HYDROLOGIC UNIT PLAN

LOYALSOCK CREEK

SULLIVAN COUNTY

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Bureau of Abandoned Mine Reclamation

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I. HYDROLOGIC UNIT

NAME: Loyalsock Creek

TRIBUTARY TO: West Branch Susquehanna River

LOCATION: Sullivan County (See Attachment A)

DRAINAGE AREA: Approximately 495 square miles

II. EFFECTS OF MINE DRAINAGE

The upper portion of Loyalsock Creek is relatively unpolluted by mine drainage. There are no major mine drainage discharges in this section, and the creek readily assimilates any minor discharges. The Loyalsock Creek AMD Project is located within the Endless Mountains of Pennsylvania, which is regionally recognized as a year-round recreational area. In reaches not affected by AMD, fishing is a major attraction to residents and tourists. Although Loyalsock Creek is designated as a Cold Water Fishery (CWF), numerous tributaries are designated as High Quality (HQ) and Exceptional Value (EV) Fisheries. According to the DEP, Bureau of Water Quality Management, designated uses are supported on all but six of the Loyalsock Creeks 54 miles. Water quality sampling and macroinvertebrate surveys conducted upstream of the "B" and "C" tunnel discharges indicate good water quality and a diverse macroinvertebrate population, while downstream the water quality was moderate with a limited macroinvertebrate population (See Attachment B for sampling locations, Attachment C for water quality data, and Attachments D and E for macroinvertebrate survey results).

Acid mine drainage from the "B" and "C" tunnel discharges significantly impacts Loyalsock Creek's ability to support aquatic life. Below the discharges, Loyalsock Creek has reduced pH values which inhibit the survival of macroinvertebrates and some fish species. In addition to a reduced pH, episodic events cause metal concentrations to exceed instream limits, thereby preventing healthy macroinvertebrate and fish populations from sustaining themselves. Biological surveys conducted by the Bureau of Water Quality Management and the Bureau of Abandoned Mine Reclamation indicate degraded water quality with reduced macroinvertebrate and fish populations below the discharges. Recovery is noticeable approximately six miles downstream at Ringdale where water quality improves and macroinvertebrate and fish diversity begins to increase. From 1987 to 1990 the Bureau of Water Quality Management conducted a stream survey and found that the diversity of the fish population was significantly reduced downstream of the discharges (See Attachment F for sample locations, Attachment G for water quality, and Attachment H for fish survey results).

III. SOURCES OF MINE DRAINAGE

The main emphasis of this plan is to address the "B" and "C" Connell Tunnel Discharges into Loyalsock Creek. Mining activities date back to the early 1900's, at which time various companies were involved in deep mine operations. Two discharges, the "B" and "C" tunnels, are responsible for draining the workings of the Connell Deep Mine Complex, which is the largest mining operation (See Attachment B for discharge locations). Stratigraphically, the coal reserves of the Bernice Basin belong to the Pottsville Formation and produce a unique form of coal - semi-anthracite. These coals cannot be correlated with the coal fields of western or northeastern Pennsylvania and are found in few places throughout the United States.

Coal mine operators from the Bernice Basin recognize four coals, which they designate A (lowest), B, C, and D. The discharges in the Loyalsock Creek watershed emanate from the B and C coals. The B coal is the most extensively mined and apparently the most continuous. In the Connel area, the B coal has as many as four benches and contains from two feet four inches to six feet of recoverable coal. Throughout the Connell Mine area where both the B and C coals were mined underground, the C coal lies from ten to fifteen feet above the B; in a few places the interval may be as much as twenty-five feet and as little as six feet. The B tunnel discharge ranges in Fe from 0.167 mg/l to 2.19 mg/l and Al from 0.135 to 1.67 mg/l, with pH ranging from 3.8 to 4.2. The C tunnel discharge has Fe ranging from 0.196 mg/l to 1.85 mg/l and Al from 1.17 mg/l to 4.52 mg/l, with pH ranging from 3.4 to 3.9. No other mine drainage contaminants are present at harmful levels.

