

ANALYSIS OF STREAM QUALITY

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Introduction:

The earliest available water quality records for Big Scrubgrass Creek date back to April 25, 1956, when the Pennsylvania Fish Commission investigated a report of acid mine pollution in the stream. The data from that investigation is incomplete. However, it was noted that a definite acid mine drainage problem did exist with a pH value on the main stream of 5.8. Mr. Robert B. Hesser, Aquatic Biologist with the Fish Commission noted that the Big Scrubgrass was stocked with trout for nearly 30 years prior to this time, and was considered to be one of the best trout streams in northwestern Pennsylvania. The stream possessed all the criteria for trout to survive, reproduce and grow; high quality water, low water temperature, high oxygen content and net alkaline conditions. With credentials such as these, to collect and analyze water quality samples seemed almost superfluous, even the Fish Commission maintained no water quality records for the Big Scrubgrass. From this date on, however, the Fish Commission kept the stream under surveillance, noting that the acid problem originated from active strip mining operations in the headwaters region. It was felt that the stream would recover naturally if action was taken to have the coal operators handle their discharge in a proper manner. With this in mind, Big Scrubgrass was kept on the stocking list but would only be stocked if water quality evaluations proved feasible.

On August 15, 1958, a more thorough examination of the effects of mine drainage of Big Scrubgrass Creek was made. The filed report indicated the stream was void of any aquatic insect life and the physical appearance was turbid with evidence of heavy iron precipitation and oil slicks on the stream bottom. The pH data did reveal though that the stream had recovered itself to the extent that it was to be tentatively placed on the 1959 stocking list. The table below indicates the pH results of the samples taken on August 15, 1958.

TABLE 6
Water Quality Data - 1958 - Pa. Fish Commission

	1958 pH <u>Data</u>
1. Bridge T-325 (Station No. 14)	6.6
2. Bridge Rt. 308 (Station No. 15)	6.9
3. Bridge L.R. 60010 (Station No. 28)	6.8
4. Bridge L.R. 60007 (Station No. 33)	7.1
5. Mouth Trout Run (Station No. 30)	3.9
6. Mouth Bullion Run (Station No. 7)	5.9

The following year as the trout season approached, again a stream analysis was made. Data indicated a decrease in water quality. At the Rt. 308 bridge (Station No. 15) the pH had dropped from 6.9 to 5.5, the sample taken at the T-325 bridge (Station No. 14) indicated a pH drop from 6.6 to 5.0 and the pH at the L.R. 60007 bridge (Station No. 33) had fallen from 7.1 to 6.2. With these results, the decision was made to cancel the 1959 stocking. Big Scrubgrass was still not officially declared polluted, however, all facts indicated it as being such.

An experimental stocking of 400 trout was planned in early April, 1960, but was cancelled. Indicated pH levels for the entire length of the stream ran between 5.1 and 5.2, necessitating the cancellation. At this time, the stream was permanently removed from the active stocking list and was officially declared polluted.

In 1969, the Appalachia Regional Commission published a report on "The Incidence and Formation of Mine Drainage in Appalachia". The analysis of six water samples collected at the mouth of Big Scrubgrass Creek was included in the report. Listed below are the average, maximum and minimum water quality values of the six samples.

TABLE 7
Water Quality Data for Big Scrubgrass Creek
Appalachia Regional Commission

	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
Flow (gpm)	6100.0	7180.0	4850.0
pH		7.5	4.8
Total Acidity (ppm)	24.8	49.0	10.0
Alkalinity (ppm)	7.3	16.0	3.0
Iron (ppm)	2.0	4.3	0.3
Sulfates (ppm)	219.2	260.0	150.0

It is interesting to note the flow values in the above data. These samples were undoubtedly collected during a period of extremely low flow since the average rate reported would represent only 4.6 inches per year runoff from the watershed; no dates were given with the chemical analysis.

In an effort to study in detail the effects of acid mine drainage on stream quality in Big Scrubgrass Creek, the Pennsylvania Department of Environmental Resources, formerly

the Department of Mines and Mineral Industries, awarded a contract to Pantech Engineers, Inc., for the engineering survey. The present study covered a period from October, 1970, to August, 1972, during which time water quality samples were taken at seventy sampling stations throughout the watershed to determine the magnitude and seasonal variation of the stream pollution and the exact location of the sources in order to plan a pollution abatement program.

Acid mine drainage becomes a pollution problem identified with water quality downstream from the source. The correlation between water quality and mine drainage is explained adequately in the definition of mine drainage provided by the Appalachia Regional Commission. "Mine drainage is surface or groundwater flowing through or from mines and mine sites. It is usually characterized by concentrations of acidity or alkalinity, iron, manganese, aluminum, sulfates and sediment. Of these constituents, acid mine drainage is the most significant since it effects water use to the greatest extent."

By obtaining periodic samples of the surface flows as was done in this project, it is very unlikely that short term fluctuations in water quality could be detected. Yet these short term fluctuations, on the order of several hours duration, can have a significant effect on the aquatic life of the watershed. Since most acid forms on the surface, and water is required to transport it to the streams, it is reasonable to assume that the first runoff from a storm would contain a slug of acid which might be extremely concentrated

but would be of such short duration it could only be detected by continuous monitoring. There is also some evidence to suggest that the acid contained in the local runoff from light rainfall on small drainage areas may accumulate in pools that are then flushed out by larger storms, producing a slug of acid in the streams. Again, these slugs could only be detected by continuous monitoring.

It was impossible to accurately distinguish between the pollution contained in direct surface runoff and pollution from seepage water which percolated through the mine spoil. Both undoubtedly contribute to the problem. However, stream quality data on the major tributaries points to surface runoff as the most important cause of pollution with strip mines as the most important source.

The criteria used for classifying streams in this project is listed below:

Predominantly Acid - Acidity greater than alkalinity.

Variable - The term variable is used here as a definition of a water quality standard (Net alkalinity 20 ppm or less) indicating net alkaline conditions but being so close to neutral that short term fluctuations may cause acid conditions.

Predominantly Alkaline - Net alkalinity greater than 20 ppm with the lower limit of alkalinity being such that short term fluctuations would still maintain net alkaline conditions.

