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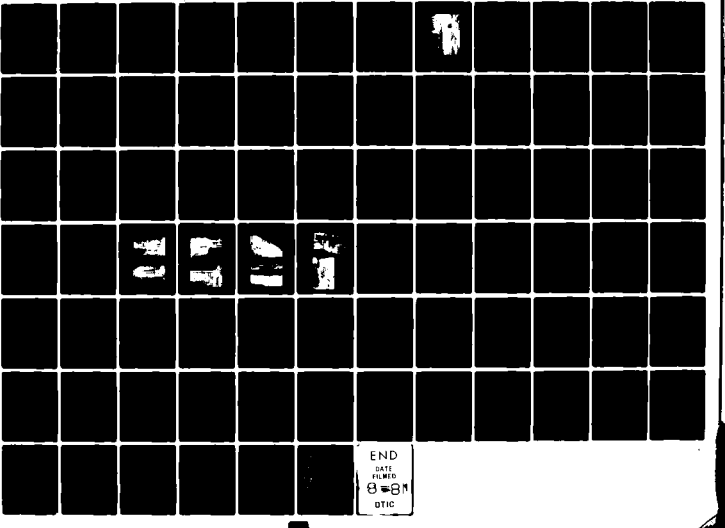

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DELAWARE RIVER BASIN

CARLEY BROOK, WAYNE COUNTY

PENNSYLVANIA

LEVEL II

BUNNELL'S POND DAM

NDI ID NO. PA-00170
DER ID NO. 64-29

WILLIAM SELAND

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

National Dam Inspection Program, Bunnell's Pond Dam (NDI ID Number PA-00170, DER ID Number 64-29), Delaware River Basin, Carley Brook, Wayne County, Pennsylvania. Phase I Inspection Report,

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

"Original contains color plates: All DTIC reproductions will be in black and white"

DACW31-81-C-0018

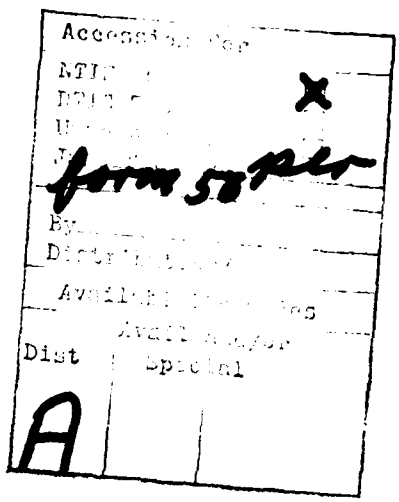
For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

MARCH 1981

DELAWARE RIVER BASIN

CARLEY BROOK, WAYNE COUNTY

PENNSYLVANIA



BUNNELL'S POND DAM

NDI ID No. PA-00170
DER ID No. 64-29

WILLIAM SELAND

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.

BUNNELL'S POND DAM

NDI ID No. PA-00170; DER ID No. 64-29

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

CONTENTS

APPENDICES

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Bunnell's Pond Dam NDI ID No. PA-00170 DER ID No. 64-29
Size:	Small (17 feet high; 339 acre-feet)
Hazard Classification:	High
Owner:	Mr. William Seland 587 Cliff Road Honesdale, PA 18431
State Located:	Pennsylvania
County Located:	Wayne
Stream:	Carley Brook
Date of Inspection:	12 November 1980

Based on the criteria established for these studies, Bunnell's Pond 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 18 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 that would occur during storms greater than 25 percent of the PMF. Failure of Bunnell's Pond Dam would cause an increased hazard for loss of life downstream.

Overall, the dam is considered to be in fair condition. Several deficiencies were observed, all of which are considered to be minor. Although some maintenance has been performed, the existing maintenance program should be upgraded.

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 Bunnell's Pond Dam and develop alternatives to provide adequate spillway capacity. Take appropriate action as required.

(2) Remove the debris and sediment which has collected behind the outlet works sluice gate so that the gate can be operated if necessary.

(3) Develop a method for drawing down the reservoir in case of an emergency. If a pipe is placed through the embankment, it should be provided with an upstream closure facility.

(4) Monitor the seepage and bulging of the masonry wall at the left end of the dam and the undermining of the concrete apron at the base of the spillway. Take appropriate action if any condition worsens.

(5) The deteriorated concrete on the top of dam, spillway and outlet works; and stones missing from the downstream face of the dam do not require any special attention at the present time. They should, however, be closely observed during all future inspections 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 Bunnell's Pond 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) Expand the existing maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

BUNNELL'S POND DAM

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

FREDERICK FUTCHKO
Project Manager, Dam Section

Date: 13 April 1981

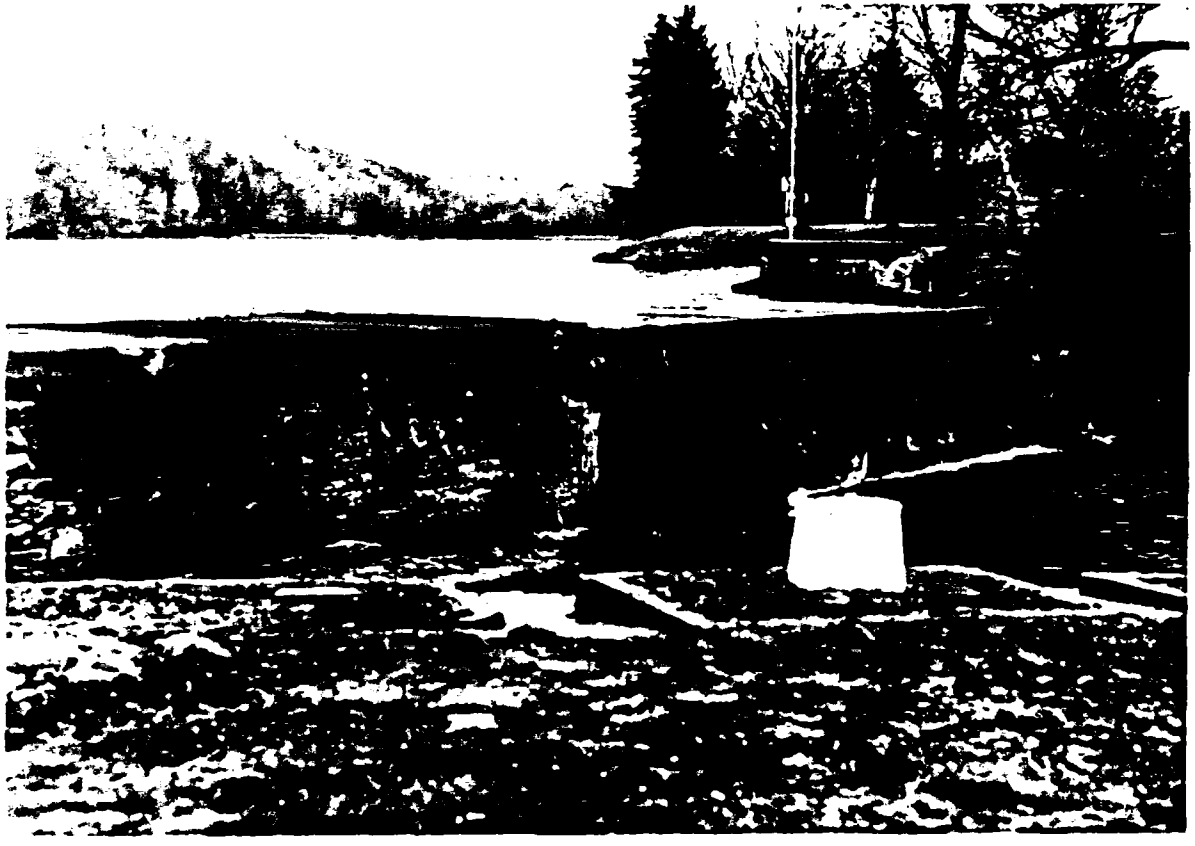
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF
ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 11 MAY 81

