II WATERSHED INVESTIGATION

METHOD OF INVESTIGATION

The first phase in the investigation of the Anderson Creek Watershed was to conduct a general reconnaissance to establish the condition of each stream with respect to acid mine drainage. With the aid of 7.5 minute U.S.G.S. topographic maps the Watershed was divided into sub-watersheds to conduct the stream reconnaissance.

Water samples were collected during October and November of 1972 a short distance upstream from the confluence of each significant stream in the Watershed. (See Exhibit No. 4)

A total of 51 stream samples were collected during October and the cycle repeated during November. The samples were analyzed for pH, acidity, total iron, ferrous iron and sulfates. At the time of each sampling the flow of the streams was determined by measuring the cross section and estimating the velocity in order to calculate the total acid and iron loads contributed by each sub-watershed. (See Exhibit No. 5 for sample results.)

Review of the U.S.G.S. topographic maps indicated very little mining activity in the area north of the DuBois Reservoir and east of Anderson Creek. The initial reconnaissance and sampling substantiated this observation. Most of the samples for the streams north of the reservoir indicated a pH over 5 with very little acidity present. The sample results also verified the initial observation that the major mining activity was along Little Anderson Creek and Kratzer Run, identifying these areas as problem areas requiring an in-depth investigation.

The field investigation consisted of a thorough examination of all mined areas (both strip and deep mines) to locate acid discharges as well as an extensive search of the Watershed to locate smaller deep mines. Location and verification of strip mined areas and larger deep mines was simplified by the utilization of aerial photographs obtained from the Soil Stabilization and Conservation Service, United States Department of Agriculture.

The in-depth investigation included:

1. Initial reconnaissance of deep and strip mined areas to locate acid discharge points.
2. Contacting persons who might have mine maps or knowledge of mines.
3. Installation of 69 weirs to measure flows of known acid mine drainage discharges. See Exhibit No. 4 for sampling locations.
4. Location and sampling of deep mine refuse piles.
5. Monthly water sampling and flow measurements.
6. Meetings with the State Mine Inspector relative to establishing an accurate record of past mining activity in the area.
7. Geologic study and correlation of stratigraphic section and accompanying coal seams.

Tracings of mine maps were obtained for all of the major deep mines in the project area. For all of the many smaller drifts we were able to obtain only sketchy information from local residents, or in many cases, were able to find nothing at all. In researching the deep mines of the Watershed we spoke with representatives from several coal mining companies, clay companies, and mine inspectors, as well as numerous local residents. We also consulted representatives of the Soil. Conservation Services in Clearfield, and the Department of Environmental Resources at Reynoldsville.

Following the field procedures necessary to the completion of a thorough investigation we interpreted the findings with respect to individual mining areas. Evaluation of each area on an individual basis led to conclusions and recommendations specific to that particular area. A reclamation plan was then designed for each area.

Upon estimating the cost of enactment of the proposed plan the recommendations were evaluated relative to the approximate reclamation cost per pound of acid per day produced by the area. Using this figure as a judgmental criteria priorities were established for enactment of the various abatement measures. The cost per pound of acid abated was not the only criteria considered in establishing priorities for reclamation. Also considered in determining priorities were relative benefit to the receiving stream, overall reclamation cost, relative ease of reclamation, probability of complete abatement, and potential future development of coal or clay reserves in the immediate area.

ACID MINE DRAINAGE SOURCES

The sources of acid mine drainage and the discharges associated with each source are presented on pages 25 through 34. A total of 75 sampling points were established and are shown on PLATE 2. The number of actual discharges located was slightly higher than that figure but in some cases the flows of two or more discharges joined shortly after leaving the spoil or deep mine. In these cases one weir was placed at a point after the confluence of the discharges. Sixty-four 7 inch V-notch weirs were placed to measure flows. Five discharges had flows exceeding the capacity of the standard weirs and therefore, required the installation of larger rectangular weirs. One discharge was wide enough to make cross sectioning more feasible than trying to place a large weir. Three locations had discharges which were quite dissipated and had relatively low flows; in these cases the flows were estimated. One discharge had a permanent 60 degree V-notch weir already in place. In addition to the regular discharge sampling points samples were collected near the mouths of Little Anderson Creek, Kratzer Run, and Anderson Creek. The flows for those streams were calculated by cross sectioning.

Water samples were collected monthly beginning February 5, 1973. The water samples were analyzed by Gwin, Dobson, and Foreman, Inc. from February 1973 through September 1973 and thereafter by Buchart-Horn Laboratory, except for the initial stream samples taken during October and November, 1972, which were analyzed by Microbac Laboratories, Inc. The samples were analyzed for pH, acidity, alkalinity, total iron, ferrous iron, sulfate and aluminum (where suspected). The results of the monthly flow measurements and chemical analysis are shown on Exhibit No. 6, and a ranking of the various project areas with respect to acid loads are presented on Exhibit No. 7.

