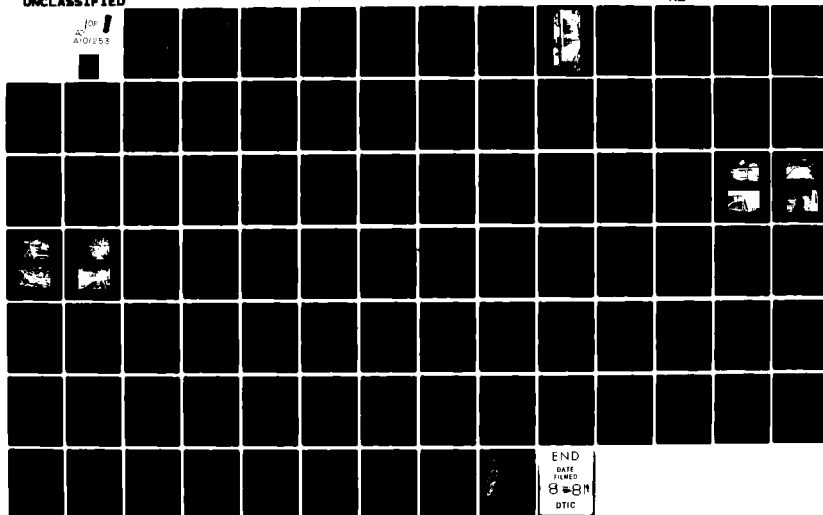


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DELAWARE RIVER BASIN
CARLEY BROOK, WAYNE COUNTY

PENNSYLVANIA

FREETHY DAM

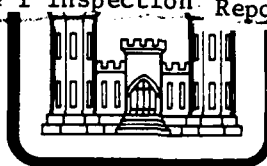
NDI ID NO. PA-00171
DER ID NO. 64-160

RUSSELL COMPTON

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

National Dam Inspection Program.
Freethy Dam (NDI ID Number PA-00171,
DER ID Number 64-160), Delaware River
Basin, Carley Brook, Wayne County,
Pennsylvania. Phase I Inspection Report,



DTIC
ELECTE

JUL 13 1981

Prepared by

GANNETT FLEMING CORDDRY AND CARPENTER, INC.

Consulting Engineers

Harrisburg, Pennsylvania 17105

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white"

DACW 31-81-C-0018

For

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

MARCH 1981

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DELAWARE RIVER BASIN
CARLEY BROOK, WAYNE COUNTY
PENNSYLVANIA

FREETHY DAM

NDI ID No. PA-00171
DER ID No. 64-160

RUSSELL COMPTON

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared by

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

For

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

MARCH 1981

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

FREETHY DAM
 NDI ID No. PA-00171; DER ID No. 64-160
 PHASE I INSPECTION REPORT
 NATIONAL DAM INSPECTION PROGRAM

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SECTION 4	- Operational Procedures	8
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APPENDICES

<u>Appendix</u>	<u>Title</u>
A	Checklist - Engineering Data.
B	Checklist - Visual Inspection.
C	Photographs.
D	Hydrology and Hydraulics.
E	Plates.
F	Geology.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam: Freethy Dam
NDI ID No. PA-00171
DER ID No. 64-160

Size: Small (26 feet high; 89 acre-feet)

Hazard Classification: High

Owner: Mr. Russell Compton
185 Tryon Street
Honesdale, PA 18431

State Located: Pennsylvania

County Located: Wayne

Stream: Carley Brook

Date of Inspection: 3 December 1980

↓
Based on the criteria established for these studies, Freethy Dam is judged to be unsafe, nonemergency, because the spillway capacity is seriously inadequate. The recommended Spillway Design Flood (SDF) for the size and hazard classification of the dam varies between 1/2 of the Probable Maximum Flood (PMF) and the PMF. Based on the size of the dam and reservoir, the 1/2 PMF is selected as the SDF. The existing spillway will pass only about 2 percent of the PMF before overtopping of the dam occurs. It is judged that the dam could not withstand the depth and duration of overtopping during storms of only 20 percent of the PMF. Failure of the dam would cause an increased hazard for loss of life downstream. Overall, the dam is judged to be in good condition.

No stability problems were observed at the dam during normal operating conditions. However, the stability of the structure is questionable during storms of large magnitude. Maintenance of the dam is generally adequate. ↗

The following studies and remedial measures, listed in approximate order of priority, are recommended to be undertaken by the Owner without delay:

(1) Perform additional studies to more accurately ascertain the spillway capacity required for Freethy Dam, as well as the nature and extent of measures required to provide adequate spillway capacity. Take appropriate action as required.

(2) As part of the studies under (1), a structural stability analysis of the dam should be made. Take appropriate action as required.

(3) Perform a detailed inspection of the 30-inch diameter outlet pipe. Take appropriate action as required.

(4) Visually monitor the seepage at the right abutment of the dam. If the condition worsens, take appropriate action as required.

(5) Replace the stones missing from the downstream face of the dam.

All investigations, studies, designs, and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams.

In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Freethy Dam. When warnings of a major storm are given by the National Weather Service, the Owner should activate the emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

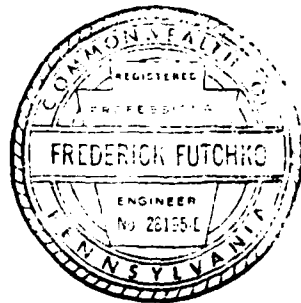
(3) Initiate an inspection program such that the dam is inspected on a regular basis. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(4) Continue the existing maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

FREETHY DAM

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.



Frederick Futchko

FREDERICK FUTCHKO
Project Manager, Dam Section

Date: 13 April 1981

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF
ENGINEERS

James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 11 May 81

FREETHY DAM



Overview

FREETHY DAM

NDI ID No. PA-00171; DER ID No. 64-160

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SECTION 1

PROJECT INFORMATION

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.

a. Dam and Appurtenances. Freethy Dam is a 26-foot high dry stone masonry gravity dam with a concrete cap. The dam is 100 feet long (including the 46.4-foot long spillway) and has top widths of 11.7 feet at the left end of the dam and 16.5 feet at the right end of the dam. Both the upstream and downstream faces are nearly vertical. The dam is founded on red and gray shale.

The spillway consists of a triangular-shaped concrete weir which discharges in a straight drop to the streambed below the dam. The weir overhangs the face of the dam 2 feet and has a crest elevation which is 1.7 feet below the minimum top of dam. A typical cross-section of the spillway is shown on Plate E-2.

The outlet works consists of a 30-inch gated steel outlet pipe located to the right of the spillway. The invert of the outlet end of the pipe is 20.5 feet below the top of dam. The manually operated gate controls are located in a small gate house on the top of the dam.

The various features of the dam are shown on the photographs in Appendix C. A description of the geology is included in Appendix F.

b. Location. Freethy Dam is located on Carley Brook in the Borough of Honesdale, Wayne County, Pennsylvania. The dam is shown on USGS Quadrangle, White Mills, Pennsylvania, at latitude N 41° 33.8' and longitude W 75° 14.5'. A location map is shown on Plate E-1.

c. Size Classification. Small (26 feet high, 89 acre-feet).

d. Hazard Classification. Downstream conditions indicate that a high hazard classification is warranted for Freethy Dam (Paragraphs 3.1e and 5.1c).

e. Ownership. Mr. Russell Compton, 185 Tryon Street, Honesdale, Pennsylvania 18431.

f. Purpose of Dam. Recreation.

g. Design and Construction History. The dam was constructed prior to 1900 by the D and H Canal Company, the original owners of the dam. Ownership was, at some later date, transferred to the Carley Brook Sand and Gravel Works. No information is available concerning the dam until 1958 when the concrete cap, spillway, and concrete facing at the toe and on the upstream face of the dam were constructed. The concrete placed on the upstream side of the dam reportedly covers the entire face and has an average thickness of 4 inches. The dam has remained in essentially the same condition since completion of these modifications.

h. Normal Operational Procedure. The reservoir pool is maintained at the spillway crest level with excess inflows discharging over the spillway. Although it is seldom used, the outlet works can be used to draw down the reservoir.

1.3 Pertinent Data.

a. <u>Drainage Area</u> . (square miles)	12.3
b. <u>Discharge at Damsite</u> (cfs)	
Maximum known flood	Unknown
Outlet works at maximum pool elevation	128
Spillway capacity at maximum pool elevation	319
c. <u>Elevation</u> . (feet above msl.)	
Top of dam	1036.7
Maximum pool	1036.7
Normal pool (spillway crest)	1035.0
Upstream invert outlet works	Unknown
Downstream invert outlet works	1016.2
Streambed at toe of dam	1011.0

d.	<u>Reservoir Length.</u> (miles)	
	Normal pool	0.50
	Maximum pool	0.55
e.	<u>Storage.</u> (acre-feet)	
	Normal pool	72
	Maximum pool	89
f.	<u>Reservoir Surface.</u> (acres)	
	Normal pool	9
	Maximum pool	11
g.	<u>Dam.</u>	
	<u>Type</u>	Stone masonry gravity
	<u>Length</u> (feet)	100, including spillway
	<u>Height</u> (feet)	26
	<u>Top Width</u> (feet)	16.5
	<u>Side Slopes</u> Upstream and Downstream	Nearly Vertical
	<u>Zoning</u>	Unknown
	<u>Cutoff</u>	Unknown
	<u>Grout Curtain</u>	None
h.	<u>Diversion and Regulating Tunnel.</u>	None
i.	<u>Spillway.</u>	
	<u>Type</u>	Triangular-shaped, concrete weir
	<u>Length of Weir</u> (feet)	46.4
	<u>Crest Elevation</u> (feet above msl.)	1035.0
	<u>Upstream Channel</u>	Reservoir
	<u>Downstream Channel</u>	Natural stream

J. Regulating Outlets.

30-inch
diameter
steel outlet
pipe with
manually
operated gate
at upstream
end

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. No design data are available for the dam or subsequent modifications.

b. Design Features. The project is described in Paragraph 1.2a. The various features of the dam are shown on the photographs in Appendix C and on Plate E-2.

c. Design Considerations. The design of the dam cannot be assessed from the available data.

2.2 Construction.

a. Data Available. There are no construction data available for Freethy Dam.

b. Construction Considerations. The construction of the dam cannot be assessed from the available data.

2.3 Operation. There are no formal records of operation. An inspection of the dam was performed by the Commonwealth in 1965. A summary of the inspection report is included in Appendix A.

2.4 Evaluation.

a. Availability. The correspondence file for the dam was provided by the Bureau of Dams and Waterway Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER). The Owner was available for information following the visual inspection.

b. Adequacy. The type and amount of available design and other engineering information are limited. The assessment of the dam is based on the combination of available data, visual inspection, performance history, hydrologic and hydraulic assumptions, and calculations developed for this report.

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

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The overall appearance of the dam and appurtenant structures is good. Noteworthy deficiencies observed are described in the following paragraphs. The complete visual inspection checklist and sketch of the dam are presented in Appendix B. A profile of the top of the dam and a typical cross-section of the spillway are included in Appendix E. On the day of the inspection, the reservoir pool was approximately 0.1 foot above the spillway crest.

b. Dam. Overall, the dam is in good condition. There are a few stones missing from the downstream face. Clear seepage was observed at the right abutment contact approximately 15 feet below the top of the dam. The flow was estimated at 30 gallons per minute (gpm.). Red shale was observed at the right abutment, just above and below the elevation of the top of the dam. Gray shale outcrops about halfway down at the right abutment and about 6 feet below the top of dam at the left abutment. The concrete cap is in good condition. It varies from 3 inches to 6 inches thick on the downstream edge. Most of the concrete facing on the upstream face was submerged and could not be observed. The portion of it above the water level, however, was in good condition.

c. Appurtenant Structures. The spillway is in good condition. The concrete shows no signs of excessive deterioration. Most of the outlet works facilities were unobservable as the intake structure was submerged and the gate house was locked. The exit end of the outlet pipe is rusted. A small amount of flow was discharging from the pipe at the time of the inspection. Because of the condition and size of the pipe, a detailed inspection was not made of the inside of the pipe. The gate house is in good condition. The Owner indicated that the gate house is secured to the dam to prevent washout during overtopping of the dam.

d. Reservoir Area. The reservoir slopes are relatively steep and partially wooded. No evidence of any landslide activity was observed. During the inspection, soundings were taken along the upstream side of the dam. They indicate that there may be several feet of sedimentation in the reservoir.

e. Downstream Conditions. A stone masonry, horseshoe-shaped road culvert, 24 feet high, is located approximately 150 feet downstream from Freethy Dam. The stream channel downstream from the culvert is deep and steeply sloping. The streambed is composed of gray shale. Erosion patterns in the shale indicate that the rock is of variable hardness. Several apartment buildings and at least 5 houses are located along the stream channel between the dam and the Lackawaxen River located approximately 1,500 feet downstream. It is likely that several of these residences would be flooded in the event of a dam failure, possibly resulting in the loss of three or more lives. Accordingly, a high hazard classification has been assigned to Freethy Dam.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is normally maintained at the level of the spillway crest with excess inflows discharging over the spillway and into the downstream channel.