BUNNELL'S POND DAM



Overview

BUNNELL'S POND DAM

NDI ID No. PA-00170; DER ID No. 64-29

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. Bunnell's Pond Dam is an earthfill structure with a vertical, dry stone masonry wall forming the downstream face of the dam. The dam is approximately 235 feet long, including the spillway and outlet works, and 17 feet high. The top width of the dam is 16 feet. The upstream slope to the left of the spillway is grass covered and has a slope of approximately 1V on 3H. The upstream slope and part of the shoreline to the right of the spillway is protected by a near vertical stone wall, the top of which is about 3 feet above the normal pool level. A 50-foot long concrete corewall, constructed after the 1952 flood, extends from the right end of the outlet works into the right abutment of the dam.

The spillway, located near the center of the dam, is a two-stage, concrete, broad-crested weir which discharges in a straight drop to the stream channel below the dam. The spillway has a crest elevation of 1079.0 feet which is 4.2 feet below the top of dam. It has a crest length of 116 feet and crest width of 16 feet. The downstream face of the spillway is constructed of stone masonry. The upstream side is faced with a one-foot thick concrete wall which extends 6 feet below the spillway crest.

The outlet works, located to the right of the spillway near the right abutment of the dam, is a four-foot wide concrete sluiceway with a manually operated steel gate on the upstream end. The gate, in its lowered position, allows the reservoir pool to be maintained at the spillway crest. With the gate in

the raised position the sluiceway can be used to lower the reservoir pool 2.9 feet below the spillway crest level.

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

b. Location. Bunnell's Pond Dam is located on Carley Brook in Honesdale Borough, Wayne County, Pennsylvania. The dam is shown on USGS Quadrangle, White Mills, Pennsylvania, at latitude N 41° 35.1' and longitude W 75° 14.8'. A location map is shown on Plate E-1.

c. Size Classification. Small (17 feet high, 339 acre-feet).

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

e. Ownership. Mr. William Seland, 587 Cliff Road, Honesdale, PA 18431.

f. Purpose of Dam. Recreation.

g. Design and Construction History. The dam was constructed sometime prior to 1914. No information concerning the design and construction of the original structure or its operating history prior to 1914 is available. A number of modifications were made to the dam in 1942. They included:

(1) Capping of the spillway crest and side walls with 12 inches of reinforced concrete. The cap covering the spillway crest was made to extend 12 inches beyond the downstream face of the dam.

(2) Capping of the top of the dam to the right of the spillway with 8 inches of reinforced concrete.

(3) Construction of a 12-inch thick cutoff wall against the upstream side of the dam and spillway. The wall was to extend from the top of the dam to an impervious foundation. (The plans prepared in 1952 show the cutoff wall extending 6 feet below the spillway crest.)

The right abutment of the dam was overtopped and breached in July 1952. The abutment area was apparently lower than the dam itself since the dam was not overtopped. It is reported that a maximum of 6 inches of water was flowing over the abutment area just prior to failure. Modifications performed to the dam following this flood included:

(1) Construction of a concrete corewall across the area where the breach occurred. The plans (see Appendix E) show that the corewall was to extend from the right end of the outlet works into the right abutment area. The total length of the wall was to be 50 feet.

(2) Widening of the spillway to approximately twice its original width.

According to photographs contained in the files of the Bureau of Dams and Waterway Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER), no major modifications have been made to the dam since 1952.

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 lower the reservoir 2.9 feet below the spillway crest.

1.3 Pertinent Data.

a. Drainage Area. (square miles) 11.0

b. Discharge at Damsite. (cfs)

Maximum known flood	Unknown
Outlet works at maximum pool elevation	235
Spillway capacity at maximum pool elevation	2475

c. Elevation. (feet above msl.)

Top of dam	1083.2
Maximum pool	1083.2
Normal pool (spillway crest)	1079.0
Upstream invert outlet works	1076.1
Downstream invert outlet works	1075.4
Streambed at toe of dam	1066.0

d. Reservoir Length. (miles)

Normal pool	0.63
Maximum pool	0.74

e. Storage. (acre-feet)

Normal pool	160
Maximum pool	339

f. Reservoir Surface. (acres)

Normal pool	37
Maximum pool	51

g.	Dam.	
	Type	Earthfill with vertical, dry stone masonry wall on downstream side
	Length (feet)	235, including spillway
	Height (feet)	17
	Top Width (feet)	16
	Side Slopes Upstream	Vary; average is about 1V on 3H
	Downstream	Vertical
	Zoning	None
	Cutoff	Concrete wall on upstream face of dam extends 6 feet below spillway crest
	Grout Curtain	None
h.	Diversion and Regulating Tunnel.	None
i.	Spillway.	
	Type	Two stage, rectangular, concrete broadcrested weir

i. Spillway. (Cont'd.)

Length of Weir (feet)	
First Stage	58
Second Stage	58
Crest Elevation (feet above msl.)	
First Stage	1079.0
Second Stage	1079.4
Upstream Channel	Reservoir
Downstream Channel	Natural Stream

j. Regulating Outlets. Four-foot wide gated sluiceway with upstream invert elevation 1076.1 feet

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. Design information for Bunnell's Pond Dam includes:

(1) A sketch prepared in July 1942 for proposed repairs and modifications to the dam.