Area	Discharge Nos.	Source	Average Acidity (Ibs./day)
1	100	Acid mine drainage is flowing from one of a series of four collapsed deep mine openings.	3
II	101	Acid water is flowing from the entry of a deep mine. (Way Mine)	5
III	102	Spring	13
IV	103,104,105	This area has been deep and strip mined. Acid water is flowing from the collapsed deep mine entry and from the strip cuts.	34
V	106	This area has been deep and strip mined. Acid mine drainage flows from the area where the deep mine entry has been stripped out.	5
VI	107	Acid mine drainage at this location represents an accumulation of seepage from the spoil of an old strip mined area.	20

Area	Discharge Nos.	Source	Average Acidity (lbs./day)
VII	111	This area is primarily a strip mined area although there is a very small deep mine present. The acid mine drainage flows from a drainage cut.	3
VIII	113	The acid mine drainage at this location is flowing from an old deep mine entry.	11
IX	114	Acid mine drainage is flowing from one of two adjacent small deep mines.	5
X	112, 201, 202, 203	This area has been strip mined and there is presently an active stripping operation here. Acid water flows from a series of gravity drains.	8
XI	204	Acid water collects in a strip cut and seeps through the spoil, emerging as a single flow.	130

Area	Discharge Nos.	Source	Average Acidity (Ibs./day)
XII	206,207	Acid mine drainage seeps from the toe of the spoil in two spots at this strip mined area.	2
XIII	208	Surface water collects in the strip cut at the base of the highwall and passes through the spoil emerging at a single location.	1
XIV	209	Surface water collects in the strip cut at the base of the highwall and passes through the spoil emerging again and forming a pond from which it later flows.	18
XV	210	Acid mine drainage flows from one of two adjacent deep mine entries.	1
XVI	211-214	Acid drainage represents a collection of several discharges located along the length of the toe of the spoil of a massive strip mined area.	904

Area	Discharge Nos.	Source	Average Acidity (Ibs./day)
XVII	215,216	Surface water collects in a number of depressions in this strip area, filters through the spoil, and emerges as acid mine drainage.	91
XVIII	217,218	Acid mine drainage is seeping from the ground overlying an extensive deep mine. (Rankin Mine)	21
XIX	220,221	Acid mine drainage is flowing from two of eight entries to a large deep mine. (Widemire)	1086
XX	232	Acid water is draining off this recently completed strip mine operation.	1
XXI	237,239	Acid mine drainage is seeping from the spoil of this old stripped area.	5

Area	Discharge Nos.	Source	Average Acidity (Ibs./day)
XXII	241	Surface water collects in a small pond on this strip mined area and filters through the spoil, emerging as acid water.	4
XXIII	301	Acid water is discharging from the entry of a deep mine (Draucker #1) and at another location where later stripping has intersected or nearly intersected the deep mine workings.	1651
XXIV	301A	Acid mine drainage is flowing from the entry to this deep mine. (Draucker #2)	89
XXV	302	Acid water flows from the entry of this abandoned deep mine. (Pearce)	61

Area	Discharge Nos.	Source	Average Acidity (Ibs./day)
XXIX	305	Acid mine drainage is seeping from the ground in several places in this strip mined area. A recently completed stripping operation borders an older operation here.	397
XXX	306	Acid water represents surface runoff from a previously strip mined area.	1
XXXI	308	Acid drainage at this sampling point represents surface runoff from a strip mined area.	1
XXXII	309	Acid mine drainage is seeping from the ground in several places along the base of the spoil of this strip area.	85
XXXIII	312	Acid water derived from strip mine at its entry to Rock Run.	18

Area	Discharge Nos.	Source	Average Acidity (Ibs./day)
XXXIV	313,313A,315	Acid mine drainage seeps from the toe of the spoil of this strip mined area, in several places.	137
XXXV	316	Acid water at this location represents surface runoff from strip mined area.	7
XXXVI	317,320	This area has been extensively strip mined. Water collects in the strip cuts and flows through the spoil materials.	21
XXXVII	322,323,324	Acid water flows from strip cuts through surface drainage ditches and by seeping through the spoil.	47
XXXVIII	325	Acid water consists of surface runoff from the strip mine area.	-1 (1 Ibs./day Alk.)

Area	Discharge Nos.	Source	Average Acidity (Ibs./day)
XXXIX	330,352	This area has been extensively deep and strip mined. Acid water is flowing from one strip cut and from one stripped out deep mine (Spencer Mine) entry.	295
XL	332	Acid mine drainage flows from the spoil of this stripped area at one major discharge point.	17
XLI	334,335,336,337	Acid mine drainage is derived from strip mined area. Water seeps from spoil and surface water flows across and down spoil.	139
XLII	340	Acid mine drainage in this strip mined area consists of surface runoff and a limited amount of seepage.	3

Area	Discharge Nos.	Source	Average Acidity (Ibs./day)
XLIII	341,342,343	Acid water flows from a series of drainage ditches which serve to drain the strip cuts of this strip mine area.	184
XLIV	345	Surface water gathers in a pond formed by a strip cut and flows from the one end, through the cut.	38
XLV	346,346A,348A, 349	Acid flows, primarily as surface runoff from an old strip mine. Active operation presently in the area.	39
XLVI	329,350,351	This area was extensively deep mined (Korb Mine) and was stripped slightly at the entries. Acid water is flowing from three entries to the Korb deep mine and from an entry to the west end of the workings where it connects to the Spencer Mine.	1263