4.2 Maintenance of Dam. There are no established procedures for maintenance of the dam. Maintenance work has generally been performed as required. The dam is checked on a regular basis by the Owner; however, no formal reports are maintained.

4.3 Maintenance of Operating Facilities. There is no established procedure for maintenance of the outlet works facilities. The Owner stated that the outlet works is operable. It is not, however, operated on a regular basis.

4.4 Warning Systems in Effect. There is no emergency operation and warning system for the dam.

4.5 Evaluation of Operational Adequacy. The maintenance of the dam is generally adequate. Inspections are necessary to detect hazardous conditions at the dam. An emergency operation and warning system is necessary to reduce the risk of dam failure should adverse conditions develop and to prevent loss of life should the dam fail.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. There are no hydrologic or hydraulic design calculations available for Freethy Dam.

b. Experience Data. Major floods occurred in the area in which Freethy Dam is located in July 1952 and August 1955. It is reported that the dam suffered no damage during either of the floods. No accurate rainfall, runoff, or reservoir level records are available for either of these storms. It is likely, however, based on a comparison of stream flow records from nearby watercourses (see Appendix D), that Freethy Dam experienced a significant amount of overtopping during both storms. The Owner reported that the dam has been overtopped several times by approximately one foot of water.

c. Visual Observations.

(1) General. The visual inspection of Freethy Dam, which is described in Section 3, resulted in a number of observations relevant to hydrology and hydraulics.

(2) Dam. Gray shale outcrops at the left abutment approximately 6 feet below the top of the dam. Above this shale is a layer of weathered rock which would be subject to erosion if excessive overtopping of the dam occurred. Such erosion could lead to loss of the concrete cap on the top of the dam and subsequent erosion of the stone masonry below it. The remainder of the dam could withstand greater depths of overtopping.

(3) Appurtenant Structures. No condition was observed that would indicate that the spillway could not operate satisfactorily during high reservoir stages. The outlet works has no significant effect on the hydraulic adequacy of the structure. Discharges through the outlet works were not included in the hydrologic and hydraulic analyses.

(4) Reservoir Area. The reservoir slopes are relatively steep and partially wooded. The watershed is approximately 1/2 woodland and 1/2 farmland and has several ponds and reservoirs located within its boundaries. Descriptions of the reservoirs which were included in the hydrologic and hydraulic analyses are included in Appendix D.

(5) Downstream Conditions. A stone masonry, horseshoe-shaped road culvert, 24 feet high, is located approximately 150 feet downstream from Freethy Dam. The culvert is not likely to attenuate the discharge to the downstream area, but could substantially increase tailwater stages at the dam. The stream channel downstream from the culvert is deep and steeply sloping. Several apartment buildings and at least 5 houses are located along the stream between Freethy Dam and the Lackawaxen River located approximately 1500 feet downstream. Failure of Freethy Dam would result in flooding of these structures. A high hazard classification is, therefore, warranted for Freethy Dam.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and hazard potential (high) of Freethy Dam is between one-half of the Probable Maximum Flood (PMF) and the PMF. Because the dam and reservoir are on the low end of the small size category, the 1/2 PMF was selected as the SDF for Freethy Dam. The watershed and reservoir were modeled with the U.S. Army Corps of Engineers' HEC-1DB computer program. A description of this computer program is included in Appendix D. The assessment of the hydrology and hydraulics is based on existing conditions, and the effects of future development are not considered.

(2) Summary of Results. Pertinent results are tabulated at the end of Appendix D. The analysis reveals that Freethy Dam can pass about 2 percent of the PMF before overtopping of the dam occurs.

(3) Spillway Adequacy. The criteria used to evaluate the spillway adequacy are described in Appendix D. Because of the depth and duration of overtopping of the dam during a storm of only 20 percent of the PMF, it was assumed that the dam would fail under such conditions. A breach analysis was performed to ascertain the impact of failure on the downstream area. The conditions contributing to the failure of the dam, as well as its failure mode, are also included in Appendix D. It was found that failure of the dam during 20 percent of the PMF could cause water levels at the damage area to rise 3 to 4 feet above levels that would exist if the dam were not to fail. This increased depth of flooding in the downstream area could contribute to a substantial increase in damages caused by discharges from the reservoir. The spillway is, therefore, rated as seriously inadequate.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Freethy Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for the various features.

(2) Dam. The stones missing from the downstream face of the dam do not constitute a serious threat to the stability of the dam for the normal pool condition. However, for a flood condition which results in overtopping, the missing stones could hasten failure of the dam. The seepage at the toe of the dam is not considered to be an immediate hazard, but it should be monitored. If seepage increases it could become a hazard.

The stability of the dam during storm events equal to or less than the SDF is questionable. Very little information is available concerning the foundation of the dam, the materials used in its construction, and the dimensions of the upstream side of the dam.

(3) Appurtenant Structures. During normal operating conditions the spillway and outlet works pose no threat to the stability of Freethy Dam.

b. Design and Construction Data. No stability calculations are available for the dam.

c. Operating Records. There are no operating records maintained for Freethy Dam and Reservoir. The normal operating procedures followed by the Owner do not indicate cause for concern relative to the structural integrity of the dam.

d. Post-construction Changes. The modifications listed previously are not considered to adversely affect the structural stability of the dam.

e. Seismic Stability. Freethy Dam is located in Seismic Zone 1 where earthquake loadings are not considered to be significant for small dams with no readily apparent stability problems. Since no readily apparent stability problems were observed, the seismic stability of the dam is assumed to be adequate.

SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND
PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on the criteria established for these studies, Freethy Dam is judged to be unsafe, nonemergency, because the spillway capacity is seriously inadequate. The recommended Spillway Design Flood (SDF) for the size and hazard classification of the dam varies between the 1/2 PMF and the PMF. Based on the size of the dam and reservoir, the 1/2 PMF is selected as the SDF. The existing spillway will pass about 2 percent of the PMF before overtopping of the dam occurs. It is judged that the dam could not withstand the depth and duration of overtopping during storms of only 20 percent of the PMF. Failure of the dam would cause an increased hazard for loss of life downstream. Overall, the dam is judged to be in good condition.

(2) No stability problems were observed at the dam during normal operating conditions. However, the stability of the structure is questionable during storms of large magnitude.

(3) Maintenance of the dam is generally adequate.

(4) A summary of the features of the dam and observed deficiencies is listed below:

<u>Feature</u>	<u>Observed Deficiency</u>
Dam	Seepage at right abutment; stones missing from downstream face.
Spillway	No deficiencies.
Outlet Works	Rusted outlet pipe; leakage.

b. Adequacy of Information. The information available is such that a preliminary assessment of the condition of the dam can be inferred from the combination of available information, visual inspection, past performance, and computations performed as part of this study. The information is not adequate, however, to evaluate the structural stability of the dam during the 1/2 PMF or lesser storms.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented without delay.

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

7.2 Recommendations and Remedial Measures.

a. The following studies and remedial measures, listed in approximate order of priority, are recommended to be undertaken by the Owner without delay:

(1) Perform additional studies to more accurately ascertain the spillway capacity required for Freethy Dam as well as the nature and extent of measures required to provide adequate spillway capacity. Take appropriate action as required.

(2) As part of the studies under (1), a structural stability analysis of the dam should be made. Take appropriate action as required.

(3) Perform a detailed inspection of the 30-inch diameter outlet pipe. Take appropriate action as required.

(4) Visually monitor the seepage at the right abutment of the dam. If the condition worsens, take appropriate action as required.

(5) Replace the stones missing from the downstream face of the dam.

All investigations, studies, designs, and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams.

b. In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Freethy Dam. When warnings of a major storm are given by the National Weather Service, the Owner should activate the emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

(3) Initiate an inspection program such that the dam is inspected on a regular basis. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(4) Continue the existing maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

NAME OF DAM: FREETHY DAM

ENGINEERING DATA

NDI ID NO.: PA-00171 DER ID NO.: 64-160DESIGN, CONSTRUCTION, AND OPERATION
PHASE ISheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	<i>None</i>
REGIONAL VICINITY MAP	<i>See Plate E-1</i>
CONSTRUCTION HISTORY	<i>Not available</i>
TYPICAL SECTIONS OF DAM	<i>A typical cross-section of the spillway is shown on plate E-2.</i>
OUTLETS: Plan Details Constraints Discharge Ratings	<i>A discharge rating is included in Appendix D; no other information is available.</i>

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	<i>None</i>
DESIGN REPORTS	<i>None</i>
GEOLOGY REPORTS	<i>None</i>
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	<i>None</i>
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	<i>None</i>
POSTCONSTRUCTION SURVEYS OF DAM	<i>None</i>

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	<i>Unknown</i>
MONITORING SYSTEMS	<i>None</i>
MODIFICATIONS	<i>Described in Section 1 of this report; no other information available.</i>
HIGH POOL RECORDS	<i>None maintained</i>
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	<i>None</i>
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	<i>None</i>

ENGINEERING DATA

Sheet 4 of 4

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	None
SPILLWAY: Plan Sections Details	See Exhibit E-1 and Plate E-2
OPERATING EQUIPMENT: Plans Details	None
PREVIOUS INSPECTIONS Dates Deficiencies	March 1965 - (Inspected by Commonwealth) Overall condition - OK

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Freethy Dam County: Wayne State: Pennsylvania
 NDI ID No.: PA-00171 DER ID No.: 64-160
 Type of Dam: Stone-masonry gravity Hazard Category: High
 Date(s) Inspection: 3 December 1980 Weather: Partly cloudy, windy Temperature: 27°F

Pool Elevation at Time of Inspection: 1035.1 ft. msl/Tailwater at Time of Inspection: 1012 ± ft. msl

Note: Elevations referenced to USGS quadrangle White Mills, PA.

Inspection Personnel:

R.E. Holderbaum (GFEC)

D.B. Wilson (GFEC)

D.B. Wilson Recorder

CONCRETE/MASONRY DAMS

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Seepage at right abutment 15.5 feet below top of dam; ~30 gpm.	Non-damaging at present; could eventually increase and cause erosion of shale; recommend monitoring.
JUNCTION OF STRUCTURE WITH: Abutment Embankment Other Features	Right abutment - red shale; Left abutment - rock outcrops six feet below top of dam.	Left abutment probably could not withstand great depths of overtopping.
DRAINS	None observed.	
WATER PASSAGES	Outlet conduit - see OUTLET WORKS	
FOUNDATION	Red shale outcrops at top of right abutment - gray shale outcrops ~ halfway down; Gray shale outcrops at left abutment ~ 6 ft. below top of dam	Gray shale in streambed below dam; erosion patterns in streambed indicate variable hardness.

CONCRETE/MASONRY DAMS

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES: Surface Cracks Spalling	Concrete cap is in good condition - slab thickness indeterminate; D/side (right) is ~6" - D/s side (left) ~3"; u/s sides have concrete to	below water level; If concrete cap were lost during flood stone masonry would erode rapidly.
STRUCTURAL CRACKING	None apparent	
ALIGNMENT: Vertical Horizontal	Vertical - see plate E-2 Horizontal - good	Top of dam is nearly level.
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	A few stones are missing from the downstream face of the dam.	Stones should be replaced.
STAFF GAGE OR RECORDER	None	

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	30" ϕ steel pipe, badly rusted at downstream end; some discharge from pipe.	Recommend detailed inspection of conduit.
INTAKE STRUCTURE	Channel at right end of spillway - unobstructed.	
OUTLET STRUCTURE	None - projecting steel pipe on downstream face.	
OUTLET CHANNEL	None	
EMERGENCY GATE	Gatehouse at top of dam locked during inspection - mechanisms unknown.	The owner indicated that the gate was operated three years ago.

