

APPENDIX C
MINE DRAINAGE ABATEMENT

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ENCLOSURE C-1

ABATEMENT DESIGN CRITERIA AND ESTIMATED COSTS

1. Surface Reclamation

A. Restoration of Strip Mined Areas

(1) Methods and Materials

- a. Clear and grub area affected by restoration
- b. Backfill strip mine to within one foot of desired grade with available material within the mined areas, compacting the fill as it is placed; fill to be graded to induce surface runoff.
- c. Place one foot of compacted select fill (best soil in adjacent areas) over the area affected by restoration, including both the areas of excavation and embankment.
- d. Place ten tons of sewage sludge (or equivalent soil builder) per acre, disk and harrow.
- e. Lime, fertilize and plant area affected by restoration with appropriate grasses.

(2) Unit and/or Lump Sum Costs Used for Estimating Project Cost

- a. Major construction contract prices - used to compute Basic Construction Cost and Table C-2.

(1) Clear and grub	\$200/ Acre
(2) Move and place fill material	\$0.40/C. Y.
(3) Move and place select fill material	\$0.50/C. Y.
(4) Transport, spread, disk and harrow soil builder	\$ 20. / Acre
(5) Lime, fertilize and seed	\$150/ Acre

- b. Additional construction costs - not included in Table C-2, but used to calculate the Total Project Cost presented in the report text.

- (1) Material replacement and surface maintenance, a recurring cost for the first five years following land restoration - equivalent to the original select fill (capping) cost of \$807/acre, revegetation cost of \$170/acre, plus \$48/acre for maintenance, for a total of \$1025/acre.

- (2) Engineering, legal and administrative expenses and contingencies - equivalent to 25% of the Basic Construction Cost.

(3) Remarks

- a. Subsidence areas are reclaimed in the same manner as the restoration of strip mined areas.
- b. The cost of any land purchases is not included in the cost estimates.

B. Mine Refuse Regrading and Burial

(1) Methods and Materials

- a. Grade refuse to induce surface runoff compacting material as it is placed.
- b. Place one foot of compacted select fill over the area affected by regrading.
- c. Place ten tons of sewage sludge (or equivalent soil builder) per acre, disk and harrow.
- d. Lime, fertilize and plant area affected by regrading with appropriate grasses.

(2) Unit and/or Lump Sum Costs Used for Estimating Project Cost

- a. Major construction contract prices - used to compute Basic Construction Cost and Table C-2.

(1) Move and regrade refuse	\$0.40/C. Y.
(2) Move and place select fill material	\$0.50/C. Y.
(3) Transport, spread, disk and harrow soil builder	\$20./Acre
(4) Lime, fertilize and seed	\$150/Acre

- b. Additional construction costs - not included in Table C-2, but used to calculate the Total Project Cost presented in the report text.

- (1) Material replacement and surface maintenance, a recurring cost for the first five years following land restoration - equivalent to the original select fill (capping) cost of \$ 807/acre, revegetation cost of \$170/acre, plus \$48/acre for maintenance, for a total of \$1025/acre.
- (2) Engineering, legal and administrative expenses and contingencies - equivalent to 25% of the Basic Construction Cost.

(3) Remarks

- a. Place refuse material in strip pits where feasible, cover and grade to drain.
- b. The cost of any land purchases is not included in the cost estimates.

2. Subsurface Drainage Control

A. Deep mine sealing and grouting

- (1) Description of seal - Front and rear reinforced concrete bulkheads with 20-foot clay plug between the two walls; leaks through rock fractures controlled by drilling and pressure grouting 2 1/8" diameter, 30 ft. holes placed at 2 ft. centers in the plane of the rear bulkhead.

- (2) Methods and Materials
 - a. Clear debris from opening
 - b. Place permanent timber supports
 - c. Construct access facilities
 - d. Prepare roof, sides and invert for placement and anchoring of the seal.
 - e. Drill 2 1/8" holes on 2 ft. centers around perimeter of rear bulkhead site to a length of 30 ft. in the plane of the seal.
 - f. Construct seal.
 - (3) Unit and/or Lump Sum Costs Used for Estimating Project Cost
 - a. Major construction contract prices - used to compute Basic Construction Cost and Table C-4.
 - (1) Seal placed at mine entrance - lump sum \$8,000
 - (2) Seal placed back from mine entrance:
 - (a) Clearing, shoring, and placing of timber supports at intervals of 12' \$40/set
 - (b) Transportation of materials \$1.00/ft.
 - (c) Reinforced concrete bulkhead \$150/C. Y.
 - (d) Bentonite or clay core \$40/C. Y.
 - (e) Drilling and grouting \$2.00/L.F.
 - b. Additional construction costs - not included in Table C-4, but used to calculate the Total Project Cost presented in the report text.
 - (1) Engineering, legal and administrative expenses and contingencies - equivalent to 25% of the Basic Construction Cost.
 - (4) Remarks
 - a. The cost of any land purchases is not included in the cost estimate nor in compensation for any coal reserves lost as the result of mine sealing.
- B. Plug Churn Drill Holes (Newkirk Drainage Tunnel Outlet)
- (1) Methods and Materials
 - a. Excavate area to uncover drill holes
 - b. Clean hole
 - c. Insert bulkhead boulder tool to stop artesian flow
 - d. Place seal in three layers:
 - (1) 3 feet concrete
 - (2) 6 feet bentonite
 - (3) 3 feet concrete
 - e. Backfill and restore excavation
 - (2) Lump sum construction cost - \$1400/hole or \$2800, used to compute Basic Construction Cost in Table C-4.
 - (3) Additional construction costs - not included in Table C-4, but used to calculate the Total Project Cost presented in the report text: - engineering, legal and administrative expenses and contingencies equivalent to 25% of the Basic Construction Cost.

