

VI. STUDY ANALYSIS

A. POLLUTION SOURCE DETERMINATION

The development and scope of this study had already been outlined in specified sections of this report. In review, the initial phase of this study centered on a reconnaissance survey of all tributaries of the Loyalsock Creek. This included stream flow and chemical analysis, as well as a review of topographic maps, mining maps, and resultant field investigations. These field studies were aided in part by participation of personnel from the Department of Environmental Resources, Pottsville Office, in particular the inspectors responsible for overseeing the strip mining activity. These personnel conveyed their knowledge of the area with emphasis on major pollution sources and areas of recent strip mining. In addition, local residents, particularly those associated with the White Ash Land Association were contacted. Some field investigations evaluating potential pollution sources were assisted by some of these citizens, whose long term knowledge of the area proved particularly helpful.

Phase I as stated, involved flow measurements and chemical analysis. Flow measurements were performed using float and chip method for specified stream cross sections. These measurements were checked toward the end of this study by the use of a Teledyne-Gurley flow meter as well as an analysis of the water balance for individual watersheds. From the correlation of this data, the flows were adjusted accordingly. All water samples collected in this study were analyzed at chemical laboratories, designated by the Pennsylvania Department of Environmental Resources, Division of Mine Area Restoration. Each sample was tested for PH, acidity, alkalinity, total iron, ferrous iron, and sulfates. Using flow measurements, together with the concentrations from each chemical analysis in milligrams per liter, the pollution loading characteristics were calculated in pounds per day.

Upon completion of Phase I, selected subwatersheds and additional points of pollution concern were monitored for a twelve month period. This monitoring included flow measurements and chemical analysis as outlined above. Figure 8 is an index map showing sample stations for the entire study area, including those monitored in Phase I and those monitored for the other phase of the study.

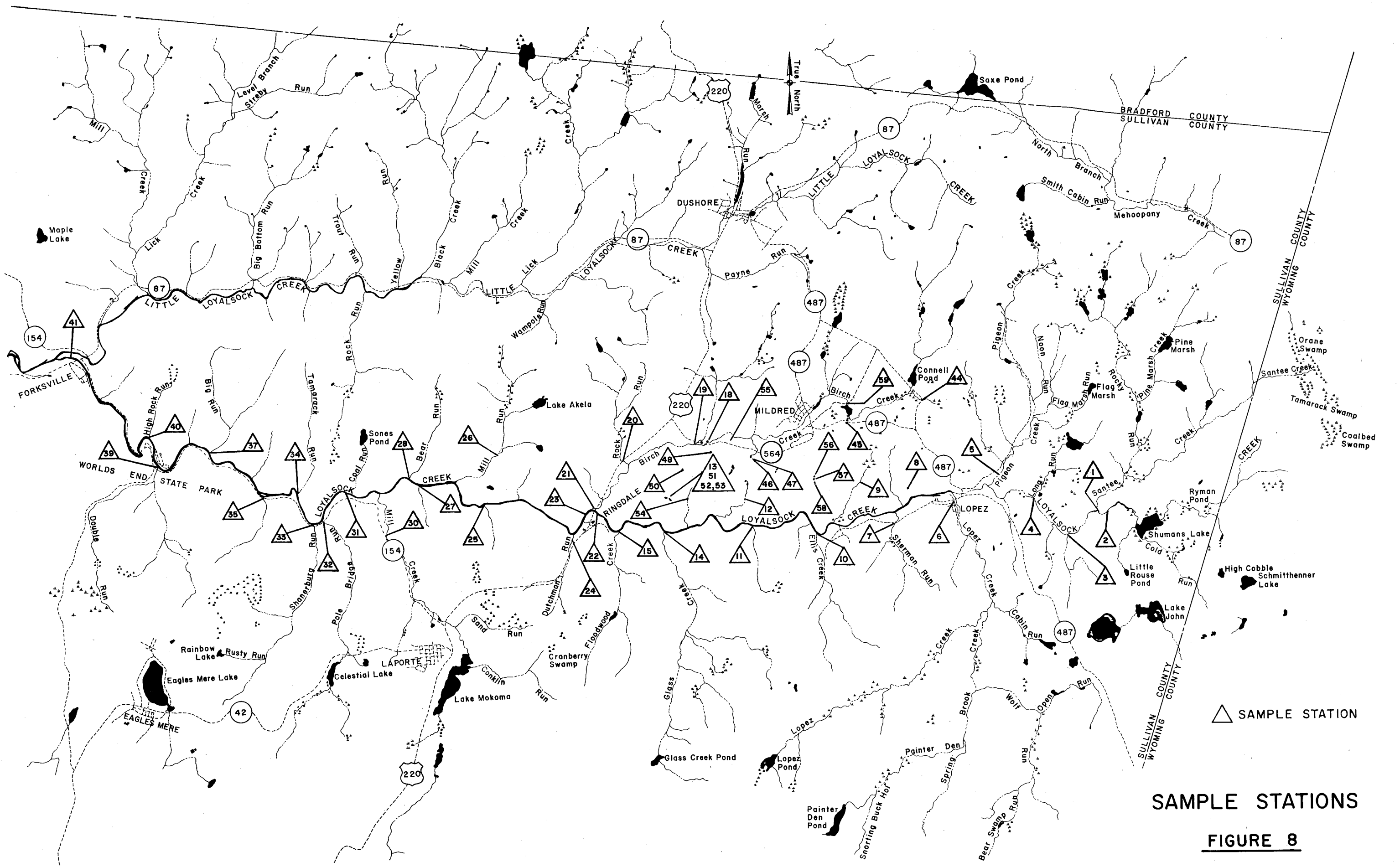
Appendix B presents sample station data for Phase I of the study. An examination of the sampling results for this phase dictated the exclusion of certain stations for further sampling. This examination also included review of the individual watersheds with emphasis on past and present land use, particularly mining. As can be seen by a review of the geology map - Figure 2-there are virtually no coal reserves west of the village of Ringdale, except for an area directly south of Forksville. A review of topographic maps plus on sight inspection, where possible, of the area encompassed by these