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	<i>Good condition - no deficiencies observed.</i>	
APPROACH CHANNEL	<i>Reservoir - No obstructions or debris.</i>	
DISCHARGE CHANNEL	<i>Natural stream channel in gray shale bedrock.</i>	
BRIDGE AND PIERS	<i>None</i>	

INSTRUMENTATION

Sheet 1 of 1

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

DOWNSTREAM CHANNEL

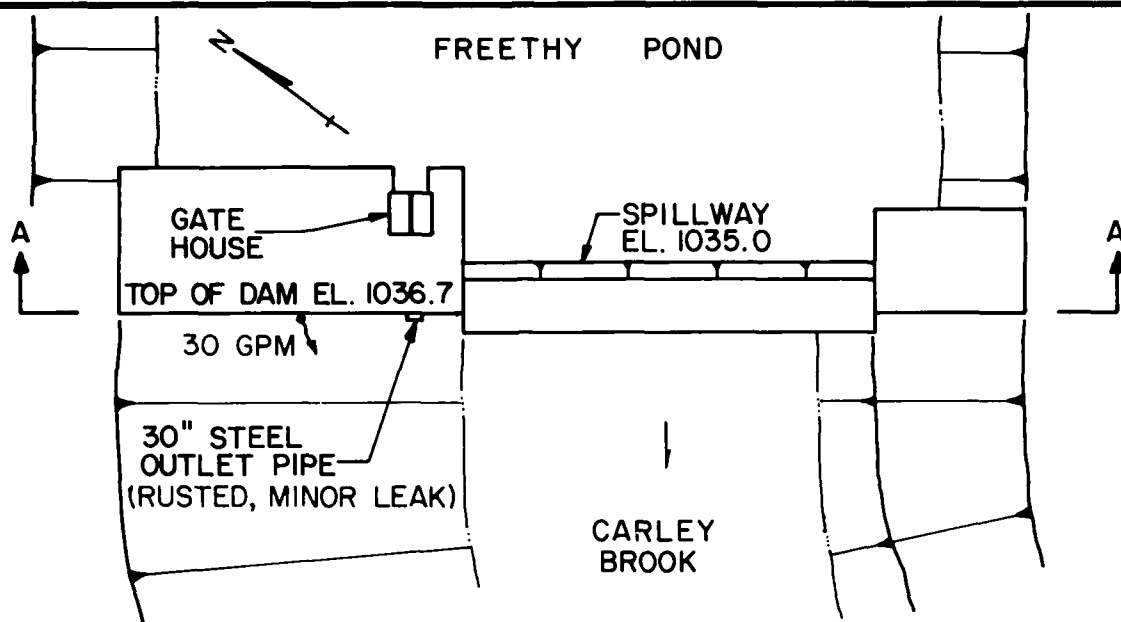
Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	24 ft. high masonry horseshoe culvert and bridge approx. 150 ft. D/S; 10 ft (it) water fall just D/S from culvert.	
SLOPES	steep to vertical rock slopes; no evidence of slides (although possible); bed slope of stream very steep.	Significant erosion of rock has occurred in some areas.
APPROXIMATE NUMBER OF HOMES AND POPULATION	several apartment buildings and at least 5 houses are located along the stream channel between the dam and the Lackawaxen River approximately 1500 feet downstream.	High hazard

RESERVOIR AND WATERSHED

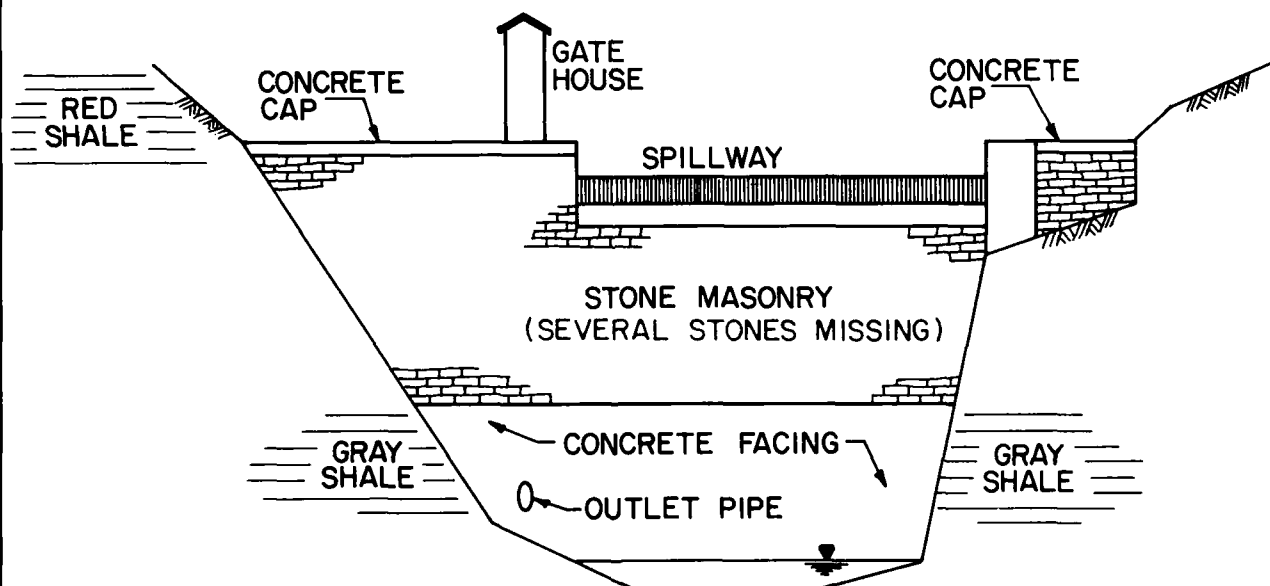
Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate to steep; partially wooded.	
SEDIMENTATION	Possible sedimentation as indicated by soundings taken on upstream side of dam.	
WATERSHED DESCRIPTION	Approximately 1/2 farmland and 1/2 wooded; several ponds and other reservoirs located within watershed.	See Appendix D for description of reservoirs included in hydrologic and hydraulic analysis.



PLAN VIEW

SCALE: 1 IN. = 20 FT. ±



CROSS-SECTION A-A

SCALE: HORIZ. - 1 IN. = 20 FT. ±
VERT. - 1 IN. = 10 FT. ±

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

FREETHY DAM

RUSSELL COMPTON

RESULT OF
VISUAL INSPECTION

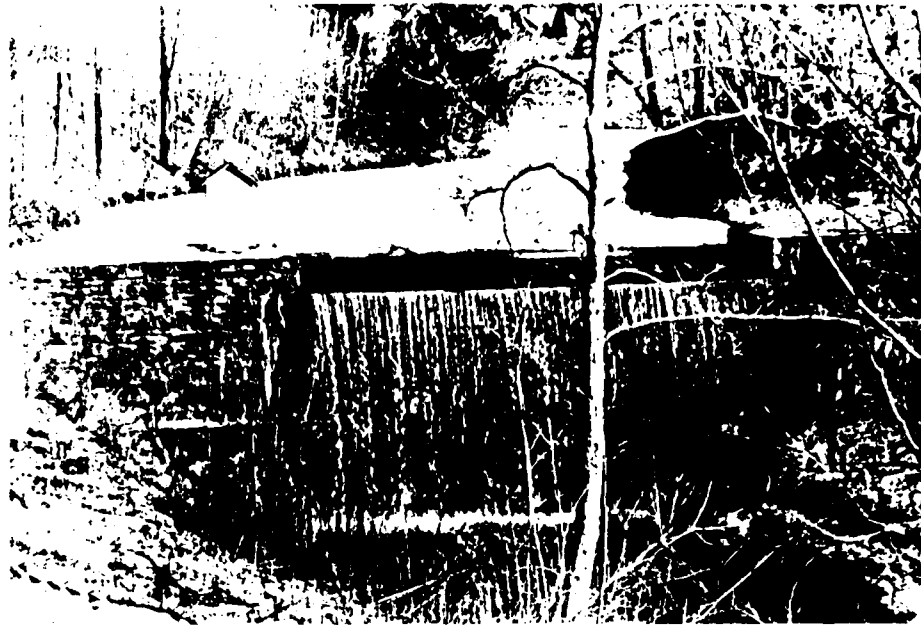
DATE OF INSPECTION: 3 DECEMBER 1980
POOL ELEVATION: 1035.1 FEET

MARCH 1981

EXHIBIT B-1

APPENDIX C

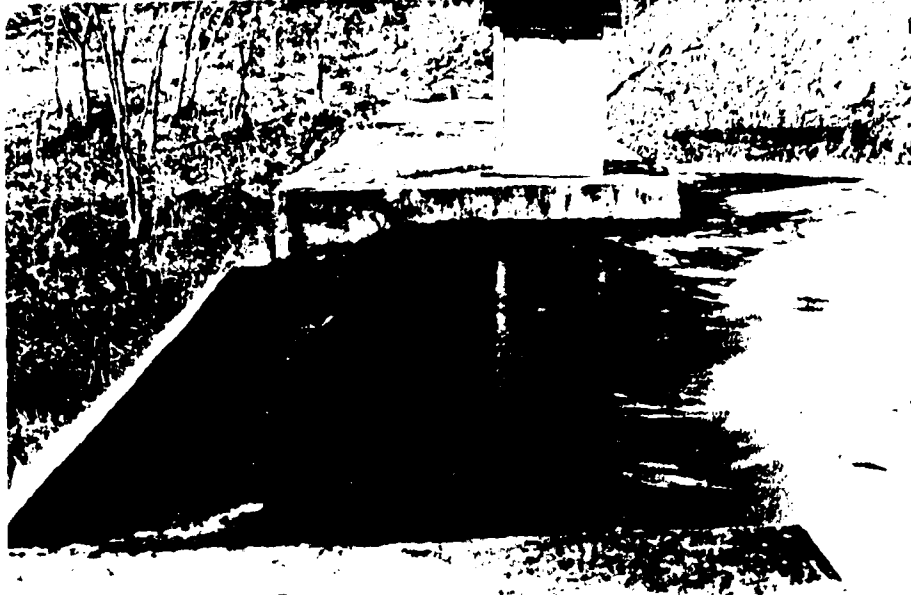
PHOTOGRAPHS



A. Dam and Reservoir.



B. Dam - From Right Abutment.



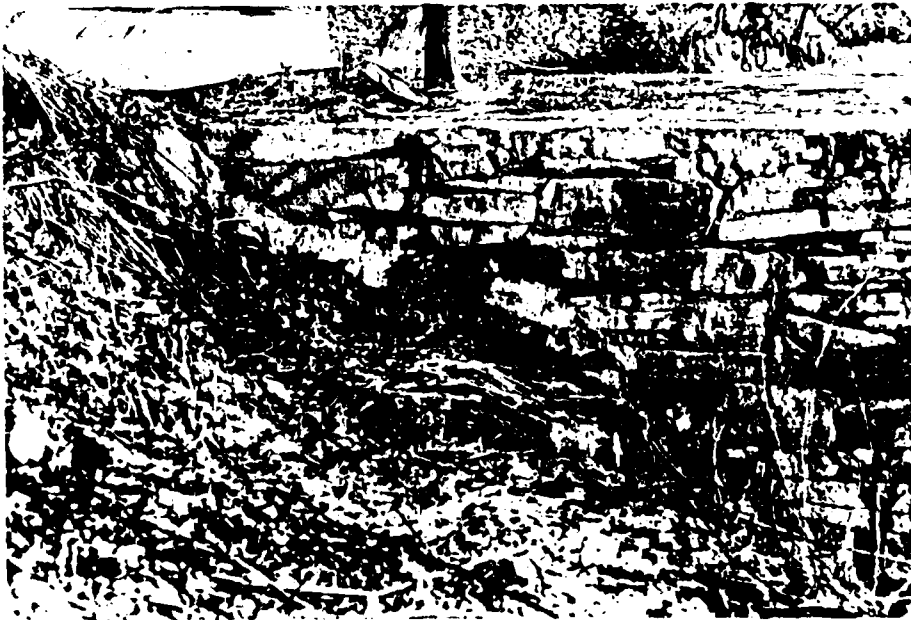
C. Spillway - Looking Toward Right:
End of Dam.