Table C-2

SURFACE RECLAMATION DETAILS*

WABASH VALLEY

RECLAMATION AREA	WATERSHED ACRES	CLEARING COST	BACKFILLING YD ³	COST	CAPPING YD ³	COST	REVEGETATION ACRES	COST	TOTAL COST	COST/ AC.REC.
W: 1S	81.15	\$ 3,300	44,120	\$ 17,648	35,945	\$ 17,973	22.28	\$ 3,787	\$ 42,708	\$1,917
W: 2S	107.49	8,200	150,885	60,354	83,909	41,957	52.01	8,842	119,353	2,295
W: 3S	93.07	7,500	347,385	138,954	79,230	39,615	49.11	8,349	194,418	3,959
W: 4S	41.95	4,800	422,970	169,188	53,869	26,935	33.39	5,677	206,600	6,187
W: 5S	17.57	2,600	43,000	17,200	28,120	14,060	17.43	2,963	36,823	2,113
W: 6S	19.18	3,000	8,000	3,200	29,863	14,932	18.51	3,147	24,279	1,312
W: 7S	4.32	300	35,800	14,320	3,630	1,815	2.25	382	16,817	7,474
Sub-Total	364.73	\$29,700	1,052,160	\$ 420,864	314,568	\$157,283	194.98	\$ 33,147	\$ 640,995	\$3,287Av.
SR: 1	63.41	4,200	580,000	232,000	48,545	24,272	30.09	5,115	265,587	8,826
SR: 2	18.63	1,600	52,600	21,040	16,214	8,107	10.05	1,708	32,455	3,229
SR: 3	9.78	1,200	158,000	63,200	15,697	7,849	9.73	1,654	73,903	7,595
Sub-Total	91.82	\$ 7,000	790,600	\$ 316,240	80,456	\$ 40,228	49.87	\$ 8,477	\$ 371,945	\$7,458Av.
W: 1N	317.67	9,000	339,100	159,640	95,460	47,733	59.17	10,058	226,431	3,827
W: 2N	193.20	6,200	208,710	83,484	66,194	33,097	41.03	6,974	129,755	3,162
W: 3N	195.54	3,800	73,300	29,320	43,220	21,610	26.79	4,554	59,284	2,213
W: 4N	145.11	12,000	141,825	56,730	123,176	61,588	76.35	12,980	143,298	1,877
W: 5N	133.47	8,600	109,520	43,808	87,829	43,914	54.44	9,254	105,576	1,939
W: 6N	12.70	300	3,000	1,200	3,485	1,742	2.16	367	3,609	1,671
W: 7N	12.88	1,900	13,000	5,200	18,231	9,115	11.30	1,921	18,136	1,605
W: 8N	88.65	6,200	75,350	30,140	65,468	32,737	40.58	6,898	75,975	1,872
W: 9N	16.54	600	550	220	6,792	3,396	4.21	716	4,932	1,171
W: 10N	34.50	1,400	2,800	1,120	18,198	9,100	11.28	1,917	13,537	1,200
W: 11N	18.18	500	2,115	846	6,776	3,388	4.20	714	5,448	1,297
W: 12N	10.49	100	5,800	2,320	1,565	782	0.97	165	3,367	3,471
W: 13N	10.37	300	2,240	896	6,196	3,097	3.84	653	4,946	1,288
Sub-Total	1,189.30	\$50,900	1,037,310	\$ 414,924	542,590	\$271,299	336.32	\$ 57,171	\$ 794,294	\$2,362Av.
Sub-Total: Misc. Basins	47.23	2,600	18,615	7,446	28,685	14,342	17.78	3,023	27,411	1,541
Strip Mine Total	1,693.08	90,200	2,898,685	1,159,474	966,299	483,152	598.98	101,818	1,834,645	3,063Av.
W: 1R	50.80	-----	200,000	80,000	81,957	40,979	50.80	8,636	129,615	2,551
W: 2R	51.00	-----	430,000	172,000	82,280	41,140	51.00	8,670	221,810	4,349
Refuse Sub-Total	101.80	-----	630,000	252,000	164,237	82,119	101.80	17,306	351,415	3,452Av.
TOTAL	1,794.88	\$90,200	3,528,685	\$1,411,474	1,130,536	\$565,271	700.75	\$119,124	\$2,186,069	\$3,120Av.

* Explanatory notes and procedural remarks follow table.

Table C-2

SURFACE RECLAMATION DETAILS*

PANTHER VALLEY

RECLAMATION AREA	WATERSHED ACRES	CLEARING COST	BACKFILLING YD ³	COST	CAPPING YD ³	COST	REVEGETATION ACRES	COST	TOTAL COST	COST/ AC.REC.
P: 1S	18.37	\$ 200	8,500	\$ 3,400	5,792	\$ 2,896	3.59	\$ 610	\$ 7,106	\$ 1,979
P: 2S	17.48	1,900	11,850	4,740	18,376	9,188	11.39	1,936	17,764	1,560
P: 3S	48.56	700	6,490	2,596	10,631	5,315	6.59	1,121	9,732	1,477
P: 4S	36.52	2,100	23,665	9,466	26,695	13,348	16.55	2,814	27,728	1,675
P: 5S	16.70	2,900	23,500	9,400	26,937	13,487	16.70	2,839	28,628	1,714
P: 6S	155.89	15,300	232,810	93,104	151,364	75,682	93.84	15,953	200,059	2,132
P: 7S	55.69	5,700	59,130	23,652	54,310	27,155	33.67	5,724	62,231	1,848
P: 8S	10.49	1,800	27,500	11,000	16,924	8,462	10.49	1,783	23,045	2,197
P: 9S	16.75	2,800	19,800	7,920	26,007	13,004	16.12	2,740	26,464	1,642
P: 10S	30.68	2,800	95,100	38,040	34,680	17,340	21.50	3,655	61,835	2,876
P: 11S	140.67	20,000	409,500	163,800	189,608	94,804	117.55	19,984	298,588	2,540
P: 12S	5.98	800	24,500	9,800	8,340	4,171	5.17	879	15,650	3,027
P: 13S	19.28	1,000	3,790	1,516	9,807	4,904	6.08	1,034	8,454	1,390
P: 14S	530.72	49,400	1,299,900	519,600	481,755	240,878	298.67	50,774	861,012	2,883
P: 15S	20.34	3,800	25,100	10,040	33,131	16,566	20.34	3,458	33,865	1,665
P: 16S	10.77	2,100	1,580	632	17,372	8,686	10.77	1,831	13,249	1,230
P: 17S	49.27	9,000	18,500	7,400	76,650	38,325	47.52	8,078	62,803	1,322
P: 18S	15.64	3,000	3,600	1,440	25,227	12,614	15.64	2,659	19,713	1,260
P: 19S	46.12	3,400	700	280	28,582	14,291	17.72	3,012	20,983	1,184
Sub-Total	1,245.92	\$128,700	2,295,515	\$ 917,846	1,242,188	\$ 621,106	769.90	\$130,884	\$1,798,909	\$ 2,336Av
P: 1N	109.80	10,698	69,800	27,900	99,974	49,987	61.98	10,536	99,141	1,600
P: 2N	66.38	4,600	166,000	66,400	51,442	25,271	31.88	5,420	102,141	3,204
P: 3N	95.92	4,600	423,000	169,200	50,777	25,389	31.48	5,352	204,541	6,498
P: 4N	73.90	3,400	909,000	363,600	48,729	24,365	30.21	5,136	396,201	13,115
P: 5N	18.06	175	19,000	7,600	1,887	944	1.17	199	8,918	7,622
Sub-Total	364.06	\$ 23,473	1,586,500	\$ 634,720	252,809	\$ 126,406	156.72	\$ 26,643	\$ 810,942	\$ 5,165Av
Sub-Total: Misc. Resins	38.97	4,332	26,540	10,616	35,535	17,766	22.03	3,746	34,736	1,577
Strip Mine Total	1,649.35	156,505	3,908,855	156,318	1,530,532	765,278	948.65	161,273	2,644,587	2,786Av
P: 1R	125.03	-----	2,500,000	1,000,000	201,673	100,837	125.03	21,255	1,122,092	8,975
P: 2R	65.70	-----	700,000	280,000	105,974	52,987	65.70	11,169	344,156	5,238
P: 3R	319.78	-----	4,000,000	1,600,000	515,805	257,903	319.78	54,363	1,912,266	5,980
P: 4R	31.52	-----	900,000	360,000	50,842	25,421	31.52	5,358	390,779	12,398
P: 5R	86.92	-----	1,090,000	436,000	140,202	70,101	86.92	14,776	520,877	5,993
Refuse Sub-Total	628.95	-----	9,190,000	\$3,676,000	1,014,496	\$ 507,249	628.95	\$106,921	\$4,290,171	\$ 6,820Av
TOTAL	2,278.30	\$156,505	13,098,855	\$5,239,442	2,545,028	\$1,272,527	1,577.60	\$268,194	\$6,934,758	\$ 4,394Av

*Explanatory notes and procedural remarks follow table.

