II WATERSHED INVESTIGATION

METHOD OF INVESTIGATION

The first phase in the investigation of the Mill Creek Watershed was to conduct a general reconnaissance to establish the condition of each stream with respect to acid mine drainage. Also included under the initial phase of investigation was to locate all acid mine drainage discharges in the watershed.

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 April 1975 a short distance upstream from the mouth of each significant stream in the watershed. A total of 53 stream samples were collected during this preliminary sampling. The samples were analyzed for pH, acidity, alkalinity, total iron, ferrous iron, and sulfates, At the time of each sampling the flow of the stream was determined by measuring the cross section and obtaining velocities with the use of a Price-type flow meter and a field pH reading was taken. The calculated flows were then used to determine chemical loadings in pounds per day. The formation of stage-discharge relationships for each stream aided in subsequent calculation of stream flows.

A total of 89 sampling and flow measurement stations for acid mine drainage discharges were established. The number of actual discharges located was slightly higher than that figure but in several cases the flows of two or more discharges joined shortly after leaving the source area. In these cases one weir was placed at a point after the confluence of the discharges. A total of seventy-five 7 inch 90 degree V-notch weirs were placed to measure flows from the acid mine drainage discharges. Several of the discharges were wide enough to make weiring impractical. In these cases flows were calculated by measuring the cross-sectional flow area and obtaining a velocity with a Price-type flowmeter.

Seventy-one stream monitoring stations were established to indicate acid input areas. Flow at most of these stations was determined by measuring the cross-sectional area and using a velocity determined with a Price-type flowmeter. Seven of the streams were small enough to allow placement of a 90 degree V-notch weir for flow measurement. Forty-six of the streams were eventually designated as permanent stations to be monitored monthly throughout the remainder of the study. Of these forty-six streams, ten were selected as WAMIS stations.

Regular monthly samples were collected beginning May 6, 1915. The water samples collected during April, May, and June 1975 were analyzed by Buchart Horn Laboratory. The samples collected during July and August were analyzed by the Pennsylvania Department of Water Quality Laboratory, and those during the remainder of the study by Green International. The samples were analyzed for pH, acidity, alkalinity, total iron, ferrous iron, and sulfates. During the period of time that the Pennsylvania Department of Water Quality Laboratory analyzed the samples, they were not tested for ferrous iron.

The field investigation consisted of a thorough examination of all mined areas, both strip and deep mines, to locate all acid discharges. The locations of all known gas wells were checked in the field to determine whether acid discharges were evident. Location and verification of strip mined areas and larger deep mines were 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. An extensive field investigation was conducted at each discharge location to determine the origin, condition, and possible abatement method for each.

2. A total of 75 weirs and 14 gauging stations were installed to measure flows at known acid mine drainage discharges.

3. Water samples were collected and flows calculated for a 12 month

period at discharge locations and stream stations.

4. An intensive geologic study was conducted to correlate the stratigraphic section and accompanying coal seams. This phase included a search of available literature and the related field investigation and correlation.

5. A field investigation was conducted to locate all deep mine refuse piles.

6. Meetings were held with the State Mine Inspectors relative to establishing an accurate record of past mining activity in the area.

7. Meetings were held with the personnel at the U.S.G.S field office in Clarion pursuant to obtaining locations of discharging gas wells. Gas wells not previously located were checked in the field.

8. All persons who might have mine maps or knowledge of mining activities were contacted.

There were no major deep mine complexes located in the watershed. Only sketchy information was obtained for the small drifts which were located. A map was located for a small drift located adjacent to Area XXIII, the Mays Mine. Most of the workings of this mine have been stripped out. In researching the deep mines of the watershed, representatives of several coal mining companies, mine inspectors, and numerous local residents were questioned.

Following the data collection and field investigation phases, 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 the reclamation of that particular area. Abatement measures were then formulated for each area and presented on a project map.