The B and C tunnel discharges are deep mine discharges that have average flows of 3103 gpm and 921 gpm, respectively. Both discharges flow directly into Loyalsock Creek downstream from the town of Lopez and they are located within the boundary of Abandoned Mine Lands Inventory Problem Area No. 0727.

IV. PROPOSED PROJECTS

The construction of AMD passive treatment facilities has been proposed to address the "B" and "C" Connell Tunnel discharges. Construction of facilities at these sites will address all known significant discharges of mine drainage into the upper Loyalsock Creek watershed.

A treatment system will be constructed at each discharge location. Three anoxic limestone drains, in a parallel system, will be constructed to treat the B tunnel discharge. The anoxic limestone drains will have the following dimensions: #1 (285 ft. long x 20 ft. wide x 5 ft. deep), #2 (300 ft. long x 20 ft. wide x 5 ft. deep), and #3 (280 ft. long x 20 ft. wide x 5 ft. deep). The total system will have an 8 hour detention time in a 17300 square feet treatment area. The C tunnel discharge will be reclaimed by constructing a vertical flow alkalinity system (310 ft. x 85 ft.). The vertical flow unit will provide 26350 square feet of treatment area with a total detention time of 15 hours. The vertical flow unit will be followed by a settling basin which will have an area of 16380 square feet.

Work items associated with the project include the construction of a permanent access road to the site, erosion and sedimentation control, clearing and grubbing, unclassified excavation of the treatment cells, external embankment construction, internal dike construction, construction of flow control/aeration structures, placement of treatment cell substrate, slope protection, diversion and care of water, and revegetation of areas disturbed during construction of the project.

V. PROJECT COSTS

Project cost estimates for the Bureau's project are based on OSM 76, Attachment C, and Commonwealth contracting experience.

Loyalsock Creek, AMD 57(0727)101.1	$342,000 (B tunnel discharge) $409,000 (C tunnel discharge)
	$751,000 total

VI. EXISTING AND PROPOSED FUNDING

The main emphasis of this plan is to address the "B" and "C" Connell Tunnel discharges (deep mine discharges) into Loyalsock Creek located on White Ash Land Association property. The project to be constructed by this Bureau, which will treat both tunnel discharges, will be funded through the Commonwealth's AML 10% Set-Aside Fund. The Commonwealth has contributed staff to this project to collect water samples, measure flows, and conduct biological stream surveys and will likely cost share in future operation and maintenance costs of the facilities. In addition, BAMR has received funding from the Office of Surface Mining's Appalachian Clean Streams Initiative. Of the total amount awarded to BAMR, approximately $475,000 will be used to remediate the B and C tunnel discharges on Loyalsock Creek.

VII. ANALYSIS OF COST EFFECTIVENESS AND ENVIRONMENTAL BENEFITS

The proposed expenditures represent capital costs to implement the abatement and treatment measures. Due to the passive nature of the proposed treatment facilities, annual operation and maintenance costs are not expected. Completion of treatment facilities for the above described discharge sites should result in substantial improvement in the water quality and aquatic habitat of 6 miles of Loyalsock Creek. The improved water quality will also improve other forms of recreation, including hiking, swimming, and fishing.

Improved water quality will also provide a benefit to Worlds End State Park, which is approximately 13 miles downstream from the two discharges. Both residents and tourists visit the park each year to enjoy fishing, swimming, and camping. Efforts to clean-up the Loyalsock Creek are supported by the Natural Resources Conservation Service (NRCS), North Central Pennsylvania Conservancy, and the Endless Mountains RC & D Council.