Maps showing acid content during high, average and low flow periods are shown in Figures 18, 19 and 20.

Major Findings:

The most pronounced major finding of the overall stream quality investigation was that the discharge water quality at

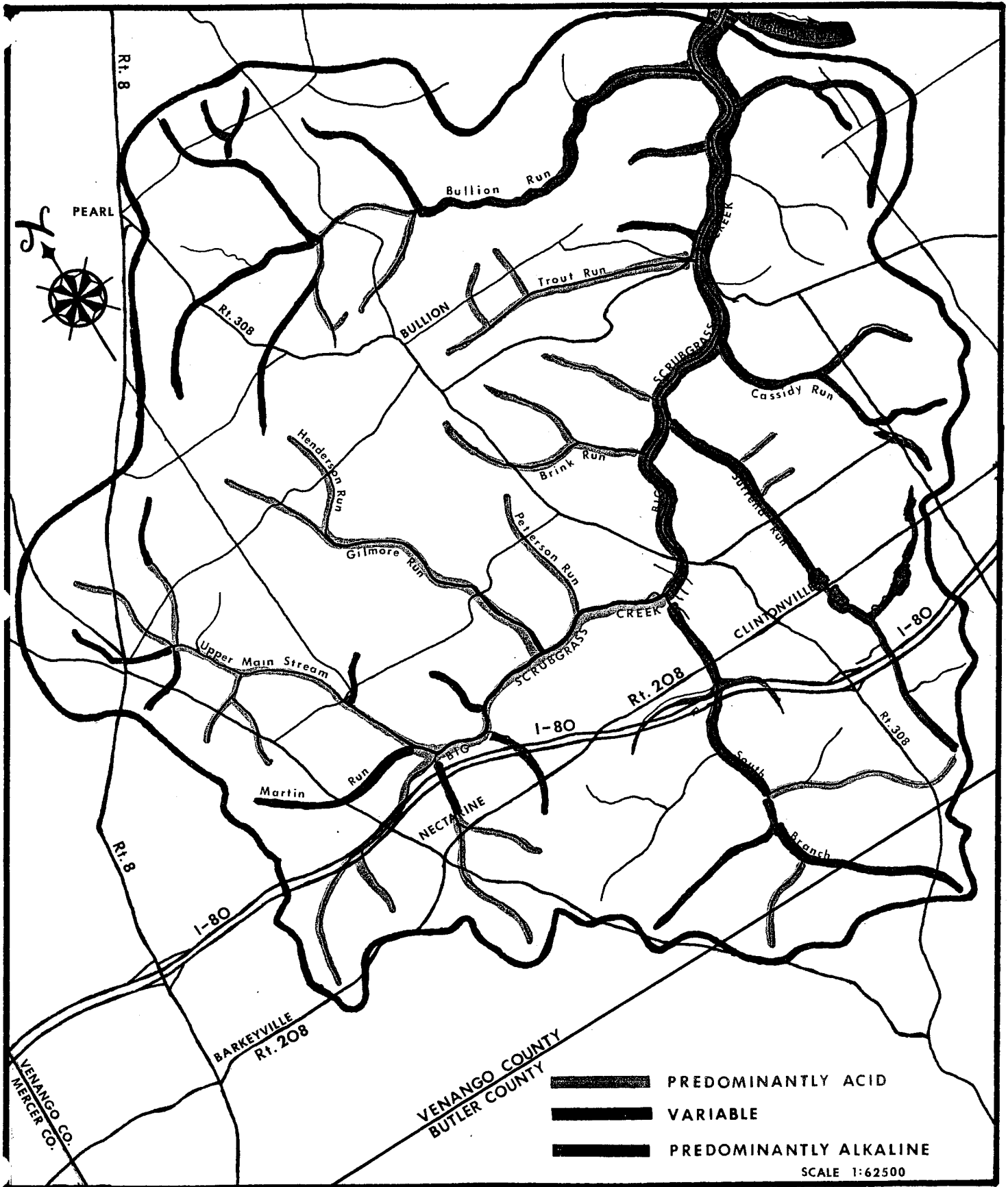


FIGURE 18 **BIG SCRUBGRASS CREEK
HIGH FLOW SCHEMATIC**

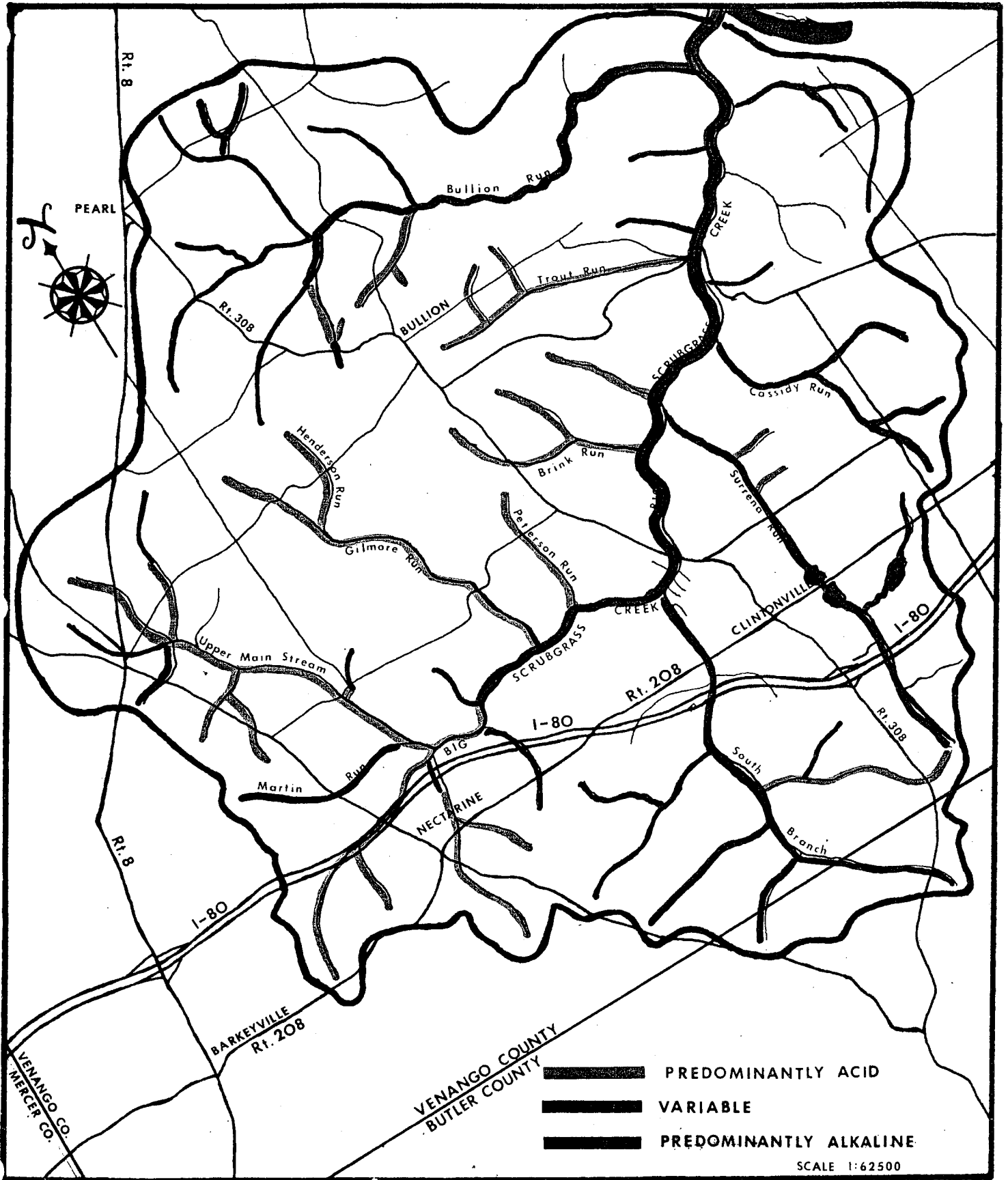


FIGURE 19 **BIG SCRUBGRASS CREEK