Table C-2

SURFACE RECLAMATION DETAILS*

SILVERBROOK BASIN

RECLAMATION AREA	WATERSHED ACRES	CLEARING COST	BACKFILLING YD ³	COST	CAPPING YD ³	COST	REVEGETATION ACRES	COST	TOTAL COST	COST/ AC.REC.
SB: 1	124.21	\$ 12,000	831,500	\$ 331,040	187,108	\$ 93,554	115.93	\$ 19,720	\$ 459,314	\$3,960
SB: 2	259.86	20,000	1,088,300	435,320	187,108	93,554	115.86	19,700	568,574	4,907
SB: 3	836.43	20,000	2,277,800	911,120	396,798	198,399	245.80	41,820	1,171,399	4,765
TOTAL	1,220.50	\$ 52,000	4,197,600	\$1,680,480	771,014	\$ 385,507	477.59	\$ 81,240	\$ 2,199,287	\$4,605Av.
GRAND TOTAL	5,293.68	\$298,705	20,825,140	\$8,331,396	4,446,578	\$2,223,305	2,755.94	\$468,558	\$11,320,114	\$4,108

* Explanatory notes and procedural remarks follow table.

Supplement to Table C-2

Procedure Employed to Secure Surface Reclamation Details

Calculation of the yardage and acreage figures was performed on 1"=200' topographic maps. The yardage figures were computed from longitudinal and transverse cross sections of each respective reclamation area. The acreage figures were determined by dividing each reclamation area into three categories - refuse storage, strip mine pits, and original surface. In this classification, subsidence areas were treated as pit areas and strip mine spoils banks were included with deep mine refuse storage areas. This classification was performed on 1"=200' ortho-photo blow-ups of the aerial photographs for the study area. Areas in which the distinctions were not clear on the photographs were field checked before the final classification was made. When this classification was complete, the acreage of each type of surface within each reclamation area was computed. A brief explanation of the meaning of the results in each column follows:

Watershed Acres - The acreage figures listed under this heading are equal to the sum of the above three categories, or the total acres within each reclamation area. These figures are utilized further in the determination of the benefit received from surface reclamation.

Clearing Cost - These figures refer to the cost of clearing and grubbing the reclamation areas prior to the beginning of backfilling or regrading. In the case of refuse storage areas, this figure is zero, due to the lack or near lack of vegetative cover.

In the case of strip-mined land, these figures represent an estimate of the number of acres within each reclamation area which will require clearing. This estimate was arrived at from field investigations and examination of aerial photographs. The number of acres was then multiplied by \$200 per acre to determine the clearing cost.

Backfilling (or Regrading) - The yardage figures expressed in this column were derived from the systematic evaluation of cross sections of the respective reclamation areas. In the case of strip-mined land, these figures represent the amount of backfilling material that would be required to provide drainage from an existing internal drainage area on a surface sloped at no less than 0.5% grade.

In the case of refuse storage areas, these figures represent the amount of material that would have to be moved to provide efficient surface drainage from these areas. In most cases a terrace morphology was sought which had a riser slope no greater than 25% grade and a tread slope no less than 0.5% grade.

Capping - The yardage figures for "Capping" were computed by multiplying the number of acres reclaimed (same as acres revegetated) by the cubic yards of select fill necessary to cover one acre with a one foot cap. This amounts to 1,613 cubic yards per acre and, at a cost of \$.50 per cubic yard, \$807 per acre.

Revegetation - The acreage figures listed under this column are equal to the sum of the refuse storage acreage within each reclamation area and that portion of the strip mine pit acreage which must be back-filled to provide runoff from the watershed. These last figures for strip mine pit acreage were calculated from the cross sections and maps used in estimating the backfill yardage figures. These backfilled areas are represented on Exhibits 33 to 36 as shaded areas. The cost figures were based on a unit cost of \$170 per acre for acquiring and applying a soil builder and the lime, fertilizer and seed,

Total Cost - These figures are the sum of the Clearing, Backfilling, Capping and Revegetation costs and are the Basic Construction Costs for surface reclamation.

Cost! Acre Reclaimed - The figures in this column refer to the Basic Construction Costs within each reclamation area, divided by the acreage reclaimed within that area. The surface area reclaimed is equivalent to the acres listed under Revegetation,

NOTE: The cost figures tabulated are in simplest basic terms and permit relative comparisons of reclamation areas. Additional costs of engineering, legal and administrative expenses and contingencies (equivalent to 25% of the Basic Construction Cost) plus a replacement and maintenance cost of \$1025 per acre reclaimed, are reflected in the report narrative section Mine Drainage Abatement, Summary of Abatement Analysis, page 78. The cost of any land purchases is not included in the analysis.

Table C-3

ABATEMENT AND COST/BENEFIT
BY SURFACE RECLAMATION AREA

WABASH VALLEY

RECLAMATION AREA	RELATED DISCHARGE Name	PRESENT ACID CONTRIBUTION Acidity, mg/l	PRESENT ACID CONTRIBUTION		ABATEMENT BY RECLAMATION			RELATIVE COST/BENEFIT		
			Flow, gal./Day	Acid, lbs./Day	Flow, gal./Day	Acid, lbs./Day	% Reduction	Impact, lb.-mi./Day	\$/lb./Day	\$/lb.-mi./Day
W: 1S	Newkirk Mine	260	211,350	458	136,468	296	64.6	6,305	144	7
W: 2S	" "	260	315,362	683	211,368	458	67.0	9,755	260	12
W: 3S	" "	260	267,496	580	175,374	380	65.5	8,094	512	24
W: 4S	A & D Mine	3,300	21,600	594	14,148	389	65.5	8,285		
W: 4S	West Lehigh Shaft	700	116,151	677	76,078	444	65.5	9,457	248	12
W: 5S	" " "	700	60,893	355	40,029	233	65.7	4,962	158	7
W: 6S	" " "	700	24,556	143	16,378	96	66.7	2,044		
W: 6S	Newkirk Mine	260	41,772	91	27,861	60	66.7	1,278	156	7
W: 7S	Smith Mine	320	11,551	31	7,196	19	62.2	404	885	42
Sub-Total			1,070,731	3,612	704,900	2,375	66.7	50,584		
W: 1N	Reevesdale #2 Drift									
	Newkirk Dr. Tunnel	80	363,200	222	192,539	118	53.0	2,513	1,919	90
W: 2N	" " "	80	461,432	307	261,365	174	56.6	3,706	746	35
W: 3N	" " "	80	431,957	288	222,021	148	51.3	3,152	401	19
W: 4N	" " "	80	358,350	239	242,961	162	67.8	3,450		
W: 4N	Zakrewsky Pumps	220	78,000	143	52,884	97	67.8	2,065	553	26
W: 5N	" " "	220	284,159	520	235,052	431	82.8	9,180		
W: 5N	Zakrewsky Grav.	100	173,058	144	83,214	69	47.9	1,469	211	10
W: 6N	" " "	100	27,661	23	13,284	11	48.0	234	328	15
W: 7N	Zakrewsky Pumps	220	44,589	88	31,106	57	69.7	1,214	318	15
W: 8N	Reevesdale #2 Drift									
	Newkirk Dr. Tunnel	80	243,644	162	152,010	101	62.3	2,151	752	35
W: 9N	" " "	80	18,930	13	9,385	6	49.5	128	822	39
W: 10N	" " "	80	42,608	28	22,616	15	53.0	319	902	42
W: 11N	" " "	80	20,309	14	9,714	6.4	47.8	136	851	40
W: 12N	" " "	80	10,480	7	4,341	3.3	41.4	64	1,122	53
W: 13N	" " "	80	12,838	9	6,801	4.5	52.9	96	1,099	52
Sub-Total			2,571,215	2,207	1,539,293	1,403.9	63.6	29,877		
SR: 1	Newkirk Mine	260	83,152	180	45,318	98	54.5	2,087	2,710	127
SR: 2	" "	260	30,728	67	23,445	51	76.3	1,086	636	30
SR: 3	" "	260	15,818	34	9,981	22	63.1	468	3,359	158
Sub-Total			129,698	281	78,744	171	60.7	3,641		
W: M		100	115,211	96	60,898	51	52.8	1,081	537	25
Sub-Total			115,211	96	60,898	51	52.8	1,081		
W: 1R	Reevesdale Seeps	150	174,489	218	113,877	142	65.1	3,024	912	43
W: 2R	Newkirk Seeps	1,000	175,176	1,400	114,326	913	65.2	19,447	243	11
Sub-Total			349,665	1,618	228,203	1,055	65.2	22,471		
TOTAL			4,236,520	7,814	2,612,038	5,052	64.7	107,654		