watersheds revealed the absence of any past or present mining activity. For these reasons, all stations downstream from the village of Ringdale were eliminated with the exception of a control station on the Loyalsock Creek at Forksville (Station 41). In general, these streams can be characterized as having a PH of 6 or greater, having negligible total and ferrous iron loading, and in many cases very little, if any, alkalinity. As was pointed out in the Mining History section of this report, Scar Run (Station 42) has been subject to some mining. However, as the low concentrations of acid, total and ferrous iron, and sulfates indicate, there is essentially no evidence of acid mine drainage in Scar Run at its confluence with Loyalsock Creek.

Elimination of sampling stations, upstream from the village of Ringdale, were limited to Rock Run (Station 19), Long Run (Station 4), and all tributaries with their confluence on the southern bank of Loyalsock, with the exception of Lopez Creek (Station 6). The chemical analysis of the samples of these stations showed no evidence of acid mine drainage, and their watersheds were not involved with any past or present mining.

The chemical analysis and determination of pollution loading for Phase I was performed in August, 1973, and included two sample collections for each station.

As was outlined in the Hydrogeology Section of this report, in addition to the Phase II sampling procedure, additional monitoring was performed at Sampling Point Numbers 8 and 9, B Vein and C Vein Tunnel Discharges. This monitoring, which entailed the use of water level recorders, provided a continuous flow record and allowed for a more complete evaluation of the water balance of the deep mine complex. Particular attention was given to the correlation of tunnel flows and rainfall in that section.



△ SAMPLE STATION

SAMPLE STATIONS
FIGURE 8



B. SAMPLE POINT DISCUSSION

Following is a discussion of the most important sample points that were monitored during the course of this study. This discussion will provide location information as well as descriptive data concerning the sources and/or watersheds of each sample point. Other pertinent information, resulting from field surveys and mapping interpretation, will be outlined. It is important to point out that all the sample points listed do not necessarily denote pollution sources. Certain creeks, as will be outlined, act as control stations, providing data for streams not associated with mining. A summary of the flow characteristics as well as chemical analysis data is listed for each sample point. This data has been summarized with the minimum, maximum, and average figures being listed. The averages are based on the totals for each parameter monitored, and are not averages for any one individual sample taken.

A complete listing of the monthly flow records for the grab samples or Phase I of the project are listed in Appendix B. The listing of the monthly flow records and sample analysis for Phase II is presented in Appendix C. The description of each sampling point follows here.

Maps showing the location of those sample points, which have a direct bearing as pollution sources, are included with the abatement program discussion later in this report.

The numerical order of the sampling points is that which was designated with the development of the sampling program. This designation has no special geographic or priority significance, which accounts for the somewhat random numbering.

Sample Station No. 1 - Santee Creek (Colley Township, Sullivan County)

The sampling point on Santee Creek is located approximately 50 feet upstream from the confluence of Santee Creek with Loyalsock Creek. This point is also approximately 200 feet north of Legislative Route No. 56026. The greatest proportion of this watershed is on State Game Lands Number 66. It was pointed out previously that some mining was undertaken in the Dutch Mountain area of Wyoming County. Any subsequent mine drainage from that area would probably lead to the Mehoopany watershed. However, the Santee Creek watershed is also associated with this area, at its headwaters. The chemical analysis data shown below, indicates no evidence of acid mine drainage.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	1.20	15.22	6.41
Flow (MGD)	.78	9.83	4.14
pH	4.1	6.3	-
Acidity (MG/L)	2	8	5.5
Acidity (Lb/Day)	38.9	386.0	200.0
Alkalinity (MG/L)	0	10	2.8
Alkalinity (Lb/Day)	0	183.4	70.0
Total Iron (MG/L)	0	.438	.35
Total Iron (Lb/Day)	0	26.5	9.7
Ferrous Iron (MG/L)	0	0.5	.04
Ferrous Iron (Lb/Day)	0	24.1	2.4
Sulfates (MG/L)	7	300	92.5
Sulfates (Lb/Day)	264.9	5,392.1	3,577.3

Sample Station No. 2 - Loyalsock Creek (Colley Township, Sullivan County)