(2) Design plans, prepared in August 1952, for enlarging the spillway and repairing the breach in the right abutment caused by the flood of July 1952.

No design calculations are available.

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 Plates E-2 through E-4.

c. Design Considerations. Design information for the dam is somewhat sketchy and is not considered sufficient to assess the design of the dam.

2.2 Construction.

a. Data Available. There is very little information concerning the original construction of the dam and subsequent modifications to it. According to information contained in the files of PennDER the 1952 modifications were performed in accordance with the design plans.

b. Construction Considerations. There are insufficient data to assess the construction of the dam.

2.3 Operation. There are no formal records of operation. Records of inspections performed by the Commonwealth are available for the period from 1924 to 1965. A summary of the inspection reports is included in Appendix A.

2.4 Evaluation.

a. Availability. Engineering data were provided by PennDER. The Owner was available for information during the visual inspection.

b. Adequacy. The type and amount of available design and other engineering data 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 fair. 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 is included in Appendix E. On the day of the inspection, the reservoir pool was at the level of the spillway crest.

b. Embankment. The embankment is in generally fair condition. The upstream slope, protected with a stand of grass on the left end of the dam and with heavy stone on the right end, shows no signs of distress or erosion. The top of the earth portion of the dam is covered with a good stand of grass. A ten-foot section of the masonry wall on the downstream side of the dam to the left of the spillway is bulged outward approximately 6 inches. This condition was observed during inspections by the Commonwealth as early as 1930. The inspection reports also indicated that the condition seemed to have stabilized by 1937. By comparing the present condition with that shown in photographs taken in 1937, the bulging does not appear to have worsened during the intervening 44 years. Clear seepage was observed at the toe of the dam in the vicinity of the bulged area. The flow rate at the time of the inspection was estimated at 1/2 gallon per minute (gpm). The concrete cap on the top of the dam between the spillway and outlet works is spalled. The condition is surficial in nature and is not considered to affect the integrity of the dam.

c. Appurtenant Structures. Overall, the spillway is in fair condition. The low-flow section of the concrete weir shows signs of erosion. The remainder of the weir has also experienced minor erosion and cracking. The concrete apron at the base of the spillway is somewhat deteriorated and undermined approximately one foot. The downstream end of the left spillway wall is deteriorated at the base. The concrete is spalled to a depth of about 5 inches. Stones are missing from the downstream face of the spillway at several locations. Most of the downstream toe and upstream side of the spillway was submerged and could not be inspected.

The outlet works gate has not been operated recently and has a substantial amount of sediment and debris built up behind it. Leakage around the edges of the gate was estimated at 10 gpm. The concrete surfaces of the outlet works are cracked and spalled.

d. Reservoir Area. The watershed is approximately 50 percent wooded and 50 percent farmland. Several small ponds and reservoirs are located within the watershed. The hills in the area rise to a maximum of about 640 feet above the reservoir surface and are gently to moderately sloping.

e. Downstream Conditions. One building containing two seasonal dwellings is located just downstream from the left end of the dam. One permanent residence is located approximately 150 feet downstream from the dam on the right stream bank. More than a few lives could be lost in the event of a failure of Bunnell's Pond Dam. Freethy Dam is located approximately 1.3 miles downstream from Bunnell's Pond Dam. Very little development has taken place in the floodplain between the two dams.

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 on an unscheduled basis. Although the dam is checked periodically by the Owner, no formal reports are maintained.

4.3 Maintenance of Operating Facilities. There is no established procedure for maintenance of the outlet works facilities.

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

4.5 Evaluation of Operational Adequacy. Although some maintenance is performed, the current program is inadequate. 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 Bunnell's Pond Dam. According to a report prepared by the Commonwealth, the spillway as redesigned in 1952 was to have a capacity of 2,570 cubic feet per second (cfs). This figure compares favorably with the spillway capacity calculated in Appendix D of this report.

b. Experience Data. A failure of the right abutment of the dam occurred in July 1952 as a result of overtopping of a low section of the abutment by approximately six inches. The dam itself was, reportedly, not overtopped and therefore suffered no damage. The depth of flow through the spillway was estimated at four feet at the peak of the storm. Damage downstream included washout of two roads, complete destruction of an old cheese factory, and flooding of one home. At the time of the failure, the bridge located 150 feet downstream from the dam had 6 feet of water flowing over its deck.

The dam also sustained minor damage during the flood of 1942. However, no information is available which documents the reservoir pool level or damages sustained.

No other failures of the dam or its appurtenant structures are known to have occurred during the recent history of the dam. No rainfall, runoff, or reservoir level records are available.

c. Visual Observations.

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

(2) Embankment. The top of the embankment is fairly uniform, having a minimum elevation of 1083.2 feet at the left end of the spillway. The low area at the right abutment of the dam was raised during the repairs of 1952, thereby decreasing the chances of a failure of the type that occurred in 1952. Although most of the embankment could withstand some overtopping, the area at the toe of the dam adjacent to the left end of the spillway would be particularly susceptible to scouring caused by water discharging over the nearly vertical 8-foot high downstream face of the dam.

(3) Appurtenant Structures. No condition was observed that would indicate that the spillway could not operate satisfactorily in the event of a flood. The operability of the outlet works, however, is questionable because of the debris and sediment that has collected behind the gate.

(4) Reservoir Area. Several small ponds and reservoirs are located within the Bunnell's Pond watershed. Two of the reservoirs, SCS PA-420 and Upper Wilcox Pond, were included in the hydrologic and hydraulic analysis. SCS PA-420 is an earthfill dam approximately 33 feet high and has a maximum storage capacity of 201 acre-feet. The purpose of the dam is flood retention. Upper Wilcox Pond has a dam approximately 18 feet high and has a maximum storage capacity of 623 acre-feet.

(5) Downstream Conditions. One building containing two seasonal dwellings is located just downstream from the left end of the dam. The first floor of this building is about 8 feet below the top of dam. One permanent residence is located approximately 150 feet downstream from the dam on the right streambank. Both residences could be flooded in the event of a failure of the dam. Freethy Dam is located 1.3 miles downstream from Bunnell's Pond Dam. Failure of Bunnell's Pond Dam could contribute to conditions leading to a failure of Freethy Dam. Very little development has taken place in the low-lying areas between the two dams.

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 Bunnell's Pond Dam is between one-half of the Probable Maximum Flood (PMF) and the PMF. Since the dam and reservoir are on the low end of the small size category, the 1/2 PMF was selected as the SDF for Bunnell's Pond 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, without consideration of the effects of future development.

