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NATIONAL DAM INSPECTION PROGRAM. WOLF CREEK DAM (NDS PA-00664/D--ETC(U)
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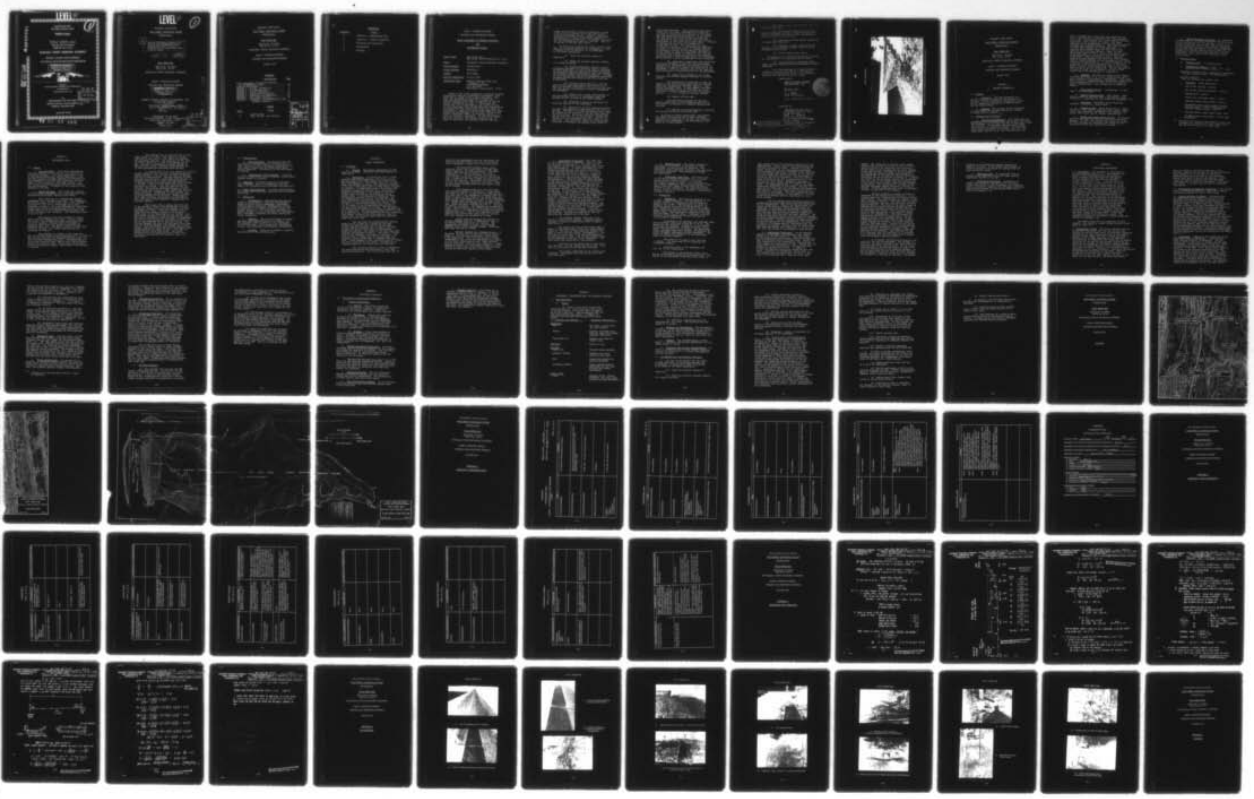

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DELAWARE RIVER BASIN
WOLF CREEK, SCHUYLKILL COUNTY

PENNSYLVANIA

WOLF CREEK DAM

NDS ID NO. PA-00664
DER ID NO. 54-53

SCHUYLKILL COUNTY MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared by
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

AUGUST 1978

LEVEL II

(1)

DELAWARE RIVER BASIN

WOLF CREEK, SCHUYLKILL COUNTY

PENNSYLVANIA

(6) National Dam Inspection Program. Wolf Creek Dam (NDS PA-00664/ DER 54-53), Delaware River Basin, Wolf Creek, Schuylkill County, Pennsylvania. Phase I Inspection Report.

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PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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Prepared by

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
P.O. Box 1963
Harrisburg, Pennsylvania 17105

Contract No. (15) DACW31-78-C-0046

For

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

411 004

AUGUST 1978

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DELAWARE RIVER BASIN

WOLF CREEK, SCHUYLKILL COUNTY

PENNSYLVANIA

WOLF CREEK DAM

NDS ID No. PA-00664
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SCHUYLKILL COUNTY MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

CONTENTS

PLATES

APPENDICES

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Wolf Creek Dam NDS ID No. PA-00664/DER ID No. 54-53
Owner:	Schuylkill County Municipal Authority
State Located:	Pennsylvania
County Located:	Schuylkill
Stream:	Wolf Creek
Date of Inspection:	20 July 1978
Inspection Team:	Gannett Fleming Corddry and Carpenter, Inc. Consulting Engineers P.O. Box 1963 Harrisburg, Pennsylvania 17105

Based on the visual inspection, available records, calculations and past operational performance, Wolf Creek Dam is judged to be in fair condition. However, the existing spillway will not pass the Probable Maximum Flood (PMF) or one-half of the PMF without overtopping the dam. If Wolf Creek Dam should fail due to overtopping, the hazard to loss of life downstream from the dam would be significantly increased from that which would exist just prior to overtopping. Based on criteria established for these studies by the Department of the Army, Office of the Chief of Engineers (OCE), the spillway capacity is rated as seriously inadequate. If the top of embankment were raised to the design elevation that is shown on the plans, the spillway capacity and sur-

charge storage effect would be sufficient to pass 1,760 cfs or 55 percent of the PMF peak inflow without overtopping the dam. However, downstream conditions will limit the discharge capacity of the spillway to a lower flow. At present, the spillway can accommodate a flood of 1,100 cfs. This is 34 percent of the PMF peak inflow.

In view of the concern for safety of Wolf Creek Dam, the following measures are recommended, in approximate order of priority, to be undertaken by the Owner immediately:

(1) Clear the spillway channel of vegetation.

(2) Grade the spillway approach channel to a proper elevation.

(3) Perform additional studies to more accurately ascertain the spillway capacity required for Wolf Creek Dam, as well as the nature and extent of mitigation measures required to make the spillway and spillway channel hydraulically adequate. Filling in the existing low area of the embankment would help increase the spillway capacity and this should be accomplished.

(4) Provide closure facilities for the outlet works pipes upstream of the concrete core wall for periodic inspection and for use in the event the pipe should leak severely, thereby endangering the embankment.

(5) Install two or more inclinometers in the downstream slope of the embankment near the maximum section to monitor any slope movement.

(6) Undertake a survey to determine the existing template of the embankment.

(7) Install ten or more observation wells, or other instrumentation, downstream of the axis of the dam. Two wells, or other instrumentation, should be located in the vicinity of the wet area right of the valve house. Two others should be located near the wet area left of the valve house. Another two should be in the embankment near the cracks in the core wall. The other four should be at appropriate locations to determine the general water level in

downstream embankment. Data collected from observation wells or other instrumentation should be utilized in evaluating the stability of the embankment and assessing piping potential in the future. The data should also be utilized in evaluating the effects of the cracks in the core wall and in determining if other core wall cracks exist. Continue to observe the wet areas and seepage downstream from the dam. If a high phreatic line is present in portions of the downstream embankment, or there is a marked increase in seepage quantity or turbidity is noted in the seepage, appropriate action should be taken to repair the core wall or to control the seepage and trubidity with properly designed drains. Action taken should be coordinated with stability studies recommended in next paragraph.

(8) Undertake an embankment and foundation exploration program to ascertain the engineering properties of the materials and perform a study to determine the factor of safety for stability of the embankment. Take any remedial action that might be found necessary to ensure stability of the embankment.

(9) Raise top of riprap to top of dam elevation and provide adequate measures to prevent erosion.

(10) Excavating the hillside to make the length of the spillway weir agree with the drawing would help increase the spillway capacity. This should be accomplished. In this regard, the Owner should undertake a study to determine the slopes required to provide a stable cut, and the erosion protection required, along the spillway channel.

(11) Repair spillway wall.

(12) Institute a program of detailed annual inspections for Wolf Creek Dam and utilize the results to ascertain if remedial measures are required.

(13) Develop a detailed emergency operation and warning system for Wolf Creek Dam.

In order to correct operational, maintenance, and repair deficiencies and to more accurately determine the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Remove brush and trees that are on or near the embankment.

(2) Monitor weathering of rock in the spillway discharge channel. Should the weathering begin to threaten the spillway wall, appropriate remedial action should be taken.

(3) Remove growth from channel downstream of outlet works outfall.

(4) Undertake a study to determine the adequacy of the spillway channel, where it flows overland to Wolf Creek.

(5) Repair leaking pipe joints.

In addition, the following operational measures are recommended to be undertaken by the Owner:

(1) During periods of unusually heavy rains, provide round-the-clock surveillance of Wolf Creek Dam.

(2) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

A. C. HOOKE
Head, Dam Section

Date: September 20, 1978

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS
OF ENGINEERS.

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Date: 23 Sep 78

Under the recently revised spillway evaluation guidelines, this dam is considered unsafe, non-emergency.

WOLF CREEK DAM

Upstream Slope of Embankment from Spillway Approach Channel

DELAWARE RIVER BASIN

WOLF CREEK, SCHUYLKILL COUNTY

PENNSYLVANIA

WOLF CREEK DAM

NDS ID No. PA-00664
DER ID No. 54-53

SCHUYLKILL COUNTY MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

SECTION I

PROJECT INFORMATION

ABSTRACT

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

ABSTRACT

a. Dam and Appurtenances. Wolf Creek Dam is a homogeneous earthen embankment with concrete core wall. The embankment is 867 feet long and 72 feet high at maximum section. The upstream and downstream slopes are covered with handplaced riprap. The upstream slope varies between 1V on 2H and 1V on 2.5H. The downstream slope is 1V on 1.5H. The concrete core

wall is founded in a trench that was excavated into rock. The spillway is located at the right abutment of the dam. The spillway has a broad crested concrete weir with a crest length of 35 feet. The crest elevation is at approximately the same elevation as the approach and discharge channels. The crest is about 5.3 feet below design top of dam elevation. A concrete wall extends along the left side of the approach and discharge channels. About 100 feet downstream from the crest, the spillway channel drops on an approximate 1V on 2H slope to the Wolf Creek flood plain. Near the center of dam, a concrete-encased 24-inch diameter cast-iron pipe (CIP) extends from an intake structure at the upstream toe to a valve house at the downstream toe. A 16-inch diameter CIP is connected to the 24-inch diameter line at the valve house, and both pipes extend from there to Wolf Creek, which is about 70 feet downstream. Various features of the dam are shown on the plates at the end of the report and on the photographs in Appendix D.

b. Location. The dam is located on Wolf Creek, 2.5 miles northeast of St. Clair, Pennsylvania and 4.5 miles northeast of Pottsville, Pennsylvania. Wolf Creek Dam is shown on USGS Quadrangle, Shenandoah, Pennsylvania, with coordinates N40°45'10"-W76°10'10" in Schuylkill County, Pennsylvania. The location map is shown on Plate 1.

c. Size Classification. Intermediate (72 feet high, 1,405 acre-feet).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Wolf Creek Dam (Paragraph 5.1e.)

e. Ownership. Schuylkill County Municipal Authority, Pottsville, Pennsylvania.

f. Purpose of Dam. Water supply for St. Clair, Pottsville, Port Carbon, Shanetown, East Mines, Wadesville, East Norwegian, Norwegian, North Manheim, New Castle, Palo Alto, and Mt. Carbon, Pennsylvania.

g. Design and Construction History. The dam was built between 1905 and 1909 for the Pottsville Water Company. In 1961, the present Owner acquired the dam. No other information concerning the design and construction history was available for review.

h. Normal Operating Procedure. The reservoir is maintained at spillway crest elevation with excess inflow discharging over the spillway. Water is released through the outlet works when the reservoir is below spillway crest or when spillway discharges are insufficient for demand. Both the spillway discharges and releases from the outlet works can be collected at Wolf Creek Intake Dam about 0.9 mile downstream. Water enters the collection system at this point.

1.3 Pertinent Data.

a. Drainage Area. 1.9 square miles.

b. Discharge at Damsite. (cfs)
Maximum known flood at damsite [1] - 790.

Emergency drawdown line at maximum pool elevation (24-inch diameter pipe) - 80 (approximate).

Spillway capacity -
Pool at existing top of dam - 870.

c. Elevation. (Feet above msl.)

Top of dam (design) - 1416.4.

Top of dam (lowest elevation) - 1415.0.

Maximum pool - 1415.0.

Normal pool (spillway crest) - 1411.1.

Upstream invert outlet works - 1351.1.

Downstream invert outlet works (24-inch diameter pipe) - 1346.9 (approximate), (16-inch diameter pipe) - 1347.0.

Upstream invert water supply line - none.

Streambed near outlet works - 1343.0 (approximate).

(1) Estimated for Tropical Storm Agnes in June 1972 assuming pool elevation 0.5 foot below top of dam and outlet works valve fully open.

d. Reservoir Length. (Miles.)

Normal pool - 0.48.

Maximum pool - 0.50.

e. Storage. (Acre-feet.)

Normal pool - 1,206.

Maximum pool - 1,383.

f. Reservoir Surface. (Acres.)

Normal pool - 45.

Maximum pool - 47.

g. Dam.

Type - Homogeneous earthfill with concrete core wall.

Length - 867 feet (embankment).

Height - 72 feet.

Top Width - Earthfill - 13.5 feet. (Design).

Side Slopes - Upstream - 1V on 2H Above Elevation 1396.1; 1V on 2.5H. Below Elevation 1396.1. - Downstream 1V on 1.5H.

Zoning - None.

Cutoff - Core wall founded in trench excavated into rock.

Grout Curtain - None.

h. Diversion and Regulating Tunnel. None.

i. Spillway.

Type - Broad-crested concrete weir (width 3.5 feet).

Length of Weir - 35.0 feet.(1)

Crest Elevation - 1411.1.

Upstream Channel - Level channel benched into right hillside.

Downstream Channel - Channel excavated into bedrock extending on a 3 percent slope for 100 feet downstream of the weir. The channel then drops down the natural hillside on a 1V on 2H slope to the flood plain below.

j. Regulating Outlets.

Type - 24-inch diameter cast-iron pipe (CIP) for water supply and emergency drawdown. A 16-inch diameter CIP connects to 24-inch diameter CIP at valve house and extends downstream.

Length - 340 feet (approximate). 24-inch diameter line.
- 70 feet (approximate). 16-inch diameter line.

Access - To downstream end and valve house only.

Regulating Facilities - For 24-inch diameter pipe, two manually operated 24-inch, non-rising stem, gate valves with exposed gear reducers. For 16-inch diameter pipe, one 16-inch valve similar to above.