This sampling point is located approximately 1,000 feet west of the intersection of L.R. 56026 and Township Route 390. At this point, the Loyalsock Creek runs through State Game Lands Number 66 and is an indicator of water quality for the headwaters. That portion of the watershed that is upstream from this sampling point is composed of small ponds and swamp areas, which may contribute organic acids and be responsible for the acidic nature of the stream. Because no mining has been associated with this portion of the Loyalsock Creek watershed, this station serves as a control point for comparison purposes for water quality downstream.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	1.40	8.69	3.87
Flow (MGD)	.90	5.61	2.50
pH	4.5	6.2	
Acidity (MG/L)	2	8	5.3
Acidity (Lb/Day)	15.1	187.3	106.2
Alkalinity (MG/L)	0	12	4.5
Alkalinity (Lb/Day)	0	187.3	86.2
Total Iron (MG/L)	.100	1.1	.478
Total Iron (Lb/Day)	1.8	20.6	8.8
Ferrous Iron (MG/L)	0	.4	.03
Ferrous Iron (Lb/Day)	0	10.2	.85
Sulfates (MG/L)	2	275	72.7
Sulfates (Lb/Day)	51.0	7,940.1	1,527.5

Sample Station No. 5 - Pigeon Creek (Colley Township, Sullivan County)

Samples for this station were collected approximately 1,000 feet upstream from the confluence of Pigeon Creek with Loyalsock Creek. This point is also some 300 feet west of Township Route Number 388. Much of the land associated with this watershed is woodland associated with private hunting clubs. One unnamed tributary of Pigeon Creek does however extend to the periphery of abandoned strip mine pits at the extreme northeasterly end of the coal basin. Field observations as well as an examination of the water quality data, indicates minimal contact with any of these strip mine drainage sources. Directly northeast and adjacent to these strip pits, swamps are present, and represent areas of a probable perched water table as reviewed in the Hydrogeology section of this report. These swampy areas are significant in terms of their flow characteristics during periods of heavy rainfall and will be described under the abatement program. Following is a list of the chemical analysis data for this station.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	.60	12.03	4.66
Flow (MGD)	.39	7.77	3.01
pH	4.4	6.6	--
Acidity (MG/L)	2	8	4.5
Acidity (Lb/Day)	13.0	259.4	112.0
Alkalinity (MG/L)	0	20	7.2
Alkalinity (Lb/Day).	0	422.7	123.9
Total Iron (MG/L)	0	1.190	.285
Total Iron (Lb/Day)	0	27.9	5.6
Ferrous Iron (MG/L)	0	.2	.02
Ferrous Iron (Lb/Day)	0	5.7	.5
Sulfates (MG/L)	6	350	80.9
Sulfates (Lb/Day)	73.8	14,675.8	1,810.7

Sample Station No. 6 - Lopez Creek - (Colley Township, Sullivan County)

This station is located approximately 50 feet downstream from Application Route No. 1583 bridge crossing at Lopez. The Lopez Creek watershed is one of the largest sub-basins in the study area, and encompasses parts of State Game Lands Numbers 13 and 66. The watershed is comprised mostly of woodlands and many swampy areas, with the water quality being characterized as slightly acidic. No mining has been associated with this watershed and this station has been included as a control point.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	4.09	49.50	14.18
Flow (MGD)	2.64	10.23	9.16
pH	3.8	6.0	-
Acidity (MG/L)	2	14	5.7
Acidity (Lb/Day)	87.2	1195.5	373.1
Alkalinity (MG/L)	0	10	2
Alkalinity (Lb/Day)	0	323.1	98.0
Total Iron (MG/L)	0	5.476	.725
Total Iron (Lb/Day)	0	512.8	75.5
Ferrous Iron (MG/L)	0	1.120	.02
Ferrous Iron (Lb/Day)	0	104.9	1.1
Sulfates (MG/L)	2	300	68.9
Sulfates (Lb/Day)	198.2	22,215.5	3,968.3

Sample Station No. 8 - B Vein Connell Tunnel (Colley Township, Sullivan County)

This sample station is the single largest acid mine drainage source in the study area. It is located between an old railroad grade and the Loyalsock Creek, approximately 400 feet east of the Cherry Township Colley Township line. The actual discharge point of the tunnel at the portal is located on lands owned by the White Ash Land Association, Mildred, Pennsylvania. The coal rights for the subsurface workings involved with the tunnel belong to Michael and Joan Comerford, Scranton, Pa. The discharge points is located in predominately a wooded area, with a portal elevation of 1753 feet. Due to the relative isolation and lack of serviceable roads to this point, accessibility is limited especially during winter months. As has already been discussed, this tunnel is responsible for draining the B vein of the Connell Deep Mine Complex and will be the focus of considerable attention for abatement measures.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	1.75	20.00	6.51
Flow (MGD)	1.13	12.92	4.20
pH	3.0	4.2	--
Acidity (MG/L)	20	64	34.3
Acidity (Lb/Day)	258.4	3753.2	1223.9
Alkalinity (MG/L)	0	4	.24
Alkalinity (Lb/Day)	0	97.1	5.3
Total Iron (MG/L)	.3	4.7	.752
Total Iron (Lb/Day)	5.6	76.1	23.2
Ferrous Iron (MG/L)	0	1.6	.21
Ferrous Iron (Lb/Day)	0	25.9	5.1
Sulfates (MG/L)	45	300	99.1
Sulfates (Lb/Day)	612.9	11,315.8	3326.4