AVERAGE FLOW SCHEMATIC**

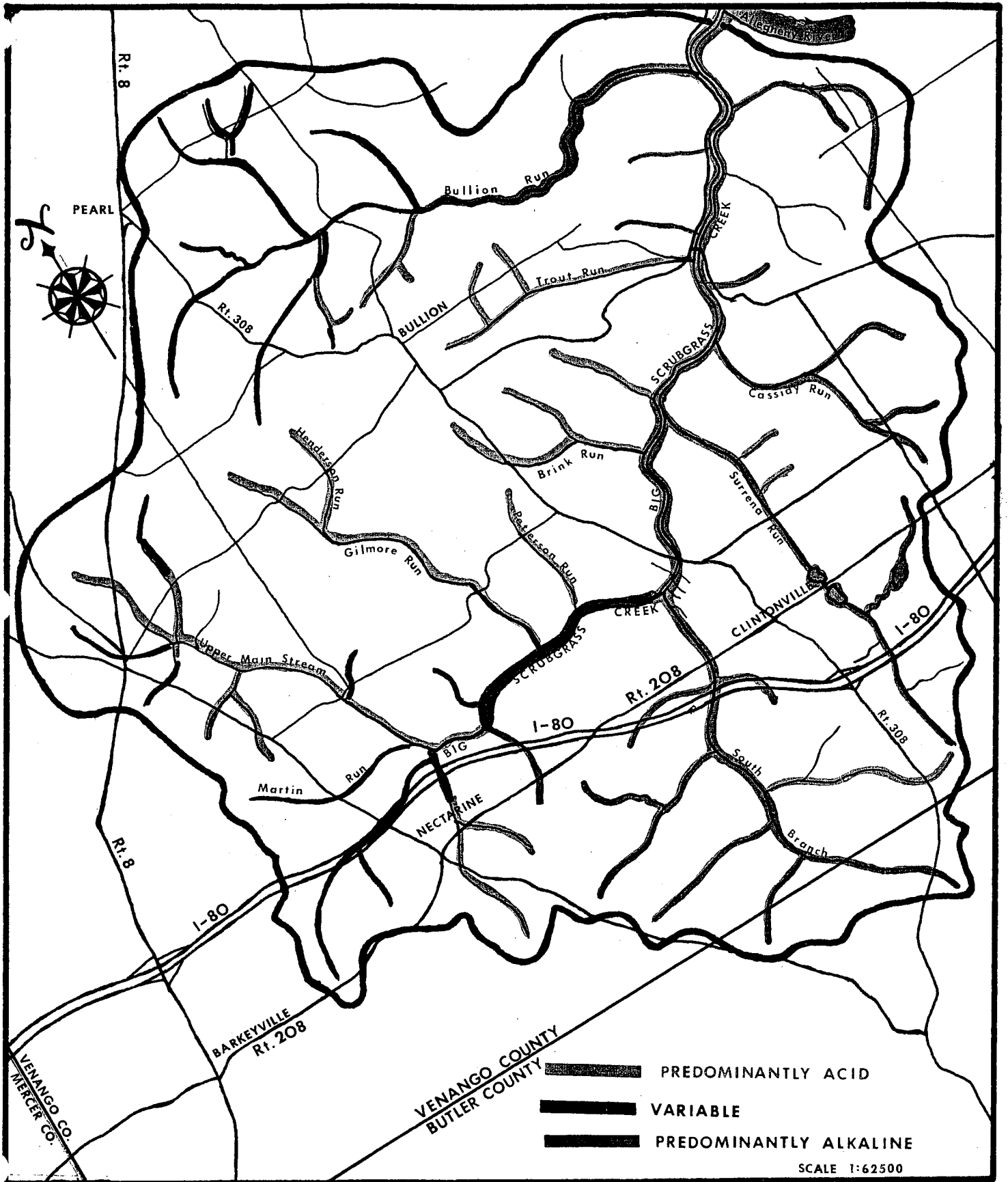


FIGURE 20

BIG SCRUBGRASS CREEK LOW FLOW SCHEMATIC

the mouth of Big Scrubgrass Creek was noticeably improved over the data reported by the Appalachia Regional Commission in 1969. An analysis of the Appalachia data and our Sampling Station No. 34 reveal an increase in average net alkalinity from -17.5 ppm to +4.0 ppm.