(2) Summary of Results. Pertinent results are tabulated at the end of Appendix D. The analysis reveals that Bunnell's Pond Dam can pass about 18 percent of the PMF before overtopping of the dam occurs.

(3) Spillway Adequacy. The criteria used to evaluate the spillway adequacy of a dam are described in Appendix D. Since the dam could not pass the 1/2 PMF and was considered to fail during storms of only 25 percent of the PMF, a breach analysis was performed to ascertain the impact of the failure on the downstream area. The conditions contributing to failure of the dam, as well as its failure mode, are included in Appendix D. It was found that failure of the dam during 25 percent of the PMF would cause a discharge from the reservoir of nearly 4,700 cfs greater than that which would occur if the dam were not to fail. This represents an increased hazard for loss of life immediately downstream from the dam and, accordingly, the spillway capacity of Bunnell's Pond Dam is rated as seriously inadequate.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Bunnell's Pond 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) Embankment. The bulged masonry wall at the left end of the dam is generally the type of deficiency which indicates a potential stability problem for a dam. However, as previously mentioned, the bulge was observed as early as 1930 and appeared to have stabilized by 1937. In as much as this condition does not seem to have worsened since that time, it is not considered to be a serious threat to the structural stability of the dam.

The seepage observed at the toe of the dam and spalled concrete cap to the right of the spillway are not, at this time, considered detrimental to the stability of the dam.

(3) Appurtenant Structures. The concrete apron at the base of the spillway does not appear to have been a design feature of the dam as it does not appear in early photographs of the dam or in the plans for the 1952 modifications. Apparently, it was added sometime during or following the construction work performed in 1952. Although the reason for the addition of the apron is unknown, the undermining and deterioration of it are not considered to adversely affect the stability of the dam or spillway at this time. The other deficiencies observed are not considered to have an adverse effect on the stability of the dam or spillway.

The conditions observed at the outlet works are not considered to seriously affect the stability of the dam.

b. Design and Construction Data. No calculations of embankment or spillway stability are available. However, nothing in the design plans or construction correspondence indicates any concern for the stability of the structure.

c. Operating Records. There are no operating records maintained for Bunnell's Pond Dam and Reservoir. The 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 do not appear to adversely affect the structural stability of the dam.

e. Seismic Stability. Bunnell's Pond 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 considered to be adequate.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND

PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on criteria established for these studies, Bunnell's Pond 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 18 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 that would occur during storms greater than 25 percent of the PMF. Failure of Bunnell's Pond Dam would cause an increased hazard for loss of life downstream.

(2) Overall the dam is considered to be in fair condition. Several deficiencies were observed, all of which are considered to be minor.

(3) Although some maintenance has been performed, the existing maintenance program should be upgraded.

(4) A summary of the features and observed deficiencies is as follows:

Feature	Observed Deficiency
Embankment	Bulged masonry wall on downstream face; seepage at toe; spalled concrete cap.
Spillway	Eroded and cracked weir; deteriorated and undermined apron at base; deteriorated left training wall at downstream end; stones missing from downstream face.
Outlet Works	Cracked and spalled concrete; debris and sediment at upstream end.

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 available data, visual inspection, past performance, and computations performed as part of this study.

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 Bunnell's Pond Dam and develop alternatives to provide adequate spillway capacity. Take appropriate action as required.

(2) Remove the debris and sediment which has collected behind the outlet works sluice gate so that the gate can be operated if necessary.

(3) Develop a method for drawing down the reservoir in case of an emergency. If a pipe is placed through the embankment, it should be provided with an upstream closure facility.

(4) Monitor the seepage and bulging of the masonry wall at the left end of the dam and the undermining of the concrete apron at the base of the spillway. Take appropriate action if any condition worsens.

(5) The deteriorated concrete on the top of dam, spillway and outlet works; and stones missing from the downstream face of the dam do not require any special attention at the present time. They should, however, be closely observed during all future inspections 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 Bunnell's Pond 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) Expand 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

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: Bunnell's Pond Dam

NDI ID NO.: PA-00170 DER ID NO.: 64-29

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	None Available
REGIONAL VICINITY MAP	See Plate E-1 (Appendix E)
CONSTRUCTION HISTORY	Not available.
TYPICAL SECTIONS OF DAM	See Plate E-3
OUTLETS: Plan Details Constraints Discharge Ratings	Discharge rating is included in Appendix D; no other detailed information is available.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	No records are maintained.
DESIGN REPORTS	"Report Upon the Bunnell's Pond Dam" prepared by the Commonwealth July 1917 give a description of the original structure.
GEOLOGY REPORTS	see Appendix F
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	None
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	None
POSTCONSTRUCTION SURVEYS OF DAM	None

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	Unknown
MONITORING SYSTEMS	None
MODIFICATIONS	Repairs and modifications performed in 1942 and 1952 are described in PennDER files and Section 1 of this report; also see Plates E-2 and E-3 (Appendix E)
HIGH POOL RECORDS	No formal records are maintained.
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	Failure of right abutment July 1952 is described in files of PennDER and Section 1 of this report.

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	Records in the form of inspection reports and correspondence are contained in the files of PennDER.
SPILLWAY: Plan Sections Details	See Plates E-2 and E-3 (Appendix E)
OPERATING EQUIPMENT: Plans Details	See Plate E-2
PREVIOUS INSPECTIONS Dates Deficiencies	Oct. 1924 - Spillway obstructed with flashboards; leakage along downstream toe; leakage through right end of sluiceway; general appearance - good.
	June 1930 - Spillway obstructed with flashboards and footbridge; heavy leakage along toe; some bulging of downstream face of masonry wall to left of spillway; general appearance - fair.

ENGINEERING DATA

ITEM	REMARKS
PREVIOUS INSPECTIONS (Continued)	Aug. 1934 - Bulging of downstream face; seepage under right end near timber sluice; flashboards in spillway; general appearance - fair.
	Nov. 1937 - Bulging of downstream face (appears to have stabilized); leakage no worse than previously reported; general appearance - fair.
	June 1948 - Leakage along toe has stabilized; no spillway obstructions; general appearance - very good.
	June 1952 - Small amount of leakage through toe; no maintenance needed; general appearance - good.
	March 1955 - Overall appearance - OK

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Bunnell's Pond Dam County: Wayne State: Pennsylvania

NDI ID No.: PA-00170 DER ID No.: 64-29

Type of Dam: Earthfill & Stone Masonry Hazard Category: High

Date(s) Inspection: 12 November 1980 Weather: Overcast, windy Temperature: 30°F

Pool Elevation at Time of Inspection: 1079.0 ft. msl/Tailwater at Time of Inspection: 1066.0 ft. msl

Note: Elevations referenced to pool level shown on USGS quad (White Mills, PA)

Inspection Personnel:

D.B. Wilson (GFCC) W. Seland (Owner)

R.E. Holderbaum (GFCC)

D.R. Ebersole (GFCC)

R.E. Holderbaum 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	Masonry wall forms downstream side of dam.	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	None	
CREST ALIGNMENT: Vertical Horizontal	Vertical - see top of dam profile (Plate E-4) Horizontal - good	
RIPRAP FAILURES	No riprap	Masonry wall at right end of dam protects upstream slope.

EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	Good	
ANY NOTICEABLE SEEPAGE	See CONCRETE/MASONRY DAMS, sheet 1 of 2.	
STAFF GAGE AND RECORDER	None	
DRAINS	None observed	

CONCRETE/MASONRY DAMS

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	small seep at toe of downstream face 10'(±) left of spillway ~ ½ gpm.	should be monitored in the future.
JUNCTION OF STRUCTURE WITH: Abutment Embankment Other Features	Bulged area in downstream face to left of spillway approximately 10 feet wide, displacement ~ 6 inches.	should be monitored in future.
DRAINS	None observed.	
WATER PASSAGES	N/A	
FOUNDATION	N/A	

CONCRETE/MASONRY DAMS

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES: Surface Cracks Spalling	Concrete on crest at right end of dam is spalled.	Considered to be minor, surficial only.
STRUCTURAL CRACKING	None	
ALIGNMENT: Vertical Horizontal	Vertical - good. Horizontal - bulged area as noted on previous page.	
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	N/A	
STAFF GAGE OR RECORDER	None	

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Erosion of low flow section; minor erosion and cracking of remainder of weir.	Downstream end of left training wall is deteriorated at base; concrete spalled to depth of 5 inches.
APPROACH CHANNEL	Lake - unobstructed.	
DISCHARGE CHANNEL	Stream channel unobstructed. Concrete apron at base of spillway undermined - 1 foot.	Should be monitored.
BRIDGE AND PIERS	N/A	
OTHER	Stones missing at several locations on downstream face.	

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Concrete sluiceway - minor cracking and deterioration of concrete.	
INTAKE STRUCTURE	Manually operated sluice gate at upstream face of dam.	
OUTLET STRUCTURE	None - straight drop into stream channel.	
OUTLET CHANNEL	Discharges into stream channel below dam.	
EMERGENCY GATE	Leakage around gate - no gunk; does not appear to have been operated recently.	Debris and sediment has collected behind gate;* could not be used to completely drawdown lake.

* Debris and sediment needs to be removed periodically.

INSTRUMENTATION

Sheet 1 of 1

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

DOWNSTREAM CHANNEL

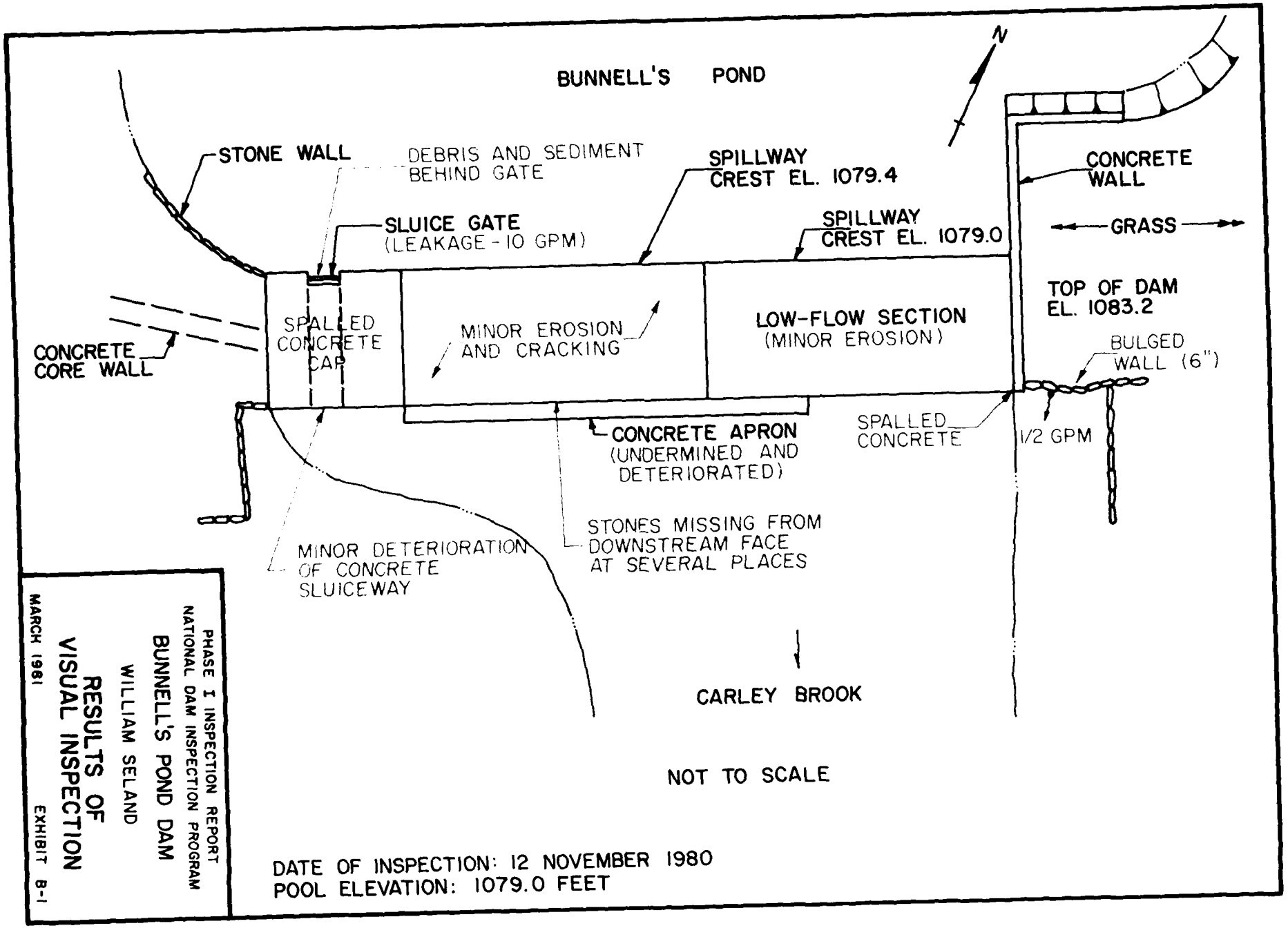
Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	Small road bridge approximately 200 feet downstream.	
SLOPES	Bed slope approximately 0.4 percent between Burnell's and Freeby Ponds.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	One permanent residence and one seasonal residence with 2 rental units are located immediately downstream.	Freeby Dam is located approximately 1700 feet downstream.