VIII. COOPERATING AGENCIES

Sullivan County Conservation District

White Ash Land Association

Pennsylvania Fish and Boat Commission

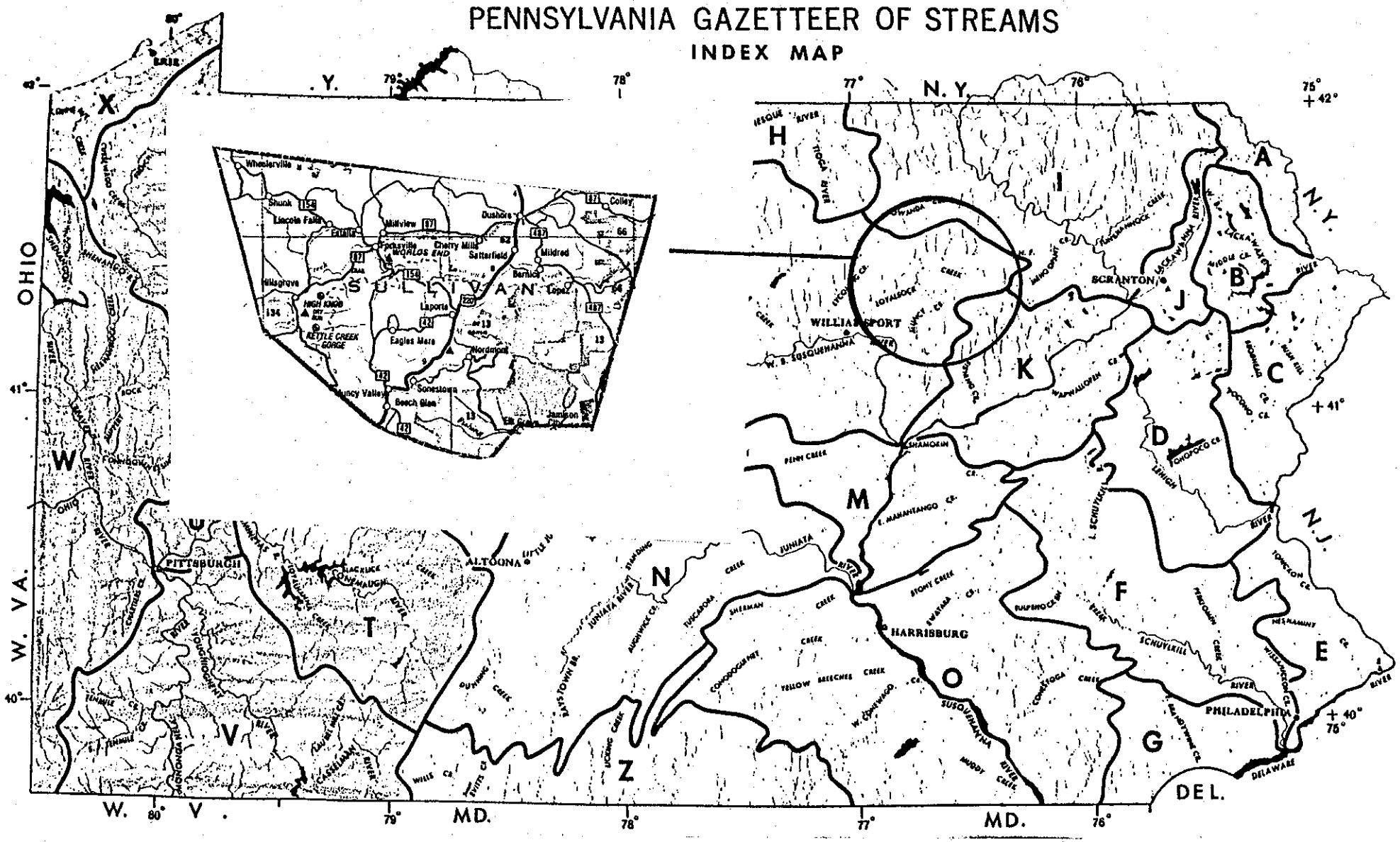
Bureau of Water Quality Management, Williamsport Office

IX. REFERENCES

Ronald E. Hughey, 1991. Aquatic Biological Investigation of Loyalsock Creek (Stream File 19804). Bureau of Water Quality Management.