Sample Station No. 9 - C Vein Connell Tunnel (Cherry Township, Sullivan County)

This sample station is located between an old railroad grade and Loyalsock Creek, approximately 4,200 feet west of the Cherry Township Colley Township line. As with the B vein tunnel it is a major source of acid mine drainage to Loyalsock Creek. The elevation of the portal for this discharge is 1837 feet, with the portal being located in a relatively isolated area which is not readily accessible. The surface owner for the area of the tunnel discharge is the White Ash Land Association, while the coal rights belong to Michael and Joan Comerford, Scranton, Pa. This tunnel drains the C vein workings of the Connell Deep Mine Complex and produce a continuous flow with a low pH and high concentrations of acid as listed below.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	0.60	6.00	2.11
Flow (MGD)	0.39	3.88	1.36
pH	2.9	3.9	--
Acidity (MG/L)	32	70	47
Acidity (Lb/Day)	117.2	1424.6	528.0
Alkalinity (MG/L)	0	0	0
Alkalinity (Lb/Day)	0	0	0
Total Iron (MG/L)	.5	6.4	1.211
Total Iron (Lb/Day)	2.9	46.4	12.0
Ferrous Iron (MG/L)	0	5.2	0.465
Ferrous Iron (Lb/Day)	0	25.6	3.3
Sulfates (MG/L)	55	300	102.6
Sulfates (Lb/Day)	309.2	3029.2	1081.9

Sample Station No. 44 - Birch Creek Tributary (Cherry Township, Sullivan County)

This station is located at Township Route 380 bridge crossing of this tributary, and is approximately 2,600 feet north of the intersection of Township Route 380 and Pa. State Highway 487. This creek carries runoff from a swamp area, which is adjacent to abandoned strip mining pools and culm piles. However, the flow from this area is relatively small and the pollution loading is minimal in terms of the overall stream dynamics of Birch Creek. The watershed drained by this tributary is presently associated with active strip mining activity, however, the sample analysis program was complete prior to the initiation of this work. Both the surface and mineral ownership for this area belong to Romuld A. Deinnrnwirz, Sewell, New Jersey.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	.06	.38	.17
Flow (MGD)	.04	.24	.11
pH	3.8	5.1	-
Acidity (MG/L)	4	14	6.7
Acidity (Lb/Day)	1.4	28.4	6.7
Alkalinity (MG/L)	0	10	1.8
Alkalinity (Lb/Day)	0	5.5	1.2
Total Iron (MG/L)	0	2.381	.464
Total Iron (Lb/Day)	0	2.2	.3
Ferrous Iron (MG/L)	0	.2	.02
Ferrous Iron (Lb/Day)	0	.3	.03
Sulfates (MG/L)	2	275	66.4
Sulfates (Lb/Day)	2.7	342.5	45.1

Sample Station 45 - Old Silt Dam (Cherry Township, Sullivan County)

Directly beside Pa. State Highway 487 remains evidence of an old silt dam from the original Connell deep mine operations. Located approximately 3,000 feet east of the intersection of Pa. State Highway 487 and Pa. State Highway 564, this dam still accumulates water, particularly during periods of heavy rainfall. This dam drains to an adjacent swamp area and eventually to Birch Creek. One drainage culvert is present crossing the above referenced highway, conveying water from the siltation pond to the adjacent swamp. It was not feasible to make flow measurements for this flow, and consequently, the only data representing concentrations in MG/L is listed below.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
pH	2.9	3.8	-
Acidity (MG/L)	44	11,000	968
Alkalinity (MG/L)	0	0	0
Total Iron (MG/L)	.292	3.333	1.117
Ferrous Iron (MG/L)	0	.9	.08
Sulfates (MG/L)	60	300	119.7

Sample Station 59 - Birch Creek (Cherry Township, Sullivan County)

This sampling point is located at Township Route 378 bridge crossing, approximately 1,500 feet north of Station 45 - Old Silt Dam. Runoff from the Silt Dam eventually reaches this Birch Creek sampling point, but appears to have little adverse impact. The pH and acidity concentrations for Station 59 are significantly better than that found for the Silt Dam. Furthermore, the chemical analysis for Birch Creek at this point does not differ greatly from Station 6 - Lopez Creek and Station 1 - Santee Creek. Thus the water quality at this sampling point, in general, is characteristic of other subwatersheds which have no acid mine drainage.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	.06	3.71	1.96
Flow (MGD)	.04	2.88	1.26
pH	4.7	6.4	-
Acidity (MG/L)	2.0	8.0	4.4
Acidity (Lb/Day)	2.0	96.1	40.8
Alkalinity (MG/L)	0	50.0	12.2
Alkalinity (Lb/Day)	0	205.9	68.6
Total Iron (MG/L)	0.2	2.857	0.738
Total Iron (Lb/Day)	0.3	47.1	8.1
Ferrous Iron (MG/L)	0	0	0
Ferrous Iron (Lb/Day)	0	0	0
Sulfates (MG/L)	10.0	275.0	71.6
Sulfates (Lb/Day)	73.0	5,503.7	659.2