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate; west shore of reservoir primarily wooded; east shore primarily open.	
SEDIMENTATION	Some sedimentation was observed on upstream side of structure.	Extent of sedimentation is unknown.
WATERSHED DESCRIPTION	Approximately 50 % farmland, 50 % wooded; several small lakes and ponds within watershed.	Very little development has taken place within watershed.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BUNNELL'S POND DAM

WILLIAM SELAND

RESULTS OF VISUAL INSPECTION

MARCH 1981

EXHIBIT B-1

APPENDIX C

PHOTOGRAPHS

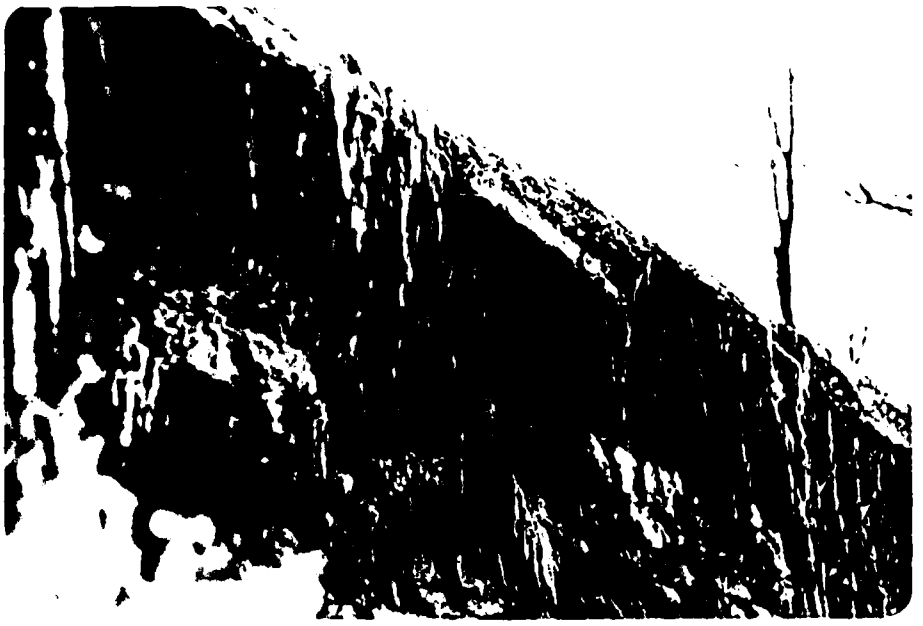
BUNNELL'S POND DAM

A. Upstream Side of Dam

B. Upstream Side of Spillway

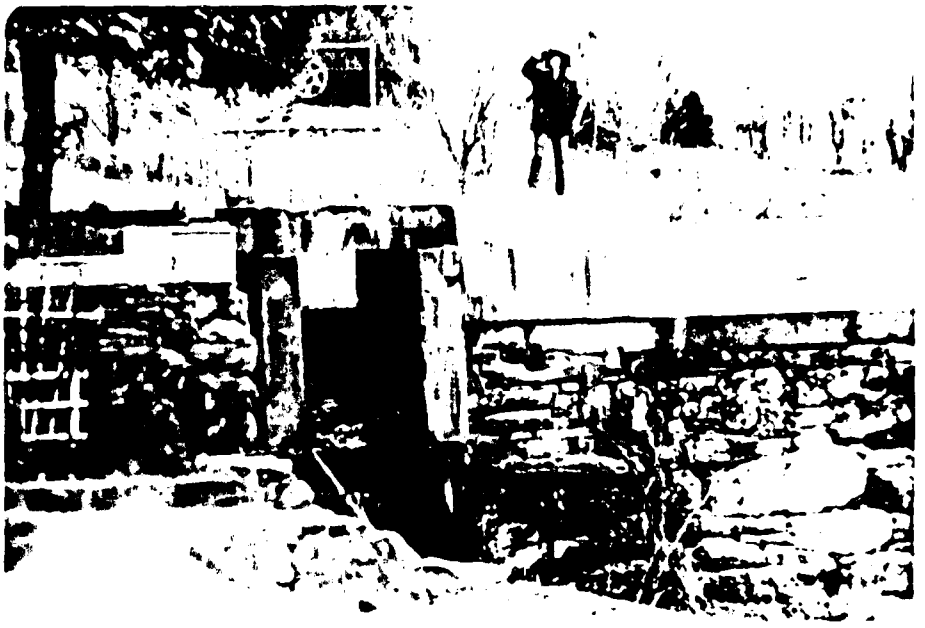
C. Spillway-Looking Toward Right Abutment