Upon estimating the cost of implementing the proposed abatement measures, each area was evaluated relative to the approximate reclamation cost per pound of acid per day abated of the total produced by the area. Using this figure as a judgemental 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, length of stream returned to a habitat suitable for aquatic life, overall reclamation cost, relative ease of reclamation, probability of complete abatement, and potential future development of remaining coal or clay reserves in the immediate area.

ACID MINE DRAINAGE SOURCES

Acid mine drainage discharges were discovered from a variety of sources including strip mines, deep mines, and gas wells. In addition, "natural acidity" was present in the discharges of numerous springs throughout the watershed. A list of the acid mine drainage discharges and their sources appears on pages 24 through 32. Mine Drainage Permit indicates potential industry interest in the abandoned mines and should be checked prior to initiating a project.

Area	Discharge Nos.	Mine Drainage Permit	Source	Average Acidity (lbs/day)	Average Total Fe (lbs/day)
I	103, 104, 105, 106	3676SM39 Glacial Minerals, Inc.	Acid mine drainage flows from three gravity drains cut through the spoils of this strip mined area, and in one. place seeps out at the outside toe of spoil.	200	2.8
II	107, 108	None	A stream flows into this strip mined area forming a series of ponds from which acid mine drainage discharges by overflow and seepage through the adjacent spoil.	13	2.3
III.	109, 110	None	Acid mine drainage discharges from two cuts through the spoil of this strip mine.	255	1.9

Area	Discharge Nos.	Mine Drainage Permit	Source	Average Acidity (lbs/day)	Average Total Fe (lbs/day)
IV	111	None	This spring discharges a high iron flow.	-18	3.4
V	112, 178	2767BSM8 H & G Coal and Clay Co.	Acid mine drainage seeps from two places in this fairly recent strip mine.	2.6	.66
VI	113, 114	2767BSM8 H & G Coal and Clay Co.	Acid water overflows from a strip mine impoundment and discharges from an adjacent strip cut.	-6.7	.12
VII	115	2767BSM8 H & G Coal and Clay Co.	Acid mine drainage discharges from an abandoned strip mine cut.	17	.49
VIII	118, 47	2768BSM11 H & G Coal and Clay Co.	Minor acid seepage from a recent strip mine is monitored at the receiving stream.	-27	1.9
IX	119	None	Acid mine drainage seeps from a low-lying area of a strip mine.	41	3.6

Area	Discharge Nos.	Mine Drainage Permit	Source	Average Acidity (lbs/day)	Average Total Fe (lbs/day)
X	120, 121	3675SM27 Mauersberg Coal Co. 3676SM21 W. P. Stahlman Coal Co.	Acid water drains into a roadside ditch from an old strip mine and joins surface runoff from an adjacent area of exposed carbonaceous shale.	9.5	.21
XI	122	3675SM27 Mauersberg Coal Co. 3676SM21 W. P. Stahlman Coal Co.	Acid drainage originates from a major point source in a barren strip mine.	106	11
XII	123, 124	3676SM21 W. P. Stahlman Coal Co.	Acid mine drainage consists of a small amount of seepage from the outer toe of a large strip mine and surface runoff from the area.	28	.21
XIII	125	3676SM21 W. P. Stahlman Coal Co.	Acid water originates as surface runoff from an old strip mine area.	17	.40
XIV	126	3674SM14 Zacherl Coal Co.	Tributary to Jones Run has been stripped out. No point sources were located.	Too Dissipated	

Area	Discharge Nos.	Mine Drainage Permit	Source	Average Acidity (lbs/day)	Average Total Fe (lbs/day)
XV	127, 128, 129, 131	3676SM21 W. P. Stahlman Coal Co.	Unnamed tributary flows through a strip mine area receiving acid mine drainage from four discharges.	236	10
XVI	130	None	Acid discharge from the side of a moderately reforested strip mine.	147	1.8
XVII	132, 133	None	Two spring-like discharges break out of spoil banks in a strip mine.	711	11
XVIII	134	None	Acid mine drainage seeps from the end of an elongate hillside strip cut.	5.4	.09
XIX	135, 136	None	Acid water originates primarily as surface runoff from an abandoned strip mine.	33	.63
XX	137, 180, 40	2765BSM35 James Kerle Coal Co. 3767BSM12 W. P. Stahlman Coal Co.	Acid mine drainage flows from an abandoned drift which apparently serves to drain an upslope strip mine.	266	18

