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General Background:

As early as 1967, the Soil Conservation Service (SCS) as part of their Penn Soil Resource Conservation and Development Program, was involved in a sediment and erosion control study of surface mining in the Big Scrubgrass Creek Watershed. The report of their study, printed and published by Pantech Engineers, Inc., identified fifty-four strip mine sites within the watershed. With the use of aerial photographs as location maps each site was evaluated in detail, studying present vegetative cover and making recommendations for sediment and erosion control practices.

In an effort to study in detail the effects of these mine sites on stream quality and to evaluate abatement measures in terms of Acid Mine Drainage (AMD), Pantech Engineers, Inc., was awarded a contract by the Pennsylvania Department of Environmental Resources for the engineering survey in October, 1970. The results of this investigation in the Big Scrubgrass Creek Watershed are based on the collection and analysis of detailed field data, the study of published reports, particularly the SCS Sediment and Erosion Control Study, and all available documents, supplemented by knowledge gained from consultations and discussions with engineers and conservationists concerned with the reclamation of the area and the mine drainage problem in general. Particular interest should be given to the fact that the SCS study and our investigation overlapped resulting in a concentrated cooperative effort.

With the awarding of the contract, immediate data collection began. U.S.G.S. quadrangle maps were used to develop the watershed boundary and base map. Aerial maps of proposed highway construction in the project area were obtained from the Pennsylvania Department of Transportation and aerial photographs of the watershed were obtained from the U.S. Department of Agriculture, Agriculture Stabilization and Conservation Service. All available publications, and information including maps, reports, various related articles and knowledge obtained from discussions and meetings were obtained from state and federal agencies. Local support was received from the Scrubgrass Creek Watershed Association, the Soil and Water Conservation District, the Venango County Planning Commission, the State Game and Fish Commissions, Venango County Federation of Sportsmen, and local township authorities.

When a basic understanding of the watershed had been developed, the first phase of field operations began. A general on-site study and analysis was made, including visual observations, familiarization with terrain, roads, streams, mine sites and general locale. Field notes and maps were kept from the beginning recording all findings.

Looked upon as a water pollution problem, a mine drainage study includes a thorough analysis of stream conditions to aid in determining the extent of the problem and to evaluate the problem's effect on the overall aquatic characteristics of the area. With this in mind, random water samples were collected and analyzed in early November, 1970, in an attempt

to become familiar with the water quality at various points within the watershed. Based on this analysis, thirty-six permanent water quality sampling stations were designated to monitor chemical characteristics. Stations were established near mine site locations, on all major tributaries and at intervals along the main stream where accessible from roads. Two additional increases in sampling stations, one in March, 1971, and the other in May, 1971, increased the number of stations to sixty and seventy respectively. The map in Figure 17 indicates the location of all sampling stations established throughout the watershed. Samples were collected at each station periodically throughout the project period and tested analytically for water quality. At some points, samples were taken once a week initially to determine if any short term fluctuations of importance could be detected. At those sampling stations where a net acidic condition prevailed, samples were continued at least once a month throughout the project period. Where consistent net alkaline conditions were observed, frequent sampling was discontinued to allow additional concentration in other phases of the project. Regular sampling was discontinued in May, 1972, however, additional samples were taken at various times at major stations and seep locations until early October, 1972. Nearly 1,900 water samples were taken and subjected to water quality tests during the 24 month period.

In order to secure flow data for use in computing the pounds per day discharge of the various pollutants, stream gaging stations were established at each of the permanent water quality sampling stations. A representative stream

channel cross-section was located at each point and a gage pole installed in the center of the stream. Each cross-section was then surveyed in detail to obtain a measure of the cross-sectional area, and the stream profile was surveyed to determine channel slope. Depth of flow was measured and recorded at the time of sampling and a rating curve was developed from current meter measurements. Periodic rechecks of the cross-sections were made along with velocity checks using the float method. On smaller tributary streams, particularly close to the AMD sources, V-notch sharp created weirs were installed to obtain more accurate flow measurements. The weir measurements were correlated with the gage pole measurements so that flow could be measured even when the weirs were not functioning, as happened several times when high flows washed them out. During high flows the Manning Equation for flow in open channels was used to obtain a flow estimate. The roughness factor was computed from data obtained during current meter velocity measurements. Road culvert hydraulics were also used to supplement and check flow values.