Other major findings of the investigation can be discussed as follows:

1. The most severe acid mine drainage conditions are exhibited in four major tributaries or subwatersheds. These are Trout Run, Brink Run, Gilmore Run and the Upper Main Stream Subwatershed. A fifth tributary, Williams Run, which is part of the Southwest Tributaries Subwatershed, is predominantly acid, but variable on occasion. Pollution source drainage areas of these five subwatersheds measures 10.06 square miles or 25 percent of the total watershed. These five subwatersheds discharge an average of 4057 pounds of acid per day into Big Scrubgrass Creek.
2. Two subwatersheds, including three major tributaries, display predominantly alkaline conditions. These are the South Branch Subwatershed and the East Tributaries Subwatershed, including Surrena Run and Cassidy Run. The drainage areas of these two subwatersheds is 15.66 square miles or 39 percent of the total watershed area. These two subwatersheds are the largest contributors of net alkaline water in the watershed.

3. The main stream was found to be acid for a length of about 4.5 miles from the headwaters to an area just below the mouth of the Upper Main Stream Subwatershed. A noticeable increase in water quality was exhibited after the confluence with South Branch. Variable alkaline to predominantly alkaline conditions prevailed for the remainder of the main stream down to the confluence.
4. Definite trends occurred during high and low flows indicating higher acid levels during high flow periods.
5. Flow data indicated that slightly above average runoff volumes were experienced during the project period.

The storm of June 21-23, 1972, caused by Hurricane Agnes, provided a unique opportunity to record the effects of an extremely high flow on water quality in Big Scrubgrass Creek. Samples were collected at 14 sampling stations in the watershed on June 23, 1972. Water quality analysis of these samples indicated similar distribution of chemical parameters as was measured during other high flow periods. Slight acid slugging effects were detected, but water quality results, varying only slightly, conformed to project averages for the most part. The basic difference was the enormous discharge volumes caused by the unusual magnitude of the storm. Estimates from hydraulic and hydrologic analysis coupled with the stream water quality samples indicated that about 114,000 pounds of net acid were discharged at the mouth of Big Scrub-

grass Creek during the three-day storm. The flow rates estimated at the time of sampling showed a discharge rate of approximately 1,694,000 gallons per minute at the stream mouth. These flow rates were estimated using the Manning Equation on sections of open stream and using culvert hydraulics at road crossings. The total rainfall on the watershed, estimated from U. S. Weather Bureau records was 3.86 inches during the three days with an estimated 2.8 inches of runoff for an average storm discharge rate of 451,100 gallons per minute. This storm produced the maximum flows and acid discharges for those sampling stations where the data was obtained as is reflected in the Sampling Station Summaries in Appendix B. Because of the unusual nature of this storm, the data was not used in determining average values of the various pollution parameters for these stations.

The Big Scrubgrass Creek has the potential of becoming a biologically fertile stream once again if the problem of acid mine pollution can be eliminated. The physiology of the stream, with its clean bottom and turbulent waters is such that it possesses the natural ability to recover from pollution if the sources were removed. Being a fast flowing, turbulent stream, constantly saturated with oxygen, it would purify itself much faster than a slower stream. In addition, it is generally narrow with high flows capable of quickly flushing out any residual pollution in the stream system.

MAIN STREAM WATER QUALITY

During the project period Big Scrubgrass Creek exhibited acid conditions from the headwaters for a length of about 4.5 miles downstream to a point just below the mouth of the Upper Main Stream Subwatershed. Water quality records at Sampling Stations No. 16 and No. 17 indicated that the next section of main stream down to the mouth of South Branch was predominantly acid during high flows. This condition is the result of acid discharges from Gilmore Run and Peterson Run. Variable conditions in water quality are evident in this stretch during low and average flow periods. Gilmore Run and Peterson Run both continue to have acid discharges which do not account for the improvement in water quality which occurs between Sampling Station No. 14 and Sampling Stations No. 16 and No. 17. There are, however, numerous oil wells in the hills above the stream banks, many of which have been abandoned and never plugged. The presence of oil bogs in the flood plain establish evidence that considerable seepage is occurring from the abandoned well casings. Literature research and data from this project (Station No. 53) have indicated that flowing abandoned oil wells may produce alkaline waters. This is the apparent cause of the water quality improvement in this specific section of the main stream.

The remainder of the main stream, from the mouth of South Branch, down to the confluence with the Allegheny River exhibited variable water quality conditions during average and

high flows and predominantly alkaline conditions during low flow periods. Water quality data at Sampling Station No. 15 indicated an increase in alkaline conditions in the main stream after the confluence with South Branch. Figure 21 shows pH values of samples collected at this station during the project period. Average net alkalinity increased from -39.7 ppm at Station No. 14 to +10 ppm at Station No. 15. Figure 22 shows indicated acidity and alkalinity values in parts per million of water samples collected at this station during the project period.