Table C-3

ABATEMENT AND COST/BENEFIT
BY SURFACE RECLAMATION AREA

PANTHER VALLEY

RECLAMATION AREA	RELATED DISCHARGE			PRESENT ACID CONTRIBUTION		ABATEMENT BY RECLAMATION			RELATIVE COST/BENEFIT	
	Name	Acidity mg/l	Flow, gal./Day	Acid, lbs./Day	Flow, gal./Day	Acid, lbs./Day	% Reduction	Impact, lb.-mi./Day	\$/lb./Day	\$/lb.-mi./Day
P: 1S	Tamaqua #14 Pumps	250	43,934	92	23,663	49	53.5	1,044	145	6.8
P: 2S	" " "	250	60,160	125	46,571	97	77.6	2,066	183	8.6
P: 3S	" " "	250	109,372	228	59,000	123	53.9	2,620	79	3.7
P: 4S	" " "	250	96,691	201	55,385	115	57.4	2,449	291	11.3
P: 5S	" " "	250	57,604	120	37,679	78	65.4	1,661	367	17
P: 6S	" " "	250	470,170	979	305,647	637	65.0	13,568	314	14.7
P: 7S	" " "	250	148,079	308	81,633	170	55.2	3,621	366	17
P: 8S	" " "	250	36,220	75	23,704	49	65.8	1,044	470	22
P: 9S	" " "	250	57,812	120	37,827	79	65.6	1,683	335	15.7
P: 10S	" " "	250	178,479	372	112,821	235	63.1	5,006	263	12.4
P: 11S	" " "	250	480,251	1,001	352,436	734	73.3	15,634	407	19
P: 12S	" " "	250	20,766	43	16,698	35	80.8	746	447	21
P: 13S	" " "	250	47,322	99	29,831	62	62.7	1,321	136	6.4
P: 14S	Greenwood #10 Pumps	0	1,571,743	0	1,074,463	0	68.2	-----	No acid abatement, only iron and sulfate	
P: 15S	" " "	0	70,048	0	45,780	0	65.7	-----	"	
P: 16S	" " "	0	37,016	0	24,166	0	64.9	-----	"	
P: 17S	" " "	0	169,672	0	112,974	0	66.5	-----	"	
P: 18S	" " "	0	53,769	0	35,109	0	64.8	-----	"	
P: 19S	" " "	0	111,949	0	56,689	0	50.9	-----	"	
Sub-Total			3,851,057	3,763	2,532,076	2,463	65.4	52,463		
P: M	Greenwood #10 Pumps	0	49,791	0	32,819	0	66.0	-----		
P: M	Tamaqua #14 Pumps	250	62,527	130	33,594	70	53.8	1,491	496	23.3
Sub-Total			112,318	130	66,413	70	53.8	1,491		
P: 1N	Tamaqua #14 Pumps	250	320,997	669	204,248	426	63.6	9,074	233	11
P: 2N	Greenwood #10 Pumps	0	180,149	0	105,995	0	58.8	-----	No acid abatement, only iron and sulfate	
P: 3N	" " "	0	235,908	0	128,505	0	54.2	-----	"	
P: 4N	" " "	0	203,429	0	128,488	0	63.0	-----	"	
P: 5N	" " "	0	34,635	0	13,087	0	37.1	-----	"	
Sub-Total			975,118	669	580,323	426	63.6	9,074		
P: 1R	Tamaqua #14 Pumps	250	366,553	764	231,661	482	63.1	10,266	2,328	109
P: 1R	E. Elm St. Seep	2,000	39,000	660	39,000	660	100.0	14,058	173	8
P: 2R	Greenwood W. Seep	750	202,675	1,267	124,190	776	62.7	16,529	444	21
P: 3R	Greenwood #10 Pumps	0	932,786	0	608,176	0	65.2	-----		
P: 3R	Coaldale Seep	1,100	165,600	1,500	107,971	978	65.2	20,831	1,955	91
P: 4R	Greenwood #10 Pumps	0	107,243	0	69,635	0	65.4	-----	No acid abatement	
P: 5R	Manbeck Seeps	600	298,554	1,493	194,846	974	65.2	20,746	535	25
Sub-Total			2,112,411	5,684	1,375,479	3,870	83.6	82,430		
TOTAL			7,049,904	10,246	4,554,291	6,829	66.6	145,458		

Table C-3

ABATEMENT AND COST/BENEFIT
BY SURFACE RECLAMATION AREA

SILVERBROOK BASIN

RECLAMATION AREA	RELATED DISCHARGE Name	Acidity mg/l	PRESENT ACID CONTRIBUTION		ABATEMENT BY RECLAMATION			Impact, lb.-mi./Day	RELATIVE COST/BENEFIT	
			Flow, gal./Day	Acid, lbs./Day	Flow, gal./Day	Acid, lbs./Day	% Reduction		\$/lb./Day	\$/lb.-mi./Day
SB: 1	Silverbrook Mine	110	429,237	393	233,311	214	54.4	6,249	2,146	74
SB: 2	" "	110	661,432	606	351,381	322	53.1	9,402	1,766	60
SB: 3	" "	110	1,817,280	1,641	912,274	974	59.4	28,341		
SB: 3	Silverbrook Seeps	415	138,317	500	89,183	326	65.2	9,519	901	31
TOTAL			3,046,266	3,140	1,586,169	1,836	58.5	53,511		
GRAND TOTAL			14,332,690*	21,200	8,752,498	13,717	64.7	306,623		

* The flow of 14 MGD is the sum of the mine drainage through all of the indicated reclamation areas. An additional 12 MGD, for a total basin mine drainage of 26 MGD, is ascribable to (1) the effluent from the Greenwood Breaker, (2) infiltration through the active mining and related surface areas of the Greenwood Stripping Corporation into the subsurface mine pools and (3) infiltration through the undisturbed central portion of Panther Valley and its interception by the deep mine workings. The infiltration is ultimately discharged to the surface by the Greenwood #10 and Tamaqua #14 pumps.