(1) See Section 3.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. Very little engineering data was available for review for the structure as originally designed. In a study performed in 1918 by the Pennsylvania Water Supply Commission, a tabularized account of design features was prepared for the components of the dam from interviews with the Owner, visual inspection, and other sources. The 1918 study also included brief analyses for hydrology and hydraulics. A summary of the results of the analyses is on file.

b. Design Features. Wolf Creek Dam consists of an earthfill embankment with a concrete core wall, concrete spillway weir, and an outlet works.

Wolf Creek Dam is a homogeneous earthen embankment with a concrete core wall. The embankment is 867 feet long, 72 feet high, and it has a design top width of 13.5 feet. The design top of dam Elevation is 1416.4. Both the upstream and downstream slopes are covered with hand-placed riprap. The upstream slope is 1V on 2H above Elevation 1396.1 and 1V on 2.5H below this elevation. The downstream slope is 1V on 1.5H.

The concrete core wall extends to within about 2 feet of design top of dam. It has a 3-foot top width. The upstream and downstream faces have 24V on 1H batters. The core wall is founded on concrete, which fills the cutoff trench that was excavated into rock. The depth of trench varies from 5 feet to 20 feet. The trench template was not available for review.

The spillway is located at the right abutment of the dam (Plate 2 and Photographs E, F, G, H and I). The spillway approach and discharge channels were cut into the right abutment hillside. The approximate 1V on 2H cuts along the right bank of both these channels contain the spillway flow. Except near the upstream end of the approach channel, the bottom of the channels is bedrock.

The spillway weir is concrete and it has a crest length of 35 feet. The crest is 3.5 feet wide and is less than 0.1 foot above the approach and discharge channels. The elevation of the crest is 1411.1, which is 5.3 feet below design top of dam. The weir is founded in a trench similar to the core wall trench. Masonry paving extends for 18 feet upstream and downstream from the weir.

A concrete wall with a top elevation of 1416.3 extends along the left side of the approach and discharge channels. The wall acts as both a retaining wall and a training wall. The wall extends 20 feet upstream from the weir. Downstream from the weir, it extends straight for 100 feet and then deflects 45 degrees to the left and extends for about 20 feet to its end. Details of the wall design were not available for review. Near the point of wall deflection, the spillway discharge channel is about 19 feet wide and is about 3 feet lower than the weir crest elevation. Downstream of this section, the spillway channel extends down the natural hillside on an approximate 1V on 2H slope. Downstream of this slope, spillway discharges flow overland for about 240 feet to Wolf Creek in a channel that is not well defined.

The outlet works is about 340 feet left of the spillway (Plate 2 and Photographs J and K). A concrete intake structure with screen is at the upstream toe of dam. A 24-inch diameter CIP extends from the intake structure to a concrete valve house at the downstream toe of the dam. The pipe invert elevation at the upstream end is 1351.1. The pipe is encased in concrete under the embankment. Two 24-inch gate valves are connected in series on the 24-inch diameter CIP at the valve house. The 16-inch diameter CIP with a 16-inch gate valve taps into the 24-inch diameter line between the 24-inch valves. Both the 24-inch and 16-inch diameter lines extend parallel for about 70 feet. They then discharge directly into Wolf Creek. The invert elevations at the outfall are 1346.9 and 1347.0 for the 24-inch and 16-inch diameter lines, respectively.

2.2 Construction.

a. Data Available. Construction data for the original structure that is available for review, consists of the information contained in the 1918 report prepared by the Pennsylvania Water Supply Commission. Information in the 1918 report is limited.

b. Construction Considerations. Since the available construction data is limited, construction methods cannot be assessed.

2.3 Operation. No formal records of operation were reviewed. Based on information from the Owner, all structures have performed satisfactorily.

2.4 Other Investigations. No known investigations other than those previously described were available for review.

2.5 Evaluation.

a. Availability. Engineering data was provided by the Division of Dams and Encroachments, Bureau of Water Quality Management, Department of Environmental Resources, Commonwealth of Pennsylvania and by the Owner, Schuylkill County Municipal Authority. The Owner made available the General Manager, and two caretakers for information and a caretaker to operate the valves during the visual inspection.

b. Adequacy. The type and amount of design data and other engineering data is limited, and the assessment must be based on the combination of available data, visual inspection, performance history, and hydrologic and hydraulic assumptions.

c. Validity. There is no reason to question the validity of the available data.

SECTION 2

VISUAL INSPECTION

3.1 Findings.

a. General. The general appearance of Wolf Creek Dam is fair. There are some deficiencies as noted below.

b. Embankment. As determined from a survey performed for this inspection, the entire top of dam was found to be below design top of dam elevation (Photograph A). The lowest point was 1.4 feet lower than design elevation. The material observed at the top of dam was a gravelly sand having virtually no cohesion. A significant amount of material had apparently eroded off the top, as a thin layer of material covered most of the riprap on the downstream slope and some of the riprap on the upstream slope. An erosion gully leading upstream was observed 240 feet left of the spillway. As also determined by the survey, the top of riprap elevation on the upstream slope was 1412.9, which is about 2.1 feet below existing top of dam. The top of riprap on the downstream slope was about 1.2 feet below existing top of dam. The top width of the dam varied from 10 to 14 feet, as measured for this inspection. The downstream slope was 1V on 1.5H, as determined by a survey performed for this inspection. This survey, based on one cross section, also revealed that the upstream slope above the reservoir level was 1V on 2.6H.

The core wall was intermittently exposed along the top of dam for a length of 450 feet between 350 and 800 feet left of the spillway. It was completely exposed for a length of 60 feet between 230 and 290 feet left of the spillway. Along this section, two cracks in the core wall were observed (Photographs B and C). One crack, 235 feet left of the spillway, was normal to the axis. The second crack, 275 feet left of the spillway, was diagonal, being angled about 60 degrees from the axis. There appeared to be a relative vertical offset of about 1/16-inch at this crack. Evidence of attempted repairs at this crack was also observed.

The upstream slope was clear of vegetation. The downstream slope had brush about 5 feet high growing sporadically. One 15-foot high tree was ob-

served on the embankment near the downstream toe. Trees are growing directly at the toe along the entire embankment, except near the outlet works.

The upstream riprapped slope, above reservoir level, has bulges about 6 inches high. These bulges are not very pronounced. The downstream slope has major bulges in the riprap (Photograph D). The major bulges are located about 20-feet vertically above the toe and extend over a length of 360 feet between 250 and 610 feet left of the spillway. The bulges are estimated to be 2 to 3 feet high normal to the slope. There is some lesser bulging both left and right of the major bulging.

Five seepage areas and a dry flow path were observed during the inspection. These areas are shown on Plate 2. A dry flow path extends from the right end of the embankment to seepage area No. 1, which is about 40 feet right of the valve house and about 10 feet downstream of the toe of the embankment. This seepage area extends for about 75 feet along the toe. Clear localized seepage was observed in this area, which has water covering part of it. The area was heavily overgrown. The seepage was estimated at 2 gpm. The area drains into Wolf Creek by the outlet works outfall. Two additional localized and adjacent seepage area (Nos. 2 and 3) were observed 15 feet right of the outlet works pipes near the outfall. The total seepage was estimated at 10 gpm.

Clear localized seepage was observed in an area (Seepage Area No. 4) immediately left of the outlet works pipes near the outfall. The seepage was estimated at 5 gpm. This seepage emanated from a small masonry headwall, which may have been the end of a drain.

Another seepage area (Seepage Area No. 5) was about 40 feet left of the valve house (Photograph L). The area was estimated to cover about 2,200 square feet. The area starts about 55 feet downstream of the toe of the embankment and extends to the outlet works access road. Water covered part of this area, which was soft underfoot. Clear seepage estimated at 2 gpm passes through a culvert under the access road to the outlet works and then through an excavated channel to Wolf Creek.

c. Appurtenant Structures. The right end of the spillway weir is indistinct where it joins the hillside (Photograph F). The right side of the approach channel has brush growing about 1 foot high (Photograph E). A survey performed for this inspection revealed that the invert elevation of the approach channel was from 0.1 to 0.7 foot higher than spillway crest elevation. Stumps up to 1.5 feet high and up to 3 inches in diameter were observed in the spillway discharge channel (Photograph H). There was some low brush growing at the left side of this channel. Where the discharge channel slope changes abruptly, to a 1V on 2H slope, severe weathering of the bedrock was observed (Photograph I). The spillway left wall has pattern cracking, especially near the upstream end. At the cracks, there was evidence of leaching, as white deposits or "efflorescence" was observed. This wall also has two larger cracks. The first crack is adjacent to the weir (Photograph G). Evidence of previous repairs was observed. The wall upstream of this crack is tilted toward the spillway. The upstream end is also slightly shifted toward the approach channel. The second crack is just downstream of the point where the wall deflects to the left. It is very fine with no apparent relative movement. The wall downstream of the crack is slightly tilted toward the spillway. Peeling was observed at the top and along the exposed toe of the wall.

The spillway channel below the 1V on 2H drop is very poorly defined. Numerous shallow channels, blocked by substantial piles of debris, were observed.

The outfall for the outlet works pipes is about 70 feet downstream of the valve house (Photograph J). The tops of both pipes are exposed for about 20 feet from the outfall (Photograph K). The bell end of these pipes is on the downstream end of each section of pipe. The 16-inch diameter pipe was discharging on the day of the inspection. The pipe joints were observed to leak severely.

Operation of the downstream 24-inch valve was observed. Two men opened the valve about 5 percent in 10 minutes with no apparent problems.

The channel downstream of the outfall was overgrown. Discharges from the outlet works flow over tree roots.

d. Reservoir Area. The slopes adjacent to the reservoir are mild. No evidence of creep, landslides, or rock slides was observed. The Schuylkill County Municipal Authority owns and posts the entire watershed. The watershed is wooded and undeveloped.

e. Downstream Conditions. The access road to the dam is unpaved and extends for 2.2 miles through heavily wooded terrain. It crosses Wolf Creek a number of times. The crossings are low roadway embankments with culverts beneath. The Owner stated that these culverts wash out during periods of high streamflow. He stated that an alternate route to the dam was passable by high ground clearance vehicles.

3.2 Evaluation.

a. Embankment. The material observed at top of dam is readily erodable. The probability of further erosion is increased by top of riprap not being at top of dam. The decreased top width is probably caused by erosion of the material at the top. Reports of various inspections by the Commonwealth indicated that the top of dam was lower than design level. The Commonwealth inspectors believed that settlement was the cause. There may be a combination of settlement and erosion that has led to the present conditions.

According to the drawings, the upstream slope above reservoir elevation should be 1V on 2H. The reason for the variation is unknown, as no evidence of sliding was observed. Because the cause is unknown, the condition is of concern. The downstream slope is steeper than would normally be expected for a well designed homogeneous earthen embankment. The factor of safety for stability of the downstream slope is probably marginal.

The cause of cracking in the core wall is unknown. The cracks may be an indication of embankment movement.

Trees and brush on the embankment and near the toe are undesirable.

The bulges in the upstream riprap slope may be from uneven grading during construction. The bulges in the downstream slope were first noted in

1938, during one of the periodic inspections by the Commonwealth. Bulges had not been noted during the previous inspection in 1933. A review of a photograph, dated 1938, in the Pennsylvania Department of Environmental Resources (PennDER) files indicates that the bulges were almost entirely to the right of the valve house and less severe than the bulges observed on the day of inspection. The most severe bulge observed on the day of inspection was to the left of the valve house. Apparently the bulge observed in 1941, during the next inspection, was worse. The Commonwealth sent a letter to the Owner requesting monitoring of the bulges. The next inspection in 1945 noted that the request had apparently been ignored. The next inspection in 1962 did not make note of the bulges. The steep downstream slope is certainly contributing to the condition. As the condition apparently has not stabilized, it is of major concern.

All the seepage areas observed during this inspection had been noted during previous inspections by the Commonwealth. Some of the descriptions contained in the previous inspection reports are insufficient to determine if the seepage areas are identical to those observed during this inspection. Flow had been reported during previous inspections along the dry flow path near the right abutment. The previous inspection reports indicate that the seepage previously observed along this path probably originated in the spillway. Based on information from previous inspection reports by the Commonwealth, the source of some of the seepage may be from drains that are connected to springs. However, since no drain pipes were observed during this inspection, it is not certain that the source of the seepage is from drains.

b. Appurtenant Structures. On the drawings supplied by the Owner, the spillway crest length scales to be 50 feet (Plate 2). The 1918 report by the Pennsylvania Water Supply Commission indicates that the spillway crest is 60 feet long. During the 1930 inspection by the Commonwealth, the spillway crest length was reported as 43 feet. During the 1942 inspection of the Commonwealth, the spillway crest length was reported as 36 feet. A length of 35 feet was measured during the inspection for this study. A review of a photograph, dated 1918, in the PennDER files indicates that the slope to the right of the spillway was a steep cut into over-

burden. The reduction in spillway crest length from 60 feet in 1918 to 35 feet on the day of inspection could be an indication that the slope on the right of the spillway may be slowly sliding toward the spillway, although no visual evidence of sliding was observed during this inspection. The conditions in the approach channel affect the hydraulics and are evaluated in Section 5. Although the growth in the discharge channel was relatively low, the size of the stumps that were observed indicate that a more frequent brush cutting schedule is warranted. The weathering of the rock in the spillway discharge channel presents no hazard at present. Further weathering may start to undermine the wall at the left of the channel.

Pattern cracking is usually evidence of shrinkage on the surface of the concrete. It is usually caused by overfinishing the concrete during construction. The cracking does not appear to present a hazard at present. The crack near the spillway weir prevents the wall from acting as a watertight structure. The cause of the crack cannot be assessed with certainty because foundation conditions and structural details for this wall were not available for review. This crack was first noted in 1932 during one of the periodic inspections by the Commonwealth. The other crack observed near the point of deflection of the wall appeared similar to a shrinkage crack. If the downstream end of the wall had not been slightly tilted towards the spillway, the crack would be termed a shrinkage crack. There is a possibility that the wall was formed with the tilting section, as the form work appeared to be quite rough. The peeling observed is probably caused by long term exposure to the elements. The condition of the wall indicates that its stability is in question. It is possible that the wall would not be stable under the maximum loading condition.