Operation Scarlift Report #188: Loyalsock Creek, Mine Drainage Abatement Measures. 1976. Department of Environmental Portection.

ATTACHMENT A. Loyalsock Creek location. The project area is located in northeastern PA, west of the town of Lopez, in Cherry and Colley Townships, Sullivan County.



Attachment C. Water quality analyses for the Loyalsock Creek watershed (collected between July 1995 to December 1997) located in Cherry and Colley Townships, Sullivan County. (See Attachment B for sample locations)

B VEIN DISCHARGE							
Map Reference # - 1							
Date	Q, gpm	Fe, mg/l	Mn, mg/l	Acidity, mg/l	Al, mg/l	SO4, mg/l	pH
4/10/96	2511	0.244	0.563	17.800	0.774	50.000	4.0
4/17/96	5022	0.196	0.628	22.000	0.994	41.000	4.0
4/22/96	4064	0.202	0.622	20.000	0.837	11.000	4.0
4/30/96	3704	0.229	0.624	16.400	0.919	49.800	4.1
5/8/96	5022	0.197	0.586	20.000	0.899	43.000	4.0
5/15/96	6975	0.167	0.573	15.200	0.829	42.000	4.1
5/21/96	4837.5	2.190	0.565	32.000	0.847	57.000	4.2
5/29/96	2673	0.296	0.559	26.000	0.805	56.000	4.0
6/4/96	1863	0.322	0.560	24.000	0.822	40.000	4.2
6/11/96	1498.5	0.389	0.648	22.000	0.945	40.000	4.2
6/18/96	1143	0.382	0.580	34.000	0.871	41.000	4.1
7/30/96	1318.5	0.349	0.674	26.000	1.020	71.000	4.2
8/29/96	1089	0.424	0.773	30.000	1.250	68.000	4.1
9/30/96	1390.5	0.335	0.836	24.000	1.400	61.000	4.0
11/13/96	6066	0.193	0.693	26.000	1.050	10.000	4.0
12/1/96	17752.5	0.183	0.020	24.000	0.135	44.000	4.1
1/14/97	2191.5	0.306	0.618	24.000	0.919	32.000	4.1
3/3/97	2650.5	0.221	0.623	22.000	0.933	36.000	4.1
4/8/97	3568	0.202	0.596	22.000	0.910	32.000	4.1
5/8/97	1886	0.304	0.603	24.000	1.030	44.000	4.2
6/11/97	1440	0.386	0.704	28.000	1.140	51.000	4.1
7/9/97	1062	0.444	0.662	26.000	1.020	49.000	4.1
8/12/97	387	0.658	0.894	32.000	1.450	43.000	4.2
9/10/97	644	0.537	0.939	28.000	1.440	61.000	4.1
10/8/97	548	0.586	0.966	32.000	1.670	35.000	4.1
11/5/97	409	0.658	0.961	19.400	1.660	64.000	4.1
12/4/97	2078	0.233	0.821	24.000	1.450	55.000	3.8