Table C-4

SUBSURFACE DRAINAGE CONTROL DETAILS

LOCATION	MAXIMUM ANTICIPATED HEAD	LUMP SUM COST	SHORING COST		TRANSPORTATION OF MATERIALS		REINFORCED CONCRETE BULKHEADS (2)		BENTONITE OR CLAY CORE		GROUTING	
	Feet		Sets	Cost	Distance	Cost	Cu. Yds.	Cost	Cu. Yds.	Cost	Feet	Cost
Reevesdale #1 Drift	32	\$ 8,000	---	\$-----	-----	\$-----	-----	\$-----	-----	\$-----	----	\$-----
Reevesdale #2 Drift	26	8,000	---	-----	-----	-----	-----	-----	-----	-----	----	-----
Newkirk Mines Portal	20	8,000	---	-----	-----	-----	-----	-----	-----	-----	----	-----
Buck Mountain Gangway	150	-----	190	7,600	2,250	2,250	32	4,800	74	2,960	900	1,800
Bot. Split Gangway	150	-----	---	-----	1,950	1,950	32	4,800	74	2,960	900	1,800
Newkirk Drainage Tunnel	18	2,800	---	-----	-----	-----	-----	-----	-----	-----	----	-----
Zakrewsky Grav.	40	8,000	---	-----	-----	-----	-----	-----	-----	-----	----	-----
A&D Mine	40	8,000	---	-----	-----	-----	-----	-----	-----	-----	----	-----
Smith Mine	40	8,000	---	-----	-----	-----	-----	-----	-----	-----	----	-----
West Lehigh Shaft	40	8,000	---	-----	-----	-----	-----	-----	-----	-----	----	-----
First North Drift	40	8,000	---	-----	-----	-----	-----	-----	-----	-----	----	-----
Coaldale #7 Mine	Unknown	8,000	---	-----	-----	-----	-----	-----	-----	-----	----	-----
TOTAL		\$74,800	190	\$7,600	4,200	\$4,200	64	\$9,600	148	\$5,920	1,800	\$3,600

Table C-5

ABATEMENT AND COST/BENEFIT
FROM SUBSURFACE DRAINAGE CONTROL

Location	ABATEMENT		CONCENTRATION, mg/l		RELATIVE COST/BENEFIT	
	Flow, gal./day	Load lbs./day	Original	Resultant	Total Cost	Cost/Lb.-Day
Reevesdale #1 Drift	144,000	100	84	*	\$ 8,000	\$ 80
Newkirk Drainage Tunnel & Reevesdale #2 Drift	201,600	135	80	70	10,800	80
Newkirk Mine (3 Seals)	110,020	238	260	200	38,920	163
Zakrewsky Mine Gravity	12,960	11	100	83	8,000	725
A&D Mine	2,590	71	3,300	2,800	8,000	112
Smith Mine	3,600	10	320	227	8,000	800
West Lehigh Shaft	20,160	118	700	523	8,000	68
First North Drift	14,400	100	833	----	8,000	80
Coaldale #7 Mine	18,720	14	90	12	8,000	571
TOTAL	528,050	797			\$105,720	\$133 Av.

* Drainage diverted internally into Newkirk Mine.

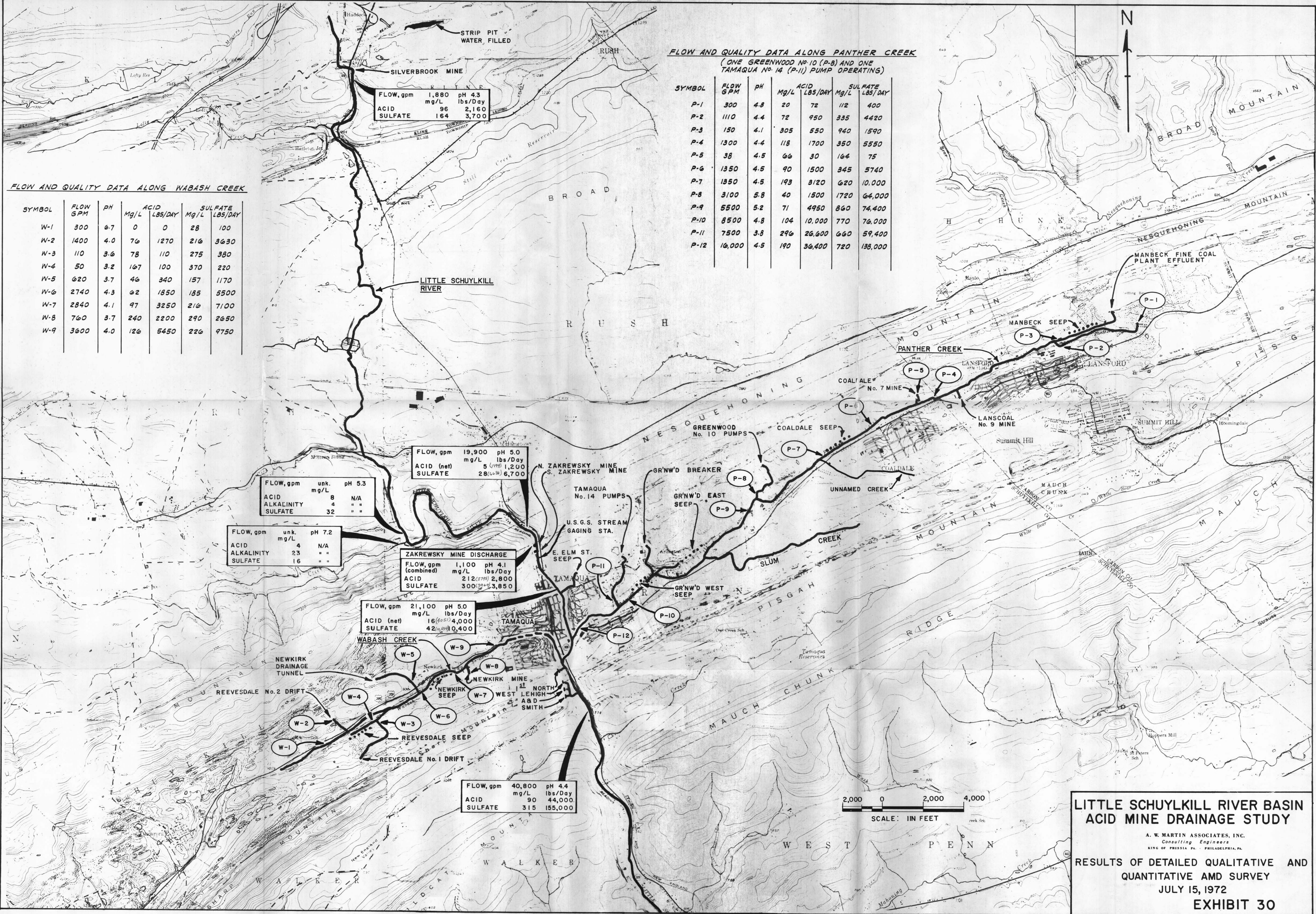
FLOW AND QUALITY DATA ALONG WABASH CREEK

