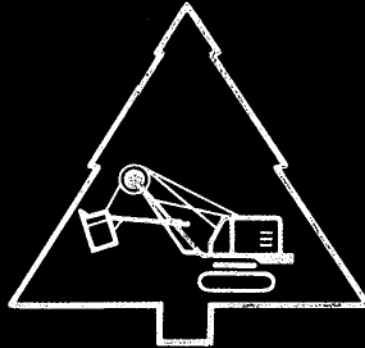


MINE DRAINAGE POLLUTION

ABATEMENT STUDY

NANTICOKE, WARRIOR & SOLOMON CREEKS  
HANOVER & WILKES-BARRE TWPS., LUZERNE CO., PA

# OPERATION SCARLIFT



COMMONWEALTH OF PENNSYLVANIA

MILTON J. SHAPP, GOVERNOR

DEPARTMENT OF ENVIRONMENTAL RESOURCES

MAURICE K. GODDARD, SECRETARY

PROJECT NO SL181-3

1975

G E O - Technical Services

CONSULTING ENGINEERS & GEOLOGISTS

HARRISBURG, PENNSYLVANIA

**GEO - Technical Services**  
CONSULTING ENGINEERS & GEOLOGISTS

AMES DIAZ-Engineering Geologist  
GIDEON YACHIN-Civil Engineer (P.E.)

July 31, 1975

3514 DERRY STREET  
HARRISBURG, PA. 17111

C.H. McConnell, Deputy Secretary  
Resources Management  
Department of Environmental Resources  
Commonwealth of Pennsylvania  
Post Office Box 1467,  
Harrisburg, Pennsylvania 17120

Re: Project No. SL 181-3;  
Study of AMD Abatement within  
the Solomon, Warrior and  
Nanticoke Creek Watersheds

Dear Mister McConnell:

Submitted herewith is our Report of findings and recommendations related to the referenced subject. The original scope of the Study was extended to include the following:

1. Determine the source and magnitude of AMD discharges into the area streams from mine pools that originate outside the limits of the study area.
2. Determine the effect of AMD discharges from the study area on the quality of the Susquehanna River.

As a result of these additional studies, our findings indicate that there are large, previously undetected mine pool discharges into the Susquehanna River. The recharge source of these discharges is attributed to river losses into the deep mines. Comparative analysis indicates that these discharges have a greater effect on River quality than all of the known AMD discharges from the study area.

At this writing, two abatement projects are being implemented by the Department in the Wilkes-Barre environs. These projects are referred to in the attached Report as the Zayre Reclamation and the Sugar Notch Run Abatement Projects.

Thank you for this opportunity to be of service to the Department and the Commonwealth.

Respectfully submitted,

GEO-Technical Services

*Gideon Yachin* *James Diaz*  
Gideon Yachin      James Diaz  
Civil Engineer      Geologist

GY:JD:tem

Attachment

COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF ENVIRONMENTAL RESOURCES

STUDY OF ACID MINE DRAINAGE ABATEMENT  
NANTICOKE, WARRIOR AND SOLOMON CREEKS

PROJECT SL 181-3  
HANOVER AND WILKES-BARRE TOWNSHIPS, LUZERNE COUNTY, PENNSYLVANIA

REPORT OF FINDINGS

FEBRUARY, 1975

Prepared By  
GEO-Technical Services  
Consulting Engineers & Geologists  
Harrisburg, Penna.

DEPARTMENT OF ENVIRONMENTAL RESOURCES  
REVIEW NOTICE

This Report, prepared by outside Consultants, has been reviewed by the Department of Environmental Resources and approved for publication. The contents indicate the conditions that are existing as determined by the Consultant, and the Consultant's recommendations for correction of the problems. The foregoing does not signify that the contents necessarily reflect the policies, views, or approval of the Department.

## ACKNOWLEDGEMENTS

The cooperation and assistance of the Department of Environmental Resources, Division of Mine Area Restoration, is gratefully acknowledged. Appreciation is also expressed to the Department's Anthracite Region Office in Wilkes-Barre and the Water Quality Management Regional Office in Kingston; both having furnished pertinent past and present data related to mine pools, AMD discharges and quality records of the Susquehanna River.

The U.S. Geological Survey is acknowledged for providing valuable hydrologic data during the study period related to the Susquehanna River, the Lackawanna River and specific tributary streams in the Wyoming Valley.

Appreciation is also expressed to Dr. J. Demchalk, Department of Environmental Resources Land Reclamation and Research Branch for his assistance in obtaining information related to subsidence, mine pool fluctuations, and AMD discharge outlets.