Sample Station Nos. 56, 57, 58 - Abandoned Strip Pits

Approximately 4,200 feet south of the intersection of Pa. State Highway 487 and Pa. State Highway 564 are located three strip pits that have accumulated water. Aside from a low pH, these pools do not show particularly high concentrations of either acids or sulfates. Topographically, Station 58 is at the lowest elevation, and there appears to be some seepage below this station that may lead to natural drainage contours. However, such drainage would most likely be dissipated before reaching Loyalsock Creek. However, these strip pits are in close proximity to the crop line limits of the deep mine workings and may act as a source of water recharge to the deep mine complex. Such recharge would eventually lead to the tunnel discharge points, Stations 8 and 9. The summary for the chemical analysis presented below, is an average for all three strip pits. No flow measurements were involved with these sampling points.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
<u>Station 56</u>			
pH	3.6	5.0	-
Acidity (MG/L)	4.0	16.0	8.9
Alkalinity (MG/L)	2.0	8.0	1.2
Total Iron (MG/L)	0.1	6.67	0.968
Ferrous Iron (MG/L)	0	0	0
Sulfates	6	275	59.9
<u>Station 57</u>			
pH	3.7	5.2	-
Acidity (MG/L)	4.0	14.0	8.2
Alkalinity (MG/L)	0	6.0	1.0
Total Iron (MG/L)	0.3	4.542	1.433
Ferrous Iron (MG/L)	0	0	0
Sulfates	0	300.0	59.8

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
<u>Station 58</u>			
pH	3.7	4.9	-
Acidity (MG/L)	6.0	40.0	18.2
Alkalinity (MG/L)	0	0	0
Total Iron (MG/L)	0.6	6.438	2.613
Ferrous Iron (MG/L)	0	3.0	0.3
Sulfates	0	3.0	0.3

Sample Station Nos. 46 and 47 - Abandoned Strip Mine Pool and Discharge Point
(Cherry Township, Sullivan County)

Station 46 is an abandoned strip mine pit located near the entrance to the present active strip mine operation, being approximately 500 feet south of Pa. State Highway 564. This pit, with an elevation of approximately 1906 feet at the bottom is somewhat unique since it is surrounded by other strip mine areas which have been restored to their original contours. The pit area exposed is not extensive but certainly allows for rainwater and some surface runoff to form a pool. Approximately 200 feet north of Station 46, water surfaces from underground sources at an elevation of 1904 feet and flows towards Birch Creek. The strip pit itself is located on White Ash Land Association property, while the resultant stream flow is on lands belonging to the William Monahan Estate. Both of these sample stations have very similar water quality, including low pH and relatively high acid concentrations. These stations are noteworthy in that the apparent polluted water eventually leads to Birch Creek where its effects will be discussed with the sample analysis of Station 18.

Station 46

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
pH	3.3	4.0	-
Acid (MG/L)	12.0	30.0	21.3
Alkalinity (MG/L)	0	0	0
Total Iron (MG/L)	0	4.286	0.605
Ferrous Iron (MG/L)	0	0.3	0.03
Sulfates (MG/L)	51	275	101.1

Station 47

Flow (CFS)	0	2.0	0.09
Flow (MGD)	0	0.13	0.06
pH	3.2	4.0	-
Acidity (MG/L)	14.0	34.0	24.0
Acidity (Lb/Day)	5.1	16.9	10.9

Station 47 - Continued

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Alkalinity (MG/L)	0	0	0
Alkalinity (Lb/Day)	0	0	0
Total Iron (MG/L)	0	3.571	0.507
Total Iron (Lb/Day)	0	2.0	0.3
Ferrous Iron (MG/L)	0	0.2	0.01
Ferrous Iron (Lb/Day)	0	0.1	0.01
Sulfates (MG/L)	5	275.0	103.9
Sulfates (Lb/Day)	3.1	124.5	35.3

Sample Station 48 - Gutten Drift (Cherry Township, Sullivan County)

At a point approximately 400 feet south of Pa. State Highway 564 and at the entrance to the former Gutten Deep Mine, there is evidence of a drift or addit used with these early operation. Although the opening of this drift has been subject to considerable collapse of the rock strata, there is a steady flow of acid mine water being discharged from this point. The source of this water is presumably from the B vein workings of Gutten Complex. At the time of the writing of this report, the Locey Coal Company was stripping the higher vein or veins of coal directly above these Gutten workings. There appears to be no direct avenue of recharge from these present strippings that would contribute to the flow from the Gutten Drift, although some infiltration obviously takes place. The top elevation of the coal vein being stripped is approximately 1943 feet, while the elevation of the water at the point of discharge is 1876 Feet. More than any other source of acid mine drainage in this study, this sample point exhibits pollution in the form of higher total iron concentrations as well as a low pH and high acidity. This is not only evident from the data listed below, but also from the precipitate observable at the discharge point. The discharge eventually drains to Birch Creek and its effects will be discussed with. Station 18.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	0.1	0.14	0.07
Flow (MGD)	0	0.09	0.05
pH	3.2	3.6	-
Acidity (MG/L)	30.0	300.0	56.2
Acidity (Lb/Day)	2.6	23.6	14.7
Alkalinity (MG/L)	0	0	0
Alkalinity (Lb/Day)	0	0	0
Total Iron (MG/L)	2.381	10.0	7.871
Total Iron (Lb/Day)	0.7	7.3	3.9
Ferrous Iron (MG/L)	0	7.84	4.4
Ferrous Iron (Lb/Day)	0	5.3	2.1
Sulfates (MG/L)	0	275.0	88.8
Sulfates (Lb/Day)	4.4	173.5	31.3