D. Spillway Slab.

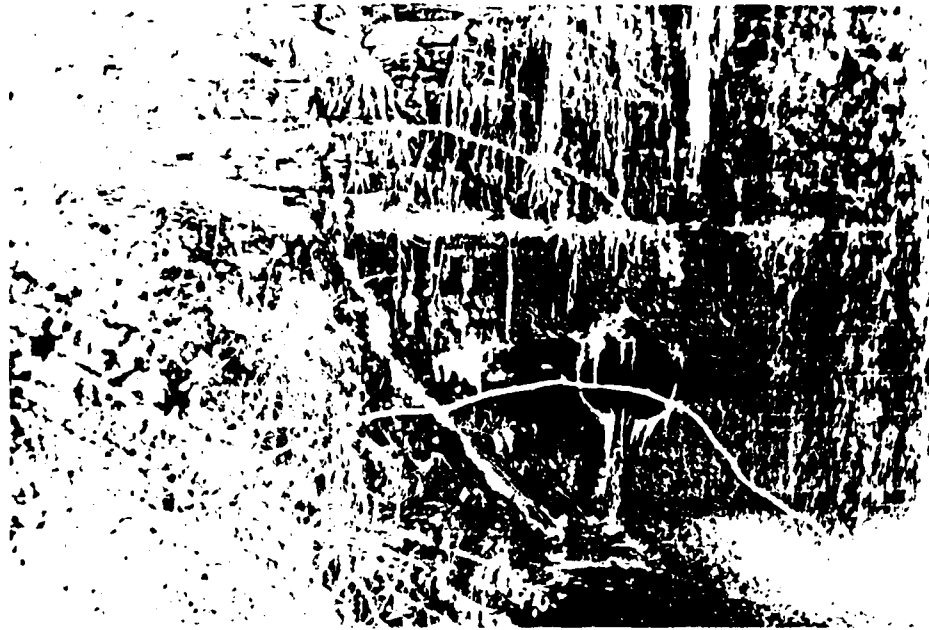


E. Left Abutment of Dam.



F. Right End of Dam - Downstream Side.

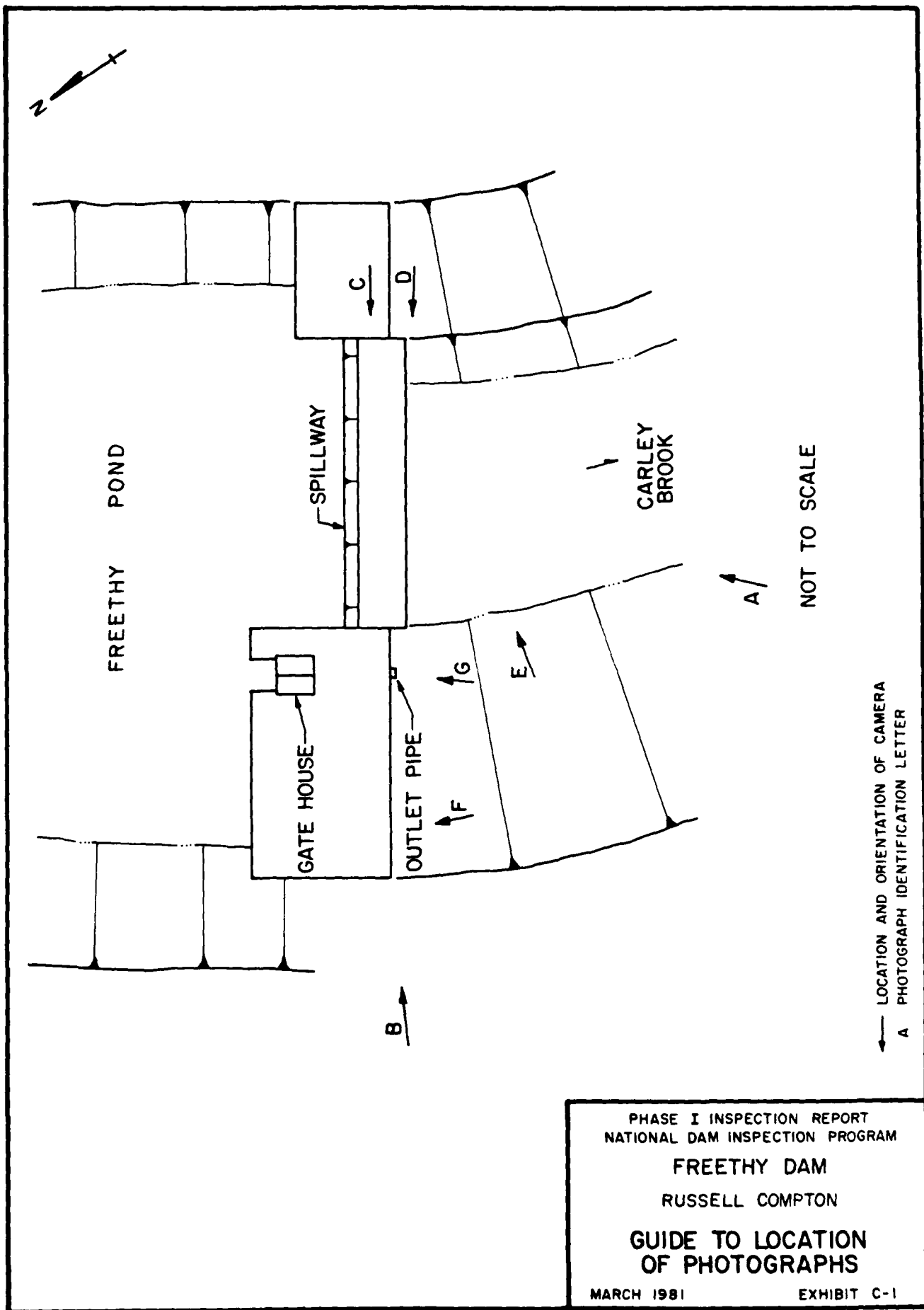
FREETHY DAM



G. Exit End of Outlet Conduit.



H. Downstream Channel.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

FREETHY DAM

RUSSELL COMPTON

GUIDE TO LOCATION
OF PHOTOGRAPHS

MARCH 1981

EXHIBIT C-1

APPENDIX D

HYDROLOGY AND HYDRAULICS

APPENDIX D
HYDROLOGY AND HYDRAULICS

Spillway Capacity Rating:

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 (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF 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, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of 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.

Description of Model:

If the Owner has not developed a PMF for the dam, the watershed is modeled with the HEC-1DB computer program, which was developed by the U.S. Army Corps of Engineers. The HEC-1DB computer program calculates a PMF runoff hydrograph (and percentages thereof) and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. By modifying the rainfall criteria, it is also possible to model the 100-year flood with the program.

APPENDIX D

DELAWARE River Basin

Name of Stream: CARLEY BROOK
 Name of Dam: FREETHY DAM
 NDI ID No.: PA-00171
 DER ID No.: 64-160
 Latitude: N 41° 33.8' Longitude: W 75° 14.5'
 Top of Dam Elevation: 1036.7 FEET
 Streambed Elevation: 1011.0 Height of Dam: 26 ft
 Reservoir Storage at Top of Dam Elevation: 89 acre-ft
 Size Category: SMALL
 Hazard Category: HIGH (see Section 5)
 Spillway Design Flood: 1/2 PMF TO PMF (USE 1/2 PMF)
(SEE SECTION 5)

UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
<u>SCS PA-420</u>	<u>3.5</u>	<u>33</u>	<u>201</u>	<u>DER ID 64-185</u>
<u>UPPER WILCOX</u>	<u>5.2</u>	<u>18±</u>	<u>623</u>	<u>DER ID 64-63</u>
<u>BUNNELL'S</u>	<u>1.3</u>	<u>17</u>	<u>339</u>	<u>DER ID 64-29</u>

DOWNSTREAM DAMS - NONE

River Basin

Name of Dam: FREETHY DAM

UNIT HYDROGRAPH DATA:

Total 12.3 (See Sketch on Sheet D-4)

(1) & (2): Snyder Unit Hydrograph coefficients supplied by Baltimore District, Corps of Engineers on maps and plates referenced in (7) & (8)

The following are measured from the outlet of the subarea:

(3): Length of main watercourse extended to divide

(4): Length of main watercourse to the centroid

The following is measured from the upstream end of the reservoir at normal pool:

(5): Length of main watercourse extended to divide

(6): $T_p = C_t \times (L \times L_{ca})^{0.3}$, except where the centroid of the subarea is located in the reservoir. Then

$T_p = C_t \times (L')^{0.6}$

Initial flow is assumed at 1.5 cfs/sq. mile

Computer Data: QRCSN = -0.05 (5% of peak flow)

RTIOR = 2.0

RAINFALL DATA:

PMF Rainfall Index= $\frac{21.2}{40}$ in., 24 hr., 200 sq. mile
Hydromet. 40 Hydromet. 33
(Susquehanna Basin) (Other Basins)

Zone:

N/A

Geographic Adjustment

Factor:

1.0

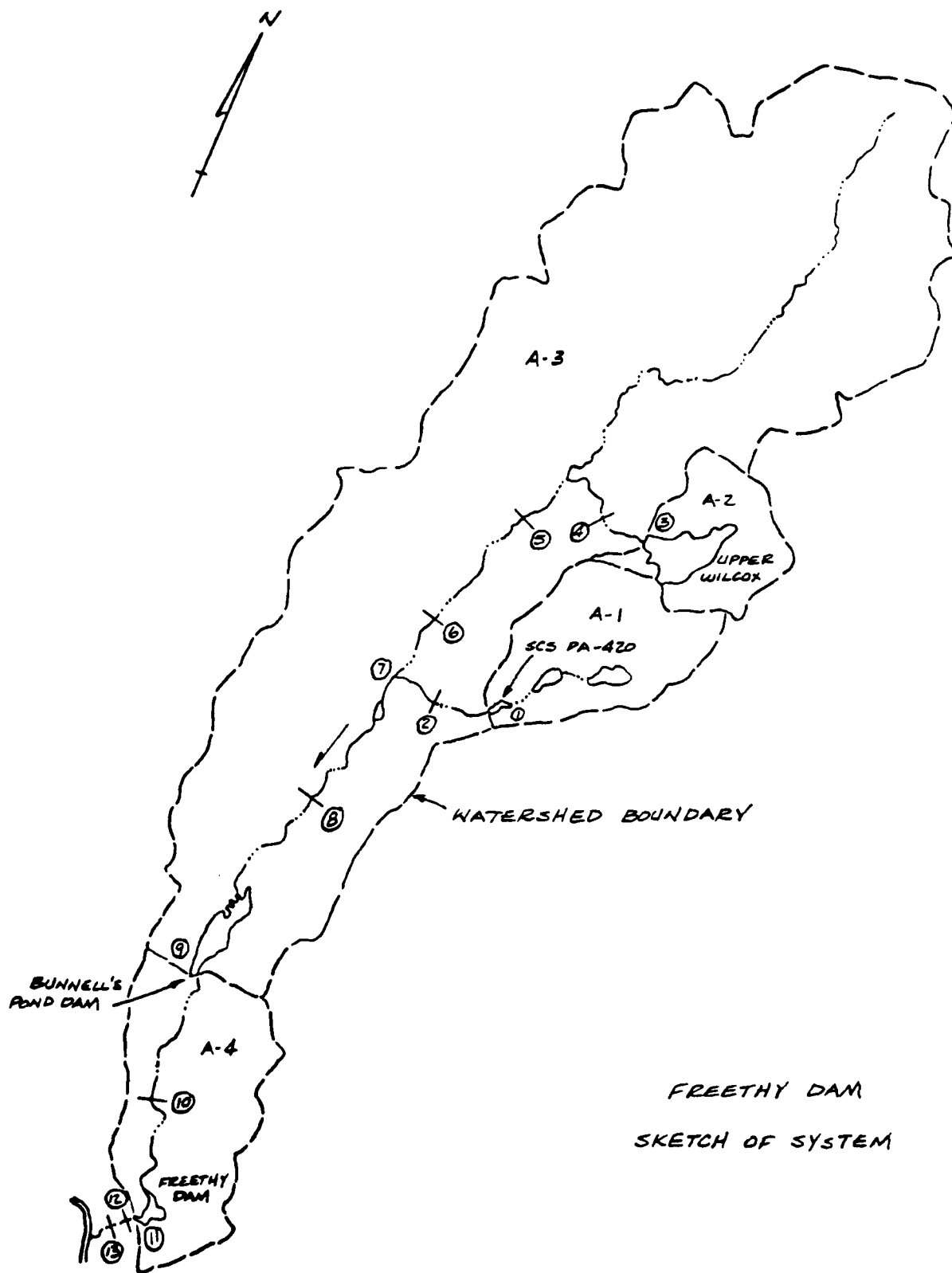
Revised Index

Rainfall:

21.2

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	109
12 hours	121
24 hours	131
48 hours	140
72 hours	
96 hours	



FREETHY DAM
SKETCH OF SYSTEM

NOTE: CIRCLED NUMBERS INDICATE HYDRAULIC MODELING STATIONS

Data for Dam at Outlet of Subarea A-1 (See sketch on Sheet D-4)

Name of Dam: SCS PA-420

STORAGE DATA: THE FOLLOWING DATA WAS TAKEN FROM THE
PHASE I REPORT FOR SCS PA-420, MAY 1980.