Area	Discharge Nos.	Mine Drainage Permit	Source	Average Acidity (lbs/day)	Average Total Fe (lbs/day)
XXI	138	None	Acid discharge flows from an apparent drift.	12	.06
XXII	139, 140	None	Two small discharges emanate from the outer slopes of a large barren strip mine.	7	.05
XXIII	141	Refuse Area Permit 500086 W. P. Stahlman Coal Co.	A large pond fed by strip mine and deep mine subsurface flows as well as surface runoff discharges acid water.	4	.58
XXIV	142, 143	None	Springs located downslope of strip mine.	1	.16
XXV	144	None	Acid water discharges from the side of spoil of this strip mine.	110	2.2
XXVI	145, 146, 147, 148, 149, 150, 151, 152, 153	None	A series of discharges located around the periphery of a hillside strip mine.	90	1.1
XXVII	154, 155, 156, 157	19105 W. Paul Glenn	A series of discharges apparently related to water impounded in the deep, narrow strip cuts.	14	.36

Area	Discharge Nos.	Mine Drainage Permit	Source	Average Acidity (lbs/day)	Average Total Fe (lbs/day)
XXVIII	158	3067BSM10 James Kerle Coal Co.	Acid water periodically discharges from a strip mine impoundment.	0	0
XXIX	159, 160	19105 W. Paul Glenn 3874SM2 R.E.M. Coal Co., Inc.	Acid mine drainage discharges from a partially reclaimed strip mine.	123	1.9
XXX	161	3776SM6 W. P. Stahlman Coal Co.	Mine drainage discharges along the road adjacent to a heavily forested strip mine.	1	.02
XXXI	162	3066BSM26 H&G Coal & Clay Co. 3874SM44 R.E.M. Coal Co., Inc.	Single discharge of mine drainage originates in highwall impoundment in this unreclaimed strip mine.	13	.17
XXXII	163, 165	38A76SM26 C & K Coal Co.	A small flow of acid mine drainage seeps from the eastern end of a large strip mine and from a widespread marshy area draining the alledged site of an old deep mine.	146	4.5

Area	Discharge Nos.	Mine Drainage Permit	Source	Average Acidity (lbs/day)	Average Total Fe (lbs/day)
XXXIII	164	None	Drainage from a unreclaimed strip mine breaks out in a roadside ditch.	36	.17
XXXIV	166, 168, 170 171, 172	3067BSM35 38A76SM14 W. P. Stahlman Coal Co.	Hilltop strip mine and old deep mine are responsible for several small discharges of acid water.	28	.07
XXXV	167	3067BSM34 W. P. Stahlman Coal Co. 3874SM19 Bracken Construction Co.	A single discharge originates in this old strip mine which is now the site of an active operation.	4	0
XXXVI	169	3067BSM35 W. P. Stahlman Coal Co.	Springlike discharge of acid water is apparently related to this old strip mine.	17	.10
XXXVII	173	3067BSM26 H&G Coal & Clay Co.	One small discharge flows from this recent strip mine.	0	.01