SYMBOL	FLOW GPM	PH	ACID Mg/L	ACID LBS/DAY	SULFATE Mg/L	SULFATE LBS/DAY
W-1	300	6.7	0	0	28	100
W-2	1400	4.0	76	1270	216	3630
W-3	110	3.6	78	110	275	380
W-4	50	3.2	167	100	370	220
W-5	620	3.7	46	340	157	1170
W-6	2740	4.3	62	1850	185	5500
W-7	2840	4.1	97	3250	216	7100
W-8	760	3.7	240	2200	290	2650
W-9	3600	4.0	126	5450	226	9750

FLOW AND QUALITY DATA ALONG PANTHER CREEK

(ONE GREENWOOD No. 10 (P-8) AND ONE TAMAQUA No. 14 (P-11) PUMP OPERATING)

SYMBOL	FLOW GPM	PH	ACID Mg/L	ACID LBS/DAY	SULFATE Mg/L	SULFATE LBS/DAY
P-1	300	4.8	20	72	112	400
P-2	1110	4.4	72	950	335	4420
P-3	150	4.1	305	550	940	1590
P-4	1300	4.4	118	1700	350	5550
P-5	38	4.5	66	30	164	75
P-6	1350	4.5	90	1500	345	5740
P-7	1350	4.5	193	3120	620	10,000
P-8	3100	5.8	40	1500	1720	64,000
P-9	5500	5.2	71	4950	860	74,400
P-10	8500	4.8	104	10,000	770	76,000
P-11	7500	3.8	296	26,600	660	59,400
P-12	16,000	4.5	190	36,400	720	138,000



FLOW, gpm 1,880 pH 4.3
ACID mg/L 96 lbs/Day 2,160
SULFATE 164 3,700

LITTLE SCHUYLKILL RIVER

FLOW, gpm unk. pH 5.3
ACID mg/L 8 N/A
ALKALINITY 4 " "
SULFATE 32 " "

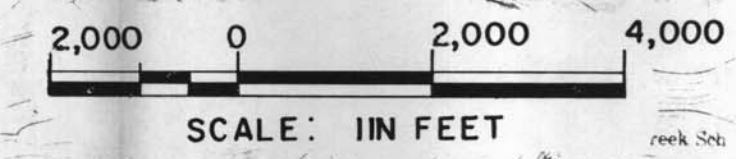
FLOW, gpm unk. pH 7.2
ACID mg/L 4 N/A
ALKALINITY 23 " "
SULFATE 16 " "

FLOW, gpm 19,900 pH 5.0
ACID (net) mg/L 5 lbs/Day 1,200
SULFATE 28,600 6,700

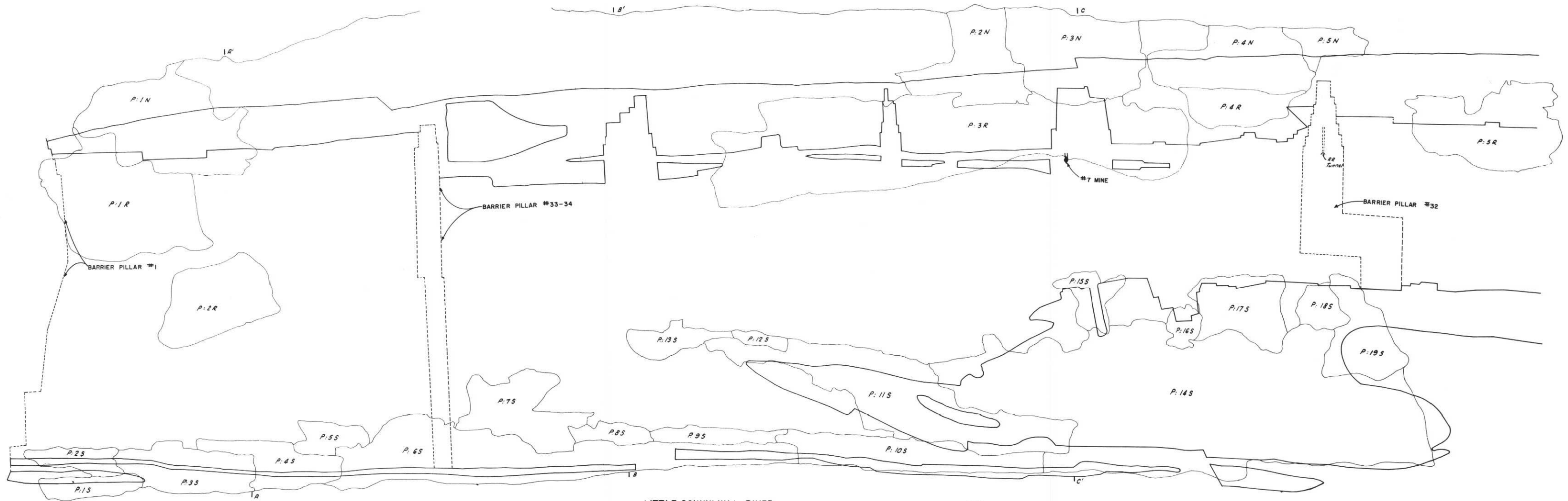
ZAKREWSKY MINE DISCHARGE
FLOW, gpm 1,100 pH 4.1
ACID (combined) mg/L 212 lbs/Day 2,800
SULFATE 300 3,850

WABASH CREEK
FLOW, gpm 21,100 pH 5.0
ACID (net) mg/L 16 lbs/Day 4,000
SULFATE 42,600 10,400

FLOW, gpm 40,800 pH 4.4
ACID mg/L 90 lbs/Day 44,000
SULFATE 315 155,000



**LITTLE SCHUYLKILL RIVER BASIN
ACID MINE DRAINAGE STUDY**
A. W. MARTIN ASSOCIATES, INC.
Consulting Engineers
KING OF PRUSSIA, PA. - PHILADELPHIA, PA.
**RESULTS OF DETAILED QUALITATIVE AND
QUANTITATIVE AMD SURVEY
JULY 15, 1972
EXHIBIT 30**