It is normal construction practice to lay pipe with the bell end upstream. The leakage observed at the joints indicates that poor joint construction practices were utilized. If the joints leak upstream of the exposed length of pipe, this could be contributing to the observed seepage. As one of these pipes extends under pressure through the embankment, there is concern for its integrity, even though it is encased in concrete. The growth

observed in the downstream channel presents no hazard to the dam. If the growth were cleared, it would be an aid in assessing the seepage from the areas previously noted.

c. Reservoir Area. No conditions were observed in the reservoir area which might present significant hazard to the dam.

d. Downstream Conditions. Although it is judged that access to the dam via the alternate access route would be time consuming, the alternate route is apparently adequate for emergency conditions. Additional discussion on downstream conditions is given in Paragraph 5.1e.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedures. The reservoir is maintained at spillway crest Elevation 1411.1 with excess reservoir inflow discharging over the spillway. Water is drawn from the reservoir through the 24-inch diameter CIP that has its upstream invert at Elevation 1351.1. Controls for regulating discharges through the 24-inch line are in the valve house at the downstream toe of the dam. At the valve house, water normally enters a 16-inch diameter CIP and discharges at the outfall about 70 feet downstream of the valve house. The upstream valve on the 24-inch diameter line is normally open and the downstream valve is normally closed. The valve on the 16-inch diameter line is usually operated in the throttled position to regulate flows from the outlet works into Wolf Creek. The discharges from the outlet works and from the spillway flow to Wolf Creek Intake Dam, which is about 0.9 mile downstream. Water collected at the intake dam enters both a 16-inch and 12-inch diameter line. Both lines extend about 1.3 miles to a treatment plant near the small community of Dark Water. From there the water enters the distribution system. The communities served by the Owner's entire system are listed in Paragraph 1.2f.

The Owner stated that the emergency 24-inch diameter line was fully opened during Tropical Storm Agnes in June, 1972.

4.2 Maintenance of Dam. The dam is visited daily by a caretaker who checks the site for security and adjusts the outlet works valve, if necessary. Reservoir elevations are taken weekly and sent to the Owner's central office, where the data is filed and used to determine the storage remaining in the reservoir. The caretaker is responsible for observing the general condition of the dam and appurtenant structures and reporting any changes to the Owner's General Manager. Brush on the downstream slope of the embankment is cut every two years. Brush on the upstream slope of embankment is cut more frequently. Penn East Corporation, an engineering consultant to the Owner, makes an inspection of the Schuylkill County Municipal Authority system each year. Reports are sent to the Owner and are kept on file. The Owner apparently

does not require a detailed inspection of the physical condition of the dam, as the annual reports place emphasis on the Authority's operations. Informal inspections are made by the caretakers during their daily visits to the damsite. These visits are mostly to obtain data for operating conditions and to check for trespassers. The Owner also employs a private security firm to apprehend trespassers.

4.3 Maintenance of Operating Facilities. The 16-inch valve is lubricated annually. There is no regular maintenance program for the 24-inch valves.

4.4 Warning Systems in Effect. The Owner gave the inspection team a verbal description of the emergency warning and operation system that is applicable for all Schuylkill County Municipal Authority Dams. The Owner said that, during periods of heavy rainfall, available personnel are dispatched to the dams to observe conditions round-the-clock. All company vehicles are equipped with radios, and the personnel can communicate with a central facility. Evaluation of risk is made by the General Manager. He is also responsible for notification of emergency conditions to the Schuylkill-Pottsville Office of Civil Defense, which in turn would notify local authorities. The Office of Civil Defense does not have a detailed emergency warning plan for the Owner's dams, but it does have a detailed emergency warning plan for severe weather conditions and similar events. Detailed emergency operational procedures have not been formally established for Wolf Creek Dam, but are as directed by the Owner's General Manager.

4.5 Evaluation. Judging by the vegetation on the downstream slope of embankment, a more frequent brush cutting schedule is warranted. The procedures used by the Owner to inspect the dam need improvement. During the annual inspection, there is insufficient emphasis placed on the physical condition of the dam. Also, insufficient emphasis is placed on the physical condition of the dam during the daily visits by the caretakers. Maintenance of the 16-inch valve is good. Although the downstream 24-inch valve was fully operational, the lack of a regular maintenance program is undesirable. The valve might not be functional if needed during emergency conditions. The emergency operational procedures are too informal and not

in sufficient detail. The emergency warning system is good, but the assessment of conditions that would require activation of the emergency warning system could be improved. The chain of command is to informal not in sufficient detail, and apparently not well defined in the General Manager's absence.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data.

(1) No hydrologic or hydraulic analyses for the original Wolf Creek Dam design were available for review. The spillway capacity was estimated by the Pennsylvania Water Supply Commission for their 1918 report on Wolf Creek Dam.

(2) In the recommended guidelines for safety inspection of dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended spillway design flood for the size (intermediate) and hazard potential (high) classification of Wolf Creek Dam is the Probable Maximum Flood (PMF). If the dam and spillway are not capable of passing the PMF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

(3) The 1918 report by the Pennsylvania Water Supply Commission shows the spillway capacity at 1,150 cfs with 4 feet of head over the spillway weir. As was noted in Paragraph 3.2b., the spillway crest has been reported at varying lengths throughout the history of the dam. Calculations were performed for this study to determine the capacity of the spillway using the section as determined by a survey made for this study. For the design con-

dition, the spillway capacity is 1,440 cfs. However, low spots exist on the top of embankment that reduce the capacity of the spillway to 870 cfs at the point of initial overtopping of the dam. Hydraulic computations are presented in Appendix C.

(4) Calculations were performed for this study to determine the adequacy of the channel downstream of the spillway (Appendix C). The channel is apparently inadequate. This may reduce the spillway discharge capacity.

(5) As was noted in Section 3, the downstream end of the spillway channel is not well defined. A substantial amount of debris was observed in this area. It is estimated that higher spillway discharges might cause backwater to flood the toe of dam. While not a threat to the embankment, access to the toe of the dam would be impossible.

(6) Schuylkill County Municipal Authority owns all of Wolf Creek Dam watershed. Most of the watershed remains undeveloped. Hydrologic analysis for this study was based on existing conditions, and the effects of future development of the watershed were not considered.

b. Experience Data. For this study, the PMF was obtained from a curve of PMF peak flow versus drainage area for this region of the Delaware River Basin. (1) The peak runoff valve used was 1,660 cfs per square mile. The PMF peak flow was estimated to be 3,200 cfs. The volume of the inflow hydrograph was adjusted so that it represented 24-inches of runoff from the entire watershed. The maximum flood at the damsite is estimated at 790 cfs. Based on information from the Owner, this discharge was estimated assuming that the pool was 0.5 foot below top of dam and that the outlet works valve was fully open.

c. Visual Observations. On the date of inspection, no conditions were observed that would indicate that the peak spillway capacity would be significantly reduced during a flood occurence. However, the spillway approach channel was observed to

(1) Obtained from the Baltimore District, Corps of Engineers.

be slightly higher than the spillway weir, as noted in Section 3. Brush was also observed in the approach and discharge channels. While these conditions would not affect the peak spillway discharge capacity, they would have a significant effect on low head spillway discharges.

d. Overtopping Potential. For an occurence of the PMF, the peak inflow of 3,200 cfs is greater than the spillway capacity of Wolf Creek Dam. A check of the surcharge storage effect of Wolf Creek Reservoir shows that the surcharge storage available is insufficient to contain an inflow with a peak flow of 3,200 cfs without overtopping the dam (Appendix C).

e. Downstream Conditions. Wolf Creek Dam is 2.4 miles northeast of St. Clair, Pennsylvania, as shown on Plate 1. Flows from Wolf Creek Dam proceed downstream about 0.9 mile to Wolf Creek-Intake Dam. The intake dam is sufficiently small that its failure would not add a significant amount of water to the stream. However, it would provide no significant mitigating effect to floodflows originating upstream. Wolf Creek then flows 1.1 miles to its confluence with Mill Creek. Mill Creek proceeds downstream 1.3 miles to St. Clair. Mill Creek in the above reach generally parallels Pennsylvania Route No. 61 and crosses under railroad tracks a few times. The railroad crossings for Mill Creek are bridges, which would provide no significant mitigating effects to floodflows.

Mill Creek flows for 0.8 mile through the center of St. Clair, which has homes directly adjacent to the low river banks. The creek then flows 1.4 miles along the edge of a railroad yard, and then flows for 0.6 mile through Port Carbon, Pennsylvania, to its confluence with the Schuylkill River. Port Carbon has homes directly adjacent to the low river banks. Downstream conditions indicate that a high hazard classification is warranted for Wolf Creek Dam.

f. Spillway Adequacy.

(1) The spillway will not pass the PMF without overtopping the dam. One-half of the PMF inflow is 1,600 cfs and is greater than the spillway capacity. A check of the surcharge storage effect of Wolf Creek Reservoir shows that the surcharge storage available is insufficient to contain

an inflow with a peak flow of 1,600 cfs without overtopping the dam (Appendix C). Overtopping of the dam would cause embankment failure.

(2) If the top of embankment were raised to the design elevation that is shown on the plans, the spillway capacity and surcharge storage effect would be sufficient to pass 1,760 cfs or 55 percent of the PMF peak inflow without overtopping the dam. However, downstream conditions will reduce the discharge capacity.

(3) The maximum tailwater is estimated to be Elevation 1346.8 at the spillway capacity of 870 cfs. At maximum pool elevation, there is a difference of about 68 feet between headwater and tailwater. If Wolf Creek Dam should fail due to overtopping, the hazard to loss of life downstream from the dam will be significantly increased from that which would exist just prior to overtopping.

(4) Based on established OCE criteria as outlined in Paragraph 5.1a.(2), the spillway capacity of Wolf Creek Dam is rated as seriously inadequate. Considering the effects of the surcharge storage of 177 acre-feet, the spillway capacity of 870 cfs can accommodate a flood with a peak flow of 1,100 cfs for a storm of the same duration as the PMF. This is 34 percent of the PMF peak inflow.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of the dam resulted in a number of observations relevant to structural stability. These observations are listed herein for various features.

(2) Embankment. Seepage was observed at locations along the toe of the embankment. Evidence of erosion at the top of the embankment and bulging in the downstream slope of embankment were observed. Cracks in the concrete core wall were also observed. A detailed description and evaluation of these conditions are in Paragraphs 3.1b. and 3.2a., respectively.

(3) Spillway. Cracks and evidence of relative movement were observed on the spillway walls. Evidence of possible sliding of the hillside to the right of the spillway was also observed. A detailed description and evaluation of these conditions are in Paragraphs 3.1b. and 3.2b., respectively.

b. Design and Construction Data. No record of design data or stability analysis for the original structures was available for review. The structure was studied in 1918 by the Pennsylvania Water Supply Commission. No stability analysis for the structures was performed.

The existing spillway weir crest is 0.1 foot above the upstream and downstream channel. During a review of the spillway section, it was estimated that the structure would be stable for the expected loads. Stability analyses on structures this small are usually not performed.

c. Operating Records. The only operating records available for review were the periodic inspections by the Commonwealth. The observations in these reports have been noted herein.

d. Post-Construction Changes. As noted herein, there have been no post-construction changes made to Wolf Creek Dam.

e. Seismic Stability. Wolf Creek Dam is located in Seismic Zone 1. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading. However, since there are no formal static stability analyses, and since there is the potential of earthquake forces moving or cracking the concrete core wall, the theoretical seismic stability of this dam cannot be assessed.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on the visual inspection, available records, calculations and past operational performance, Wolf Creek Dam is judged to be in fair condition. Some maintenance and repair deficiencies were noted. A summary of features and observed deficiencies are listed below:

Feature and Location	Observed Deficiencies
Embankment:	
Top	Low areas, riprap below top, and erosion.
Slopes	Bulging, upstream slope does not agree with design template, and brush.
Downstream toe	Seepage and trees too close to toe.
Core Wall:	Cracks at top.
Spillway:	
Right side	Possible slope movement.
Approach channel	Channel above weir elevation and brush.
Wall	Cracks and evidence of relative movement.
Discharge channel	Poorly defined channel downstream of drop from hillside and severe weathering.
Outlet Works:	
Pipes	Leaking joints, channel overgrown, and pipe under pressure through embankment.

(2) The overtopping potential analysis shows that Wolf Creek Dam will be overtopped by the PMF and one-half the PMF. Overtopping of the dam would cause embankment failure. Therefore, based on OCE criteria, as outlined in Paragraph 5.1a.(2), the existing spillway capacity is rated as seriously inadequate. The existing spillway can accomodate a flood with a peak inflow of 34 percent of the PMF peak inflow. If the top of embankment were raised to the design elevation that is shown on the plans, the spillway capacity and surcharge storage effect would be sufficient to pass 1,760 cfs or 55 percent of the PMF peak inflow without overtopping the dam. However, downstream conditions will limit the discharge capacity of the spillway to a lower flow.

(3) Stability computations were not performed for this study. The spillway weir was judged to be stable.

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, computations performed prior to and as a part of this study, and other information.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented immediately or in a timely manner as noted.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations will be required.

7.2 Recommendations and Remedial Measures.

a. In view of the concern for the safety of Wolf Creek Dam, the following measures are recommended, in approximate order of priority, to be taken by the Owner immediately:

(1) Clear the spillway channel of vegetation.

(2) Grade the spillway approach channel to a proper elevation.

(3) Perform additional studies to more accurately ascertain the spillway capacity required for Wolf Creek Dam, as well as the nature and extent of mitigation measures required to make the spillway and spillway channel hydraulically adequate. Filling in the existing low area of the embankment would help increase the spillway capacity and this should be accomplished.

(4) Provide closure facilities for the outlet works pipes upstream of the concrete core wall for periodic inspection and for use in the event the pipe should leak severely, thereby endangering the embankment.

(5) Install two or more inclinometers in the downstream slope of the embankment near the maximum section to monitor any slope movement.

(6) Undertake a survey to determine the existing template of the embankment.

(7) Install ten or more observation wells, or other instrumentation, downstream of the axis of the dam. Two wells, or other instrumentation, should be located in the vicinity of the wet area right of the valve house. Two others should be located near the wet area left of the valve house. Another two should be in the embankment near the cracks in the core wall. The other four should be at appropriate locations to determine the general water level in downstream embankment. Data collected from observation wells or other instrumentation should be utilized in evaluating the stability of the embankment and assessing piping potential in the future. The data should also be utilized in evaluating the effects of the cracks in the core wall and in determining if other core wall cracks exist. Continue to observe the wet areas and seepage downstream from dam. If a high phreatic line is present in portions of the downstream embankment, or there is a marked increase in seepage quantity or turbidity is noted in the seepage, appropriate action should be taken to repair the core wall or to control the seepage and turbidity with properly designed drains. Action taken should be coordinated with stability studies recommended in next paragraph.

(8) Undertake an embankment and foundation exploration program to ascertain the engineering properties of the materials and perform a study to determine the factor of safety for stability of the embankment. Take any remedial action that might be found necessary to ensure stability of the embankment.

(9) Raise top of riprap to top of dam elevation and provide adequate measures to prevent erosion.

(10) Excavating the hillside to make the length of the spillway weir agree with the drawing would help increase the spillway capacity. This should be accomplished. In this regard, the Owner should undertake a study to determine the slopes required to provide a stable cut and the erosion protection required along the spillway channel.