<u>Elevation</u>	<u>Area</u> <u>(acres)</u>	<u>Storage</u>		<u>Remarks</u>
		<u>million</u> <u>gals</u>	<u>acre-ft</u>	
<u>1272.7</u> =ELEVO	<u>0</u>	<u>0</u>	<u>0</u>	
<u>1281.4</u> =ELEV1	<u>2.3</u> =A1		<u>6.7</u> =S1	<u>NORMAL POOL</u>
<u>1285.0</u>	<u>5.2</u>			
<u>1290.0</u>	<u>7.1</u>			
<u>1295.0</u>	<u>9.3</u>			
<u>1300.0</u>	<u>12.0</u>			
<u>1305.0</u>	<u>14.5</u>			

* ELEVO = ELEV1 - (3S₁/A₁)

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is < / percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = $(2/3) \times H$ & $A = L \cdot \text{depth}$)

HMAX = $(4/9 V^2/C^2)$ = _____ ft., C = _____ Top of Dam El. = _____

HMAX + Top of Dam El. = _____ = FAILURE
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of
zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL = _____ mins = _____ hrs (time for breach to
develop)

Data for Dam at Outlet of Subarea A-1

Name of Dam: SCS PA-420

SPILLWAY DATA: TAKEN FROM PHASE I
REPORT SCS PA-420,
MAY 1980

	Existing Conditions	Design Conditions
Top of Dam Elevation	1304.3	(N/A)
Spillway Crest Elevation	1281.4	
Spillway Head Available (ft)	22.9	
Type Spillway	DROP INLET	
"C" Value - Spillway	0.6 (ORIFICE)	
Crest Length - Spillway (ft)	N/A	
Spillway Peak Discharge (cfs)	130	
Auxiliary Spillway Crest Elev.	1298.4	
Auxiliary Spill. Head Avail. (ft)	5.9	
Type Auxiliary Spillway	VEGETATED CHANNEL	
"C" Value - Auxiliary Spill. (ft)	2.7	
Crest Length - Auxil. Spill. (ft)	125	
Auxiliary Spillway Peak Discharge (cfs)	5590	
Combined Spillway Discharge (cfs)	5720	

Spillway Rating Curve:

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
1281.4	0		0
1282.5	5		5
1285.0	11		11
1290.0	17		17
1296.8	23		23
1298.4	105	0	105
1299.65	121	487	605
1300.6	123	1165	1285
1302.2	126	2751	2877
1304.3	130	5590	5720

OUTLET WORKS RATING:

	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	(N/A)	(N/A)	(N/A)
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction = $29.1 N^2 L / R^{4/3}$			
Sum of K			
$(1/K)^{0.5} = C$			
Maximum Head (ft) = HM			
$Q = CA \sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

Data for Dam at Outlet of Subarea A-2 (See sketch on Sheet D-4)

Name of Dam: UPPER WILCOX POND

STORAGE DATA:

<u>Elevation</u>	<u>Area (acres)</u>	<u>Storage</u>		<u>Remarks</u>
		<u>million gals</u>	<u>acre-ft</u>	
<u>1412</u> =ELEVO	<u>0</u>	<u>0</u>	<u>0</u>	<u>U.S. TOE</u>
<u>1426</u> =ELEV1	<u>70</u> =A1	<u>106</u>	<u>327</u> =S1	<u>NORMAL POOL</u>
<u>1440**</u>	<u>87</u>			

* ELEVO = ELEV1 - (3S₁/A₁)

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 18 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = $(2/3) \times H$) & $A = L \cdot \text{depth}$

HMAX = $(4/9 V^2/C^2)$ = _____ ft., C = _____ Top of Dam El. = _____

HMAX + Top of Dam El. = _____ = FAILUREL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of
zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL = _____ mins = _____ hrs (time for breach to
develop)

Data for Dam at Outlet of Subarea A-2

Name of Dam: UPPER WILCOX POND

SPILLWAY DATA:

	Existing Conditions	Design Conditions
Top of Dam Elevation	<u>1430.1</u>	<u>(N/A)</u>
Spillway Crest Elevation	<u>1426.0</u>	
Spillway Head Available (ft)	<u>4.1</u>	
Type Spillway	<u>DROP INLET</u>	
"C" Value - Spillway	<u>N/A</u>	
Crest Length - Spillway (ft)	<u>N/A</u>	
Spillway Peak Discharge (cfs)	<u>90</u>	
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway		
Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve:

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
<u>1426.0</u>	<u>0</u>		
<u>1427.0</u>	<u>10</u>		
<u>1428.0</u>	<u>29</u>		
<u>1429.0</u>	<u>53</u>		
<u>1430.0</u>	<u>88</u>		
<u>1431.0</u>	<u>106</u>		
<u>1432.0</u>	<u>122</u>		
<u>1433.0</u>	<u>135</u>		
<u>1434.0</u>	<u>147</u>		

OUTLET WORKS RATING:

	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	<u>(N/A)</u>	<u>(N/A)</u>	<u>(N/A)</u>
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction = $29.1 N^2 L / R^{4/3}$			
Sum of K			
$(1/K)^{0.5} = C$			
Maximum Head (ft) = HM			
$Q = CA \sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

BY _____ DATE _____
 CHKD BY _____ DATE _____

SUBJECT UPPER WILCOX POND

SHEET NO _____ OF _____
 JOB NO _____

SPILLWAY RATING

- ① Calculate weir flow from spillway crest (1426.0) to elevation 1429.0 (top of conduit)

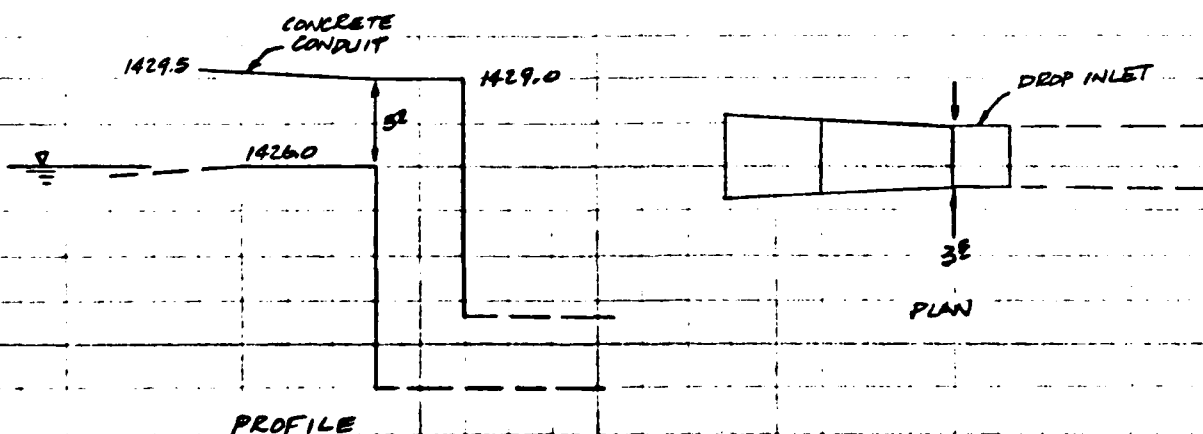
$$Q_w = C_L H_w^{1.5} = 2.9 (3.5) H_w^{1.5} = 10.15 H_w^{1.5}$$

- ② Calculate pressure flow above 1429.0

$$Q_p = C_A \sqrt{2g H_p} = 0.7 (3.0) (3.5) \sqrt{64.4} H_p^{0.5} = 59.0 H_p^{0.5}$$

ELEV	H _w	H _p *	Q _w	Q _p	Q
1426.0	0		0		0
1427.0	1		10		10
1428.0	2		29		29
1429.0	3		53		53
1430.0		2.25		88	88
1431.0		3.25		106	106
1432.0		4.25		122	122
1433.0		5.25		135	135
1434.0		6.25		147	147

* H_p measured from center of orifice at 1427.75 feet

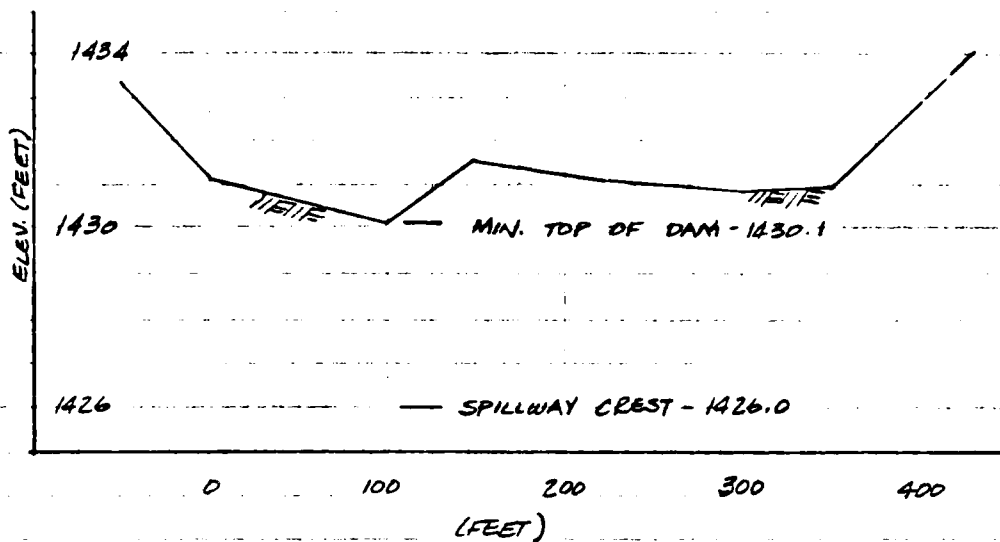


BY _____ DATE _____
CHKD BY _____ DATE _____

SUBJECT UPPER WILCOX POND

SHEET NO _____ OF _____
JOB NO _____

TOP OF DAM PROFILE



#L	#V
0	1430.1
95	1430.9
380	1431.7
390	1432.0
440	1433.0
500	1434.0

NOTE: All elevations are referenced to the reservoir pool level shown on USGS quadrangle, Galilee, PA.