C VEIN DISCHARGE							
Map Reference # - 2							
Date	Q, gpm	Fe, mg/l	Mn, mg/l	Acidity, mg/l	Al, mg/l	SO4, mg/l	pH
4/22/96	1724	0.371	0.829	32.000	1.870	58.000	3.6
4/30/96	2115	0.395	0.821	28.000	2.010	59.600	3.7
5/8/96	1575	0.397	0.812	30.000	1.950	44.000	3.6
5/15/96	2178	0.306	0.763	30.000	1.830	41.000	3.7
5/21/96	859.5	0.450	0.805	44.000	1.970	52.000	3.8
5/29/96	504	0.674	0.846	38.000	2.030	53.000	3.7
6/4/96	322.65	0.796	0.862	32.000	2.110	45.000	3.8
6/11/96	166.5	0.976	1.010	32.000	2.390	46.000	3.8
6/18/96	63	1.060	0.988	46.000	2.330	46.000	3.7
7/30/96	396	0.979	1.050	42.000	2.730	58.000	3.9
8/29/96	247.5	1.530	1.500	50.000	3.850	80.000	3.7
9/30/96	247.5	0.902	1.500	46.000	4.030	68.000	3.7
11/13/96	2056.5	0.431	1.060	36.000	2.610	80.000	3.7
12/1/96	4693.5	0.196	0.694	36.000	1.170	37.000	3.7
1/14/97	571.5	0.619	0.868	36.000	2.170	36.000	3.7
3/3/97	886.5	0.433	0.881	28.000	2.180	39.000	3.7
4/8/97	1426	0.421	0.845	32.000	2.140	27.000	3.8
5/8/97	464	0.532	0.880	36.000	2.310	53.000	3.8
6/11/97	220	0.824	1.040	40.000	2.860	51.000	3.7
7/9/97	117	1.230	1.130	42.000	2.910	70.000	3.8
8/12/97	162	1.850	1.500	46.000	3.960	49.000	3.8
9/10/97	536	1.010	1.720	52.000	4.180	74.000	3.7
10/8/97	168	1.360	1.720	54.000	4.520	57.000	3.6
11/5/97	172	1.390	1.710	50.000	4.470	69.000	3.7
12/4/97	1147	0.473	1.220	44.000	3.050	44.000	3.4

Attachment C. Water quality analyses for the Loyalsock Creek watershed (collected between July 1995 to December 1997) located in Cherry and Colley Townships, Sullivan County. (See Attachment B for sample locations)

LOYALSOCK CREEK UPSTREAM OF DISCHARGES						
Map Reference # - 3						
Date	**Fe, mg/l**	**Mn, mg/l**	**Acidity, mg/l**	**Al, mg/l**	**SO4, mg/l**	**pH**
11/7/95	0.134	0.102	4.8	0.178	<10.0	5.7
5/5/97	0.143	0.056	4.8	0.235	34.0	5.7
5/8/97	0.059	0.075	6.800	0.266	38.000	5.1
8/12/97	0.203	0.033	1.400	<0.2	<10.0	6.1
9/10/97	0.116	0.021	0.600	<0.2	<10.0	6.0
10/8/97	0.100	0.017	0.600	<0.2	<10.0	6.0
11/5/97	0.092	0.116	1.200	0.258	<10.0	5.6
12/4/97	0.064	0.091	4.800	<0.2	<10.0	5.2

LOYALSOCK CREEK DOWNSTREAM OF DISCHARGES						
Map Reference # - 4						
Date	**Fe, mg/l**	**Mn, mg/l**	**Acidity, mg/l**	**Al, mg/l**	**SO4, mg/l**	**pH**
11/7/95	0.116	0.207	3.2	0.37	15.0	4.9
5/5/97	0.137	0.093	5.8	0.277	<10.0	5.1
5/8/97	0.100	0.068	4.400	0.239	15.000	5.5
8/12/97	0.183	0.000	2.800	0.230	11.000	6.1
9/10/97	0.128	0.096	2.2	<0.2	18.0	5.9
10/8/97	0.115	0.098	2.800	<0.2	15.000	5.9
11/5/97	0.120	0.089	2.600	<0.2	<10.0	5.8
12/4/97	0.075	0.110	6.000	<0.2	<10.0	5.3