(11) Repair spillway wall.

(12) Institute a program of detailed annual inspections for Wolf Creek Dam and utilize the results to ascertain if remedial measures are required.

(13) Develop a detailed emergency operation and warning system for Wolf Creek Dam.

b. In order to correct operational, maintenance, and repair deficiencies and to more accurately determine the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Remove brush and trees that are on or near the embankment.

(2) Monitor weathering of rock in the spillway discharge channel. Should the weathering begin to threaten the spillway wall, appropriate remedial action should be taken.

(3) Remove growth from channel downstream of outlet works outfall.

(4) Undertake a study to determine the adequacy of the spillway channel, where it flows overland to Wolf Creek.

(5) Repair leaking pipe joints.

c. In addition, the following operational measures are recommended to be undertaken by the Owner:

(1) Provide round-the-clock surveillance of Wolf Creek Dam during periods of unusually heavy rains.

(2) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

DELAWARE RIVER BASIN

WOLF CREEK, SCHUYLKILL COUNTY

PENNSYLVANIA

WOLF CREEK DAM

NDS ID No. PA-00664
DER ID No. 54-53

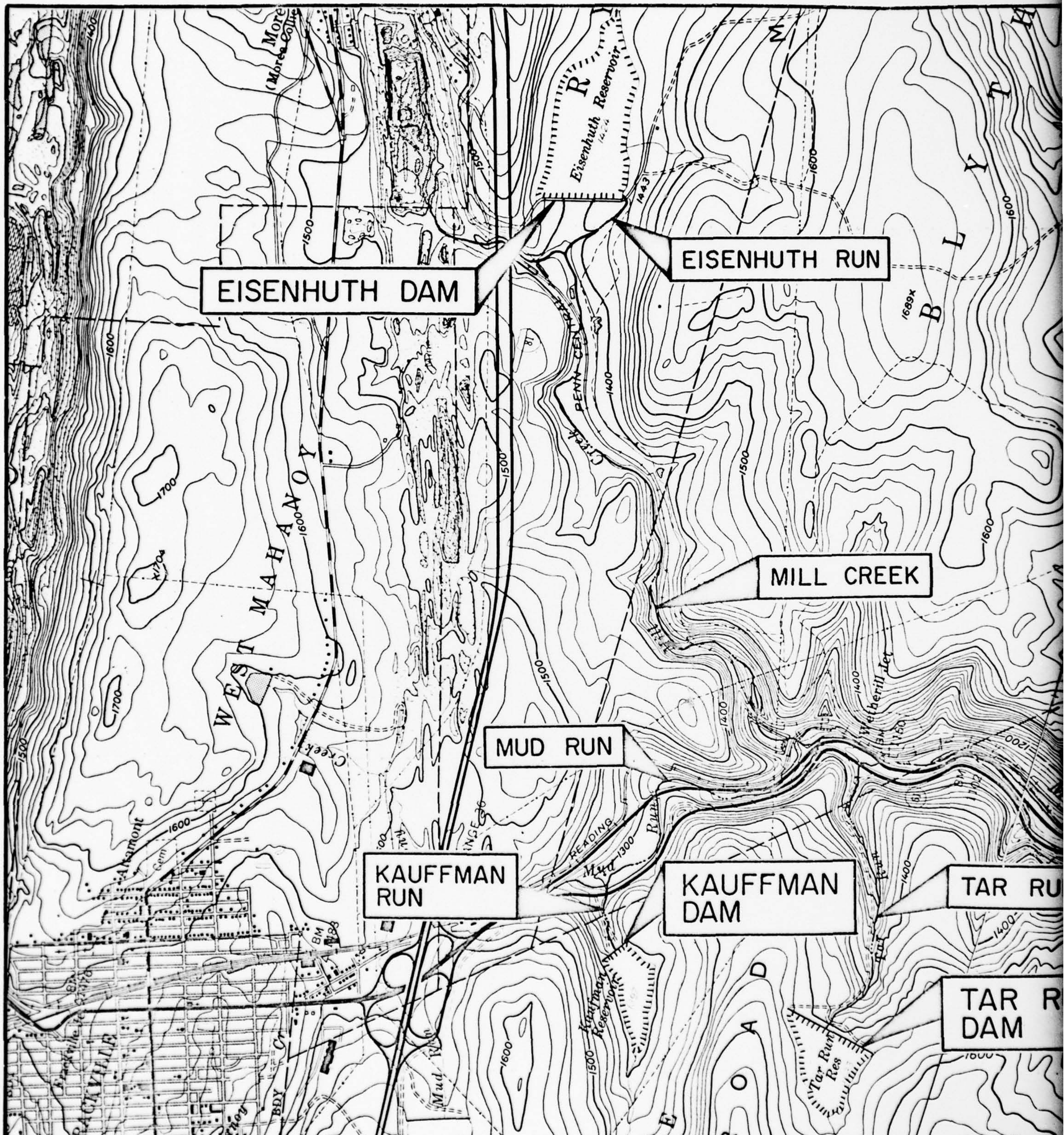
SCHUYLKILL COUNTY MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

PLATES


EISENHUTH DAM
EISENHUTH RUN
Eisenhuth Reservoir
MILL CREEK
MUD RUN
KAUFFMAN RUN
KAUFFMAN DAM
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TAR RU
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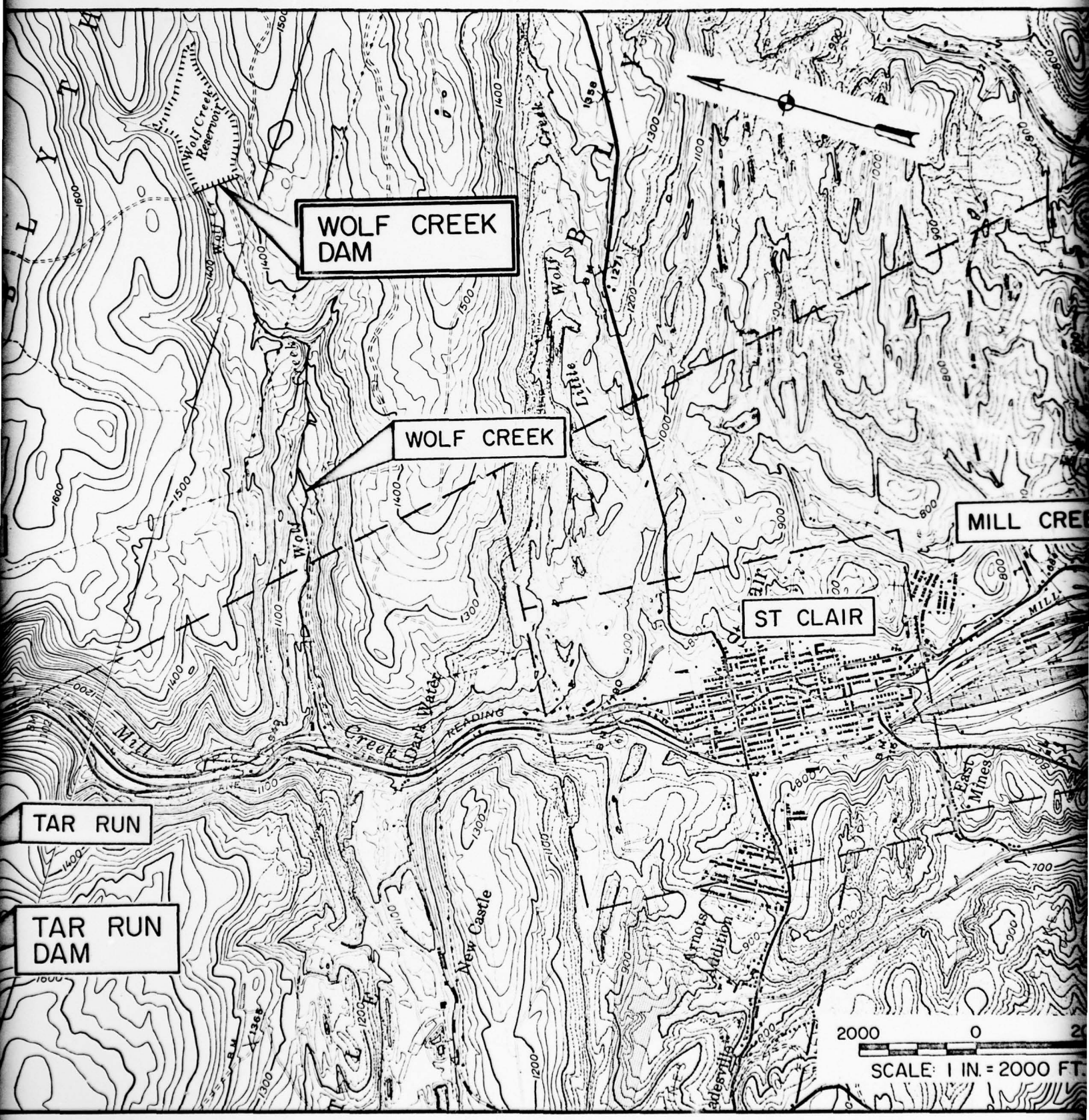
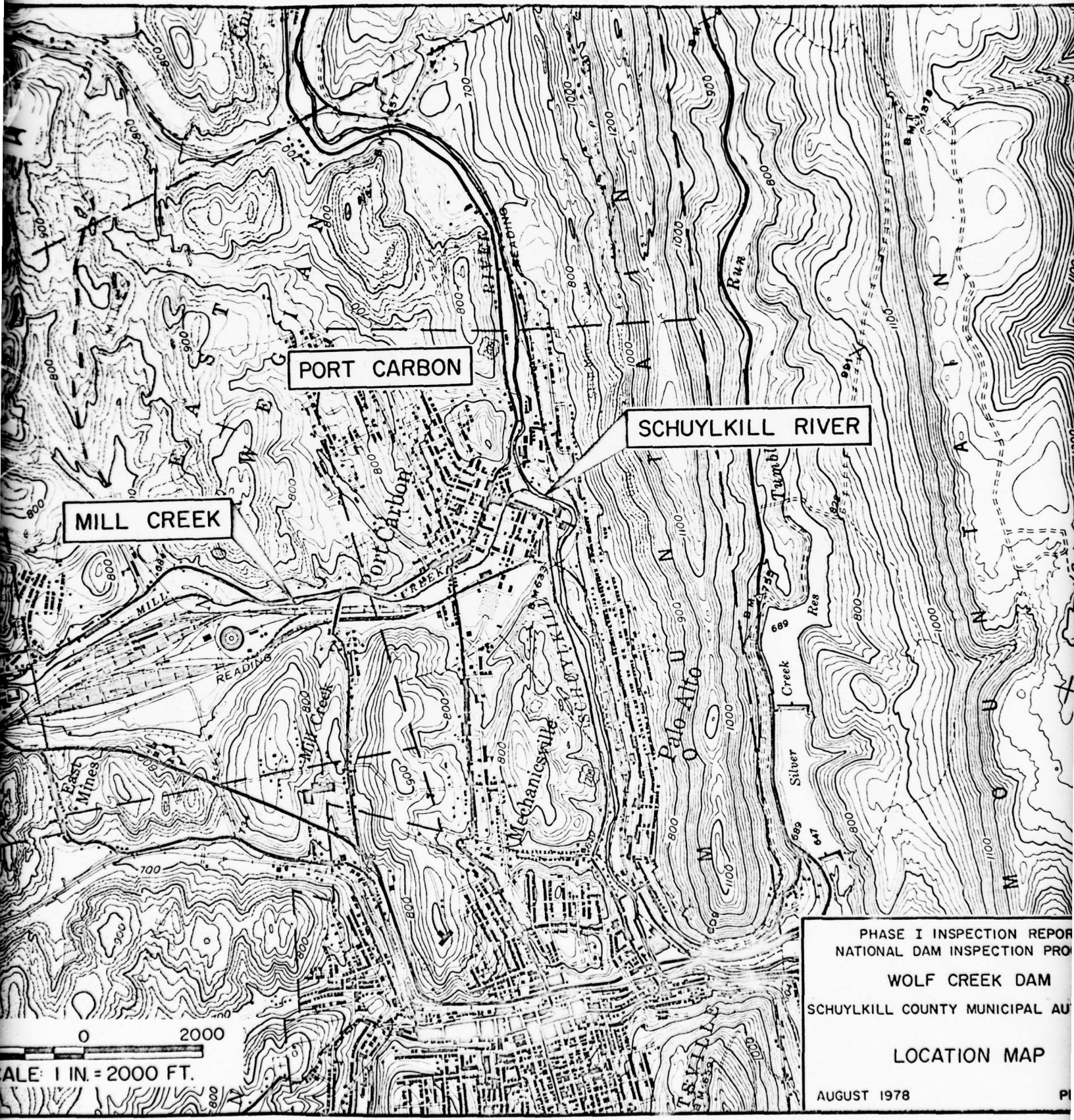
DAM
Tar Run Res
WEST MAHANOY
FRACKVILLE
PENN CENTRAL
READING


WOLF CREEK DAM
WOLF CREEK
TAR RUN
TAR RUN DAM
ST CLAIR
MILL CRE
Wolf Creek Reservoir
Little Wolf Creek
Mill Creek Park Water
READING
New Castle
Arnots Addition
East Mines
2000 0
SCALE: 1 IN. = 2000 FT.