Water Quality Analytical Methods:

Water quality samples were collected in 500 ml. plastic bottles and were designated as to location, time and water temperature. The samples were returned to the laboratory as soon as possible and stored in a refrigerator. Analysis began within 24 hours using procedures adopted from "Standard Methods for the Examination of Water and Wastewater", 13th

Edition published by the American Public Health Association. The following water quality parameters were generally evaluated:

1. pH - This was measured using a Leeds and Northrup model 7411 pH meter. While pH is not a measure of the total acid content of a solution, it is useful because it has been correlated to other parameters in water quality analysis. In Pennsylvania, the acceptable limits for coal mine drainage are between a pH of 6.0 and 9.0.

2. Acidity - This was measured by cold titration using the Delta Scientific Model 410-T Titration Apparatus using 0.1 Normal sodium hydroxide solution, titrating to the pink phenolphthalien end point. The total acidity is a measure of the total amount of acid producing mineral salts present and is expressed as equivalent milligrams of Calcium Carbonate per liter.

3. Alkalinity - This was measured using the Delta Scientific Model 710-T Titration Apparatus using 0.1 Normal sulfuric acid, titrating to the pink methyl orange end point. The total alkalinity is a measure of the capacity of the water to neutralize acid and is expressed as equivalent milligrams per liter of Calcium Carbonate.

4. Iron (ferrous) - This was measured using the Delta Scientific Series 260 Analysis System employing photometric determinations. Iron concentrations change rapidly due to oxidation and hydrolysis so that samples taken for this measurement had to be acidified when first collected.

5. Sulfate - This was measured by the turbidimetric method using the Delta Scientific Series 260 Analysis System, precipitating the sulfate ion in a hydrochloric acid medium with barium chloride, resulting in the formation of barium sulfate crystals. Sulfate is the principal anion present in acid mine drainage and is probably the most stable and least changed after its formation.

Investigation of Acid Sources:

The Soil Conservation Service report was a detailed investigation of the individual mine sites in the watershed with recommendations for the elimination of excessive sedi-

ment discharges into the stream. It did not consider the problem of acid mine drainage. Beginning with the information supplied by the Soil Conservation Service, we reviewed the mine sites in detail with emphasis placed on acid sources and the condition of the mines in the source areas. Data from collected water samples of major point sources and ponded water on or around the mine was used to determine the size and strength of the acid discharges. This information, with pH analysis of mine spoils and considerable field observations, was used to develop the proposed abatement plan. Where the SCS recommendations did not appear adequate to abate the acid mine drainage problem, more extensive methods of restoration were recommended. Where sediment production appeared to be the only problem, no recommendations are made.

Although deep mining was practiced in the past in many parts of the Big Scrubgrass Creek Watershed, the extent was apparently small and few records of this mining were found. Maps of old deep mines prepared by the WPA during the 1930's were obtained where available in the watershed. Long-time residents of the area were interviewed to obtain their knowledge of old deep mine locations. Additional data on the possible location of deep mine openings were obtained from strip mine permit applications on file in the Department of Environmental Resources offices in Harrisburg.

From the data obtained in the stream water quality sampling program, acid mine drainage source areas were identified, and all known deep mines in these areas were investigated in the field. Where source areas indicated the possi-

bility of deep mine discharge but no other information was available, extensive field explorations were conducted and several unrecorded deep mine openings were located, In areas where stream water quality was good no extensive field investigations were made.

Where discharges from abandoned deep mine openings were observed in the field investigations, water quality samples were taken and flow measurements were made to determine the magnitude of each pollution source. No mine maps were found, and because of the small volumes of discharge involved, no field drilling programs were conducted at this stage. From the surface investigations and the water quality data, several mine openings were recommended for detailed investigation with possible hydraulic sealing.