CONCLUSIONS ABOUT ACID MINE-DRAINAGE IN THE ANDERSON CREEK WATERSHED

The area north of the DuBois Reservoir and the area east of Anderson Creek have, for the most part, been left relatively unscathed by mining activity with the exception of a few areas immediately adjacent to the eastern bank of Anderson Creek. This area has been mined primarily for the Mercer clay. The remainder of the Watershed has been extensively deep and strip mined for both coal and clay. The majority of the acid mine drainage is coming from the inactive mines (coal and clay) of this area. The abandoned clay mines, particularly the deep mines, are perhaps the greatest contributors of acid to the streams of the Watershed.

Clay was mined at about 50 percent of the forty-six locations which showed discharges. All of the large deep mines in the study area were involved in the mining of the Mercer clay. These include the Widemire and Irvin Mines east of Stronach, the Rankin Mine along Route 219 about 1 mile south of Chestnut Grove, the Way Mine just north of Curwensville, the Draucker #1 and #2 Mines, the Pearce Mine, the Wingert Mine, and the Pentz Mine north of Chestnut Grove on the west side of Little Anderson Creek, and the Korb and Spencer Mines east of Chestnut Grove. The numerous smaller drifts were of both types coal and clay. The study area has been subjected to extensive strip mining. Strip mines remain in varied conditions ranging from moderately well reclaimed to completely unreclaimed. Acid water is discharging from several "reclaimed" areas as well as those which were not reclaimed. See Exhibit No. 8 for stream flows and analyses.

RELATIVE ACID CONTRIBUTION OF CLAY VS. COAL MINES AND STRIP VS. DEEP MINES

	Strip Mined	Deep Mined	Strip & Deep Mined	Total	
Coal	1891.8 (25%)	6.0 (-1%)	3.0 (<1%)	1900.8 (25%)	lbday
Clay	397.3 (5%)	2539.0 (33%)	334.4 (4%)	3270.7 (42%)	lbday
Coal & Clay	9.3 (<1%)	0 (0%)	2436.0 (33%)	2445.3 (33%)	lbday
Total	2298.4 (30%)	2545.0 (33%)	2773.4 (37%)	7616.8 (100%)	lbday

A large percentage of the total acid discharging into the streams of the Watershed is coming from a relatively small number of discharges. Six discharges (nos. 211, 220, 301, 303, 305 & 329) account for approximately 72.2% of the acid and fourteen discharges (211, 220, 301, 303, 305, 329, 204, 215, 301A, 304, 309, 334, 350 & 352) constitute 88.0% of the total recorded acid discharged daily. It becomes immediately apparent that the abatement of acid discharge at any of these locations, particularly any of the six major discharges, would appreciably improve the water quality of Anderson Creek. A Seasonal Discharge Record is included with the specific reclamation project description for each of the 14 major discharges.

The deep mine refuse piles within the study area represent a periodic source of acid mine drainage. These refuse piles are composed primarily of low grade coal and carbonaceous shale. Under dry conditions these refuse piles do not emit any acid mine drainage; however, during rainy periods surface water percolates through the pile contacting acid producing materials and emerging as acid mine drainage. See Exhibit No. 9 for relative acid producing potential of refuse piles in the Watershed.

Although there are few mining operations or mined areas north of the DuBois Reservoir in the Watershed, the streams in this portion of the study area are not free of acid. The streams are polluted by acid from two natural sources. First, decaying organic matter produces acid which has affected these streams. This type of acid is commonly prevalent in the headwaters of a stream where large areas of swampland exist. In addition to these organic acids the streams are polluted by "natural acidity" inherent to the rocks comprising the geologic column of the area. See PLATE 5 for relative acidity of the streams of the Watershed.

The sediments in the formation of these rocks were deposited in either aerobic or anaerobic environments. Under aerobic conditions, that is, in well oxygenated water, accumulating vegetable matter was oxidized and ultimately converted to water and carbon dioxide. The iron present, if any, reached the ferric state. Rocks formed with the ferric iron present maintained a reddish color.

Anaerobic bacteria functioned in poorly oxygenated environments. Vegetable matter deposited in this stagnant water decayed after quickly depleting dissolved oxygen, by a slow process of anaerobic distillation. Oxygen bearing materials such as sulfates provided the needed oxygen producing hydrogen sulfide as the end product. This hydrogen sulfide reacts with the soluble iron compounds to form a disulfide which precipitates as pyrite. Coal was generally formed in association with the pyrite as the organic matter present decayed. In some areas, however, there was not sufficient vegetable matter present to form coal, and the pyrite was deposited into the sediments producing a source for future "natural acidity." This pyrite, when oxidized, forms sulfuric acid which results in acid soils and water.