Data for Dam at Outlet of Subarea A-3 (See sketch on Sheet D-4)

Name of Dam: BUNNELL'S POND

STORAGE DATA:

Elevation	Area (acres)	Storage		Remarks
		million gals	acre-ft	
<u>1066</u> =ELEVO	<u>0</u>	<u>0</u>	<u>0</u>	<u>D/S TOE</u>
<u>1079</u> =ELEV1	<u>37</u> =A1	<u>52</u>	<u>160</u> =S1	<u>NORMAL POOL</u>
<u>1083.2</u>	<u>51</u>	<u>110</u>	<u>339</u>	<u>TOP OF DAM</u>
<u>1100**</u>	<u>108</u>	<u>-</u>	<u>-</u>	

* ELEVO = ELEV1 - (3S₁/A₁)

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 41 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = $(2/3) \times H$ & $A = L \cdot \text{depth}$)

HMAX = $(4/9 V^2/C^2)$ = _____ ft., C = _____ Top of Dam El. = _____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL = _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-3

Name of Dam: BUNNELL'S POND

SPILLWAY DATA:

	Existing Conditions	Design Conditions
Top of Dam Elevation	<u>1083.2</u>	<u>(N/A)</u>
Spillway Crest Elevation	<u>1079.0</u>	<u></u>
Spillway Head Available (ft)	<u>4.2</u>	<u></u>
Type Spillway	<u>CONCRETE BROAD CRESTED WEIR</u>	<u></u>
"C" Value - Spillway	<u>2.65</u>	<u></u>
Crest Length - Spillway (ft)	<u>116 (TOTAL- BOTH STAGES)</u>	<u></u>
Spillway Peak Discharge (cfs)	<u>2475</u>	<u></u>
Auxiliary Spillway Crest Elev.	<u></u>	<u></u>
Auxiliary Spill. Head Avail. (ft)	<u></u>	<u></u>
Type Auxiliary Spillway	<u></u>	<u></u>
"C" Value - Auxiliary Spill. (ft)	<u>N/A</u>	<u></u>
Crest Length - Auxil. Spill. (ft)	<u></u>	<u></u>
Auxiliary Spillway	<u></u>	<u></u>
Peak Discharge (cfs)	<u></u>	<u></u>
Combined Spillway Discharge (cfs)	<u></u>	<u></u>

Spillway Rating Curve: SEE PAGE D-13

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
<u>1079.0</u>	<u>0</u>	<u></u>	<u></u>
<u>1079.4</u>	<u>39</u>	<u></u>	<u></u>
<u>1080.0</u>	<u>226</u>	<u></u>	<u></u>
<u>1080.5</u>	<u>461</u>	<u></u>	<u></u>
<u>1081.0</u>	<u>748</u>	<u>N/A</u>	<u></u>
<u>1082.0</u>	<u>1446</u>	<u>N/A</u>	<u>N/A</u>
<u>1083.0</u>	<u>2284</u>	<u></u>	<u></u>
<u>1084.0</u>	<u>3241</u>	<u></u>	<u></u>
<u>1085.0</u>	<u>4304</u>	<u></u>	<u></u>
<u>1086.0</u>	<u>5463</u>	<u></u>	<u></u>

OUTLET WORKS RATING:

	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	<u>(N/A)</u>	<u>(N/A)</u>	<u>(N/A)</u>
Invert of Inlet	<u></u>	<u></u>	<u></u>
Type	<u></u>	<u></u>	<u></u>
Diameter (ft) = D	<u></u>	<u></u>	<u></u>
Length (ft) = L	<u></u>	<u></u>	<u></u>
Area (sq. ft) = A	<u></u>	<u></u>	<u></u>
N	<u></u>	<u></u>	<u></u>
K Entrance	<u></u>	<u></u>	<u></u>
K Exit	<u></u>	<u></u>	<u></u>
K Friction = $29.1 N^2 L / R^{4/3}$	<u></u>	<u></u>	<u></u>
Sum of K	<u></u>	<u></u>	<u></u>
(1/K) 0.5 = C	<u></u>	<u></u>	<u></u>
Maximum Head (ft) = HM	<u></u>	<u></u>	<u></u>
Q = $CA \sqrt{2g(HM)}$ (cfs)	<u></u>	<u></u>	<u></u>
Q Combined (cfs)	<u></u>	<u></u>	<u></u>

BY _____ DATE _____

SUBJECT BUNNELL'S POND DAM

SHEET NO _____ OF _____

CHKD BY _____ DATE _____

JOB NO _____

SPILLWAY RATINGTwo stage broad-crested weir, $C=2.65$ (standard Handbook for Civil Engineers)

ELEV	H_1	H_2	Q_1	Q_2	Q_T
1079.0	0		0		0
1079.4	0.4	0	39	0	39
1080.0	1.0	0.6	154	72	226
1080.5	1.5	1.1	283	178	461
1081.0	2.0	1.6	436	312	748
1082.0	3.0	2.6	800	646	1446
1083.0	4.0	3.6	1232	1052	2284
1084.0	5.0	4.6	1722	1519	3241
1085.0	6.0	5.6	2263	2041	4304
1086.0	7.0	6.6	2852	2611	5463

$$Q = CLH^{1.5} \quad L_1 = L_2 = 58 \text{ feet}$$

$$Q_1 = 2.65 (58) H_1^{1.5} = 154 H_1^{1.5}$$

$$Q_2 = 2.65 (58) H_2^{1.5} = 154 H_2^{1.5}$$

TOP OF DAM RATING *

$\$L$	$\$V$
0	1083.2
115	1083.3
135	1083.5
175	1084.0
270	1085.0
460	1086.0

* TAKEN FROM PHASE I REPORT FOR BUNNELL'S POND DAM

Data for Dam at Outlet of Subarea A-4 (See sketch on Sheet D-4)

Name of Dam: FREETHY DAM

STORAGE DATA:

Elevation	Area (acres)	Storage		Remarks
		million gals	acre-ft	
<u>1011</u> =ELEVO	0	0	0	
** <u>1035</u> =ELEV1	<u>9</u> =A1	<u>23</u>	<u>72</u> =S1	<u>NORMAL POOL</u>
** <u>1040</u>	<u>14</u>			
** <u>1050</u>	<u>26</u>			

* ELEVO = ELEV1 - (3S₁/A₁)

** Planimetered contour
(USGS Quadrangle)

Reservoir Area at Normal Pool is ~ / percent of subarea watershed.

BREACH DATA: ALSO SEE SHEET D-18

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: WEATHERED ROCK

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) (N/A) fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = $(2/3) \times H$) & $A = L \cdot \text{depth}$

HMAX = $(4/9 V^2/C^2) =$ ft., C = Top of Dam El. =

HMAX + Top of Dam El. = = FAILURE (SEE SHEET D-28)
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = 50 ft (width of bottom of breach)

Z = 1.0 (side slopes of breach)

ELBM = 1020 (bottom of breach elevation)*

WSEL = 1035 (normal pool elevation)

T FAIL = 18 mins = 0.3 hrs (time for breach to develop)

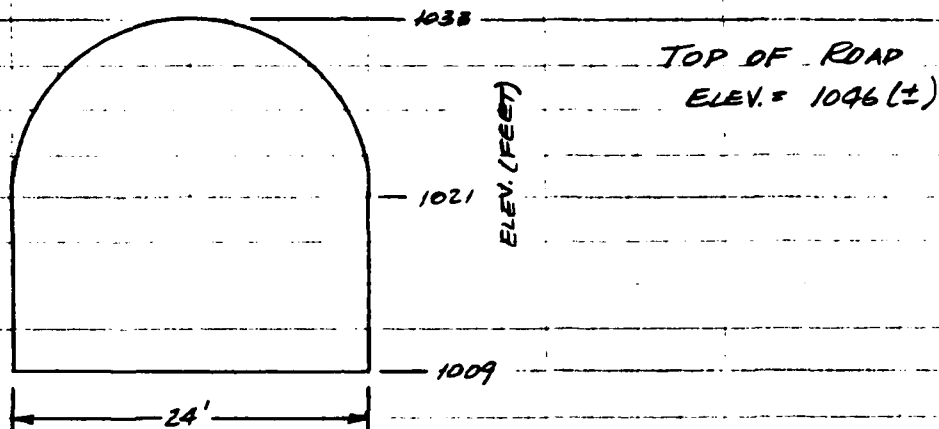
* ESTIMATED TAILWATER ELEVATION

BY REN DATE _____
 CHKD BY _____ DATE _____

SUBJECT FREETHY DAM

SHEET NO _____ OF _____
 JOB NO _____

CULVERT DOWNSTREAM FROM FREETHY DAM



Assume water surface passes through critical depth within the culvert:

y_c (ft)	A (ft ²)	T (feet)	Q (cfs.)	V (ft/s.)	$V^2/2g$ (ft)	Pool Elev. (ft)
0						1009.0
2	48	24	385	8.02	1.0	1012.0
4	96		1090	11.35	2.0	1015.0
6	144		2002	13.90	3.0	1018.0
8	192		3082	16.05	4.0	1021.0
10	240		4307	17.95	5.0	1024.0
12	288	24	5661	19.66	6.0	1027.0
14	336	23.6	7194	21.41	7.2	1030.2
16	359	22.7	8101	22.57	7.9	1032.9

BEGIN PRESSURE FLOW
 ABOVE 1033 FEET

BY REN DATE _____SUBJECT FREETHY DAM

SHEET NO _____ OF _____

CHKD BY _____ DATE _____

JOB NO _____

CULVERT (CONTINUED)

Calculate pressure flow through culverts:

$$Q = CA\sqrt{2gh}$$

$$C \approx 0.65$$

$$h = \text{pool elevation} - 1021 \text{ (center of opening)}$$

$$A = 515 \text{ ft}^2$$

Pool El. (feet)	h (ft.)	Q (cfs)
1034	13	9686
1036	15	10,404
1038	17	11,076
1040	19	11,710
1042	21	12,310
1044	23	12,883
1046	25	13,431

Storage capacity between Freethy Dam and culvert:

Approximate area at elev 1040 = $\frac{1}{2}$ acre

$$\text{Storage at elev 1040} \approx 0.5(31)(\frac{1}{3}) = 5 \text{ A-F}$$

 $\therefore$ storage is minimal

Gage	DA	Maximum Recorded Flow		Est. Flow at Freethy Dam ¹
		July 1952	Aug. 1955	
Dyberry Creek at Dyberry, PA	63.2	15,500	11,400	4184/3077 ²
West Branch Lackawaxen River at Prompton, PA	59.7	2740	5860	774/1655 ²

$$^1 \text{ Estimated by } Q_2 = \left(\frac{DA_1}{DA_2} \right)^{0.8} \times Q_1$$

where:

Q_2 = Flow at Freethy Dam

Q_1 = Observed Flow at Gage

DA_1 = Drainage area of Gage

DA_2 = Drainage area at Freethy Dam

² 1952/1955

It is possible that Freethy Dam may have experienced floods in the range of 15-25% of the PMF. Some damage, the extent of which is unknown, was caused by the 1952 flood. Because of the limited gage information the flows calculated above are considered to be rough estimates. It is assumed for this study that the dam could not withstand much greater than 20% of the PMF.

BY _____ DATE _____
CHKD. BY _____ DATE _____

SUBJECT FREETHY DAM

SHEET NO. _____ OF _____
JOB NO. _____

SELECTED COMPUTER OUTPUT

Item

Page

Multi-ratio Analysis

Input

D-20 - D-22

Summary of Peak Flows

D-23, D-24

Overtopping Summary

D-25 - D-29

Dam Breach Analysis

Input

D-30 - D-32

Summary of Peak Flows

D-33 - D-35

Breach and Channel

Routing Summary

D-36 - D-38

 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 01 APR 80

MULTI-RATIO ANALYSIS

NATIONAL DAM INSPECTION PROGRAM											
BALTIMORE DISTRICT CORPS OF ENGINEERS											
FREETHY DAM											
	A1	A2	A3	B	C	D	E	F	G	H	I
1	300	0	15	0	0	0	0	0	0	-4	0
2	5										
3	1										
4	1										
5	1										
6	1										
7	1.0	0.5	0.3	0.2	0.1	0.05					
8	0										
9	0										
10	1										
11	1										
12	1										
13	1.23	0.45									
14	-1.5	-0.05	2.0								
15	1										
16	1										
17	1										
18	1										
19	1										
20	1										
21	1										
22	1										
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48	1										
49	1										
50	1										

[illegible]