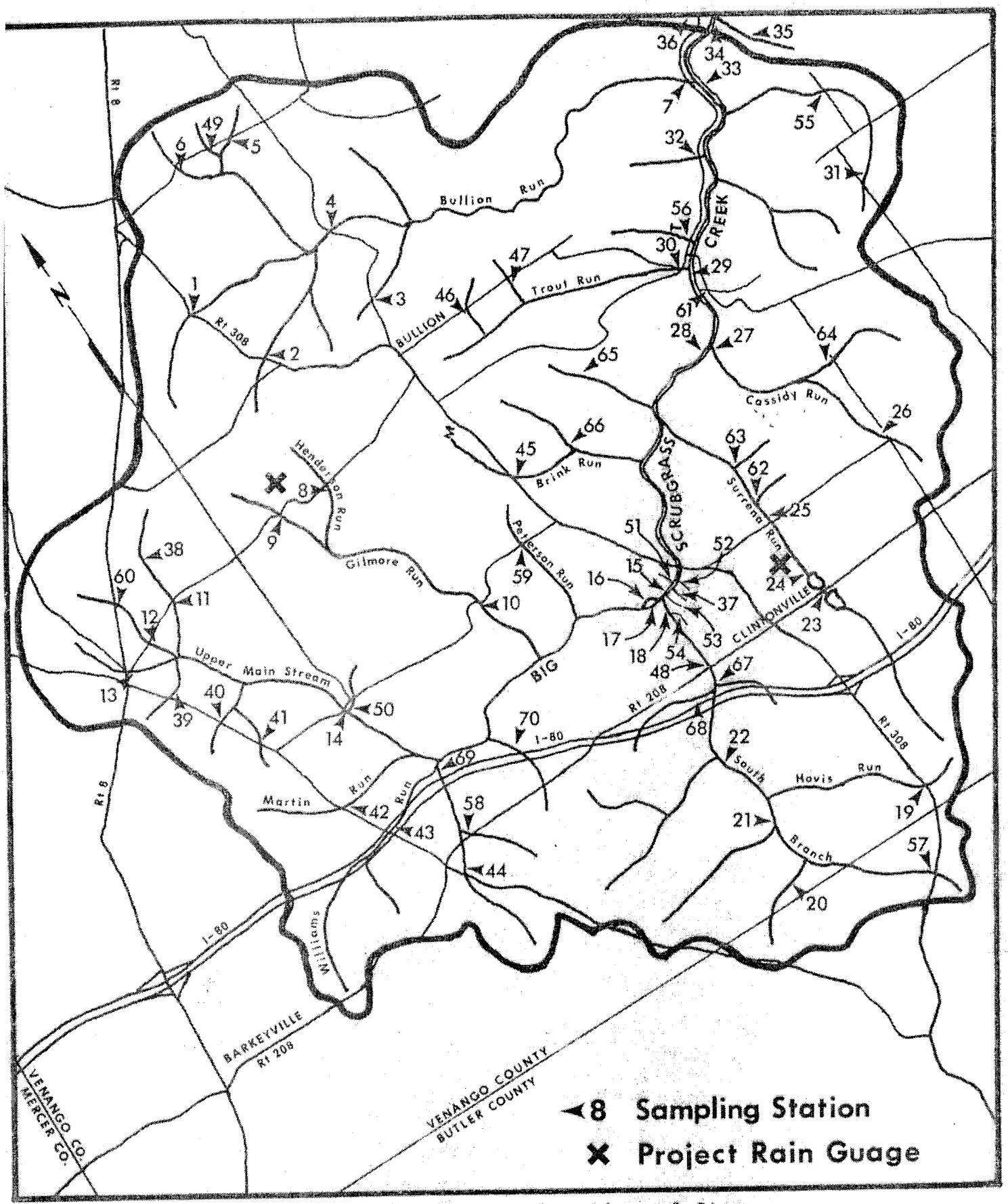

Figure 17. Watershed Map Showing Location of Stream Sampling Stations and Project Rain Gages.