Special thanks are due to Mr. J. R. Hollowell of the Susquehanna River Basin Commission for furnishing valuable unpublished information on mine pools and for his personal assistance in locating mine pool monitoring stations and other features related to deep mining within the study area.

## TABLE OF CONTENTS

<u>DESCRIPTION</u>	<u>PAGE</u>
LETTER OF TRANSMITTAL	
DEPARTMENT OF ENVIRONMENTAL RESOURCES REVIEW NOTICE	
ACKNOWLEDGEMENTS	
LOCATION MAP	Frontispiece
CONCLUSIONS	i
RECOMMENDATIONS	xvi
I. <u>INTRODUCTION</u>	
PURPOSE OF THIS REPORT	1
SCOPE OF STUDY	1
SEQUENCE AND METHOD OF STUDY	3
II. <u>EXISTING CONDITIONS</u>	
WATERSHED CHARACTERISTICS	5
GEOLOGIC CONDITIONS	7
HYDROLOGIC CONDITIONS	11
AMD POLLUTION SOURCES	12
FIELD OBSERVATIONS	19
OTHER MAJOR PROBLEMS IN THE STUDY AREA	27
MULTI-PURPOSE APPROACH TO AREA PROBLEMS	30
III. <u>ANALYSIS AND INTERPRETATION OF FINDINGS</u>	
GENERAL	31
PRESENT WATER QUALITY IN THE STUDY AREA	31
WATER QUALITY IN THE SUSQUEHANNA RIVER	34
THE WATER QUALITY MANAGEMENT CONCEPT	
AND ITS EFFECT ON RIVER QUALITY	40
ORIGIN OF MAJOR AMD DISCHARGES	43
THE SOUTHEAST MINE POOL COMPLEX	43
THE NORTHWEST MINE POOL COMPLEX	54
IV. <u>PROPOSED PLAN FOR AMD ABATEMENT</u>	
GOALS AND OBJECTIVES	66
PREVENTION OF WATER LOSSES INTO THE DEEP MINES	66
PREVENTION OF STREAM POLLUTION	67
SINGLE-PURPOSE AND MULTI-PURPOSE	
APPROACH TO AMD ABATEMENT	68
FUNDING ABATEMENT PROJECTS	70
PROPOSED ABATEMENT PROJECTS	71
PRESENT STATUS OF AMD ABATEMENT	76
V. <u>COST ANALYSIS OF AMD ABATEMENT</u>	
GENERAL	78
ESTIMATED ABATEMENT COST -- NANTICOKE AND WARRIOR	78
ABATEMENT BY NEUTRALIZATION (TREATMENT PLANT)	79
ALTERNATIVE ABATEMENT METHODS	82
COMPARISON BETWEEN ALTERNATIVE METHODS	86
ESTIMATED ABATEMENT COST -- SOLOMON CREEK	86
ABATEMENT WITHIN THE STUDY AREA LIMITS	86
ABATEMENT OF ALL AMD DISCHARGES	88
REFERENCES AND SOURCES OF INFORMATION	

TABLE OF CONTENTS  
(CONT.)

ILLUSTRATIONS

<u>TABLE NO.</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
I.	Description of Previously Established Monitoring Stations .....	4
II.	Solomon Creek Watershed; Summary of Water Quality Records .....	23
III.	Warrior Creek Watershed; Summary of Water Quality Records .....	24
IV.	Nanticoke Creek Watershed; Summary of Water Quality Records .....	26
V.	Quality of Study Area Streams; Above the Coal Measures .....	32
VI.	Quality of Base Flow Recharge in the Study Area Streams .....	33
VII.	Magnitude of AMD Discharges.....	36
VIII.	Reported Fish Kills Attributed to AMD Discharges.....	38
IX.	Magnitude & Concentration of AMD Discharges Askam Borehole .....	46
X.	Magnitude & Concentration of AMD Discharges South Wilkes-Barre Boreholes .....	49
XI.	Susquehanna River at Wilkes-Barre; Duration of Daily Flow (1899 - 1963) .....	59
XII.	Mean Annual Distribution of Buttonwood Tunnel Discharges .....	60
XIII.	AMD Treatment for Askam Borehole Discharge .....	81
XIV.	Cost of Treatment - Askam AMD Discharges .....	83
XV.	Proposed Projects for the Abatement of the Askam Borehole AMD Discharges .....	84
XVI.	Estimated Cost of Askam Borehole AMD Abatement; Proposed Alternative Methods of Neutralization .....	84
XVII.	Estimated Maximum Abatement Costs for South Wilkes-Barre Boreholes and the Buttonwood Tunnel .....	88

TABLE OF CONTENTS  
(CONT.)