D. Downstream Face of Left End of Spillway



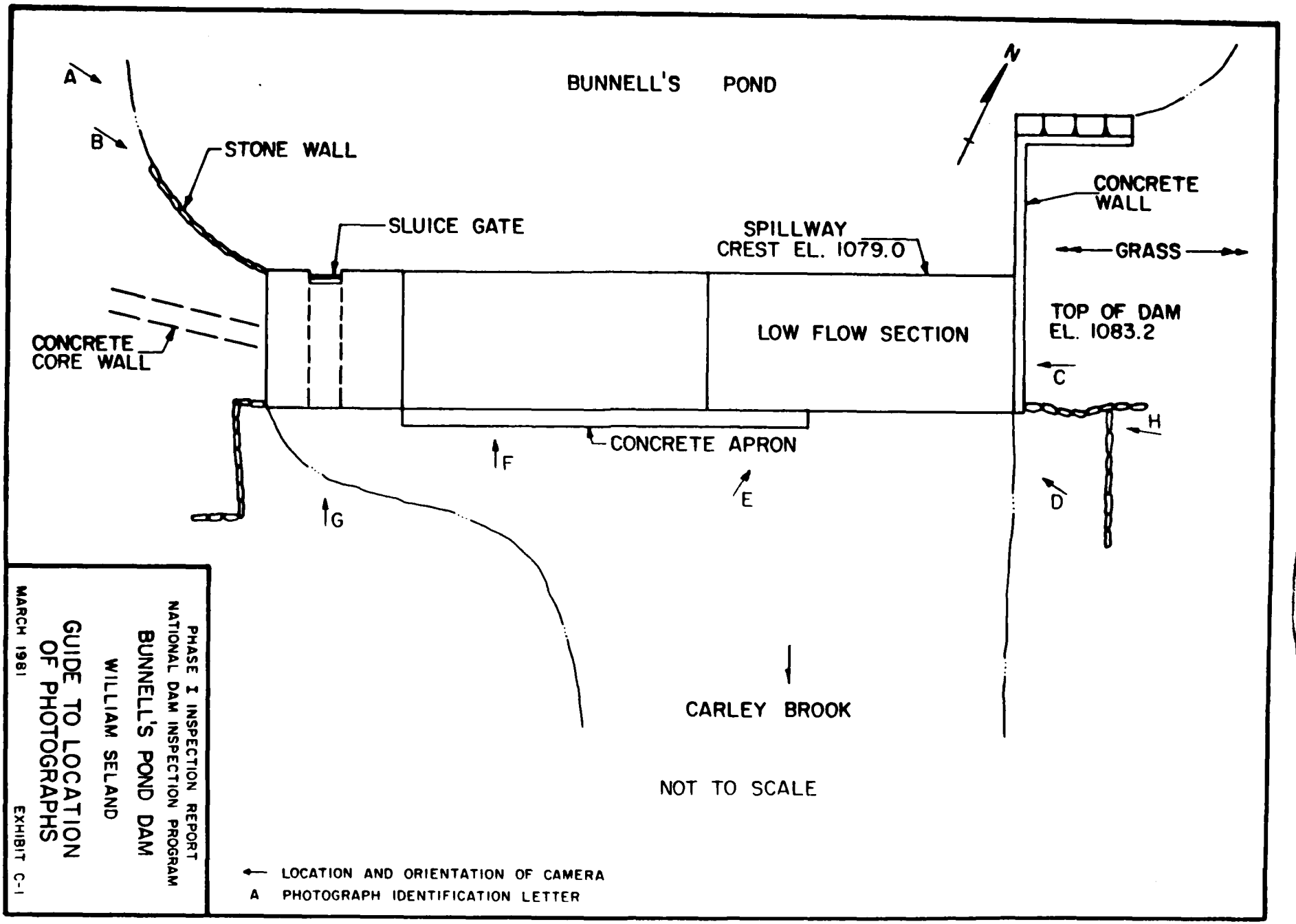
E. Downstream End of Spillway Weir

F. Concrete Apron At Base of Spillway



G. Above - Downstream Side of Outlet Works

H. Left - Bulged Masonry Wall Near Left Abutment



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BUNNELL'S POND DAM

WILLIAM SELAND

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 River Basin
Name of Stream: CARLEY BROOK
Name of Dam: BUNNELL'S POND DAM
NDI ID No.: PA-02170
DER ID No.: 64-29
Latitude: N 41° 35.1' Longitude: W 75° 14.8'
Top of Dam Elevation: 1083.2 ft.
Streambed Elevation: 1066.0 ft. Height of Dam: 17 ft
Reservoir Storage at Top of Dam Elevation: 339 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
SCS PA-420	2.2	33	301	DER ID 64-185
UPPER WILCOX	3.9	18±	623	DER ID 64-53

DOWNSTREAM DAMS

FREETHY	1.3	26	89	DER ID 64-160

DELAWARE River Basin

Name of Stream: CARLEY BROOK

Name of Dam: BUNNELL'S POND DAM

DETERMINATION OF PMF RAINFALL & UNIT HYDROGRAPH

UNIT HYDROGRAPH DATA:

Sub-area	Drainage Area (square miles)	Cp (1)	Ct (2)	L miles (3)	L_{ca} miles (4)	L' miles (5)	Tp hours (6)	Map Area (7)	Plate (8)
A-1	0.9	0.45	1.23	1.33	0.76	N/A	1.23	1	A
A-2	0.6	0.45	1.23	N/A	N/A	0.51	0.82	1	A
A-3	9.5	0.45	1.23	7.39	3.51	N/A	3.27	1	A
Total	11.0								

(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): $Tp=C_t \times (L \times L_{ca})^{0.3}$, except where the centroid of the subarea is located in the reservoir. Then $Tp=C_t \times (L')^{0.6}$

Initial flow is assumed at 1.5 cfs/sq. mile

Computer Data: QRCSN = -0.05 (5% of peak flow)
RTIOR = 2.0

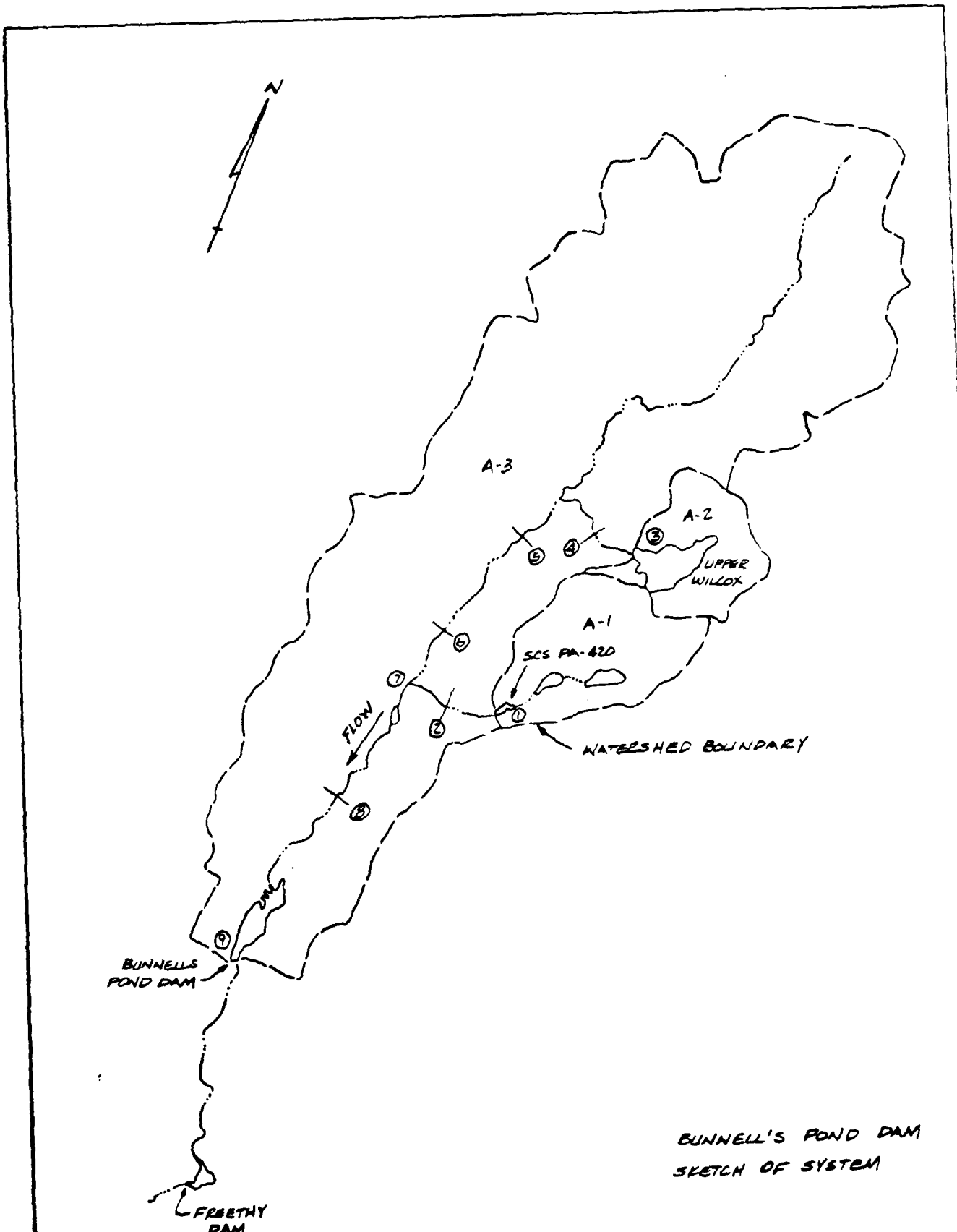
RAINFALL DATA:

