

SECTION IV

PLAN OF WATERSHED STUDY AND REPORT

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The Loyalhanna Watershed Study Program was carried out to provide answers to the following questions:

- 1) What are the sources of the acid contamination entering Loyalhanna Creek?
- 2) How many pounds of acid are being discharged into Loyalhanna Creek and its tributaries per day and per year.
- 3) What potentially beneficial uses of the watershed are currently foregone because of the presence of acid contamination?
- 4) What degree of water quality improvement would be necessary to enjoy these potential benefits?
- 5) To achieve an upgrading of water quality in the watershed, which sources of acid mine pollution should be abated or treated?
- 6) What equivalent annual expenditure would be required to enjoy the benefits related to improved water quality?

SAMPLING PHASE

During the 18 month sampling period eight sampling stations were maintained

on Loyalhanna Creek to measure mainstream water quality. Every tributary to the creek was also periodically sampled to determine if it was a contributor to the mine acid pollution of the mainstream.

During the same period each known source of acid mine discharge was sampled to determine the quantity and strength of discharge. This dis

charge source survey utilized the findings of an investigation conducted by the Environmental Protection Administration in 1968 as an initial discharge inventory. Each EPA identified discharge was located and several newly located discharges were added to the inventory. Several discharges cited by the EPA study were found to have been altered, removed or were dry. The original STORET (STOrage and RETrieval of data for water quality control system) numbers given the sites were retained and additional sites were numbered within the system.

ANALYSIS PHASE

Each inventoried discharge was matched with its receiving stream and each stream exhibiting water quality characteristics indicating discharge from an acid mine drainage source was matched to sources within its watershed. With only one or two minor exceptions, which reflect instances of undetected subsurface seepage, each polluted tributary could be traced back to an inventoried discharge source. Each inventoried discharge was also referenced back to the appropriate mine seam map compiled by the Works Progress Administration (WPA) to determine its relative location within the mapped coal seams. As anticipated, each subsurface discharge was located at a coal outcrop line or in an area underlain by coal deposits. Surface discharges related to coal waste piles were also referenced to the WPA seam maps and were found to be in close proximity to former shafts, drifts and slope openings.

Further reference to the WPA coal seam maps indicated a degree of inter

connection between subsurface discharges located in common formations and confirmed the existence of a hierarchy of major and minor discharges which the source sampling data had inferred.

A correlation between acidity discharged throughout the watershed and acidity carried by Loyalhanna Creek as it drained the watershed was attempted. Within the limits of accuracy and representativeness possible through the use of instream sampling methods, the acidity measured instream compared favorably with those values of instream acidity predicted by the inventory of discharge sources except during periods of high stream flow when acidity from non-inventoried intermittent surface sources was also present. Factors tending to distort the results of instream sampling were: 1) incomplete mixing 2) stream flow stratification, 3) time and flow differentials between same day samples and 4) instream neutralization and oxidation of mine drainage. The major function of the attempted correlation was to insure that no major discharge source had been overlooked or omitted. A correlation between measured acidity and lowered pH in the pollution affected portions of Loyalhanna Creek and Reservoir was also made to determine the instream pH-acidity concentration relationship.

LITERATURE REVIEW PHASE

To augment the sampling and analysis phases of the study, additional data not observable or obtainable in the study area was required. This data need concerned: 1) relationships between acid mine drainage pollution and diminished water usability and 2) geologic and subsurface data not accessible in the field.

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Criteria establishing the water quality significance of various degrees of mine drainage pollution were obtained primarily from the findings of the Appalachian Regional Commission's Acid Mine Drainage Investigations.

Subsurface data not readily accessible in the study area was augmented with information from early mining records and published sources. The total reconnaissance of the study area was made difficult by the impossibility of on-site examination of the abandoned acid mine drainage producing coal mines. These mines, abandoned in many cases over 50 years ago were in most instances flooded and wholly or partially caved in and judged unsafe or impossible to enter. The publications of the Pennsylvania Geologic Survey and the records of the Department of Mines and Mineral Industries provided much of the information used to assess the probable conditions at these inaccessible sites.

ABATEMENT PLAN FORMULATION PHASE

At the completion of the sampling, literature review and analysis phases of the study, sufficient information had been acquired to determine:

1. The major water resource related needs of the watershed.
2. The degree of acid mine drainage abatement required to satisfy these needs.
3. The acid contribution of each discharge to the total watershed acidity.
4. The amenability of each acid source to recognized abatement techniques and treatment methods.

With this information alternate abatement plans were formulated and on a basis of reliability and economic analysis, the recommended plan was selected.

METHODS OF WATER QUALITY ANALYSIS

Sample analysis was performed in accordance with APHA's Standard Methods for the Examination of Water and Wastewater 12th Edition, 1965; ASTM Standards, Part 32; and FWPCA Standards for pH, Acidity and/or Alkalinity, Total Iron, Total Manganese, Total Aluminum, Calcium, Magnesium Hardness and Sulfates. Following is a brief description of the procedures:

1. pH - Electrometric determination using standard glass electrode in conjunction with a calomel electrode reference. The pH meter (Beckman Expandomatic) was standardized against three known buffers pH 4. 01, 7. 01 and 8. 03 before sample analysis.
2. Acidity - a 50 ml. sample is boiled for two minutes. The sample is then titrated with .02 Normal (N/50) sodium hydroxide to the phenolphthalein end point of pH 8. 3. The results are expressed as Mg/L (milligrams per liter) calcium carbonate equivalents.
3. Alkalinity - a 50 ml. sample is titrated with . 02 N sulfuric acid to the methyl orange end point or alternatively to the potentiometric end point of pH 4. 2.
4. Hardness: Calcium (Ca⁺⁺) Magnesium(Mg⁺⁺) is calculated from concentrations of Ca⁺⁺ and Mg⁺⁺ as found by atomic absorption spectrophotometry data (Ca⁺⁺ in mg/L x 2.5) + (Mg⁺⁺ in mg/L x 4. 12 = mg/L Hardness as CaCO₃).

5. Sulfate - Analyzed by the barium turbidimetric method. A 100 ml. aliquot is prepared and acidified with a glycerol - HCl mixture. Barium chloride is then added to the solution and -stirred for exactly one minute. The solution is transferred to a 50 ml. test tube and placed in the photometer. Readings are taken at 30 second intervals until a maximum absorption is reached. Sulfate concentrations are estimated by comparing the turbidity reading to a standard curve.
6. Iron - determined by utilization of Perkin-Elmer 290-B Atomic Absorption Spectrophotometer. The method used was that of additions to a measured volume of acidified sample in three 100 ml. volumetric flasks, increasing quantities of a standard iron solution were added to each and diluted to volume. The samples were then aspirated into the A. A. Flame, data plotted on graph paper and extrapolated to concentration base line. Results were obtained as mg/L total iron.
7. Manganese - manganese was determined using the same method as the iron analysis.
8. Aluminum was determined by the atomic absorption method of additions.