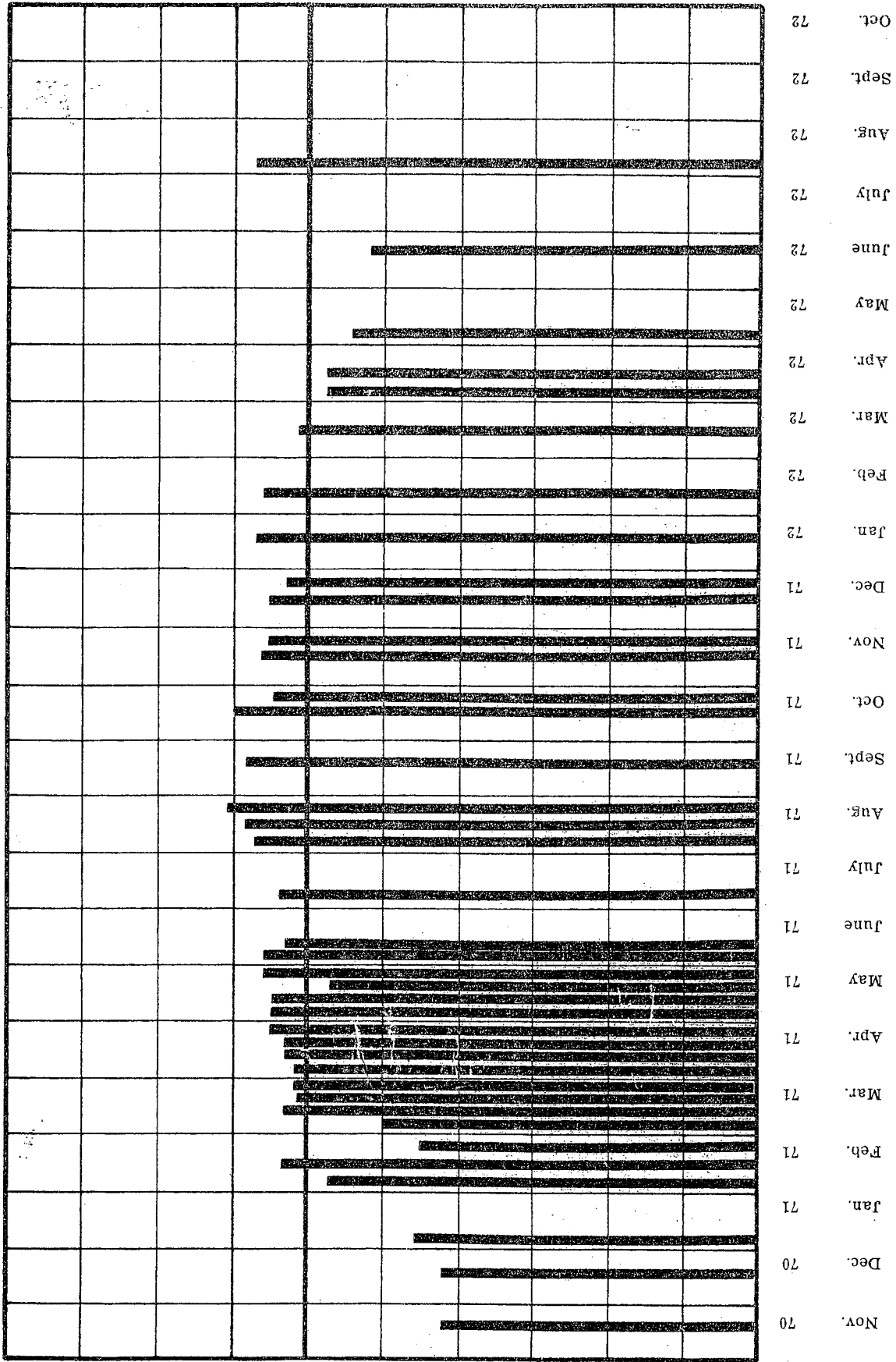
Downstream from Station No. 15, two major sources of acid water enter Big Scrubgrass Creek. These are Brink Run and Trout Run. An average of 1535 pounds per day acid was discharged into the main stream from these two drainage areas. However, these loadings were counteracted by the average discharge of 1605 pounds per day alkaline water from Surrena Run (Station No. 25) and Cassidy Run (Station No. 27). Variable and alkaline conditions were evident downstream to Station No. 33, just prior to the confluence with Bullion Run. Data at Station No. 33 indicated an average pH of 6.0 with a maximum of 7.1. Figure 23 shows indicated pH values of this station from water samples taken during the project period. Net alkaline conditions averaging 0.5 parts per million were indicated at this station. The results of total acidity and alkalinity of samples collected at this station during the study period are shown in Figure 24. At this point, Bullion Run enters the main stream with a project average of 7.0 ppm net alkalinity resulting in an average discharge at the mouth of Big Scrubgrass Creek of 4.0 ppm alkalinity and an average pH of 6.1.