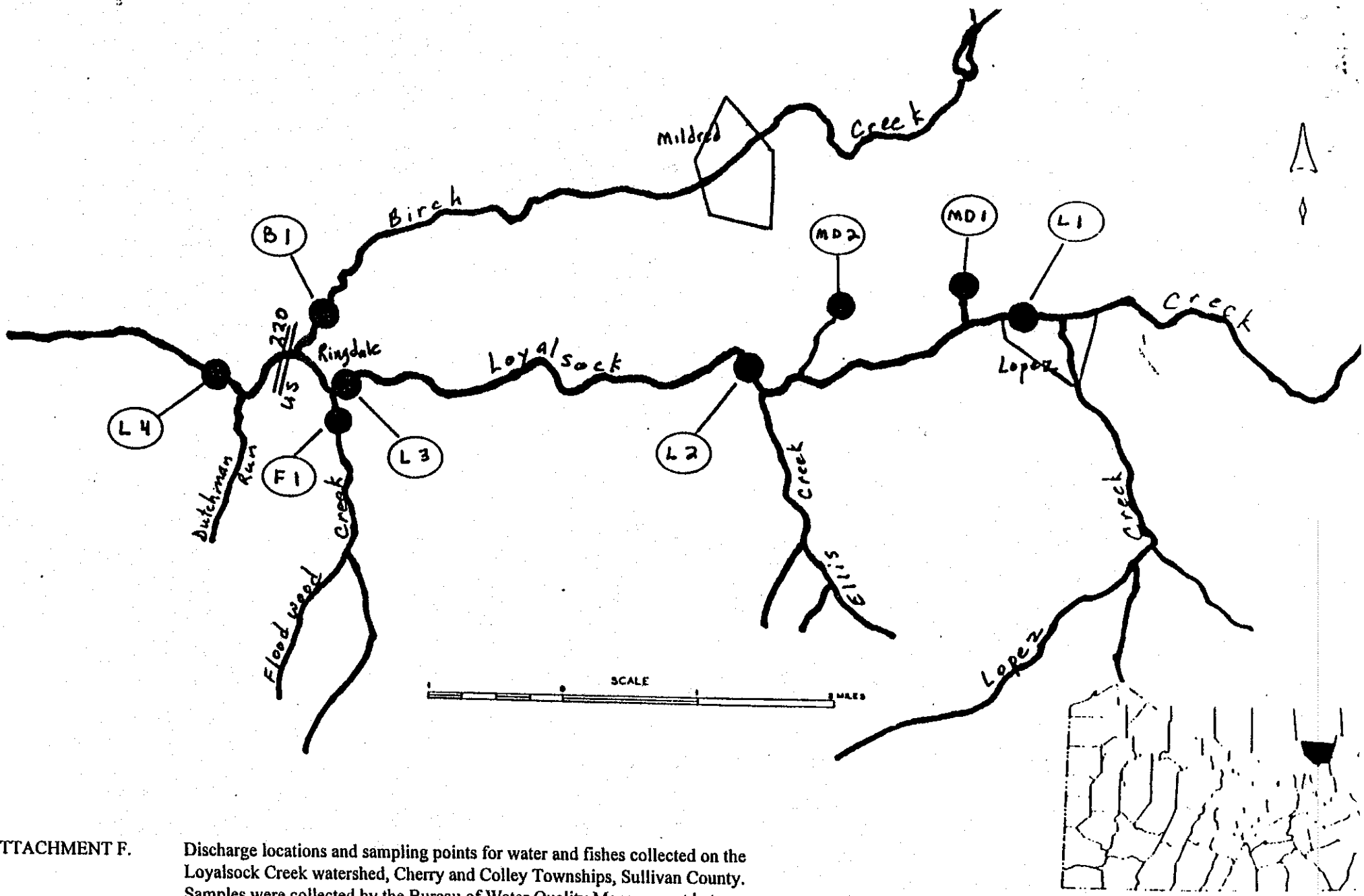
LOYALSOCK CREEK AT RINGDALE						
Map Reference # - 5						
Date	**Fe, mg/l**	**Mn, mg/l**	**Acidity, mg/l**	**Al, mg/l**	**SO4, mg/l**	**pH**
7/26/95	0.165	0.02	2.4	<0.135	<10.0	6.0
11/7/95	0.049	0.131	5.0	<0.135	12.0	5.3
12/5/95	0.049	0.131	5.0	<0.135	12.0	5.3
5/5/97	0.144	0.072	4.4	0.253	<10.0	5.2