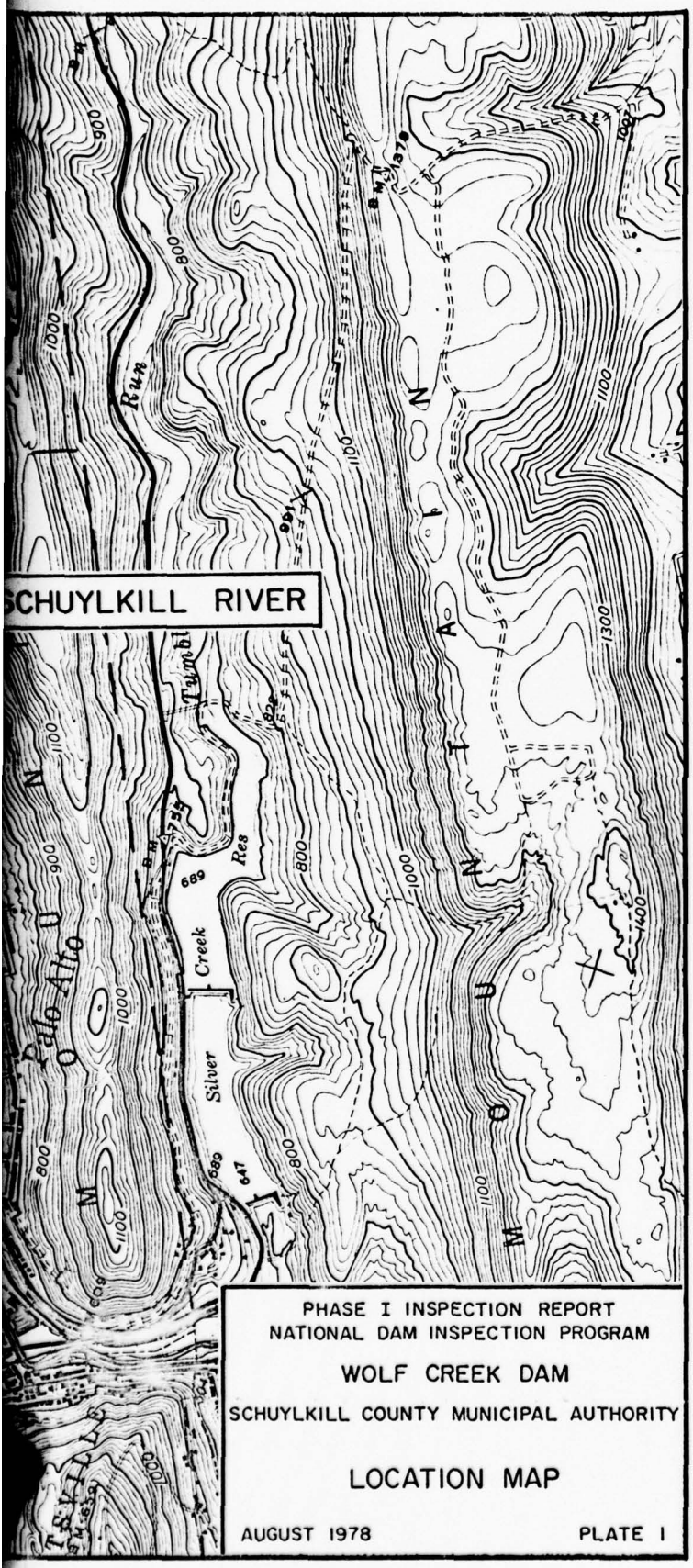
PHASE I INSPECTION REPOR
NATIONAL DAM INSPECTION PRO

WOLF CREEK DAM

SCHUYLKILL COUNTY MUNICIPAL AU

LOCATION MAP

AUGUST 1978 PI



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

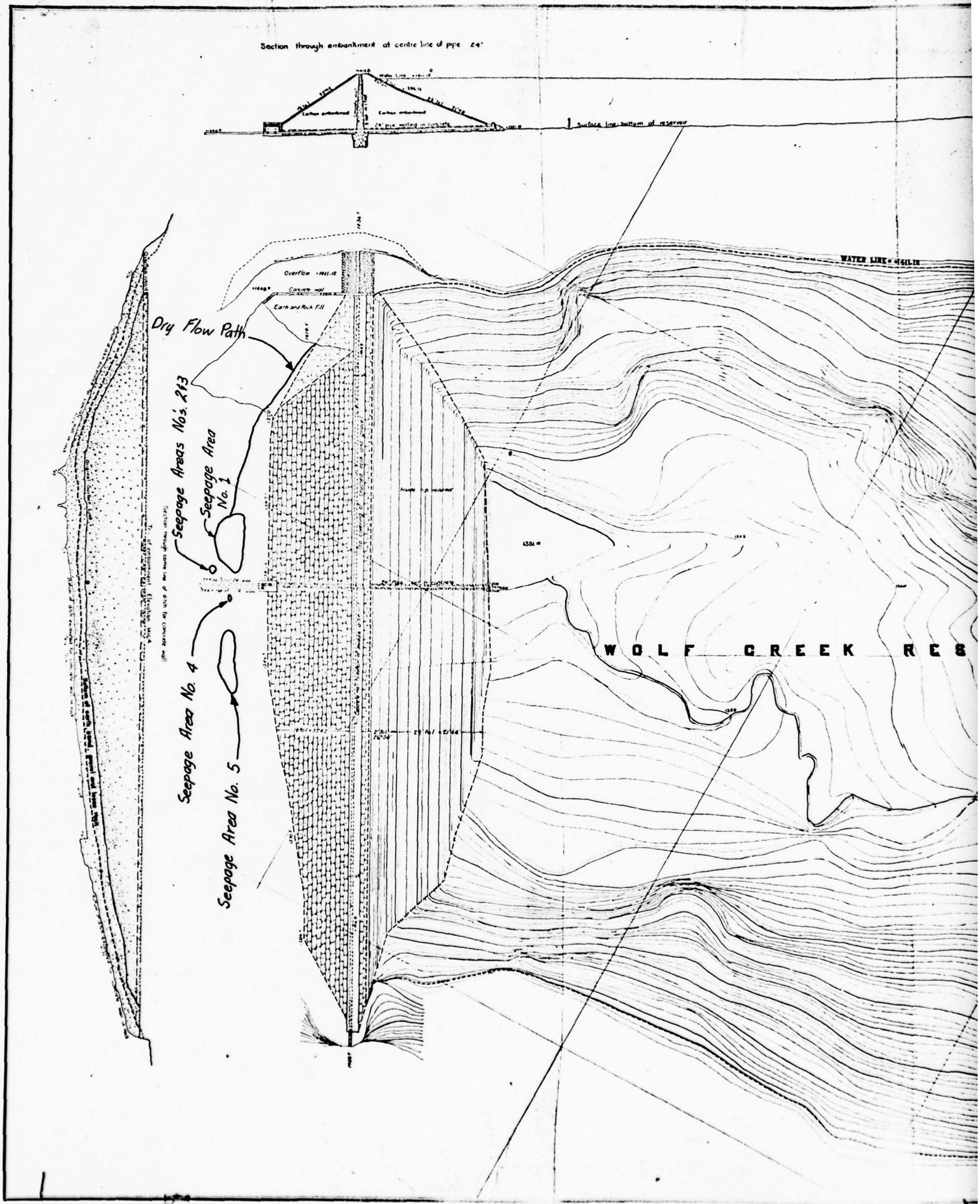
WOLF CREEK DAM

SCHUYLKILL COUNTY MUNICIPAL AUTHORITY

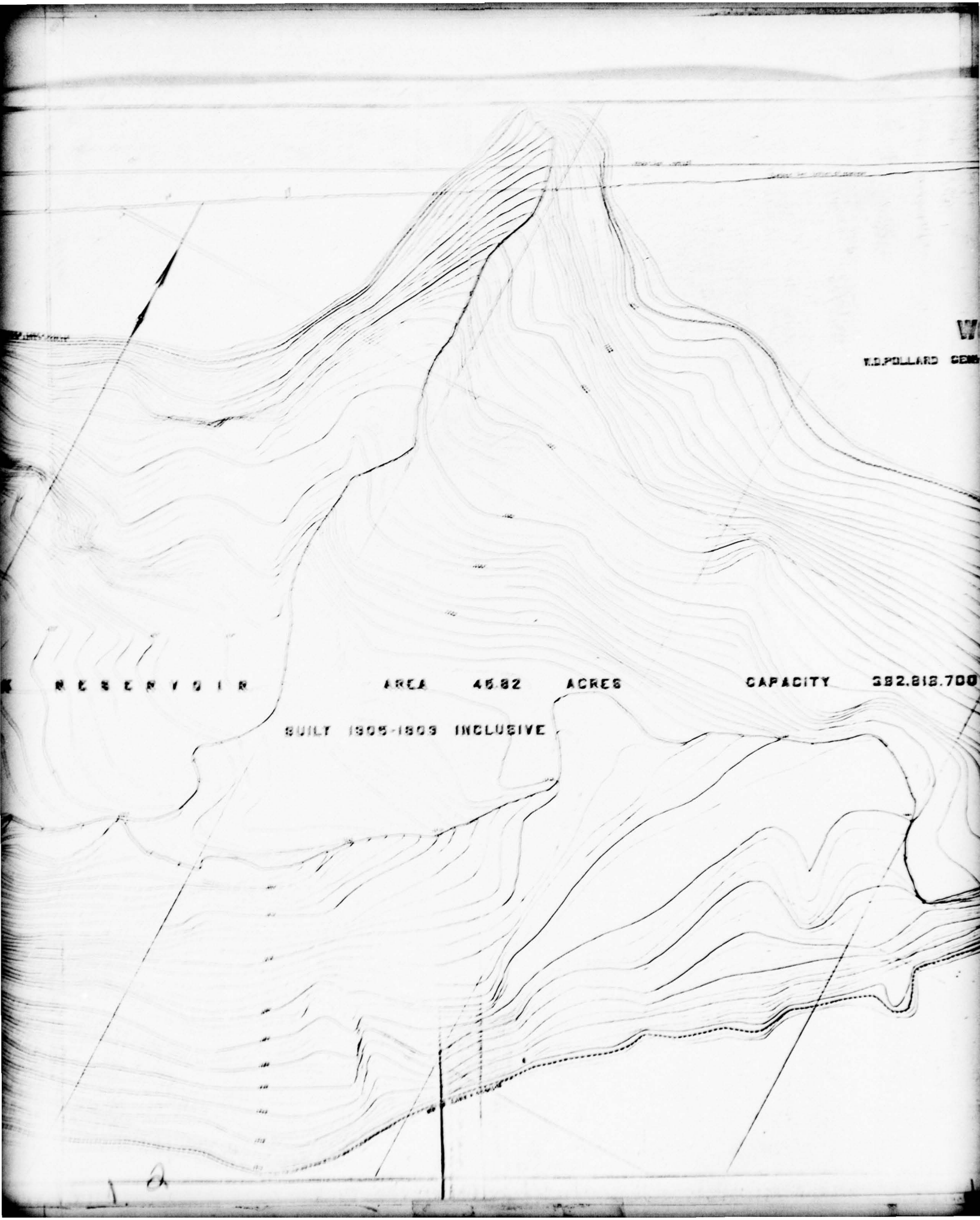
LOCATION MAP

AUGUST 1978 PLATE 1

4



Section through embankment at centre line of pipe 24"
Surface line bottom of reservoir
Overflow
Concrete wall
Earth and Rock Fill
Dry Flow Path
Seepage Areas No's. 2 & 3
Seepage Area No. 1
Seepage Area No. 4
Seepage Area No. 5
WATER LINE
WOLF CREEK RES

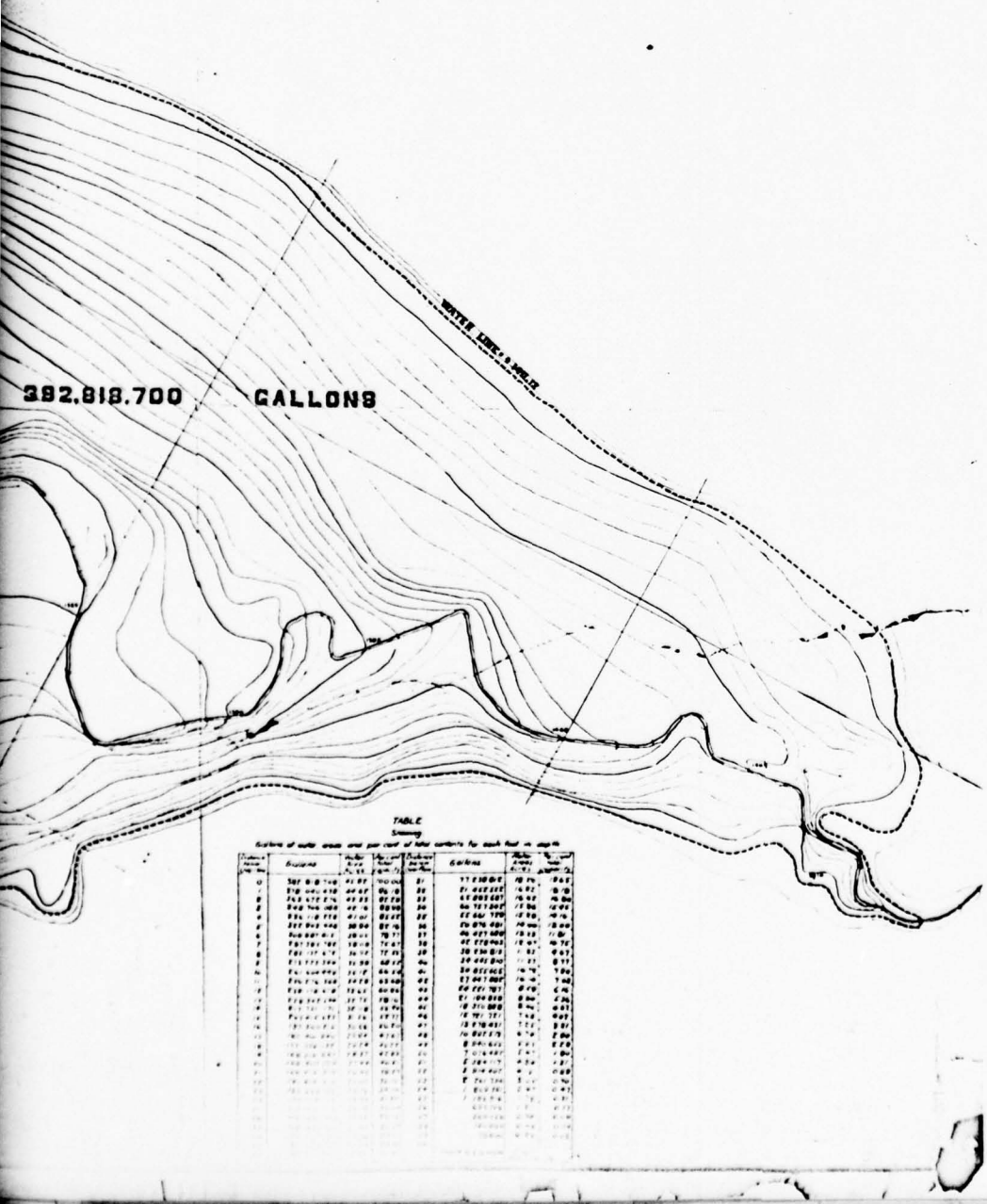

W
W.D.POLLARD
R E S E R V O I R
AREA 45.82 ACRES
CAPACITY 382,818,700
BUILT 1905-1909 INCLUSIVE

PLAN AND SECTIONS
OF THE
POTTSVILLE WATER CO'S
WOLF CREEK RESERVOIR

W.D.POLLARD GEN! MGR.

FRANK G.CLEMENS ENG!