Area	Discharge Nos.	Mine Drainage Permit	Source	Average Acidity (lbs/day)	Average Total Fe (lbs/day)
XXXVIII	174, 175	19105 W. Paul Glenn 3067BSM10 James F. Kerle 3874SM2 R.E.M. Coal Co., Inc.	A stream flows through this strip mine, becomes acidic, and is joined by another adjacent acid discharge.	65	11.9
XXXIX	176, 177, 181	3067BSM26 H & G Coal & Clay Co. 3067BSM34 W. P. Stahlman Coal Co.	Three large discharges of acid water break out from the toe of spoil of this recent strip mine.	1125	897
XL	179	2765BSM35 James Kerle Coal Co. 2767BSM12 W.P. Stahlman Coal Co. 3675SM66 Midway Resources, Inc.	A small discharge of acid mine drainage breaks out of the lower slopes of a strip mine.	24	3.5
XLI	182, 187	3067BSM26 H & G Coal & Clay Co. 3067BSM34 W.P. Stahlman Coal Co. 3874SM19 Bracken Const. Co.	Widespread seepage of acid water seeps from the edge of this recent strip mine.	15	4.9

Area	Discharge Nos.	Mine Drainage Permit	Source	Average Acidity (lbs/day)	Average Total Fe (lbs/day)
XLII	183	3874SM44 R.E.M. Coal Co.	Discharge from a small drift	0	.10
XLIII	184, 185, 203	None	Gas Well	est. 246	est. 72
XLIV	186	None	Gas Well	0	.11
XLV	101, 188	None	Gas Wells	est. 58	est. 26
	201, 202, 204, 207, 208, 209 210, 211, 212 213, 214, 215 216		These discharges originate in abandoned gas wells but were not included as potential reclamation projects due to their water quality and flow characteristics. Only discharge 214 exhibited a net acidity of any magnitude and this discharge had only small and intermittent flows. Most of the discharges were alkaline.		

CONCLUSIONS ABOUT ACID MINE DRAINAGE IN THE MILL CREEK WATERSHED

The area north of Mill. Creek has, for the most part, been left unscathed by mining activity with only a few small strip mines in evidence. Field investigation have revealed less than 100 acres of strip mined land in the watershed north of Mill Creek. In sharp contrast, the area south of Mill Creek has had a significant amount of mining activity with over 2000 acres being mined. Mining activity on the watershed has been limited to coal with no evidence of the mining of underclays or flint clay for refractories as is common farther east. The coal seams mined include the Mercer, Brookville, Lower Clarion, Upper Clarion, Lower Kittanning and Middle Kittanning. Nearly all coal mined on the watershed was removed by strip mining. Only about half a dozen small drifts were located with no evidence of significant underground workings. Another source of acid mine drainage is abandoned gas wells. Several discharging wells were located on the watershed. Discharges #185 and #186 were gas wells which had been sealed several years ago under a Department of Environmental Resources Project SL 133-1. They are, at this time, discharging again. In all, acid production from deep mines and gas wells is small, representing only about 10% of the total recorded load from mining sources.

To gain some insight into the concentration of acid mine drainage, in certain portions of the watershed one need only look at the mine drainage loadings by subwatershed.

Whites Run

Area	Discharges	Acidity (lbs/day)	Total Fe (lbs/day)
I	103,104,105,106	200	2.8
II	107,108	13	2.3
III	109,110	255	1.9
IX	119	41	3.6
	Totals	509	10.6
	% of Total	10.4%	0.9%

Jones Run

Area	Discharges (lbs/day)	Acidity (lbs/day)	Total Fe (lbs/day)
XI	122	106	11
XII	123, 124	28	.21
XIII	125	17	.40
XIV	12E, 12F	758	100
xv	127, 128, 129, 131, 30	236	10
XVI	130	147	1.8
XVII	132, 133	711	11
XIX	135, 136	33	.63
	Totals	2036	135
	% of Total	41.6%	11.3%

Douglass Run

Area	Discharges (lbs/day)	Acidity (lbs/day)	Total Fe (lbs/day)
XVIII	134	5.4	.09
xx	137, 180, 40	266	18
XXI	138	12	.06
XXII	139, 140	7	.05
XL	179	24	3.5
Totals		281	20
of Total		5.7%	1.7%