**LITTLE SCHUYLKILL RIVER
ACID MINE DRAINAGE STUDY**

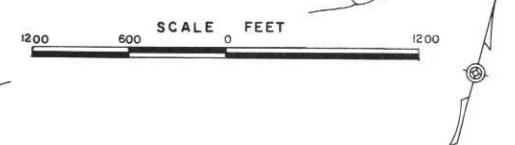
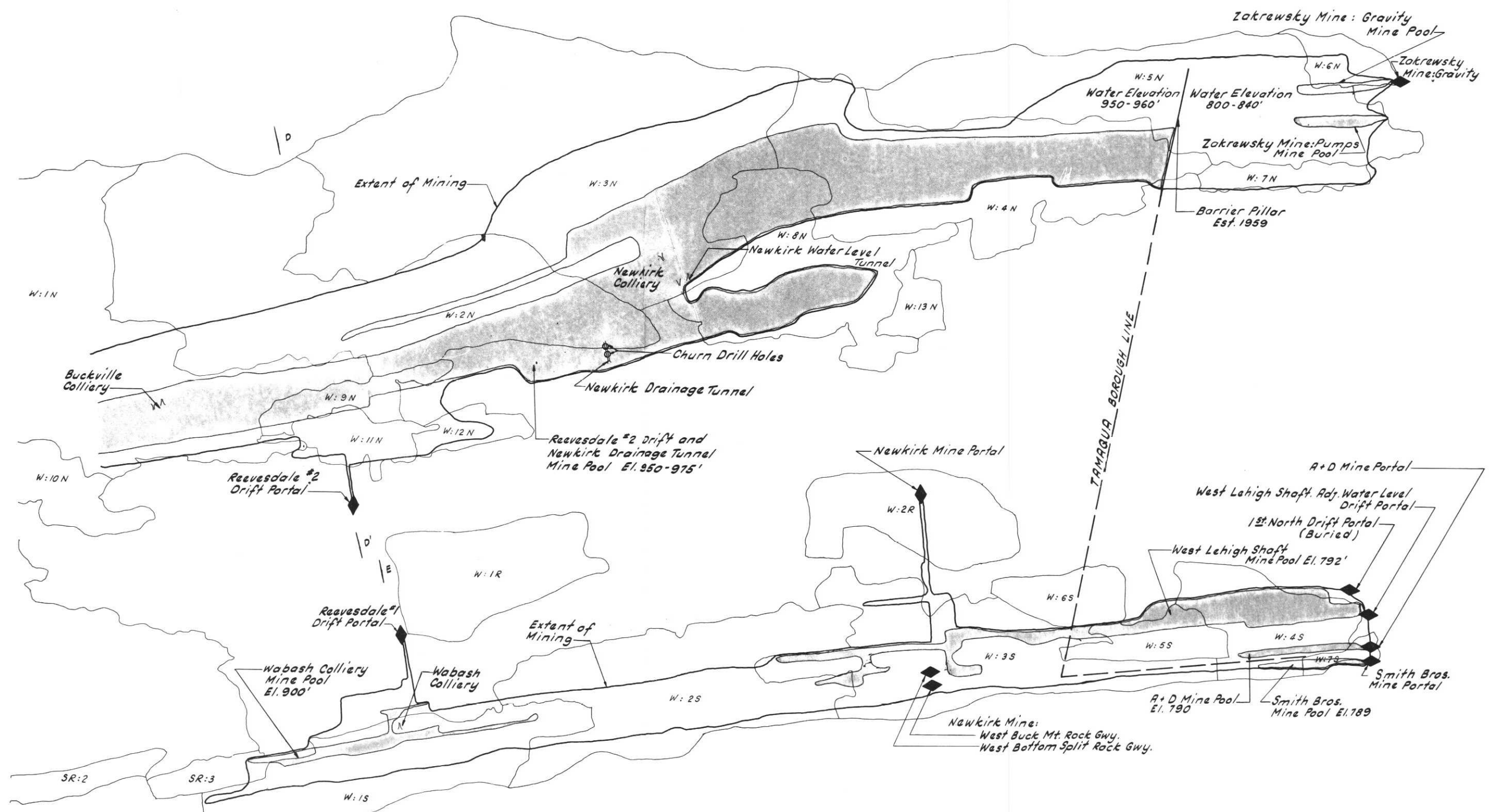
A. W. MARTIN ASSOCIATES, INC.
Consulting Engineers
KING OF PRUSSIA, PA. - PHILADELPHIA, PA.

NOTE:
INSUFFICIENT DATA DOES NOT ALLOW ACCURATE
DELINEATION OF MINE POOLS. THE MINE POOLS
IN PANTHER VALLEY APPROXIMATE THE MINED
OUT AREA.