Sample Station 55 - (Cherry Township, Sullivan County)

As a result of runoff from culm piles, plus a portion of the discharge from the Gutten Drift (Station 48), a pool of acid mine water has accumulated approximately 1,000 feet north of Station 48, between Pa. State Highway 487 and Birch Creek. The water from this pool eventually drains to Birch Creek, where its impact will be discussed under Station 18. This pool is situated near the former Gutten Breaker and runoff from the resultant culm piles and wasted material reaches this pool. However, the water quality of this pool does not differ significantly from the Gutten Drift, and the runoff from the waste piles does not appear to add appreciably to the pollution factor.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	0.01	0.06	0.04
Flow (MGD)	0.0	0.04	0.02
pH	3.1	3.9	-
Acidity (MG/L)	16.0	400.0	56.3
Acidity (Lb/Day)	2.7	28.5	7.6
Alkalinity (MG/L)	0	0	0
Alkalinity (Lb/Day)	0	0	0
Total Iron (MG/L)	0.438	4.524	1.568
Total Iron (Lb/Day)	0	1.0	0.36
Ferrous Iron (MG/L)	0	2.24	0.36
Ferrous Iron (Lb/Day)	0	0.6	0.1
Sulfates (MG/L)	54	250.0	105.2
Sulfates (Lb/Day)	5.2	56.0	17.5

Sample Station 18 - Birch Creek (Cherry Township, Sullivan County)

Between Bernice and U.S. Route 220, a sampling point was established where Pa. State Highway 564 crosses Birch Creek. This station is only a short distance downstream from the following acid mine drainage sources previously described--Stations 47, 55 and 48. Although these stations produced a discharge with a pH less than 4.0, concentrations of acid of 30 MG/L and greater, and no alkalinity, Birch Creek at Station 18 does not exhibit these qualities. In fact, Birch Creek is one of the few tributaries that has any appreciable alkalinity load. The reason for this is not clear. Perhaps calcite may be present in the sandstone that outcrops near the Creek bed, accounting for the relative alkaline nature. Outside of some siltation evident at this station resulting from runoff from the culm piles, there appears to be little detrimental effects from the acid mine drainage from the north side of the basin. Following is a summary of the pollution loading data.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	1.31	24.24	6.33
Flow (MGD)	.85	15.65	4.09
pH	5.1	6.9	
Acidity (MG/L)	2	8	3.7
Acidity (Lb/Day)	28.3	1045.3	160.2
Alkalinity (MG/L)	0	34	12.7
Alkalinity (Lb/Day)	0	1045.3	314.1
Total Iron (MG/L)	.1	2.346	.706
Total Iron (Lb/Day)	.7	306.5	38.5
Ferrous Iron (MG/L)	0	.5	.04
Ferrous Iron (Lb/Day)	0	19.3	1.6
Sulfates (MG/L)	2	275	57.2
Sulfates (Lb/Day)	75.9	10,273.7	1466.6

Sample Station No. 19 - Unnamed Tributary of Birch Creek
 (Cherry Township, Sullivan County)

This point is located between Bernice and U.S. Route 220 where Pa. State Highway 564 crosses this unnamed tributary. This station is also approximately 200 feet upstream from the confluence of this tributary with Birch Creek. The water quality of this creek is similar to that of Birch Creek at Station 18, insofar as it has a distinctive alkalinity load. There has been no mining associated with the watershed of this creek.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	.02	4.99	1.13
Flow (MGD)	.01	3.22	.73
pH	4.9	6.7	-
Acidity (MG/L)	0	6	3.7
Acidity (Lb/Day)	0	161.4	24.5
Alkalinity (MG/L)	0	36	14.5
Alkalinity (Lb/Day)	0	115.3	51.5
Total Iron (MG/L)	.1	2.010	.695
Total Iron (Lb/Day)	.1	54.1	6.7
Ferrous Iron (MG/L)	0	.5	.04
Ferrous Iron (Lb/Day)	0	3.6	.3
Sulfates (MG/L)	2	275	72.5
Sulfates (Lb/Day)	14.4	1276.4	233.6

Sample Station 12 - Unnamed Tributary of Loyalsock Creek
(Cherry Township - Sullivan County)

This station is a creek that drains a swampy area, located approximately 8,000 feet southwest of the intersection of Pennsylvania State Highway 487 and Pennsylvania State Highway 564. Much of the area adjacent to this swamp has been subject to strip mining with practically all of the area being restored to its original contours and some vegetative restoration being initiated. It is apparent from the water quality analysis that little acid mine drainage is being produced from these former strip areas.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	0	.18	.08
Flow (MGD)	0	.12	.05
pH	3.9	5.7	--
Acidity (MG/L)	2	10	6.2
Acidity (Lb/Day)	0	10	3.3
Alkalinity (MG/L)	0	6	1.8
Alkalinity (Lb/Day)	0	3.3	1.0
Total Iron (MG/L)	0	2.381	.8
Total Iron (Lb/Day)	0	5.2	.7
Ferrous Iron (MG/L)	0	.5	.05
Ferrous Iron (Lb/Day)	0	.3	.03
Sulfates (MG/L)	44	300	119.4
Sulfates (Lb/Day)	.8	165.4	45.7