SCALE 40 FEET TO 1 INCH



TABLE
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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

WOLF CREEK DAM

SCHUYLKILL COUNTY MUNICIPAL AUTHORITY

PLAN, PROFILE, AND SECTION

AUGUST 1978 PLATE 2

3

DELAWARE RIVER BASIN

WOLF CREEK, SCHUYLKILL COUNTY

PENNSYLVANIA

WOLF CREEK DAM

NDS ID No. PA-00664
DER ID No. 54-53

SCHYLKILL COUNTY MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: Wolf Creek

NDS ID NO.: PA-00664 DER ID NO.: 54-53

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	No formal as built drawings available.
REGIONAL VICINITY MAP	Project is shown on USGS Quadrangle Shenandoah, Pennsylvania, N4045-W7607.5/7.5, 1955. Photo revised 1969.
CONSTRUCTION HISTORY	Built 1905 - No other details available.
TYPICAL SECTIONS OF DAM	Available.
OUTLETS: Plan Details Constraints Discharge Ratings	Only plan and profile available.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	None available.
DESIGN REPORTS	None available.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	None available.
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	None available.
POSTCONSTRUCTION SURVEYS OF DAM	1918 Report by Pennsylvania Water Supply Commission.

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	Not available.
MONITORING SYSTEMS	None.
MODIFICATIONS	None.
HIGH POOL RECORDS	None available.
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	1918 Report by Pennsylvania Water Supply Commission.
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	None known.

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	None available.
SPILLWAY: Plan Sections Details	Plan available.
OPERATING EQUIPMENT: Plans Details	No plan or details available.
PREVIOUS INSPECTIONS Dates Deficiencies (Continued)	1922: No deficiencies. 1926: Some settlement along top of dam. Trees growing is spillway channel. 1930: Some small bulges on downstream slope. Stream starting 20 feet above toe at right abutment hillside. Another stream is to the right of and below the valve house. A third stream is along the outlet works pipes and a fourth from a drain to the left of the pipes. A fifth stream is 20 feet to the left of the valve house and at other places along the toe to the left. The third stream was reported by the owner to be leakage from the pipe joints. 1932: Small trees and brush in spillway channel. Crack in left spillway wall. No seepage except along outlet works pipes. (Continued on page A-5)

ITEM	REMARKS
PREVIOUS INSPECTIONS (Continued from page A-4)	1933: Large crack in left spillway wall by weir. Seepage from right abutment hillside, reportedly coming from spillway channel. 1938: Riprap bulged 25 feet up slope to right of valve house. No apparent seepage. 1941: Very uneven surface on downstream and upstream slope caused by sliding and settlement. Swampy area to right and below of valve house. Large crack in left spillway abutment. 1942: Top of dam 8 inches below top of spillway wall. Brush in upstream and downstream slopes. Buckling in downstream slope. Some leakage at toe to right of valve house and along both pipes. Crack in left spillway wall. Stones across spillway. 1945: Identical to 1942 inspection except less leakage. Stones in spillway had been removed. 1962: Crack in left spillway wall. Swampy condition at toe.

CHECKLIST

ENGINEERING DATA

HYDROLOGY AND HYDRAULICS

NAME OF DAM: Wolf Creek NDS ID NO.: PA-00664 DER ID NO.: 54-53

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1411.12

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1415.0

ELEVATION MAXIMUM DESIGN POOL: 1415.0 (existing)

ELEVATION TOP DAM: 1415.0 (1416.4 - design)

SPILLWAY CREST:
- a. Elevation 1411.12
- b. Type Broad Crested Weir.
- c. Width 3.5 Feet.
- d. Length 35.0 Feet.
- e. Location Spillover Right Abutment.
- f. Number and Type of Gates None.

OUTLET WORKS:
- a. Type 24-inch diameter CIP (16-inch diameter CIP taps off 24-inch at valve house)
- b. Location Approximate Center of Dam
- c. Entrance Inverts 1351.1.
- d. Exit Inverts 1346.9 - 24-inch, 1347.0 - 16-inch.
- e. Emergency Draindown Facilities Above.

HYDROMETEOROLOGICAL GAGES:
- a. Type None.
- b. Location None.
- c. Records None.

MAXIMUM NONDAMAGING DISCHARGE: 870 CFS

DELAWARE RIVER BASIN

WOLF CREEK, SCHUYLKILL COUNTY

PENNSYLVANIA

WOLF CREEK DAM

NDS ID No. PA-00664
DER ID No. 54-53

SCHUYLKILL COUNTY MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Wolf Creek County: Schuylkill State: Pennsylvania

NDS ID No.: PA-00664 DER ID No.: 54-53

Type of Dam: Earthfill with Concrete Core Wall Hazard Category: High

Date(s) Inspection: 20 July 1978 Weather: Hazy Temperature: 85°F

General Soil Condition: Moist, except top of dam dry.

Pool Elevation at Time of Inspection: 1407.6 msl/Tailwater at Time of Inspection: 1344.5 msl

Inspection Personnel:

I. Crouse (GFCC)	T. Stank (SCMA)	
D. Ebersole (GFCC)		
D. Holley (SCMA)		

A. Whitman (GFCC) Recorder

EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	Top of Dam: Material from top has eroded onto slopes. An erosion gully leading upstream was observed 240 feet left of spillway. Also see page B-9.	Core wall intermittently exposed from 800 feet left of spillway to 350 feet left of spillway. Totally exposed from 235 feet left to 290 feet left. Date 1909 observed 2 cracks - one 235 feet left normal to axis and one 275 feet left diagonal with evidence of repair. This latter one has vertical offset of 1/16-inch.
CREST ALIGNMENT: Vertical Horizontal	Horizontal - Straight. Vertical - Surveyed: Entire top of dam low, lowest point El. 1415 500 feet left of spillway.	
RIPRAP FAILURES	Upstream slope bulged 6 inches, may be uneven construction. For downstream slope see page B-9.	

EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	No deficiencies except dry seepage path at right - see seepage on page B-9.	
ANY NOTICEABLE SEEPAGE	See page B-9.	
STAFF GAGE AND RECORDER	None.	
DRAINS	See seepage - page B-9.	
VEGETATION	Sporadic brush about 5 feet high. One 15-foot high tree observed in embankment.	Trees at toe along entire length except near outlet works.

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not applicable.	
INTAKE STRUCTURE	Submerged.	
PIPES	16-inch diameter pipe discharging during inspection. Joints on both the 16-inch and 24-inch pipes laid backwards.	Joints in 16-inch diameter pipe leak severly.
OUTLET CHANNEL	Rubble stilling pool leading to heavily overgrown stream.	
EMERGENCY GATE	Operation of 24-inch valve: opened 5 percent in 10 minutes with no apparent problems.	

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Aggregate exposed. 1-foot diameter stones on weir.	Right end of weir is indistinct where it joins the hillside.
APPROACH CHANNEL	1-foot high brush along right side. Survey indicates that the approach channel is higher than weir by up to 0.7 foot.	Left wall - map cracking. Structural crack at weir in approach wall with evidence of attempted repair. Upstream part of wall tilts toward spillway 0.15 feet. The upstream end of this wall (10.5 feet beyond weir) is offset 0.7 foot toward spillway. Wall continues down discharge channel and deflects near end. There is slight pitting along the toe of wall. SEE BELOW
DISCHARGE CHANNEL (Continued Below)	3-inch diameter stumps protrude 1.5 feet above invert. Some growth on left of channel. Paved 18-foot long apron has no mortar may have been dry masonry.	
BRIDGE AND PIERS	None.	
DISCHARGE CHANNEL (Continued from Above)	The natural rock in the channel has evidence of severe weathering, especially at 1V on 2H drop. Channel is then poorly defined to existing stream.	After the wall deflects, it is slightly tilted toward the channel. 5-foot long areas are peeling near deflect ion point. Crack near this point. Some leaching at crack.

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Mild.	
SEDIMENTATION	No reported problems.	
WATERSHED DESCRIPTION	Wooded, undeveloped, entirely owned by owner. Strip mines near but not in watershed.	

DOWNSTREAM CHANNEL

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	Laurel tree roots act as dam across channel.	
SLOPES	Almost flat overbanks.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	None - Access to site is via 2.2 mile unpaved road which is close to or crosses stream in many instances.	Access road would be impassable during high stream flows. Owner stated that another access road could be used.

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOUGHING OR EROSION (Continued from page B-2)	Bulges in riprap on downstream slope. Major bulges start about 250 feet left of the left spillway wall and extend to 610 feet left of the left spillway wall. Bulges are generally about 20 feet above the toe and are 2 to 3 feet high normal to the slope.	Smaller bulges extend beyond these limits.
ANY NOTICEABLE SEEPAGE (Continued from page B-3)	Seepage directly to left of exposed outlet works pipes - 5 gpm clear. Wet area 40 feet left of valve house extends from 55 feet downstream of toe further downstream. Area is about 2200 square feet and has standing water. Seepage area 40 feet right valve house. - Dry seepage path leading from right abutment to seepage area measuring 75 feet along toe. Some standing water - localized seep at 2 gpm.	May be from drain. Clear flow of 2 gpm from this area flows in culvert under access road and into excavated ditch leading to stream. Stones at toe of embankment wet. 2 localized seeps 50 feet downstream of valve house and 15 feet right - Total flow 10 gpm which joins with seepage noted at left.

DELAWARE RIVER BASIN

WOLF CREEK, SCHUYLKILL COUNTY

PENNSYLVANIA

WOLF CREEK DAM

NDS ID No. PA-00664
DER ID No. 54-53

SCHUYLKILL COUNTY MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

APPENDIX C

HYDROLOGY AND HYDRAULICS

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT WOLF CREEK DAM (54-53) FILE NO. 7613.2A
HYDROLOGY AND HYDRAULICS ANALYSIS SHEET NO. 1 OF 9 SHEETS
FOR USCE - BALTIMORE DISTRICT
COMPUTED BY JAC DATE 7/21/78 CHECKED BY DAW DATE 8/28

CLASSIFICATION

HIGH HAZARD, SINCE DOWNSTREAM POPULATION IS SUBSTANTIAL, AND FAILURE OF THE DAM COULD RESULT IN MORE THAN A FEW LIVES LOST AND EXCESSIVE ECONOMIC LOSS

INTERMEDIATE SIZE, SINCE HEIGHT = 70 FEET AND CAPACITY = 1,405 AC-FT
REFERENCE: "RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS," p. D-3

SPILLWAY DESIGN FLOOD (SDF)

THE SDF SHOULD BE THE PMF (FROM p. D-12 OF "REC. GUIDELINES ...")

HYDROLOGY AND HYDRAULICS ANALYSIS

REFERENCE: PHASE I PROCEDURE PACKAGE

II. A. 2. PMF INFLOW HYDROGRAPH NOT AVAILABLE

a. BALTIMORE CONTACT, MIKE KANOWITZ, RECOMMENDS 1,660 CSM FOR THE PMF PEAK FLOW FOR THE WOLF CREEK DAM WATERSHED

PMF PEAK = 1,660 CFS/SQ.MI. × 1.93 SQ.MI. = 3,204 - SAY 3,200 CFS

EFFECT OF UPSTREAM RESERVOIRS

NO UPSTREAM RESERVOIRS EXIST

B. ABILITY OF SPILLWAY TO PASS PMF

1. CAPACITY OF SPILLWAY -

DESIGN TOP OF DAM ELEV.	= 1116.4'
ACTUAL MIN. TOP OF DAM ELEV.	= 1115.0'
SPILLWAY CREST ELEVATION	= 1111.12'
DESIGN HEAD ON SPILLWAY	= 5.28'
AVAILABLE HEAD ON SPILLWAY	= 3.88'

BROAD-CRESTED WEIR EQUATION (p. 372 VENNARD, ELEMENTARY FLUID MECHANICS)

$$q = \sqrt{g(2H/3)^3}$$

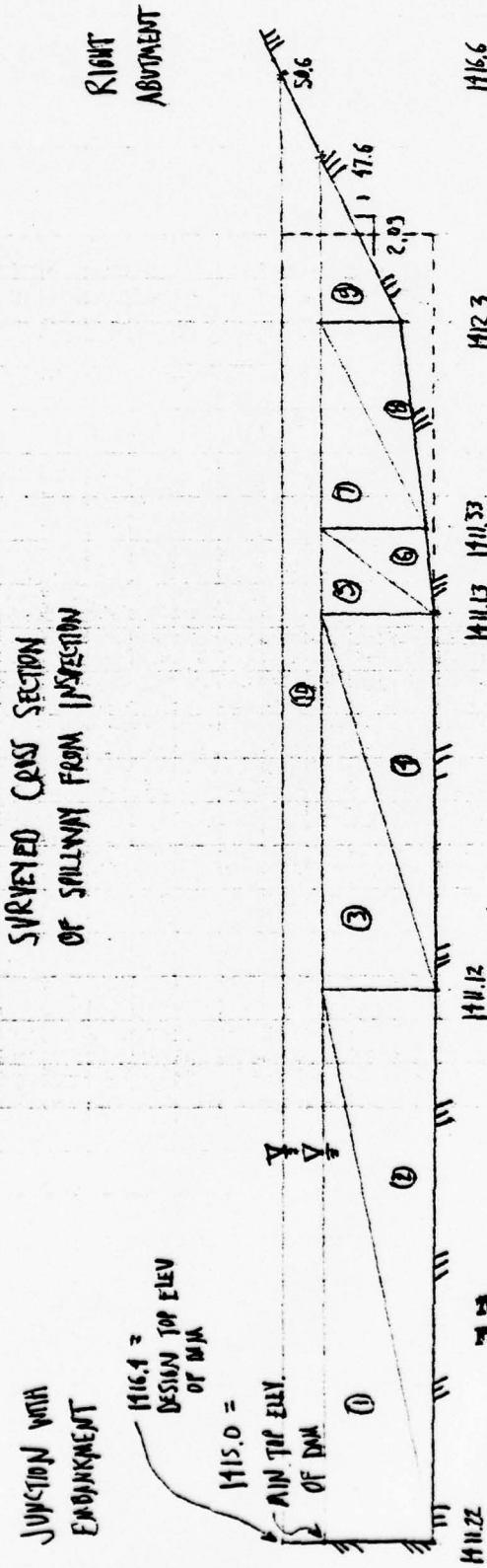
$$\therefore Q = L\sqrt{g(2H/3)^3}$$

AND $Q = 3.089\, L\, H^{3/2}$ (OK FOR CREST AND APPROACH CONDITIONS)

L = LENGTH = AREA / DEPTH = A / 3.88

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT WOLF CREEK DAM (SF-53) FILE NO. 7613.21
HYDROLOGY AND HYDRAULICS ANALYSIS SHEET NO. 2 OF 9 SHEETS
FOR USCE - BALTIMORE DISTRICT
COMPUTED BY JMC DATE 7/28/78 CHECKED BY DAW DATE 8/78



TOTAL AREA = ① + ② + ③ + ④ + ⑤ + ⑥ + ⑦ + ⑧ + ⑨

AREA NO.	AREA
①	$\frac{1}{2}(3.79)(13) = 35.9$
②	$\frac{1}{2}(3.98)(13) = 36.9$
③	$\frac{1}{2}(3.88)(13) = 25.2$
④	$\frac{1}{2}(3.87)(13) = 25.2$
⑤	$\frac{1}{2}(3.87)(3) = 5.8$
⑥	$\frac{1}{2}(3.67)(3) = 5.5$
⑦	$\frac{1}{2}(3.67)(7) = 12.8$
⑧	$\frac{1}{2}(2.7)(7) = 9.5$
⑨	$\frac{1}{2}(2.7)(5.6) = 7.6$

TOTAL AREA = 164 SQ. FT.