ATTACHMENT D. Benthic macroinvertebrates collected from Loyalsock Creek watershed in Cherry and Colley Townships, Sullivan County on 7 November 1995 using a D-frame net. Sampling was conducted to determine the effects of the B and C tunnel discharges on Loyalsock Creek. (See Attachment B for sampling locations)

LOCATION	U.S. LOYALSOCK	D.S. LOYALSOCK	RINGDALE
TAXA			
EPHEMEROPTERA (MAYFLIES)			
Heptageniidae			
Stenonema sp.	14	---	3
Stenocron sp.	1	---	---
Oligoneuridae			
Isonychia sp.	2	---	---
PLECOPTERA (STONEFLIES)			
Capniidae	1	---	---
Perlidae	3	---	---
Acroneuria sp.	---	1	2
TRICHOPTERA (CADDISFLIES)			
Hydropsychidae			
Hydropsyche sp.	---	2	3
Philotamidae			
Chimarra sp.	1	---	---
ODONATA (DRAGON FLIES)			
Aeshnidae	---	1	---
MEGALOPTERA (ALDER FLIES, DOBSON FLIES)			
Corydalidae			
Nigronia sp.	---	---	1
OTHER			
Crayfish	1	---	---
Salamander	---	---	1
TOTAL TAXA	7	3	5
Total No.	23	4	10

ATTACHMENT E. Benthic macroinvertebrates collected from Loyalsock Creek watershed in Cherry and Colley Townships, Sullivan County on 5 May 1997 using a D-frame net. Sampling was conducted to determine the effects of the B and C tunnel discharges on Loyalsock Creek. (See Attachment B for sampling locations)

	Loyalsock at Ringdale (212)	Loyalsock d.s. B & C Tunnels (213)	Loyalsock U.S. (216)
EPHEMEROPTERA (MAYFLIES)			
Ephemeroptera			1
Heptageniidae			
Epeorus sp.	4		1
Stenonema sp.			4
Ephemerellidae			
Eurylophella sp.		1	2
Ephemerella sp.			8
Baetiscidae			
Baetisca sp.			
PLECOPTERA (STONEFLIES)			
Plecoptera			
Leuctridae			
Leuctra sp.	2	1	2
Chloroperlidae			
Alloperla sp.	5	1	6
Perlidae			
Acroneuria sp.		2	1
Perlodidae			
Isoperla sp.			1
TRICHOPTERA (CADDISFLIES)			
Hydropsychidae			
Hydropsyche sp.	4	1	9
Philopotamidae			
Chimarra sp.			2
Leptoceridae			
Mystacides sp.			1
Polycentropidae			
Polycentropus sp.	1		
DIPTERA (TRUE FLIES)			
Tipulidae			
Hexatoma sp.	4		2
Chironomidae		1	6
Simulidae			
Prosimulium sp.	1		1
Ceratopogonidae		1	
ODONATA (DRAGON-, DAMSELFLIES)			
Gomphidae			
Lanthus sp.			
Cordulegastridae			
Cordulegaster sp.			
NON-INSECT TAXA			
DECAPODA (CRAYFISH)			
Cambaridae			
Cambarus sp.		2	
Total No. of Taxa	7	8	16
Total No. of Individuals	21	10	48



ATTACHMENT F. Discharge locations and sampling points for water and fishes collected on the Loyalsock Creek watershed, Cherry and Colley Townships, Sullivan County. Samples were collected by the Bureau of Water Quality Management between 1987 and 1990 (Stream File 19804). (See Attachment G for water quality and Attachments H for fish survey results)

ATTACHMENT G. Water quality analyses for samples collected between 1987 and 1990 for the Loyalsock Creek watershed, Cherry and Colley Townships, Sullivan County. Samples were collected by the Bureau of Water Quality Management (Stream File 19804). (SeeAttachment F for sample locations)