- LEGEND**
- EXTENT OF SUBSURFACE MINING
 - ◆ PROPOSED MINE SEAL
 - SURFACE RECLAMATION DRAINAGE BASINS

PANTHER VALLEY
EXTENT OF SUBSURFACE MINE WORKINGS AND
PROPOSED MINE SEAL

EXHIBIT 31



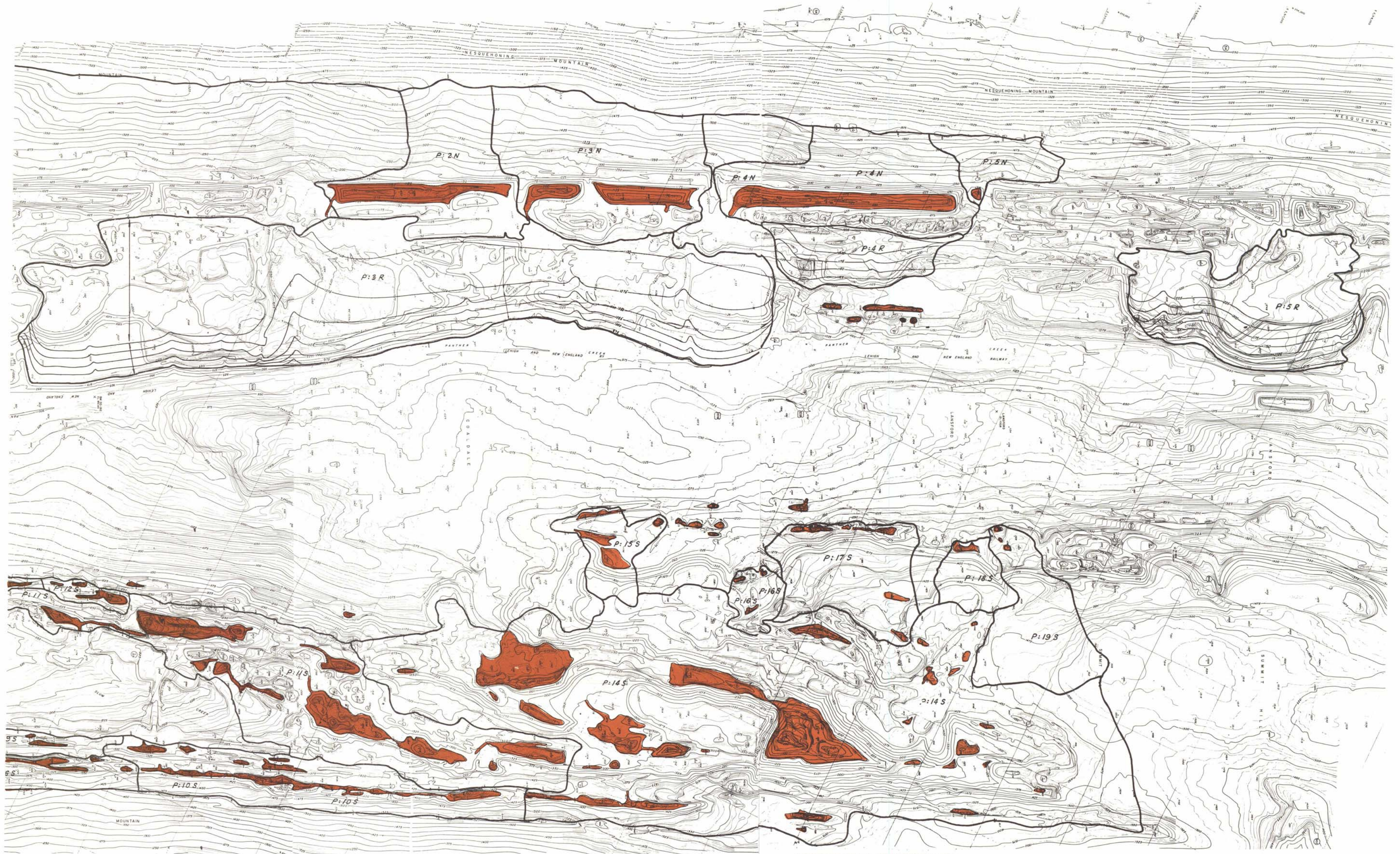
**LITTLE SCHUYLKILL RIVER
ACID MINE DRAINAGE STUDY**

A. W. MARTIN ASSOCIATES, INC.
Consulting Engineers
KING OF PRUSSIA, PA. - PHILADELPHIA, PA.

- LEGEND**
- EXTENT OF SUBSURFACE MINING
 - POST RECLAMATION DRAINAGE BASINS
 - W:1S BASIN #1, SOUTH SIDE WABASH VALLEY
 - ◆ PROPOSED MINE SEALS
 - MINE POOL

**WABASH VALLEY
MINE WORKINGS & PROPOSED MINE SEALS**

EXHIBIT 32



1000 FOOT (1:10) BASED ON PENNSYLVANIA STATE PLANE
 COORDINATE SYSTEM (NORTH ZONE) 1927 NA DATUM
 VERTICAL CONTROL BASED ON 1929 MEAN SEA LEVEL DATUM



COMMONWEALTH OF PENNSYLVANIA
 DEPARTMENT OF ENVIRONMENTAL RESOURCES

LITTLE SCHUYLKILL RIVER
 ACID MINE DRAINAGE STUDY

LEGEND
 POST RECLAMATION DRAINAGE BASINS
 PANTHER CREEK VALLEY / PLUMMER CREEK VALLEY (W),
 LITTLE SCHUYLKILL BASIN (S), SCHUYLKILL RIVER (S)
 BASIN NUMBER | NORTH (N), SOUTH (S), OR REFERENCE PILE (R)

STRIP MINE RECLAMATION PROJECTS

A. W. MARTIN ASSOCIATES, INC.
 Consulting Engineers
 KING OF PRUSSIA, PA. PHILADELPHIA, PA.
 PANTHER VALLEY EAST - SURFACE RECLAMATION
 EXHIBIT 33



1000 FOOT GRID BASED ON PENNSYLVANIA STATE PLANE
 COORDINATE SYSTEM (NORTH ZONE) 1927 NA DATUM
 VERTICAL CONTROL BASED ON 1929 MEAN SEA LEVEL DATUM

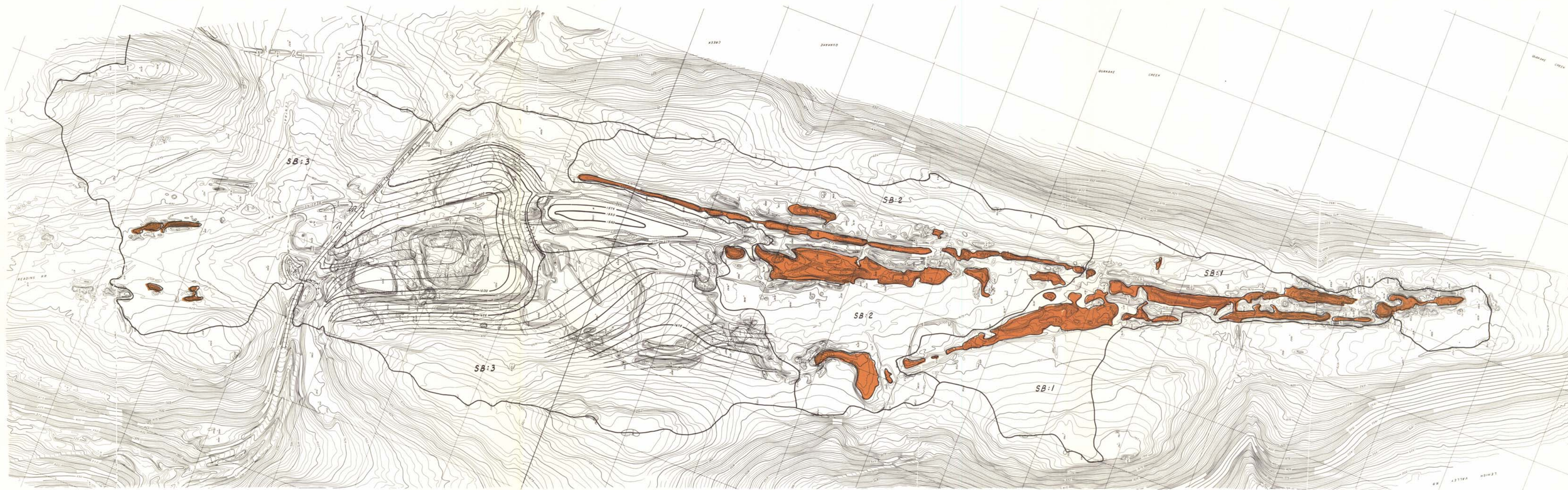


COMMONWEALTH OF PENNSYLVANIA
 DEPARTMENT OF ENVIRONMENTAL RESOURCES

LITTLE SCHUYLKILL RIVER
 ACID MINE DRAINAGE STUDY

LEGEND
 POST RECLAMATION DRAINAGE BASINS
 PANTHER CREEK VALLEY (P), MARSH CREEK VALLEY (M),
 SILVERBROOK BASIN (SB), SCHUYLKILL RIVER (SR)
 BASIN NUMBER, NORTHING, SOUTHING OR REFERENCE FILE NO.
 STRIP MINE RECLAMATION PROJECTS

A. W. MARTIN ASSOCIATES, INC.
 Consulting Engineers
 KING OF PRUSSIA, PA. PHILADELPHIA, PA.
 PANTHER VALLEY WEST - SURFACE RECLAMATION
 EXHIBIT 34



1000 FOOT GRID BASED ON PENNSYLVANIA STATE PLANE
 COORDINATE SYSTEM (NORTH ZONE) 1981-86 DATUM
 VERTICAL CONTROL BASED ON 1929 MEAN SEA LEVEL DATUM



COMMONWEALTH OF PENNSYLVANIA
 DEPARTMENT OF ENVIRONMENTAL RESOURCES

LITTLE SCHUYLKILL RIVER
 ACID MINE DRAINAGE STUDY

LEGEND
 POST RECLAMATION DRAINAGE BASINS
 POTTER-OPEN VALLEY (P), WARREN GREEN VALLEY (W),
 SILVERBROOK BASIN (SB), SCHUYLKILL RIVER (SR)
 BASIN NUMBER; NORTH(S), SOUTH(S), OR REFERENCE FILE (R)
 STRIP MINE RECLAMATION PROJECTS

A. W. MARTIN ASSOCIATES, INC.
 Consulting Engineers
 KING OF PRUSSIA, PA. - PHILADELPHIA, PA.
 SILVERBROOK - SURFACE RECLAMATION
 EXHIBIT 36