SP 11660A

$L = 164 / 3.88 = 42.3$ FT

$Q = (3.089)\ 42.3\ (3.88)^{3/2}$
$Q = 999$, SAY 1,000 CFS

COMPARE WITH CAPACITY USING DISCHARGE COEFFICIENT, $C = 2.7$

$Q = (2.7)\ 42.3\ (3.88)^{3/2}$
$Q = 873$, SAY 870 CFS ← EXISTING

DISCHARGE CAPACITIES WITH FULL DESIGN HEAD OF 5 FEET ON SPILLWAY WEIR

TOTAL AREA = ① + ② + ③ + ④ + ⑤ + ⑥ + ⑦ + ⑧ + ⑨ + ⑩
= $164.0 + \frac{1}{2}(50.6 + 42.6)(1.4)$
= 232.7, SAY 232 SQ. FT.

$L = 232 / 5.28 = 43.9$ FT

IF $C = 3.089$,
$Q = (3.089)\ 43.9\ (5.28)^{3/2}$
$Q = 1,645$, SAY 1,650 CFS

IF $C = 2.7$,
$Q = (2.7)\ 43.9\ (5.28)^{3/2}$
$Q = 1,438$, SAY 1,440 CFS ← DESIGN

SINCE THE APPROACH CHANNEL IS NEARLY FLAT AND IS APPROXIMATELY AT THE SAME ELEVATION AS THE SPILLWAY WEIR, USE $C = 2.7$

3. THE PMF PEAK FLOW IS GREATER THAN THE SPILLWAY CAPACITY ($3,200 > 870$)
   b. ROUTING OF THE PMF IS NOT AVAILABLE
      (1.) THE SPILLWAY WILL PASS $(870 / 3,200) = 0.272 = p = 27.2\%$ OF THE PMF PEAK
      (2.) INCLOSURE 3 METHOD TO ESTIMATE THE STORAGE EFFECT OF THE RESERVOIR
         (a) TRIANGULAR SHAPE FOR PMF HYDROGRAPH
         (b) ASSUME 24 INCHES OF RUNOFF AS PER INSTRUCTIONS FROM BALTIMORE CONTACT

VOL = $\frac{1}{2}bh$; $b = 2\,VOL / h$

VOL = 24" RUNOFF x 1.93 SQ.MI. x 640 ACRES / SQ.MI. = 29,645 AC-IN

29,645 AC-IN x 1FT/12 IN x 43,560 FT²-HR / 3,600 AC-SEC = 29,892 CFS-HRS

$b = \frac{2\,VOL}{h} = \frac{2 \times 29,892\ CFS\text{-}HRS}{3,200\ CFS} = 18.7$ HOURS

$1-p = 1 - 0.272 = 0.728 = \Delta AOC / \Delta AOB$

$\Delta AOB = \frac{1}{2}bh = VOL = 29,645$ AC-IN x (1FT/12IN) = 2,470 AC-FT

SUBSTITUTING, $\Delta AOC = (1-p)\,\Delta AOB = 0.728\,(2,470) = 1,798$ AC-FT

REQUIRED STORAGE = ΔAOC = 1,798 AC-FT

(c) INCREMENTAL STORAGE AVAILABLE BETWEEN NORMAL POOL ELEVATION AND MAXIMUM POOL ELEVATION

NORMAL POOL ELEVATION = SPILLWAY CREST ELEVATION = 1411.12'

MAXIMUM POOL ELEVATION = ELEVATION OF OVERTOPPING = 1415.0'

AREA OF RESERVOIR WITH W.S. AT SPILLWAY CREST = 44.8 ACRES

AREA OF RESERVOIR WITH W.S. AT MAXIMUM POOL = ?

ASSUME RESERVOIR SIDE SLOPES OF 4H ON 1V AND ASSUME CIRCULAR SHAPE

44.8 ACRES x 43,560 FT²/1ACRE = πr_1^2

621,178 FT² = r_1^2

r_1 = 788.1 FT

r_2 = $r_1 + \Delta H = r_1 + 4(\Delta V) = r_1 + 4(3.88')$

= 788.1 + 15.5 = 803.6'

A_2 = $\pi r_2^2 = \pi (803.6')^2 = 2,028,756$ FT²

A_2 = 46.6 ACRES

INCREMENTAL STORAGE = $\left(\frac{A_1 + A_2}{2}\right)\Delta V$

= $\left(\frac{44.8 + 46.6}{2}\right) 3.88'$

INCREMENTAL STORAGE = 177 AC-FT

STORAGE REQUIRED = 1,798 AC-FT > STORAGE AVAILABLE = 177 AC-FT

C. PROCEDURES FOR DETERMINATION OF ADEQUATE/INADEQUATE SPILLWAY CAPACITY

2. STORAGE REQUIRED FOR THE PMF IS GREATER THAN THE STORAGE AVAILABLE

a. ETL 1110-2- STATES THREE CONDITIONS THAT MUST EXIST BEFORE THE SPILLWAY

CAPACITY IS CONSIDERED TO BE SERIOUSLY INADEQUATE. CHECK CONDITION "C"
(IS THE SPILLWAY ABLE TO PASS ½ PMF W/O OVERTOPPING FAILURE?)

b. REPEAT CALCULATIONS FOR ½ PMF PEAK

½ PMF PEAK = ½(3,200) = 1,600 CFS

II. B. ABILITY OF SPILLWAY TO PASS ½ PMF

1. CAPACITY OF SPILLWAY = 870 CFS
3. ½ PMF PEAK FLOW IS GREATER THAN THE SPILLWAY CAPACITY (1,600 > 870)
   b. ROUTING OF ½ PMF IS NOT AVAILABLE
      (1.) THE SPILLWAY WILL PASS (870/ 1,600) = 0.544 = p = 54.4 % OF ½ PMF PEAK
      (2.) INCLOSURE 3 METHOD TO ESTIMATE THE STORAGE EFFECT OF THE RESERVOIR
         (a) TRIANGULAR SHAPE FOR ½ PMF HYDROGRAPH
         (b) SAME AS BEFORE, EXCEPT THAT THE PEAK IS NOW 1,600 CFS

$1-p = 1-0.544 = 0.456 = \frac{\Delta A_{OC}}{\Delta A_{OB}}$

$\Delta A_{OB} = \frac{1}{2}bh = \frac{1}{2}(18.7 \text{ HOURS})(1,600 \text{ CFS}) = 14,960 \text{ CFS-HOURS}$

∴ 14,960 CFS-HOURS IS REQUIRED TO PASS ½ PMF W/O OVERTOPPING

$14,960 \frac{FT^3}{SEC} \times \text{HOURS} \times \frac{3,600 \text{ AC-SECS}}{43,560 FT^2\text{-HRS}} = 1,236 \text{ AC-FT}$

      (c) INCREMENTAL STORAGE AVAILABLE BETWEEN NORMAL POOL ELEVATION AND MAXIMUM POOL ELEVATION - SEE SHEET 4 - = 177 AC-FT

STORAGE REQUIRED = 1,236 AC-FT > STORAGE AVAILABLE = 177 AC-FT

C. PROCEDURES FOR DETERMINATION OF ADEQUATE/ INADEQUATE SPILLWAY CAPACITY

2. STORAGE REQUIRED IS GREATER THAN STORAGE AVAILABLE
   a. ETL 1110-2-
      ① THERE IS A HIGH HAZARD OF LOSS OF LIFE FROM LARGE FLOWS DOWNSTREAM OF DAM
      ② CHECK TAILWATER AT INSTANT BEFORE OVERTOPPING OCCURS
      ③ THE DAM AND SPILLWAY ARE NOT CAPABLE OF PASSING ½ PMF WITHOUT OVERTOPPING FAILURE
   b. TAILWATER AT INSTANT BEFORE OVERTOPPING OCCURS

SPILLWAY CAPACITY DISCHARGE = 870 CFS. FROM HEC-2 COMPUTER RUN USING A USGS TOPO SHEET CROSS-SECTION DOWNSTREAM OF DAM,

TAILWATER DEPTH @ Q = 870 CFS IS 3.8 FEET
TOP OF DAM ELEVATION = 1,416.4'
HEIGHT OF DAM = 70'

BOTTOM OF DAM ELEV. = 1,346.1'
TAILWATER DEPTH = 3.8'
TAILWATER ELEVATION = 1,350.2'
TOP OF DAM ELEV. - TAILWATER ELEV. = 1,416.4' - 1,350.2' = 66.2'

PERCENT OF PMF THAT SPILLWAY CAN PASS
GENERAL FORMULA

$$\% \text{ OF PMF THAT SPILLWAY CAN PASS} = \frac{Q_T}{Q_{PMF}} \times 100\%,$$

WHERE $Q_T = Q_{SPILLWAY} + 2S/\Delta t$,

$S = \sum_{i=1}^{n} S_i$ FOR UPSTREAM RESERVOIR CASES,

AND T = TOTAL TIME OF PMF HYDROGRAPH

$$\% \text{ OF PMF} = \frac{870 + \left(\frac{2 \times 111 \text{ AC-FT}}{18.7 \text{ HRS}} \times \frac{43,560 \text{ FT}^2\text{-HRS}}{3,600 \text{ AC-SECS}} \right)}{3,200} \times 100\%$$

$$= \frac{870 + 229}{3,200} \times 100\%$$

% OF PMF = 34 % (EXISTING CONDITIONS)

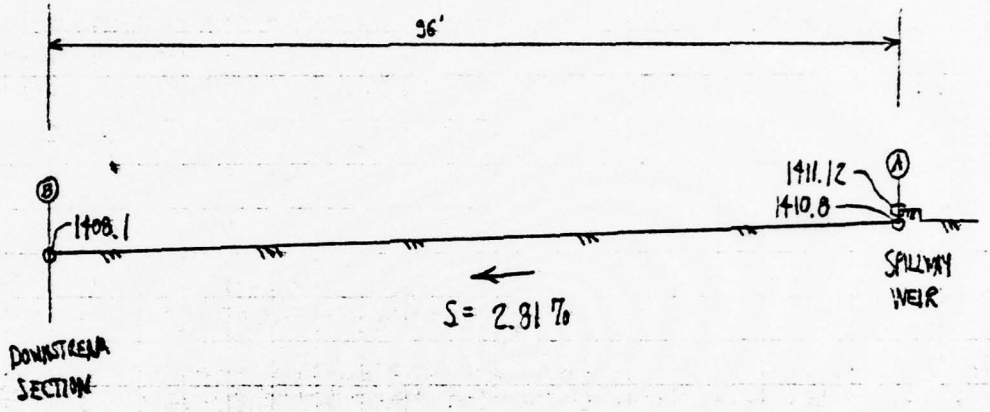
SPILLWAY CAPACITY THAT COULD BE REALIZED IF THE EMBANKMENT ELEVATION WERE BROUGHT UP TO THE DESIGN ELEVATION

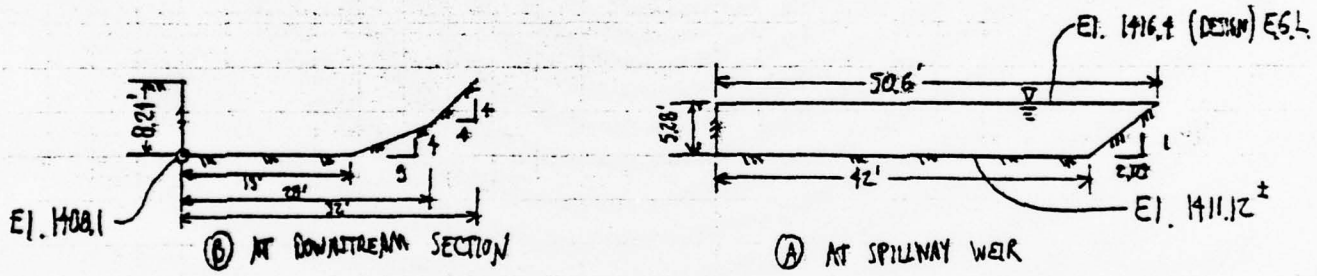
$$\% \text{ OF PMF} = \frac{1,440 + 314}{3,200} \times 100\%$$

% OF PMF = 55% (DESIGN CONDITIONS)

SPILLWAY CONTROL SECTION

DURING THE VISUAL INSPECTION OF WOLF CREEK DAM, IT WAS NOTED THAT THE HYDRAULIC CONTROL SECTION OF THE SPILLWAY CHANNEL MAY SHIFT FROM THE WEIR TO A SECTION DOWNSTREAM APPROXIMATELY WHERE THE SPILLWAY OUTLET CHANNEL SLOPE INCREASES TO ABOUT 1H ON 1V. CHECK ENERGY REQUIRED AT THE DOWNSTREAM SECTION TO PASS THE DESIGN CONDITION DISCHARGE WITH THE RESERVOIR WATER SURFACE ELEVATION TO DETERMINE IF AN OBVIOUS SUBMERGENCE OF THE SPILLWAY WEIR EXISTS.