FIGURE 21

SAMPLING STATION NO. **15**

ACID MINE DRAINAGE PROJECT
BIG SCRUBGRASS CREEK WATERSHED

pH
10
9
0



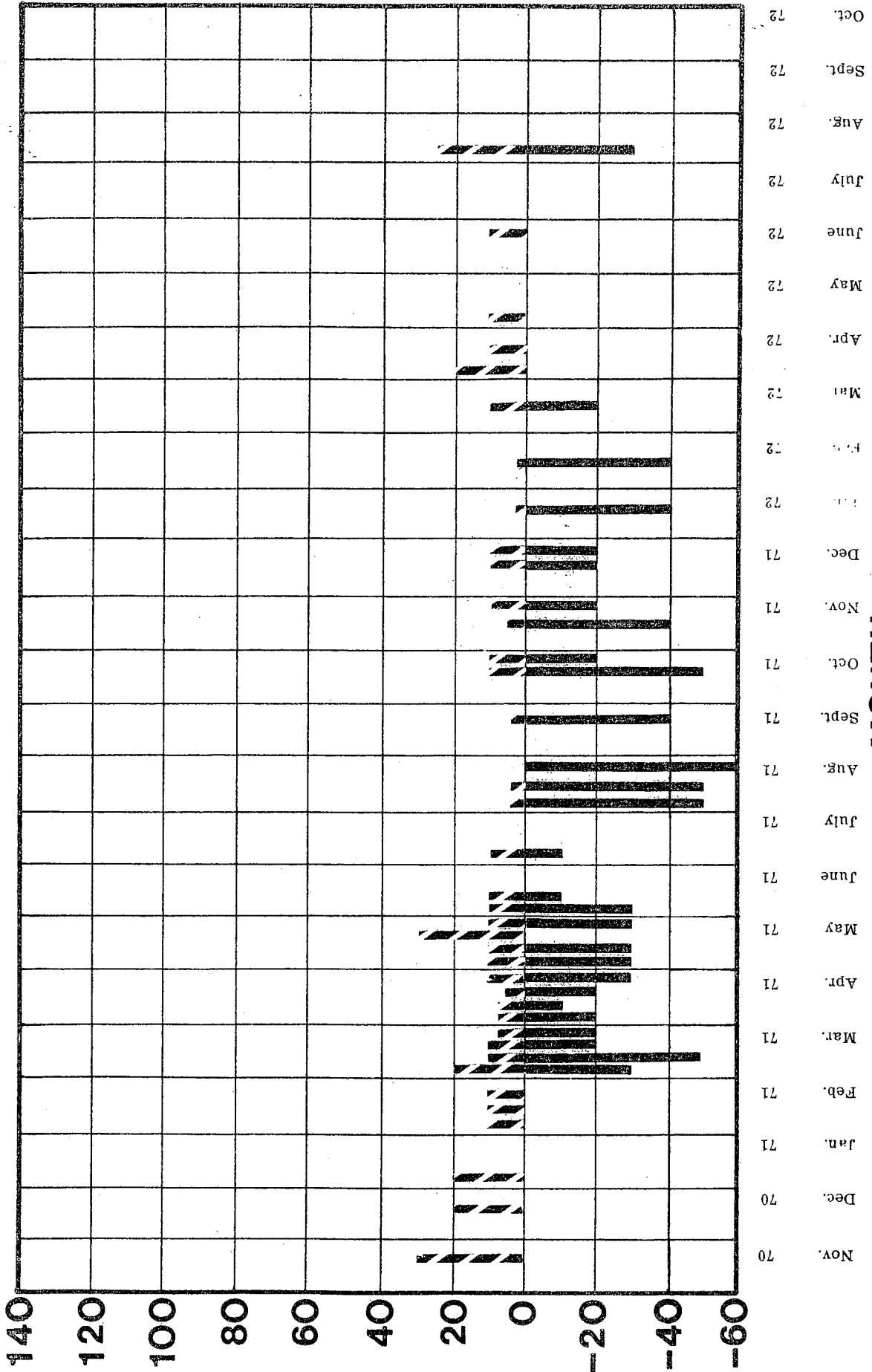
MONTH

FIGURE 22

SAMPLING STATION NO. 15

ACID MINE DRAINAGE PROJECT
BIG SCRUBGRASS CREEK WATERSHED

TOTAL ACIDITY PPM

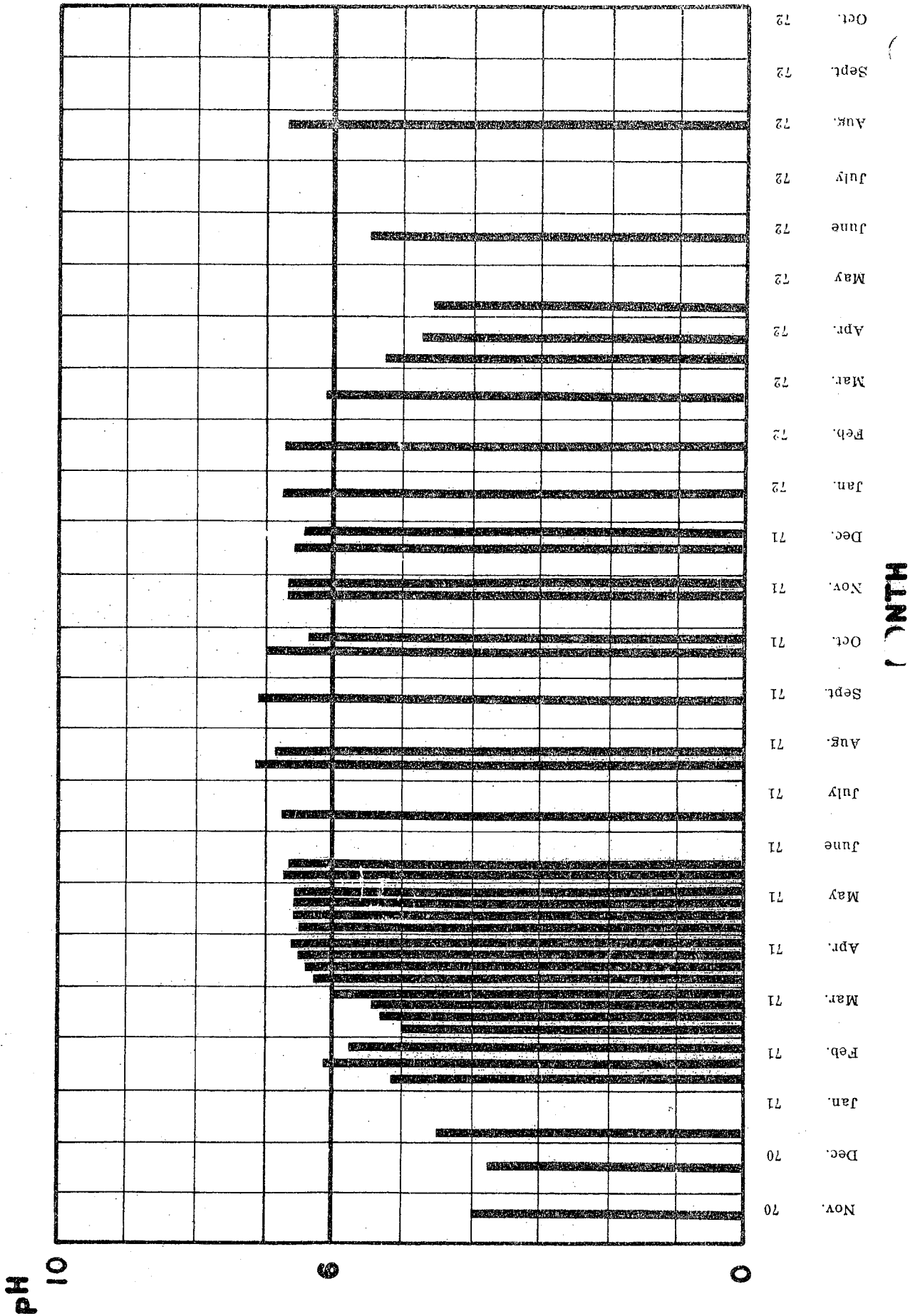


MONTH

SAMPLING STATION NO. 33

ACID MINE DRAINAGE PROJECT
BIG SCRUBGRASS CREEK WATERSHED

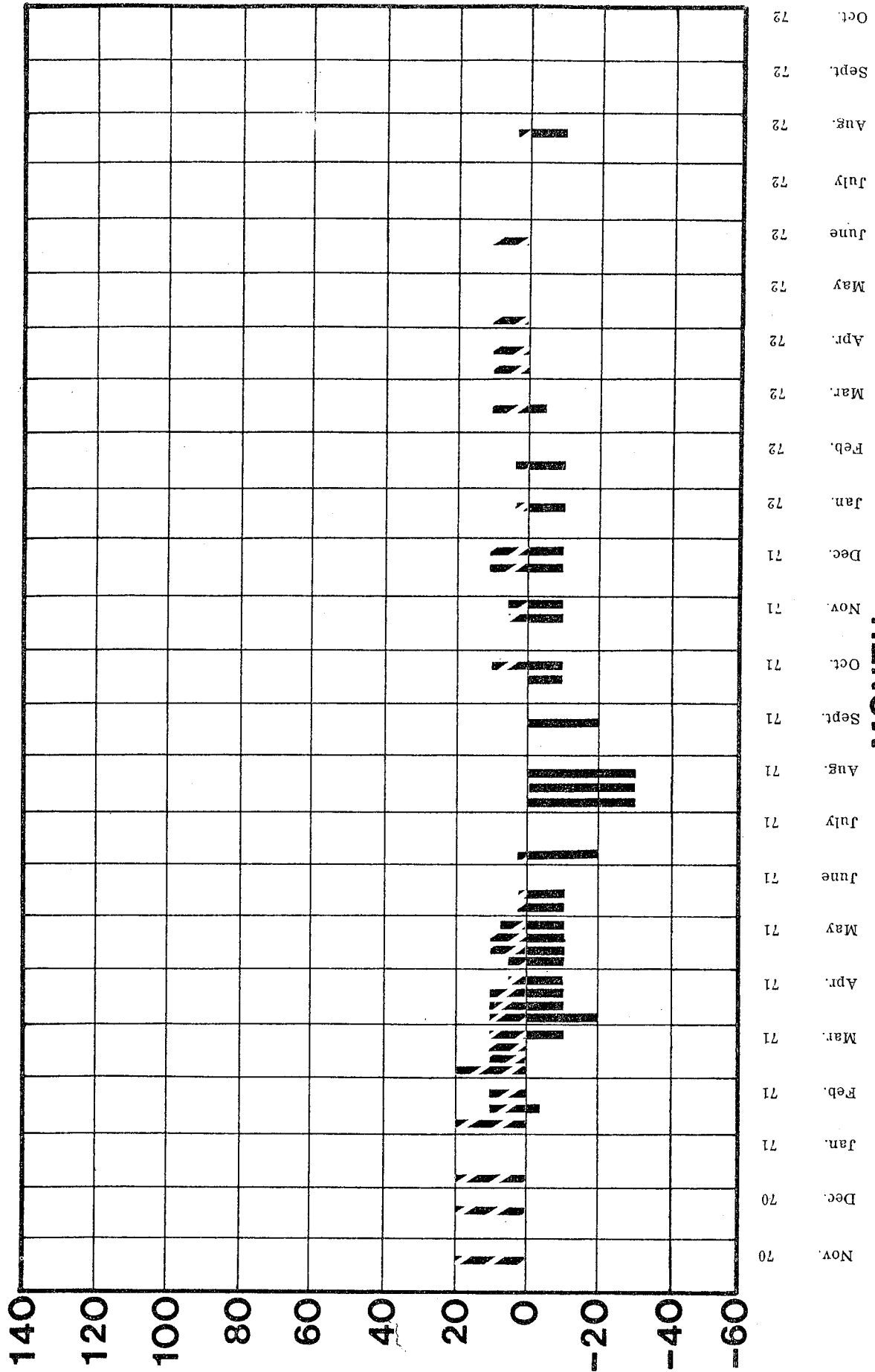
FIGURE 23



SAMPLING STATION NO. **33**

ACID MINE DRAINAGE PROJECT
BIG SCRUBGRASS CREEK WATERSHED

TOTAL ACIDITY PPM



MONTH

FIGURE 24

A discussion of the nine sampling stations associated with the Main Stream in terms of location, drainage areas and summary of water quality test determinations follows.

Station No. 15 was established on Big Scrubgrass Creek about 400' upstream from where the stream passes under Pa. Route 308. The stream at this station has a drainage area of 19.24 square miles and collects flows from the heavily polluted headwaters region, the mined out areas of Gilmore Run and the net alkaline South Branch. Many small tributaries, natural spring seepage, flowing oil well casings and field drainage also contribute to the flow past Station No. 15. Seasonal fluctuations in flow quite obviously reveal variations in water quality with pH rising above 7.0 during low flow