the west, from the State Game Lands area, and joins the Lorberry Creek just south of Panther Head Mountain. Stumps Run Creek is a "clean stream" and is not polluted. Its water aids in the dilution of the acidic waters of Lorberry Creek. The terrain adjacent to the stream ranges from one or high relief to that of a flood plain near its confluence with lower Rausch Creek within the right-of-way of Interstate Route I-81. The area nearer Lorberry Junction, closer to the confluence of Lorberry Creek and Lower Rausch Creek, is composed mostly of alluvium and there is a tremendous volume of subsurface drainage, probably from underground springs. This is evidenced by the fact that the volumes of water measured at toe Lorberry Creek Culvert are greater than the total sum of the various mine discharges. The quality of the water is also less acidic.

The sources of Lower Rausch Creek is at the Westwood Dredging Operation immediately north of Pennsylvania Route No. 209. The original streambed has been altered by strip mine operations and also by the construction of Interstate Route No. I-81. The terrain in this area is gently sloping, but farther to the south, at the site of the former village of Rausch Creek, the slopes rise rather sharply.

Goodspring Creek flows from west to east immediately north of the Watershed and has little effect upon the drainage of the Watershed area.