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIOS APPLIED TO FLOWS					
					RATIO 2 .50	RATIO 3 .30	RATIO 4 .20	RATIO 5 .10	RATIO 6 .05	
HYDROGRAPH AT	1	.90 (2.33)	1	2232. (63.20)	1116. (31.60)	670. (18.96)	446. (12.64)	223. (6.32)	112. (3.16)	SCS PA-420
ROUTED TO	1	.90 (2.33)	1	2233. (62.67)	1095. (31.02)	577. (16.35)	285. (8.07)	21. (.60)	16. (.45)	
ROUTED TO	2	.90 (2.33)	1	2208. (62.52)	1096. (31.03)	577. (16.33)	280. (7.93)	21. (.60)	16. (.45)	
HYDROGRAPH AT	3	.60 (1.55)	1	1827. (51.74)	914. (25.87)	548. (15.52)	365. (10.35)	183. (5.17)	91. (2.59)	UPPER WILCOX
ROUTED TO	3	.60 (1.55)	1	1086. (30.77)	90. (2.56)	43. (1.21)	24. (.68)	9. (.25)	4. (.13)	
ROUTED TO	4	.60 (1.55)	1	1083. (30.68)	90. (2.56)	43. (1.21)	24. (.68)	9. (.25)	4. (.13)	
ROUTED TO	5	.60 (1.55)	1	1039. (29.41)	90. (2.55)	43. (1.21)	24. (.68)	9. (.25)	4. (.13)	
ROUTED TO	6	.60 (1.55)	1	961. (27.20)	90. (2.55)	43. (1.21)	24. (.68)	9. (.25)	4. (.13)	
2 COMBINED	7	1.50 (3.88)	1	2525. (71.49)	1131. (32.03)	600. (17.00)	299. (8.47)	30. (.85)	20. (.57)	
ROUTED TO	8	1.50 (3.88)	1	2478. (70.16)	1032. (29.23)	537. (15.20)	257. (7.27)	30. (.85)	20. (.57)	
HYDROGRAPH AT	9	9.50 (24.60)	1	13305. (376.74)	6652. (188.37)	3991. (113.02)	2661. (75.35)	1330. (37.67)	665. (18.84)	BUNNELL'S POND
2 COMBINED	9	11.00 (28.49)	1	15782. (446.90)	7614. (215.62)	4529. (128.22)	2865. (81.14)	1355. (38.36)	681. (19.28)	
ROUTED TO	9	11.00 (28.49)	1	15721. (445.18)	7584. (214.75)	4472. (126.63)	2788. (78.95)	1294. (36.64)	641. (18.15)	
ROUTED TO	10	11.00 (28.49)	1	15603. (441.84)	7404. (212.22)	4399. (124.55)	2745. (77.72)	1277. (36.16)	632. (17.90)	
HYDROGRAPH AT	11	1.30 (3.37)	1	3147. (89.10)	1573. (44.55)	944. (26.73)	620. (17.82)	315. (8.91)	157. (4.46)	FIFEETHY DAM
2 COMBINED	11	12.30 (31.86)	1	17444. (493.96)	8409. (238.13)	4871. (137.94)	2994. (84.77)	1403. (39.73)	690. (19.53)	

ROUTED TO	11	12.30	1	17437.	8399.	4858.	2987.	1400.	687.
	(	31.86)	(	493.75)	237.84)	137.55)	84.57)	39.65)	19.46)

SUMMARY OF DAM SAFETY ANALYSIS

SCS PA-420

PLAN 1

ELEVATION STORAGE OUTFLOW	INITIAL VALUE	EMERGENCY SPILLWAY CREST	TOP OF DAM
	1281.41	1298.40	1304.30
	7.	126.	201.
	..	105.	5720.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1301.53	0.00	163.	2213.	0.00	41.00	0.00
.50	1300.33	0.00	148.	1095.	0.00	41.25	0.00
.30	1299.57	0.00	139.	577.	0.00	42.00	0.00
.20	1298.85	0.00	131.	285.	0.00	43.00	0.00
.10	1294.57	0.00	87.	21.	0.00	47.25	0.00
.05	1289.01	0.00	44.	16.	0.00	46.25	0.00

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2208.	1197.7	41.25
.50	1096.	1196.1	41.25
.30	577.	1194.9	42.00
.20	280.	1193.8	43.25
.10	21.	1190.9	47.50
.05	16.	1150.7	46.50

stream section

Overlapping Summary

SUMMARY OF DAM SAFETY ANALYSIS

UPPER WILCOX

PLAN 1	INITIAL VALUE		SPILLWAY CREST		TOP OF DAM	
	ELFVATION	STORAGE	OUTFLOW	1426.00	1430.10	1430.10
				327.0	327.0	623.0
				0.0	0.0	90.0
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV		MAXIMUM STORAGE AC-FT		MAXIMUM OUTFLOW CFS	
	OVER DAM		OVER TOP		HOURS	
1.00	1431.94	1.84	763.0	1086.0	15.50	42.25
.50	1430.13	.03	625.0	90.0	2.25	45.25
.30	1428.57	0.00	510.0	4.0	0.00	45.50
.20	1427.75	0.00	451.0	24.0	0.00	46.00
.10	1426.89	0.00	390.0	9.0	0.00	46.75
.05	1426.45	0.00	358.0	4.0	0.00	46.50
						0.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	1083.0	1366.3	42.50
.50	90.0	1362.1	45.25
.30	43.0	1361.2	45.75
.20	24.0	1360.9	46.00
.10	9.0	1360.3	46.75
.05	4.0	1360.2	46.75

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	1039.0	1186.0	42.75
.50	90.0	1182.7	46.00
.30	43.0	1181.8	46.00
.20	24.0	1181.2	46.25
.10	9.0	1180.6	47.50
.05	4.0	1180.3	47.50

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	961.0	1154.6	43.25
.50	90.0	1151.5	46.25
.30	43.0	1150.5	46.50
.20	24.0	1150.0	46.75
.10	9.0	1149.4	48.50
.05	4.0	1149.2	48.25

stream sections

PLAN 1		STATION		8	
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS		
1.00	2478.	1129.5	43.00		
.50	1032.	1127.1	42.00		
.30	537.	1125.7	43.00		
.20	257.	1124.3	43.75		
.10	30.	1121.1	44.50		
.05	20.	1120.9	47.75		

stream section

BUNNELL'S POND

PLAN ?

INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
1079.00	1079.00	1083.20
160.	160.	339.
0.	0.	2475.

ELEVATION
STORAGE
OUTFLOW

RATIO OF PHF	MAXIMUM RESERVING W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1087.67	4.47	584.	15721.	15.50	43.00	0.00
.50	1085.72	2.52	470.	7584.	10.25	43.00	0.00
.30	1084.52	1.32	405.	4472.	6.00	43.25	0.00
.20	1083.48	.28	353.	2788.	2.25	43.75	0.00
.10	1081.78	0.00	273.	1294.	0.00	43.75	0.00
.05	1080.81	0.00	232.	661.	0.00	44.00	0.00

PLAN 1	STATION	10
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RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	15603.0	1069.4	43.50
.50	7494.0	1065.3	43.50
.30	4399.0	1062.8	43.75
.20	2745.0	1060.9	44.25
.10	1277.0	1058.2	44.25
.05	632.0	1056.3	44.50

Stream section

SUMMARY OF DAM SAFETY ANALYSIS

FREETHY DAM

PLAN 1	ELEVATION		INITIAL VALUE		SPILLWAY CREST		TOP OF DAM		TIME OF FAILURE HOURS
	STOPAGE	OUTFLOW	1035.00	72.	1035.00	72.	1036.70	89.	
			0.	0.	0.	0.	319.		
RATIO OF PMF	MAXIMUM RESERVOIR V.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS			
1.00	1049.74	12.04	294.	17437.	35.25	43.25	0.00		
.50	1044.28	7.58	199.	8399.	29.50	43.25	0.00		
.30	1041.92	5.22	158.	4858.	24.50	43.75	0.00		
.20	1040.35	3.65	134.	2987.	20.75	44.25	0.00		
.10	1038.63	1.93	111.	1400.	15.00	44.00	0.00		
.05	1037.57	.87	98.	687.	9.75	44.25	0.00		

Overtopping Summary

FLOOD HYDROGRAPH PACKAGE (WEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 01 APR 80

BREACH ANALYSIS
 (20% PMF)

NATIONAL DAM INSPECTION PROGRAM BALTIMORE DISTRICT CORPS OF ENGINEERS FREETHY DAM													
	A1	A2	A3	B	6	0	0	0	0	0	0	-4	0
1	300												
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
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50													

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CURIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN RATIO	1	20
HYDROGRAPH AT	1	.90	1	448.	(12.68)(
	(	2.33)	2	448.	(12.68)(
			3	448.	(12.68)(
ROUTED TO	1	.90	1	267.	(7.56)(
	(	2.33)	2	267.	(7.56)(
			3	267.	(7.56)(
ROUTED TO	2	.90	1	262.	(7.43)(
	(	2.33)	2	262.	(7.43)(
			3	262.	(7.43)(
HYDROGRAPH AT	3	.60	1	372.	(10.52)(
	(	1.55)	2	372.	(10.52)(
			3	372.	(10.52)(
ROUTED TO	3	.60	1	23.	(.65)(
	(	1.55)	2	23.	(.65)(
			3	23.	(.65)(
ROUTED TO	4	.60	1	23.	(.65)(
	(	1.55)	2	23.	(.65)(
			3	23.	(.65)(
ROUTED TO	5	.60	1	23.	(.65)(
	(	1.55)	2	23.	(.65)(
			3	23.	(.65)(

SLS PA-420

UPPER WILCOX

ROUTED TO	6	(	.60 1.55)	(	.65)(
	1	(	23.		
	2	(	.65)(		
	23.				
	3	(	.65)(		
	23.				
	3	(	.65)(		
2 COMBINED	7	(	1.50 3.88)		
	1	(	280.		
	2	(	7.92)(		
	280.				
	3	(	7.92)(		
	280.				
	3	(	7.92)(		
ROUTED TO	8	(	1.50 3.88)		
	1	(	242.		
	2	(	6.85)(		
	242.				
	3	(	6.85)(		
	242.				
	3	(	6.85)(		

BUNNELLS POND

HYDROGRAPH AT	9	(	9.50 24.60)		
	1	(	2641.		
	2	(	74.78)(		
	2641.				
	3	(	74.78)(		
	2641.				
	3	(	74.78)(		
2 COMBINED	9	(	11.00 28.49)		
	1	(	2804.		
	2	(	79.39)(		
	2804.				
	3	(	79.39)(		
	2804.				
	3	(	79.39)(		

ROUTED TO	9	(	11.00 28.49)		
	1	(	2734.		
	2	(	77.41)(		
	2734.				
	3	(	77.41)(		
	2734.				
	3	(	77.41)(		
ROUTED TO	10	(	11.00 28.49)		
	1	(	2693.		
	2	(	76.25)(		
	2693.				
	3	(	76.25)(		
	2693.				
	3	(	76.25)(		

FREETHY DAM

HYDROGRAPH AT	11	(	1.30 3.37)		
	1	(	632.		
	2	(	17.89)(		
	632.				
	3	(	17.89)(		
	632.				
	3	(	17.89)(		
2 COMBINED	11	(	12.30 31.86)		
	1	(	2943.		
	2	(	83.33)(		

ROUTED TO	11	12.30 (31.86)	2	2943.
			(	83.33)(
			3	2943.
			(	83.33)(
	11	12.30 (31.86)	1	2938.
			(	83.18)(
			2	7299.
			(	206.69)(
			3	9071.
			(	256.87)(
FREETHY DAM				
ROUTED TO	12	12.30 (31.86)	1	2938.
			(	83.18)(
			2	7156.
			(	202.64)(
			3	8867.
			(	251.08)(
CULVERT				
ROUTED TO	13	12.30 (31.86)	1	2937.
			(	83.18)(
			2	7092.
			(	200.81)(
			3	8788.
			(	249.86)(
DAMAGE CENTER				

SUMMARY OF DAM SAFETY ANALYSIS

FREETHY DAM

PLAN 1	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 1035.00 72. 0.	SPILLWAY CREST 1035.00 72. 0.	TOP OF DAM 1036.70 89. 319.		
RATIO OF PMF 0.20	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
	1040.30	133.	2938.	14.50	20.10	0.00
PLAN 2	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 1035.00 72. 0.	SPILLWAY CREST 1035.00 72. 0.	TOP OF DAM 1036.70 89. 319.		
RATIO OF PMF 0.20	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
	1038.23	106.	7299.	2.29	16.50	16.20
PLAN 3	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 1035.00 72. 0.	SPILLWAY CREST 1035.00 72. 0.	TOP OF DAM 1036.70 89. 319.		
RATIO OF PMF 0.20	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
	1039.71	125.	9071.	4.34	18.50	18.20

Breach Analysis and
Channel Routing
Summary

SUMMARY OF DAM SAFETY ANALYSIS

CULVERT

PLAN 1									
RATIO OF PMF	ELEVATION STORAGE OUTFLOW	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	TOP OF DAM
.20	1020.60	0.00	0.00	0.	2938.	0.00	20.10	0.00	1046.00 12. 13431.

PLAN 2									
RATIO OF PMF	ELEVATION STORAGE OUTFLOW	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	TOP OF DAM
.20	1030.12	0.00	0.00	2.	7156.	0.00	16.50	0.00	1046.00 12. 13431.

PLAN 3									
RATIO OF PMF	ELEVATION STORAGE OUTFLOW	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	TOP OF DAM
.20	1033.43	0.00	0.00	4.	8867.	0.00	18.50	0.00	1046.00 12. 13431.