ILLUSTRATIONS

<u>FIGURE NO.</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
1	Location Map, Site Map and Pertinent Watershed Data	*
2	Geologic Map and Sections	*
3	Existing Conditions: Solomon Creek Watershed	13
4	Existing Conditions: Warrior Creek Watershed	14
5	Existing Conditions: Nanticoke Creek Watershed	15
6	Hydrograph of Solomon Creek	22
7	Effect of AMD Discharges on the Quality of the Susquehanna River	*
8	Southeast Mine Pool Complex: Fluctuations and Discharges	*
9	Southeast line Pool Complex: Inflow-Outflow-Storage Relationship	46A
10	Askam Borehole: Concentration of AMD Discharges	47
11	South Wilkes-Barre Boreholes: Concentration of AMD Discharges	48
12	Northwest Mine Pool Complex: Plan, Profile and Pertinent Data	*
13	Buttonwood Tunnel: Concentration of AMD Discharges	64
14	Proposed Plan for AMD Abatement: Solomon Creek Watershed	72
15	Proposed Plan for AMD Abatement: Warrior Creek Watershed	73
16	Proposed Plan for AMD Abatement: Nanticoke Creek Watershed	74
17	Neutralization of AMD by Treatment	80
18	Cost Comparison of Abatement Methods	87
*	Figure enclosed in pocket (following Appendices)	



TABLE OF CONTENTS  
(CONT.)

APPENDICES

APPENDIX A: SUMMARY OF WATER QUALITY TESTS

Nanticoke Creek Watershed Warrior Creek  
Watershed Solomon Creek Watershed

WATER LEVEL RECORDS OF MINE POOLS

APPENDIX B: HYDROLOGIC ANALYSIS

"Precipitation-Runoff-Water Loss" Relationship	
"Inflow-Outflow-Mine Pool Storage" Relationship	
Long Term Records .....	B-1
Comparison Between Annual Stream Flow Records	
TABLE B- I .....	B-2
Runoff Characteristics During the 1972 Flood	
FIGURE B-1 .....	B-5
Upper Mine Pools - Nanticoke and Warrior Creek Watersheds; Sample Calculations ....	B-6
Summary of Flow Records - Nanticoke Cr. Watershed	
TABLE B-II .....	B-8
Recorded Streambed Losses - Nanticoke Creek	
TABLE B-III .....	B-9
Lower Mine Pools .....	B-18

APPENDIX C: BREAKDOWN OF COSTS AND BENEFITS

Cost Estimate .....	C-1
Stream Restoration and Lining .....	C-1
Strip Mine Area Restoration .....	C-3
Benefits .....	C-19
Breakdown of Water Loss Prevention by Proposed Abatement Projects .....	C-32
Streambed Losses .....	C-32
Off-Stream Losses in Mined Areas .....	C-33
AMD Abatement by Groundwater Interception .....	C-34
Drilled Wells in the Fracture Zones .....	C-34
Drilled Artesian Wells in the Elevated Valleys. ....	C-37
Grout Curtains Across Limited Fracture Zones . . . . .	C-39

TABLE OF CONTENTS

(CONT.)

APPENDIX C (CONT.):

Alternative Solution to Blue Coal Company

Discharges into the Deep Mines .....	C-42
Multi-Purpose Reservoir in Solomon Creek Watershed .....	C-46
Combining AIM Abatement with Recreation and Historic Preservation .....	C-51

<u>FIGURE NO.</u>	<u>ILLUSTRATIONS DESCRIPTION</u>	<u>PAGE</u>
C-1	Cost of Channel/Channel Discharge CFS . . .	C-2
C-2	Peak Rates of Discharge for Small Watersheds - SCS Eng. Design Manual ES 1027 - Curve 75 .....	C-4
C-3	Nanticoke Creek - Total Loss .....	C-22
C-4	Leuder Creek Flume .....	C-23
C-5	Truesdale Branch - Nanticoke Creek .....	C-24
C-6	Nanticoke Creek - Sta. N6 & N7 - N5 .....	C-25
C-7	Espy Run .....	C-26
C-8	Sugar Notch Run .....	C-27
C-9	Spring Run - Sta. S8A - S6 .....	C-28
C-10	Spring Run - Sta. S6 - Gilligan St .....	C-29
C-11	Solomon Creek - Mean Daily Flow Distribution .....	C-30
C-12	Flow at Solomon Creek Gage - CFSM .....	C-31
C-13	Illustration of Groundwater Interception . . .	C-35
C-14	Site Map - Multi-Purpose Reservoir .....	C-47
C-15	Alternative Proposals for Structural Measures .....	C-48
C-16	Artist's Conception .....	Pocket