Sample Station No. 54 - Unnamed Creek (Cherry Township, Sullivan County)

This sampling point is a natural drainage stream that flows directly to Loyalsock Creek in the southwesterly portion of the basin. It is located approximately 6,200 feet south, southwest of the intersection of Pa. State Highway 564 and U.S. Route 220. Other than a restored strip mine area directly east of this sampling point, no mining or mine drainage is associated with this creek, and it essentially acts as a control point.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	0	0.05	0.01
Flow (MGD)	0	0.03	0.006
pH	3.8	6.4	-
Acidity (MG/L)	2.0	12.0	6.5
Acidity (Lb/Day)	0	1.5	0.63
Alkalinity (MG/L)	0	66.0	7.8
Alkalinity (Lb/Day)	0	1.1	0.14
Total Iron (MG/L)	0	4.762	0.900
Total Iron (Lb/Day)	0	0.1	0.03
Ferrous Iron (MG/L)	0	0.3	0.02
Ferrous Iron (Lb/Day)	0	0.1	0.01
Sulfates (MG/L)	5.0	300.0	67.1
Sulfates (Lb/Day)	0.1	16.0	1.8

Sample Station No. 50 - Discharge from Abandoned Strip
(Cherry Township, Sullivan County)

This sampling station is located at the northwesterly end of the Bernice Basin near the restored SBP Coal Company strippings, on lands owned by Dwight Lewis, Hills Grove, Pa. This stripped area is relatively small, although some coals are exposed. Surface runoff from the adjacent access roads as well as some slight lateral movement of groundwater contributes to this discharge from this strip. Because very little material in the exposed strip is subject to contact with water, the water quality shows only minor adverse effects. The discharge from the strip flows toward Birch Creek, but much of this water is dissipated in terms of a definite stream.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	0	0.08	0.02
Flow (MGD)	0	0.05	0.02
pH	4.7	6.0	-
Acidity (MG/L)	2.0	14.0	6.3
Acidity (Lb/Day)	0.1	4.2	1.0
Alkalinity (MG/L)	0	16.0	5.3
Alkalinity (Lb/Day)	0	1.2	0.4
Total Iron (MG/L)	0	3.81	0.598
Total Iron (Lb/Day)	0	0.6	0.09
Ferrous Iron (MG/L)	0	0.2	0.02
Ferrous Iron (Lb/Day)	0	0	0
Sulfates (MG/L)	0	300.0	71.1
Sulfates (Lb/Day)	0	60.5	8.8

Sample Station No. 51, 52, 53, 13 - Abandoned Strip Mine Pits -
Former Meylert's Opening

At the extreme southwest end of the Bernice Basin lies an area of abandoned strip mines, which are presently accumulating water and acting as a source of groundwater recharge. According to the Second Geological Survey of Pennsylvania, September 1884, this area was designated as Meylert's Opening. Stations 52 and 53 are the actual strip pits, with Station 52 being fed by a continuous surface stream flow from a swampy area to the north. This stream (Station 51) has been sampled as well as the strip mine pools and there is very little variation in water quality from one point to the other. In addition, approximately 200 feet south of Station 53, groundwater surfaces (Station 13) and leads directly to natural drainage paths flowing to Loyalsock Creek. All four of these sampling points have similar chemical analysis and in fact, do not deviate significantly from Station 54, which has not been subject to any mining. Because of these comparisons, it would appear that the exposed coal and other minerals in these strip pits are not altering the water quality significantly, and may only be providing a more direct path for infiltration.

Station 51

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	0	0.7	0.3
Flow (MGD)	0	0.04	0.02
pH	3.4	4.9	-
Acidity (MG/L)	4.0	14.0	8.4
Acidity (Lb/Day)	0.2	2.1	1.0
Alkalinity (MG/L)	0	0	0
Alkalinity (Lb/Day)	0	0	0
Total Iron (MG/L)	0	8.095	1.117
Total Iron (Lb/Day)	0	1.9	0.3
Ferrous Iron (MG/L)	0	0.5	0.04
Ferrous Iron (Lb/Day)	0	0.1	0.01
Sulfates (MG/L)	2	275.0	67.3
Sulfates (Lb/Day)	0.1	29.4	4.7

Station 52

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
pH	3.5	4.8	-
Acidity (MG/L)	4.0	10.0	7.5
Alkalinity (MG/L)	0	0	0
Total Iron (MG/L)	0	5.355	0.84
Ferrous Iron (MG/L)	0	0.5	0.04
Sulfates (MG/L)	5	325.0	78.1

Station 53

pH	3.8	4.8	-
Acidity (MG/L)	0	32.0	8.9
Alkalinity (MG/L)	0	8	1.5
Total Iron (MG/L)	0	3.4	0.716
Ferrous Iron (MG/L)	0	0.5	0.04
Sulfates (MG/L)	5.0	250.0	65.3