periods and on occasion below 4.5 at high flow periods. Station No. 15 was sampled 40 times between November 20, 1970, and August 8, 1972. Indicated below are the the average, maximum and minimum water quality results.

	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
Flow (gpm)	14,321	26,900	6,200
pH	6.0	7.1	4.5
Total Acidity (ppm)	11.0	30.0	0.0
Alkalinity (ppm)	21.0	60.0	0.0
Iron (ppm)	0.9	3.4	0.2
Sulfates (ppm)	112.0	250.0	38.0
Acid (ppd)	1,674.0	5,470.0	0.0
Alkalinity (ppd)	3,816.0	7,060.0	0.0
Iron (ppd)	166.0	685.0	15.0
Sulfates (ppd)	17,472.0	31,800.0	5,950.0

Station No. 16 and Station No. 17 were both established on the Big Scrubgrass Creek approximately 0.5 miles upstream from the point where the stream passes under Pa. Route 308. Initially it was thought that the streams on which the stations were located were separate. Further investigations revealed that they were one in the same. Upstream from the point of confluence about 2000', Big Scrubgrass divides into separate channels and flows around an island. The stations were maintained for comparison purposes. The drainage area of both stations is 12.89 miles. Each station was sampled 38 times between November 20, 1970, and May 4, 1972, revealing very similar water quality results. Following are the indicated average maximum and minimum values for each station.