DEPTH OF FLOW AT (A), DESIGN Q = 1,440 CFS

SECTION IS NEARLY RECTANGULAR — SAY SECTION IS RECTANGULAR AND WIDTH ≈ 45', ASSUME n = 0.025

$$E = y + \frac{V^2}{2g} = 1416.4 - 1411.12 = 5.28' = y + \frac{Q^2}{y^2(2g)(45)^2} = y + \frac{15.9}{y^2}$$

$y = 2.32'$, $A = (2.32)(45) = 104.4\ ft^2$, $V = Q/A = 13.8$ fps

$V^2/2g = 2.95$ ft, $P = 2.32 + 42 + 4.85 = 49.2'$, $R = 2.12'$

$$S_f = \frac{V^2 n^2}{1.486^2 R^{4/3}} = \frac{(13.8)^2 (0.025)^2}{(1.486)^2 (2.12)^{4/3}} = 0.020 \text{ FT/FT}$$

ASSUME CRITICAL DEPTH AT (B) AND DETERMINE WATER SURFACE ELEVATION

$\frac{A^3}{B} = \frac{Q^2}{g}$ (FOR NON-RECTANGULAR SECTION, p. 51, HENDERSON, OPEN CHANNEL FLOW)

$A^3/B = 1{,}440^2 / 32.2 = 64{,}398$

TRY $B = 28'$, $A = (19)(4) + \frac{1}{2}(9)(4) = 94\ ft^2$
$A^3/B = 29{,}664$

TRY $B = 32'$, $A = (19)(8) + \frac{1}{2}(4+8)(9) + \frac{1}{2}(4)(4) = 214\ ft^2$
$A^3/B = 306{,}261$

TRY $B = 30'$, $A = (19)(6) + \frac{1}{2}(2+6)(9) + \frac{1}{2}(2)(2) = 152\ ft^2$
$A^3/B = 117{,}060$

TRY $B = 29'$, $A = (19)(5) + \frac{1}{2}(1+5)(9) + \frac{1}{2}(1)(1) = 122.5\ ft^2$
$A^3/B = 63{,}388$

TRY $B = 29.1'$, $A = (19)(5.1) + \frac{1}{2}(1.1+5.1)(9) + \frac{1}{2}(1.1)(1.1) = 125.4\ ft^2$
$A^3/B = 67{,}769$

SAY $B = 29.0'$, $A^3 = 1{,}867{,}542$, $A = 123\ ft^2$

$d_c = 5.0'$, $V_{dc} = 1{,}440/123 = 11.7$ fps

$E = Y + \frac{Q^2}{2gA^2} = 5.0 + \frac{1440^2}{64.4(123)^2} = 7.1'$

$P = 5.0 + 19 + 9.8 + 1.6 = 35.4'$, $R = \frac{A}{P} = \frac{123}{35.4} = 3.47'$

$S_f = \frac{V^2 n^2}{1.486^2 R^{4/3}} = \frac{(11.7)^2 (0.025)^2}{(1.486)^2 (3.47)^{4/3}} = 0.0074$ FT/FT

AVERAGE HEAD LOSS = $\frac{\text{SLOPE AT (A)} + \text{SLOPE AT (B)}}{2} \times \text{REACH DIST.} = \left(\frac{0.0205 + 0.0074}{2}\right) 36'$

$= 1.32'$

HEAD AVAILABLE AT DOWNSTREAM SECTION = 1416.4 - 1.32 ≈ 1415.08'
1415.08 - 1408.1 = 7.0 FT

MINIMUM ENERGY REQUIRED AT DOWNSTREAM SECTION = 7.1 FT (SHEET 8)

∴ SPILLWAY OUTLET CHANNEL WOULD PROBABLY BE UNABLE TO PASS THE SPILLWAY DISCHARGE OF 1,440 CFS WITH THE TAILWATER ELEVATION AT THE DESIGN TOP OF DAM ELEVATION WITHOUT SHIFTING THE CONTROL FROM THE SPILLWAY WEIR AND PARTIALLY SUBMERGING THE WEIR.

DELAWARE RIVER BASIN

WOLF CREEK, SCHUYLKILL COUNTY

PENNSYLVANIA

WOLF CREEK DAM

NDS ID No. PA-00664
DER ID No. 54-53

SCHUYLKILL COUNTY MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT

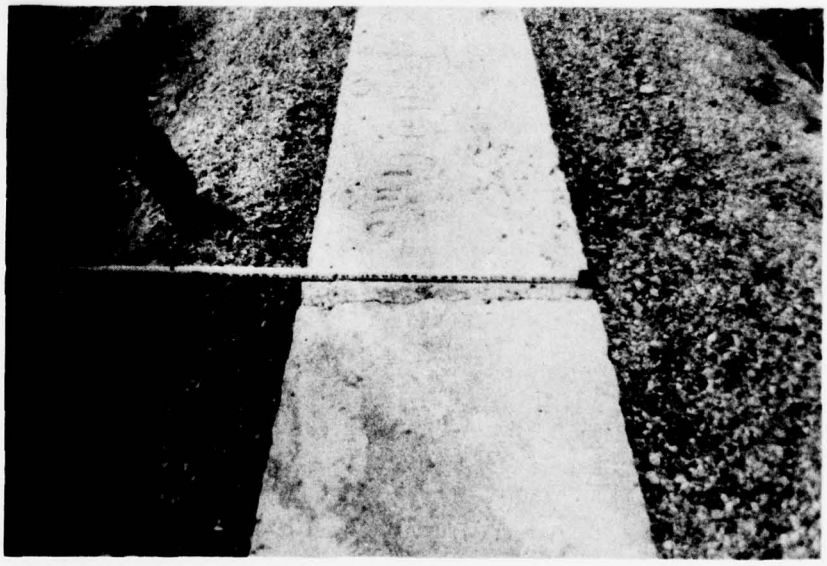
NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

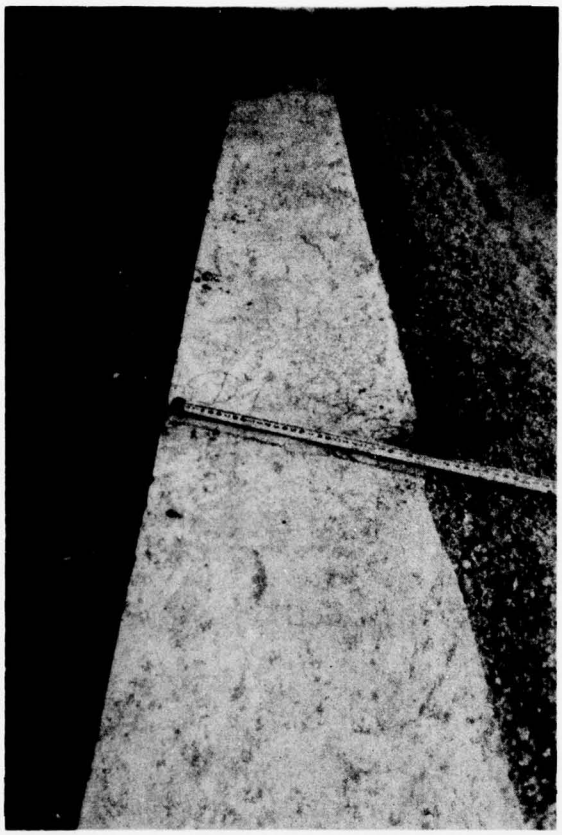
APPENDIX D

PHOTOGRAPHS

A. Top of Embankment from Spillway.



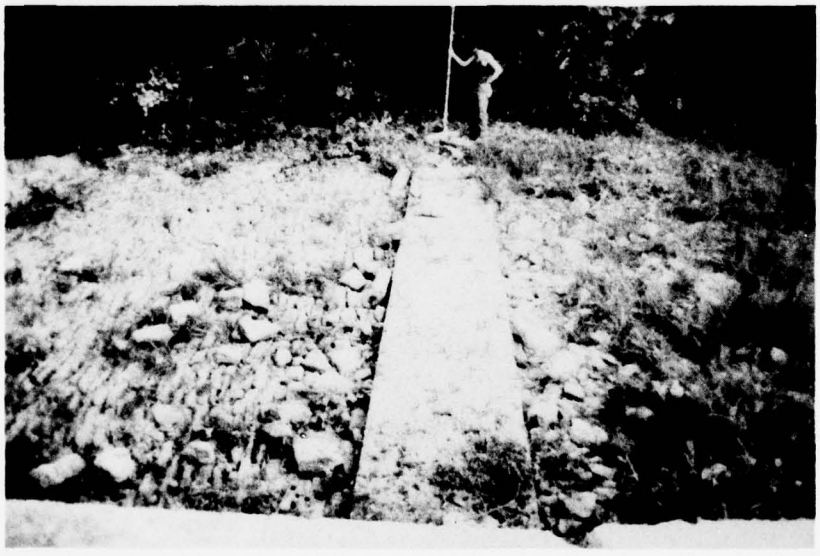
B. Crack in Exposed Section of Concrete Core Wall.



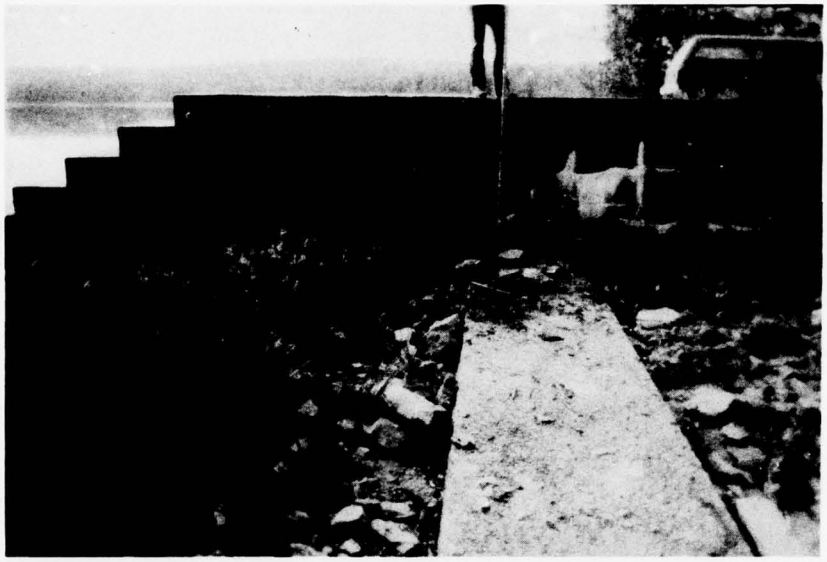
C. Crack in Exposed Section of Concrete Core Wall.

D. Bulges in Riprap on Downstream Slope of Embankment.

E. Spillway Approach Channel — Looking Downstream.



F. Concrete Spillway Weir and Masonry Apron — Flow from Right to Left.

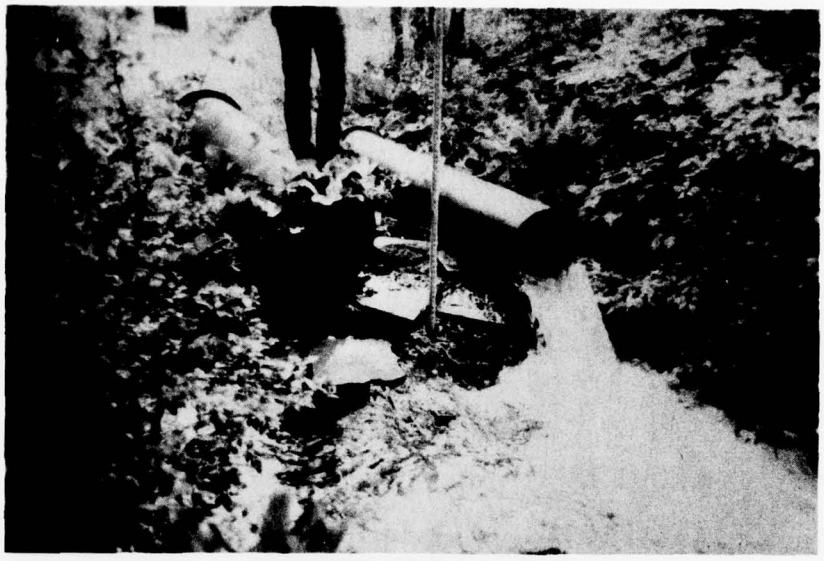


G. Left Spillway Wall.

H. Spillway Outlet Channel — Looking Downstream.

I. Spillway Outlet Channel —
Looking Downstream at 1V on 2H Section.

J. Valve House at Toe of Downstream Slope of Embankment.



K. Outlet Works Outfall.

L. Wet Area to Left of Valve House.

M. Seepage Area to Right of Outlet Pipes.

N. Wolf Creek Intake Dam —
Downstream of Wolf Creek Dam.

DELAWARE RIVER BASIN

WOLF CREEK, SCHUYLKILL COUNTY

PENNSYLVANIA

WOLF CREEK DAM

NDS ID No. PA-00664
DER ID No. 54-53

SCHUYLKILL COUNTY MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

APPENDIX E

GEOLOGY

WOLF CREEK DAM

APPENDIX E

GEOLOGY

1. General Geology. The dam and reservoir are located in Schuylkill County. The County lies entirely south of the Wisconsin and Illinoian drift borders. The Jerseyan drift border is believed to traverse the middle of the county, but very few definite deposits of drift have been located. The rock formations exposed in Schuylkill County range from the post-Pottsville formations, of Pennsylvania age, down to the Tuscarora Sandstone, of Silurian age. The youngest formations, the post-Pottsville, crop out in the large Southern anthracite field and part of the Western Middle field. The oldest formation, the Tuscarora, crops out along Kittatinny (Blue) Mountain which forms the southern boundary of the County.

The geologic structure of Schuylkill County is complex. The strata have been sharply folded along northeast axes, and the truncated hard and soft beds now form an intricate system of long narrow ridges and valleys. The carboniferous rocks suffer the most intense folding and are overturned in many places. The most important structure feature economically is the large synclinorium of the Southern anthracite field which occupies the center of the County. This basin consists of a number of smaller connected basins, which become successively deeper and have steeper sides as they progress towards the South. In the southern part of the County, the Silurian and Devonian rocks have been folded for some distance on both sides of the Schuylkill River. An anticline passes eastward from Cressona, exposing the Cayuga group and part of the Clinton formation. A syncline extending West from Landingville exposes the Catskill group. The Lehighton anticline of Carbon County extends into Schuylkill County as far as Reynolds. The ridge north of Port Clinton is an anticlinal ridge exposing the Clinton formation, and a syncline crosses the Schuylkill River just north of Port Clinton exposing the Cayuga Group.

The geology produces a complex runoff pattern in Schuylkill County whereby there is drainage in five different directions. The northwestern part is drained by Mahantango Creek, and smaller streams, all of which drain into the Susquehanna River north of Harrisburg. The southwestern part is drained by Swatara Creek, which drains into the Susquehanna River South of Harrisburg. The northernmost part is drained by Catawissa Creek, which drains into the North Branch of the Susquehanna River upstream of Danville. The eastern portion of the County is drained by tributaries of the Lehigh River, which in turn drains into the Delaware River near Easton. The central and greater part of the County is drained by tributaries of the Schuylkill River, which, in turn, drains into the Delaware River near Philadelphia.

2. Site Geology. The damsite is underlain by gray sandy shale and gray conglomerate strata of the Pottsville Formation in the highly faulted and folded Southern anthracite field in the center of the county. The area is drained by the Schuylkill River. The axis of a syncline, called Jugular Syncline, follows the approximate original streambed through the damsite and reservoir. The axis of the Powder Hill Anticline is located about one-half mile to right of the Jugular Syncline; while the axis of the Wolf Creek Anticline is located about a half mile to the left of Jugular Syncline. A major fault, called Jugular Fault, is located between the axis of Jugular Syncline and Powder Hill Anticline and passes through the right abutment of Wolf Creek Dam.

The upper portion of the bedrock was highly fractured and shattered. It was necessary to excavate from 5 to 20 feet into the bedrock in order to find a firm rock foundation for the cutoff trench. The cutoff trench was filled with concrete and served as a foundation for the concrete core wall that extended to within 2 feet of the top of dam. No other foundation treatment was performed. No mention is made in available reports of problems associated with construction across the Jugular Fault. As built drawings, however, show an abruptly deeper cut-off trench in the approximate area where the fault crosses the axis of dam.