Station 13

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	0	.04	.03
Flow (MGD)	0	.03	.02
pH	3.9	4.7	--
Acidity (MG/L)	2	12	5.8
Acidity (Lb/Day)	.1	1.3	.8
Alkalinity (MG/L)	0	2	.4
Alkalinity (Lb/Day)	0	.3	.06
Total Iron (MG/L)	0	3.4	.629
Total Iron (Lb/Day)	0	.1	.03
Ferrous Iron (MG/L)	0	.4	.04
Ferrous Iron (Lb/Day)	0	.1	.01
Sulfates (MG/L)	0	275	52.6
Sulfates (Lb/Day)	0	58.7	10.4

Sample Station No. 21 - Birch Creek (Laporte Township, Sullivan County)

This station is located approximately 200 feet upstream from the confluence of Birch Creek with Loyalsock Creek at the village of Ringdale. As discussed with Station 18, Birch Creek is generally responsible for absorbing any acid mine drainage that discharges from the north side of the Bernice Basin, and unlike most tributaries of Loyalsock Creek, maintains a greater alkalinity load than acidity load. As noted with Station 18, Birch Creek does not exhibit any major adverse impact from the acid mine drainage.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	1.40	32.76	8.32
Flow (MGD)	.91	21.16	5.37
pH	5.0	6.7	-
Acidity (MG/L)	0	6	3.1
Acidity (Lb/Day)	0	706.3	141.4
Alkalinity (MG/L)	0	28	12.8
Alkalinity (Lb/Day)	0	1,412.7	433.1
Total Iron (MG/L)	0	3.571	.633
Total Iron (Lb/Day)	0	384.2	48.8
Ferrous Iron (MG/L)	0	.3	.02
Ferrous Iron (Lb/Day)	0	14.7	1.1
Sulfates (MG/L)	2	250	62.4
Sulfates (Lb/Day)	97.9	7,756.4	1,796.4

Sample Station No. 22 - Loyalsock Creek (Laporte Township - Sullivan County)

This sampling point is located approximately 100 feet upstream from the confluence of Birch Creek with Loyalsock Creek at Ringdale. This station is downstream from any pollution sources of the Bernice Basin and is an indicator of the effects from the two Connell drainage tunnels (Stations 8 and 9) as well as any other pollution source that drains from the south side of the Basin.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	20.10	304.06	77.60
Flow (MGD)	12.98	196.42	50.13
pH	4.3	5.7	-
Acidity (MG/L)	2	8	3.9
Acidity (Lb/Day)	286.9	6,556.5	1,594.9
Alkalinity (MG/L)	0	12	4.9
Alkalinity (Lb/Day)	0	3,278.2	1,556.4
Total Iron (MG/L)	0	5.952	.746
Total Iron (Lb/Day)	0	3,294.6	449.6
Ferrous Iron (MG/L)	0	.2	.02
Ferrous Iron (Lb/Day)	0	90	6.9
Sulfates (MG/L)	2	300	63.1
Sulfates (Lb/Day)	899.5	82,600.2	14,998.7

Sample Station 23 - Loyalsock Creek (Laporte Township, Sullivan County)

This sampling station is located approximately 150 feet downstream from the confluence of Birch Creek with Loyalsock Creek at Ringdale. The water quality does not differ significantly from Station 22 on the Loyalsock Creek, and aside from pH and concentrations of alkalinity, does not differ appreciably from Birch Creek.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	21.50	336.81	86.31
Flow (MGD)	13.89	217.58	55.75
pH	4.0	6.4	-
Acidity (MG/L)	2	8	4.4
Acidity (Lb/Day)	347.2	10,894.2	2,249.6
Alkalinity (MG/L)	0	14	4.6
Alkalinity (Lb/Day)	0	6,760.2	1,478.0
Total Iron (MG/L)	0	3.333	.557
Total Iron (Lb/Day)	0	3,052.2	396.3
Ferrous Iron (MG/L)	0	.3	.02
Ferrous Iron (Lb/Day)	0	149.6	11.5
Sulfates (MG/L)	5	275	63.4
Sulfates (Lb/Day)	1,687.9	114,164.7	20,641.2

Sample Station No. 41 - Loyalsock Creek (Forksville, Sullivan County)

This sampling station is located at the Pa. State Highway 220 bridge crossing of Loyalsock Creek at Forksville. Essentially, this point has been included as a control point for it is at the extreme westerly end of the watershed, and is roughly 14 miles downstream from the two Connell Drainage Tunnels (Stations 8 and 9). This station does exhibit a slightly higher pH than those shown for the other sampling points on the Loyalsock Creek, which are closer to the mine drainage area.

	<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Flow (CFS)	42.87	759.58	198.70
Flow (MGD)	27.69	490.69	128.36
pH	4.2	6.8	-
Acidity (MG/L)	2	56	7.9
Acidity (Lb/Day)	924.4	54,268.8	8,147.6
Alkalinity (MG/L)	0	12	5.5
Alkalinity (Lb/Day)	0	32,758.3	6,292.1
Total Iron (MG/L)	0	1.1	.269
Total Iron (Lb/Day)	0	3,660.7	451.6
Ferrous Iron (MG/L)	0	.2	.02
Ferrous Iron (Lb/Day)	0	227.4	19.0
Sulfates (MG/L)	7	300	74.5
Sulfates (Lb/day)	5,463.9	314,956.3	51,360.4