Little Mill Creek

Area	Discharges	Acidity (lbs/day)	Total Fe (lbs/day)
XXIII	141	4	58
XXIV	142, 143	1	.16
XXV	144	110	2.2
XXVI	145, 146-147, 148-149 150, 151, 152, 153	90	1.1
XXVII	154, 155, 156, 157	14	.36
XXVIII	158	0	0
XXIX	159, 160	123	1.9
XXX	161	1	.02
XXXII	163, 165	146	4.5
XXXIV	166, 168, 170, 171, 172	28	.07
XXXV	167	3.6	0
XXVI	169	17	.10
XXXVII	173	0	.01
XXXVIII	174, 175	65	11.9
XXXIX	176, 177, 181	1125	897
XLI	182, 187	15	4.9
XLII	183	0	.10
XLIII	184, 185, 203	est. 246	est. 72
XLIV	186	0	.11
Totals		1989	993
% of Total		40.6%	83.3%

Mill Creek (direct or through tributaries other than those already listed)

Area	Discharges	Acidity(lbs/day)	Total Fe(lbs/day)
IV	111	-18	3.4
V	112,178	2.6	.66
VI	113,114	-6.7	.12
VII	115	17	.49
VIII	47 (118)	-27	1.9
X	120, 121	9.5	.21
XXXI	162	13	.17
XXXIII	164	36	.17
XLV	101,188	est. 58	est. 26
	TOTAL	84	33
	% OF TOTAL	1.7%	2.8%

As indicated, the sub watersheds of Jones Run and Little Mill Creek are the principal problem areas contributing 82% of the total acid load entering Mill Creek from mining sources. Several major source areas located on either Jones Run or Little Mill Creek constitute a major portion of the total acid input into Mill Creek. Area XXXIX on Little Mill Creek and Areas XIV, XV, and XVII on Jones Run contribute a combined acid load of 2830 lbs/day or 58% of the total input. Abatement of acid at these locations would constitute a significant step toward the ultimate reclamation of Mill Creek.

Area XXXIX is a part of the Immediate Action Program outlined later in the report although the condition of this area will require the use of unorthodox reclamation measures as there are no obvious conventional methods available. Much of Area XIV is covered by an active mine drainage permit 3674SM14 issued to the Zacherl Coal Company and efforts should be made to incorporate reclamation of this area with the Zacherl mining and reclamation plan. Area XV is not a high priority project due to a price tag in excess of $200,000 an projected abatement cost of over $1700 per lb. of acid abated. Area XVII is included under the Immediate Action Program.

In contrast to these sub-watersheds Whites Run has only four source areas - located. The two major Areas I and III contribute nearly 500 lbs. of acid daily to Whites Run. Reclamation of these two areas would be quite reasonable with estimated costs of $97,300 and $27,900 respectively. Abatement of the acid mine drainage from these two areas would have a significant impact on the water quality of Whites Run, hence these projects were assigned high priorities.

It should be noted that the sum of acid loads from the observed acid mine drainage discharges does not equal the recorded acid loads at the mouths of the various tributaries.. There are several probable explanations for this.---One possible introduction of error, which is procedural, is the fact that due to the length of sampling period, generally one to. two weeks, there is quite often a considerable time difference between the stream sampling and the sampling of its discharges. This means that the samples are frequently taken under varying flow conditions. Of much greater significance is the production and input of "natural acidity" into the stream of the watershed. Natural acidity is derived from two 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 marshy areas exist. In addition to these organic acids the streams are polluted to a far greater degree by "natural acidity" inherent to the rocks comprising the geologic column of the area. The sandstones and shales contain acid-producing pyritic materials much the same as the coals and underclays . Acid drainage is introduced both as surface flow from innumerable sandstone springs in the watershed and from groundwater input to the streams,

The sediments involved in the lithification 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 in the sediments producing a source for future "natural acidity." This pyrite, when oxidized, forms sulfuric acid which results in the pollution of both ground and surface waters.