PLAN 1 STATION 13				
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS	
.20	2937.	996.5	20.10	

PLAN 2 STATION 13				
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS	
.20	7092.	999.5	16.50	

Damage Center

Plan 3 - Station 13

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
.20	8788.	1000.5	18.50

Damage Center

BY _____ DATE _____
CHKD BY _____ DATE _____

SUBJECT FREETHY DAM

SHEET NO _____ OF _____

JOB NO _____

SUMMARY OF PERTINENT RESULTS

Multi-ratio Analysis:

	<u>PMF</u>	<u>1/2 PMF</u>	<u>20 % PMF</u>
Rainfall (in.)	23.96	—	—
Runoff (in.)	21.59	10.80	4.32
Peak Inflow (cfs)	17,444	8409	2994
Peak Outflow (cfs)	17,437	8399	2987
Depth of Overtopping (ft.)	12.04	7.58	3.65
Duration of Overtopping (ft.)	35.25	29.50	20.75

Breach and Channel Routing Analysis (20 % PMF):

Plan 2:

	<u>No failure</u>	<u>Failure</u>	<u>Difference</u>
Peak Outflow (cfs)	2938	7299	4361
Stream Depth at Damage Center (ft.)	4.5	7.5 *	3.0

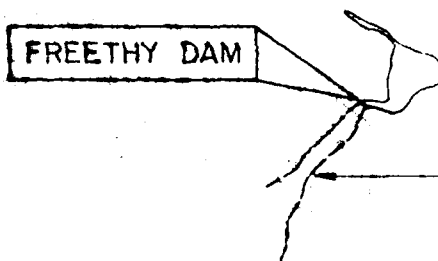
Plan 3

Peak Outflow (cfs)	2938	9071	6133
Stream Depth at Damage Center (ft.)	4.5	8.5 *	4.0

*The depth of flooding could be substantially increased by bridges and other channel obstructions. Excessive damages may result from debris washed downstream from the dam.



← BUNNELL'S POND DAM



APPROXIMATE MINIMUM LIMITS
OF DOWNSTREAM FLOODING SHOULD
DAM FAILURE OCCUR

← LACKAWAXEN RIVER

NOTES:

1. LIMITS OF DOWNSTREAM FLOODING ARE ESTIMATES BASED ON VISUAL OBSERVATIONS.
2. CIRCLED NUMBERS INDICATE STATIONS USED IN COMPUTER ANALYSIS.
3. THIS MAP SHOULD NOT BE USED IN CONNECTION WITH THE EMERGENCY OPERATION AND WARNING PLAN.

2000 0 2000
SCALE: 1 IN. = 2000 FT.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

FREETHY DAM

RUSSELL COMPTON

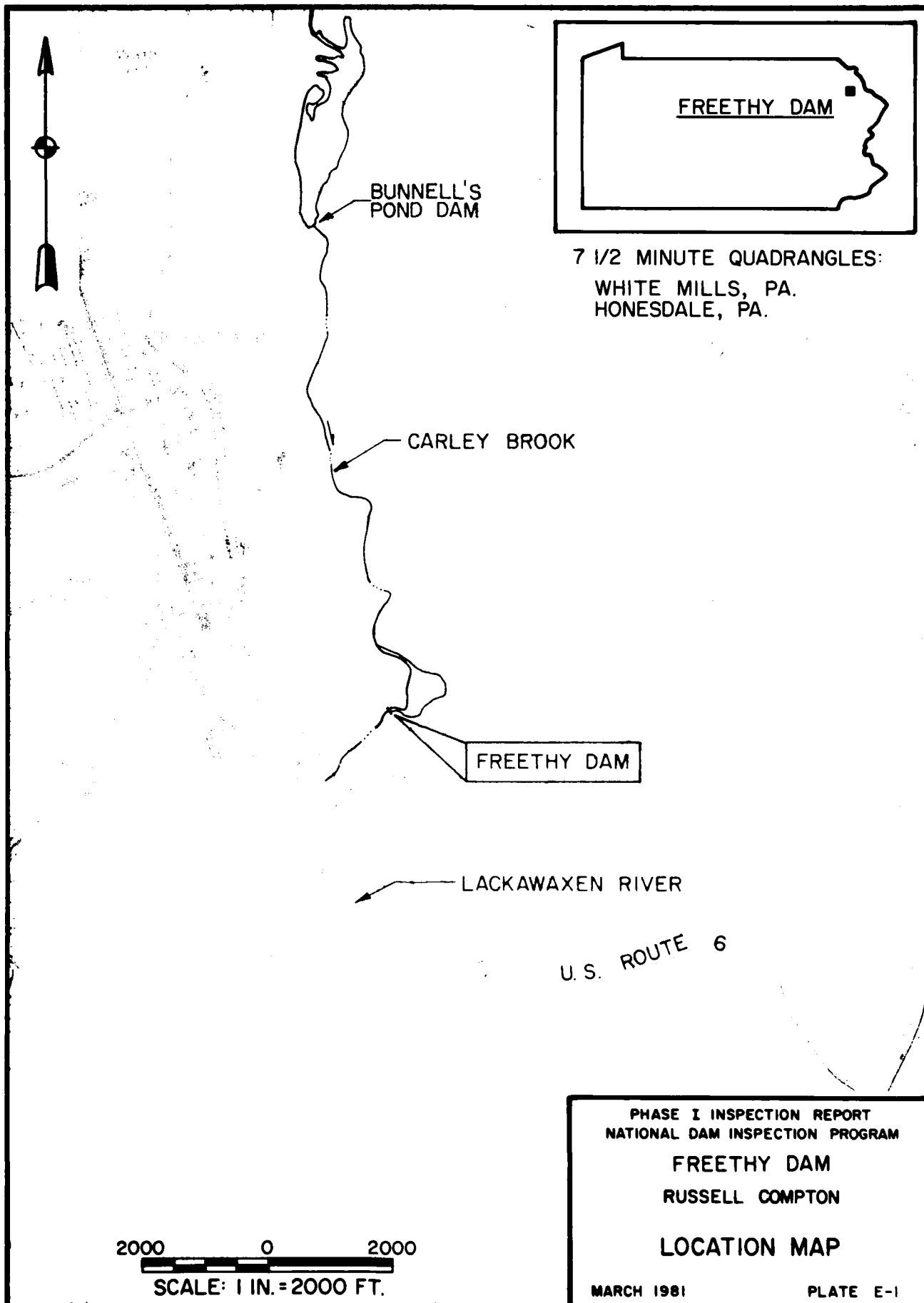
**DOWNSTREAM
DEVELOPMENT PLAN**

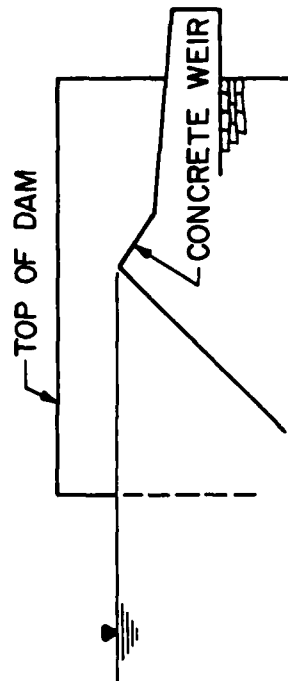
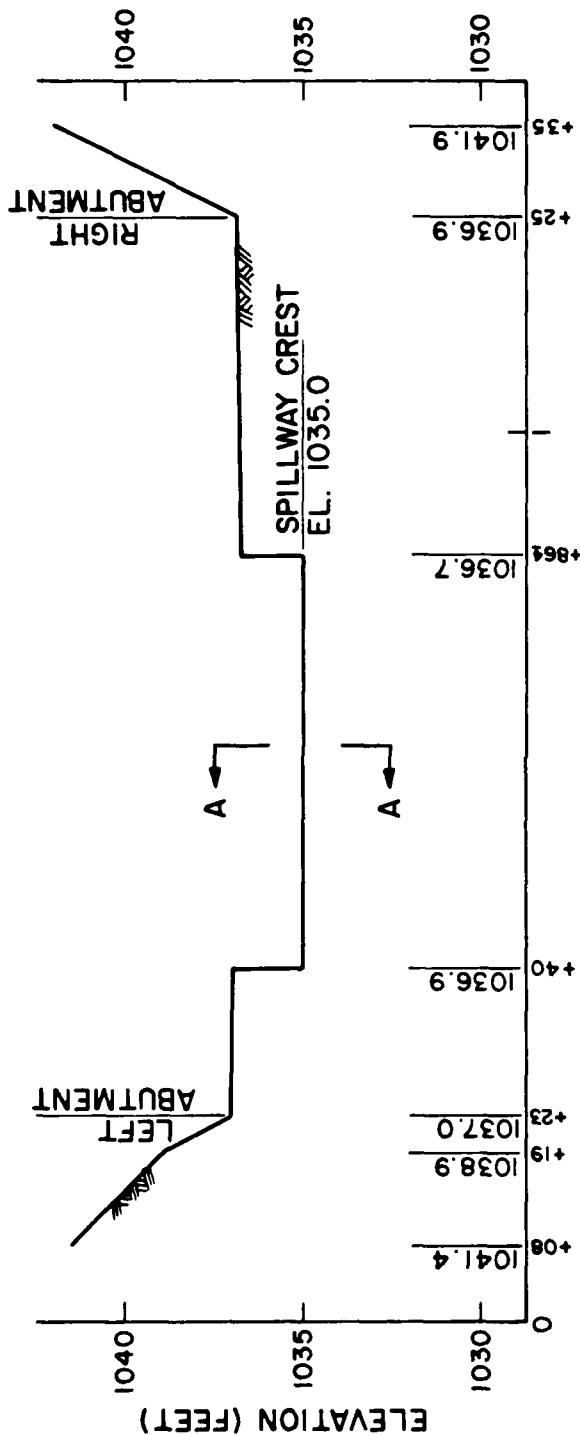
MARCH 1981

EXHIBIT D-1

APPENDIX E

PLATES





PHASE I INSPECTION REPORT
 NATIONAL DAM INSPECTION PROGRAM
 FREETHY DAM
 RUSSELL COMPTON
 PROFILE-TOP OF DAM
 SPILLWAY CROSS-SECTION
 MARCH 1981

PLATE E-2

APPENDIX F

GEOLOGY

FREETHY DAM

APPENDIX F

GEOLOGY

Freethy Dam is located in Wayne County within the Appalachian Plateau Physiographic Province. The most pronounced topographic feature in the area is Camelback Mountain, which is part of the Pocono Plateau Escarpment. The escarpment has a well-defined, southwestward trend from Camelback Mountain; but it is irregular between Camelback Mountain and Mt. Pocono, which lies to the north. Streams east of the escarpment drain directly to the Delaware River, while those to the west drain to the Lehigh River.

The Pocono Plateau Section lies to the west of the escarpment. This area is relatively flat, with local relief seldom exceeding 100 feet. The topography has been greatly influenced by continental glaciation. Many features were created by deposition of glacial materials. The entire plateau lacks well-developed drainage.

East of the escarpment is the Glaciated Low Plateaus Section of the province. This area is characterized by preglacial erosional topography with locally-thick glacial deposits. Local relief is generally 100 to 300 feet.

Bedrock units of the sections described above are the lithified sediments of offshore marine, marginal marine, deltaic environments, and fluvial environments associated with the Devonian Period. These units include siltstones of the Mahantango Formation, siltstones and shales of the Trimmers Rock Formation, and seven mapped members of the Catskill Formation. These members include sandstones, siltstones, and shales of the Towamensing Member; sandstone, siltstone and shale of the Walcksville Member; sandstones, siltstones and shale of the Beaverdam Run Member; sandstone and shale in the Long Run Member; sandstones and conglomerates in the Packerton Member; sandstones and some conglomerates in the Poplar Gap Member; and sandstones and conglomerates in the Duncannon Member.

Freethy Dam is underlain by the Catskill Formation. The Catskill Formation is predominantly red to brownish gray shales and sandstone with interbedded siltstones and conglomerates. Sandstones present are thick-bedded, fine- to coarse-grained and exhibit very low primary porosity due to a clay and silica matrix. Effective porosity results from fractures and parting planes.

The rocks are well-indurated and generally are not susceptible to slope failure; however, the presence of well-developed bedding and joint planes will result in some rockfall from vertical and high-angle cut slopes.

Bedrock is entirely overlain by glacial till of Late Wisconsin Age. This till is an unsorted mixture of clay, silt, sand, and gravel. It is moderately cohesive and is generally derived locally from the sandstones of the Catskill Formation. Thickness of the till varies from 5 to 75 feet.