STATION NO. 16

	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
Flow (gpm)	974.0	1800.0	350.0
pH	5.9	7.0	3.6
Total Acidity (ppm)	14.0	40.0	0.0
Alkalinity (ppm)	19.0	60.0	0.0
Iron (ppm)	1.1	4.1	0.05
Sulfates (ppm)	138.0	400.0	18.0
Acid (ppd)	144.0	430.0	0.0
Alkalinity (ppd)	214.0	470.0	0.0
Iron (ppd)	14.5	54.0	2.8
Sulfates (ppd)	1375.0	3020.0	420.0

STATION NO. 17

	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
Flow (gpm)	8,926.0	15,800	3,400.0
pH	5.9	6.9	3.6
Total Acidity (ppm)	15.0	50.0	0.0
Alkalinity (ppm)	18.0	60.0	0.0
Iron (ppm)	1.19	4.6	0.15
Sulfates (ppm)	142.0	325.0	97.0
Acid (ppd)	1,320.0	4,030.0	0.0
Alkalinity (ppd)	1,978.0	3,780.0	0.0
Iron (ppd)	132.0	540.0	26.0
Sulfates (ppd)	12,817.0	27,090.0	4,320.0

Station No. 28 was established on Big Scrubgrass Creek about 100' upstream from the entering of Cassidy Run, just west of Township Road 380 and about 1.4 miles north of Township Road 327. Big Scrubgrass at this point has a drainage area of 25.33 square miles collecting flows from most of the mine sites in the watershed. Water quality has ranged from variable in high flows to predominantly alkaline in low flows. Station No. 28 was sampled 40 times between November 20, 1970, and August 22, 1972. Following is a list of average, maximum and minimum water quality values.

	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
Flow (gpm)	20,941	30,400	15,500
pH	6.1	7.1	3.8
Total Acidity (ppm)	10.0	40.0	0.0
Alkalinity (ppm)	18.0	60.0	0.0
Iron (ppm)	0.73	3.8	0.05
Sulfates (ppm)	108.0	200.0	44.0
Acid (ppd)	1,855.0	4,850.0	0.0
Alkalinity (ppd)	4,914.0	14,540	0.0
Iron (ppd)	200.0	1,100.0	9.0
Sulfates (ppd)	26,323	40,130	17,280

Station No. 29 was located on Big Scrubgrass Creek about 400' upstream from the point where Trout Run enters the main stream. There are 27.98 square miles of drainage area above this station and it receives flows from essentially the same sources as Station No. 28, in fact, the chemical quality data is almost identical. During the period between November 20, 1970, and August 22, 1972, Station No. 29 was sampled 39 times. Listed below are average, maximum and minimum water quality information.

	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
Flow (gpm)	23,325	36,400	17,100
pH	6.0	7.0	3.8
Total Acidity (ppm)	10.0	40.0	0.0
Alkalinity (ppm)	15.0	40.0	0.0
Iron (ppm)	0.62	3.3	0.05
Sulfates (ppm)	108.0	250.0	70.0
Acid (ppd)	1,887.0	5,090.0	0.0
Alkalinity (ppd)	5,035.0	12,910	0.0
Iron (ppd)	166.0	690.0	10.0
Sulfates (ppd)	28,859	41,450	18,140

Station No. 33 was established about 200' upstream of the point where Bullion Run enters Big Scrubgrass Creek. This station, encompassing approximately 32.29 square miles of drainage area collects flows from all the mine sites in the watershed except those in the Bullion Run headwaters. Water quality indicates a net alkaline condition during low flows and a variable condition during high flows. Big Scrubgrass Creek at this point was sampled 40 times between November 20, 1970, and August 24, 1972. Following is a list of average, maximum, and minimum test results.

	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
Flow (gpm)	26,773	1,380,000	19,300
pH	6.0	7.1	3.8
Total Acidity (ppm)	8.4	20.0	0.0
Alkalinity (ppm)	8.9	30.0	0.0
Iron (ppm)	0.7	3.1	0.0
Sulfates (ppm)	104.0	300.0	31.0
Acid (ppd)	2,210.0	165,600	0.0
Alkalinity (ppd)	3,621.0	11,950	0.0
Iron (ppd)	223.0	6,620.0	0.0
Sulfates (ppd)	33,821	513,400	18,990

Station No. 34 was established at the mouth of Big Scrubgrass Creek about 200' upstream from its confluence with the Allegheny River. The drainage area at this point includes the entire watershed covering 40.02 square miles. Stream quality at the mouth was variable on occasion. Net alkaline conditions prevailed for a large portion of the project reaching a maximum pH of 7.2. Between November 20, 1970, and June 23, 1972, this station was sampled 39 times resulting in the following listed average, maximum and minimum water quality test results.

	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
Flow (gpm)	32,476	1,694,000	22,170
pH	6.1	7.2	4.2
Total Acidity (ppm)	8.0	30.0	0.0
Alkalinity (ppm)	12.0	30.0	0.0
Iron (ppm)	0.48	1.7	0.0
Sulfates (ppm)	94.0	130.0	29.0
Acid (ppd)	2,026.0	203,280	0.0
Alkalinity (ppd)	5,420.0	60,980	0.0
Iron (ppd)	188.0	7,110.0	0.0
Sulfates (ppd)	32,986	589,500	23,600

Station No. 35 was established on the Allegheny River about 1000' downstream from the point where Big Scrubgrass Creek enters. This station was set up primarily to monitor the water quality of the river below the confluence of Scrubgrass and compare it with that of Station No. 36 established upstream from the confluence. This station was sampled 38 times between November 20, 1970, and May 4, 1972. Following is a list of average, maximum and minimum water quality test values.

	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
pH	6.8	7.3	6.3
Total Acidity (ppm)	2.3	7.0	0.0
Alkalinity (ppm)	47.0	80.0	10.0
Iron (ppm)	0.09	0.35	0.05
Sulfates (ppm)	40.0	110.0	6.0

Station No. 36 was established on the Allegheny River about 1000' upstream from the point of confluence of the Big Scrubgrass Creek. This station was set up in conjunction with Station No. 35, to monitor the river above and below the point of entry of Big Scrubgrass Creek. In comparing the data of the two river stations, it can be seen that a difference in quality is contributing pollution to the Allegheny River. Undoubtedly the pollution is diluted further downstream from the large volume of alkaline water from the river. Between November 20, 1970, and May 4, 1972, this station was sampled 38 times resulting in the following average, maximum and minimum water quality values.

	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
pH	7.0	7.5	6.8
Total Acidity (ppm)	0.4	3.0	0.0
Alkalinity (ppm)	59.0	90.0	20.0
Iron (ppm)	0.05	0.1	0.05
Sulfates (ppm)	11.0	23.0	3.0