PHYSICAL & CHEMICAL DATA
(values reported in mg/l unless noted otherwise)

Parameter	Stations					
	L1	MD1	MD2	L2N	L2C	L3
Time	13:30	13:00	10:00	13:30	13:30	10:00
Temperature C (field)	21.00	8.00	8.50	23.50	23.50	21.00
Dissolved Oxygen (field)	8.60	10.70	10.40	8.90	8.90	9.10
pH (field)	5.60	3.85	3.20	4.80	5.40	5.10
pH (lab)	5.60	4.00	3.60	5.60	5.70	5.80
Turbidity (NTU)	5.30	<1.00	<1.00	2.00	1.80	2.80
Specific Conductance (micromhos/cm)	30.00	210.00	280.00	31.00	30.00	31.00
Alkalinity	4.00	0.00	0.00	4.00	4.00	4.00
Acidity	14.00	32.00	56.00	12.00	12.00	12.00
P (total)	0.09	0.03	0.03	0.05	0.05	0.03
Al (total ug/l)	520.00	1790.00	4410.00	840.00	250.00	340.00
Fe (total ug/l)	880.00	770.00	1970.00	320.00	340.00	350.00
Mn (total ug/l)	160.00	1150.00	1630.00	80.00	80.00	60.00
Dissolved Residue	54.00	160.00	230.00	64.00	52.00	66.00
NO_2-N	0.00	0.00	0.00	0.00	0.00	0.00
NO_3-N	0.18	<0.04	0.06	0.04	0.04	0.12
NH_3-N	<0.02	<0.02	0.02	0.02	0.03	0.02
Hardness	11.00	66.00	79.00	10.00	11.00	12.00
Ca	3.24	9.84	7.40	3.10	3.04	3.11
Mg	<1.00	8.63	10.00	<1.00	<1.00	<1.00
SO_4	14.00	78.00	91.00	15.00	15.00	14.00
Cl	2.00	2.00	2.00	2.00	2.00	2.00

* numbers = station number
  prefixes: L = Loyalsock Creek
  MD = mine discharge
  F = Floodwood Creek
  B = Birch Creek
  suffixes: N = north bank
  C = center stream

ATTACHMENT H. Fish survey results from the Loyalsock Creek watershed. Samples were collected between 1987 and 1990 by the Bureau of Water Quality Management (Stream File 19804). (See Attachment F for sample locations)

FISH DATA

Species	Station L1	L2	L3	B1	L4
Trouts - Salmonidae					
Brown Trout, Salmo trutta <7"			3	9	
Brown Trout, Salmo trutta >7"			4	4	1
Brook Trout, Salvelinus fontinalis <7"				73	7
Brook Trout, Salvelinus fontinalis >7"				12	
Minnows - Cyprinidae					
Cutlips Minnow, Exoglossum maxillingua				P	
Blacknose Dace, Rhinichthys atratulus	C		P	C	C
Longnose Dace, Rhinichthys cataractae	P		P	P	
Creek Chub, Semotilus atromaculatus	P				P
Suckers - Catostomidae					
White Sucker, Catosomus commersoni	P	P	P	C	P
Bullhead Catfishes - Ictaluridae					
Brown Bullhead, Ictalurus nebulosus	P				
Margined Madtom, Noturus insignus	P				
Killifishes - Cyprinodontidae					
Banded Killifish, Fundulus diaphanus	P				
Sunfishes - Centrarchidae					
Pumpkinseed Sunfish, Lepomis gibbosus	P				
Largemouth Bass, Micropterus salmoides	P				
Perches - Percidae					
Tessellated Darter, Etheostoma olmstedi	P				
Sculpins - Cottidae					
Slimy Sculpin, Cottus cognatus				A	
Total Species	10	1	4	7	5
Temperature, degrees C	20	16	26	14	21

A = Abundant C = Common P = Present