PMF Rainfall Index= 21.2 in., 24 hr., 200 sq. mile

	Hydromet. 40 (Susquehanna Basin)	Hydromet. 33 (Other Basins)
Zone:	N/A	1
Geographic Adjustment Factor:		1.0
Revised Index Rainfall:		21.2

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	110
12 hours	122
24 hours	132
48 hours	141
72 hours	N/A
96 hours	N/A



BUNNELL'S POND 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

Elevation		Area (acres)	Storage million gals	Storage acre-ft		Remarks
1272.7	=ELEVO*	0	0	0		
1281.4	=ELEV1	2.3 =A1			=S1	
1285.0		5.2				
1290.0		7.1				
1295.0		9.3				
1300.0		12.0				
1305.0		14.5				

* ELEVO = ELEV1 - $(3S_1/A_1)$

** 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) x H) & A = L·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-1

Name of Dam: SCS PA-420

SPILLWAY DATA: TAKEN FROM PHASE I REPORT, SCS PA-420, MAY 1980	Existing Conditions	Design Conditions
		(N/A)
Top of Dam Elevation	1304.3	
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.	1293.4	
Auxiliary Spill. Head Avail. (ft)	5.9	
Type Auxiliary Spillway	VEGETATED CHANNEL	
"C" Value - Auxiliary Spill. (ft)	2.7	
Crest Length - Auxil. Spill. (ft)	155	
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	608
1300.6	123	1165	1288
1302.2	126	2751	2877
1304.3	130	5590	5720

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
	(N/A)	(N/A)	(N/A)
Invert of Outlet			
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction=$29.1_N{}^2L/R^{4/3}$			
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:

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

* ELEVO = ELEV1 - $(3S_1/A_1)$

** 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) x H) & A = L·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-2

Name of Dam: UPPER WILCOX POND

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

Spillway Rating Curve: SEE PAGE D-9

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

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=$29.1_N{}^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5}$ = C			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$(cfs)			
Q Combined (cfs)			

BY REH DATE 1/21/81 SUBJECT UPPER WILCOX POND SHEET NO ____ OF ____
CHKD BY ____ DATE ____ SPILLWAY RATING JOB NO ____

① Calculate weir flow from crest (1426.0) to elev. 1429.0 (top of conduit)

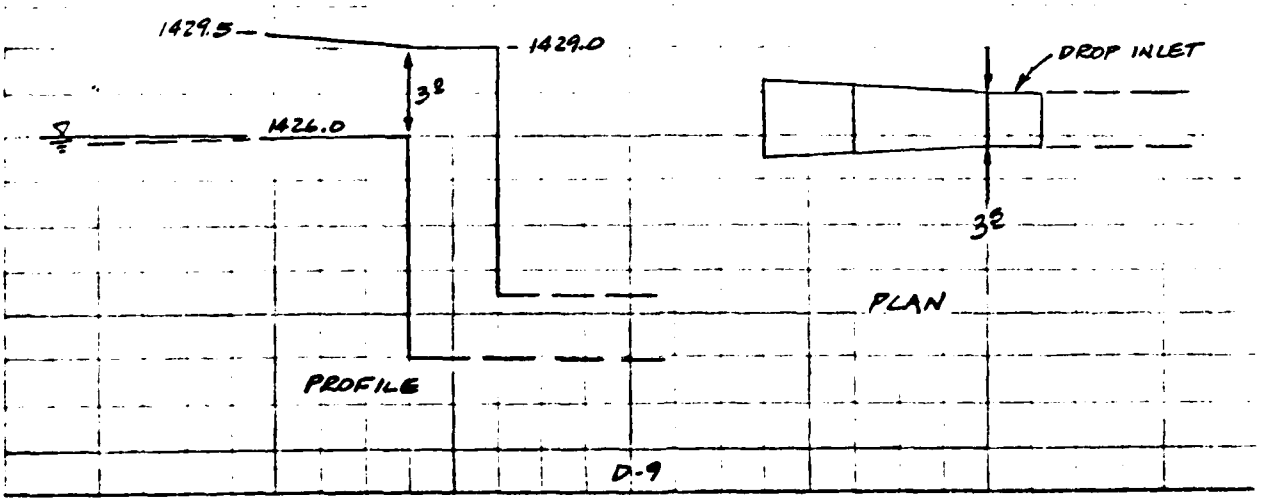
$$Q_w = CL H_w^{3/2} = 2.9(3.5) H_w^{3/2} = 10.15 H_w^{3/2}$$

② Calculate pressure flow above elev. 1429.0

$$Q_p = CA\sqrt{2gH_p} = 0.7(3.0)(3.5)\sqrt{64.4}\, H_p^{1/2} = 59.0 H_p^{1/2} *$$

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 ft.

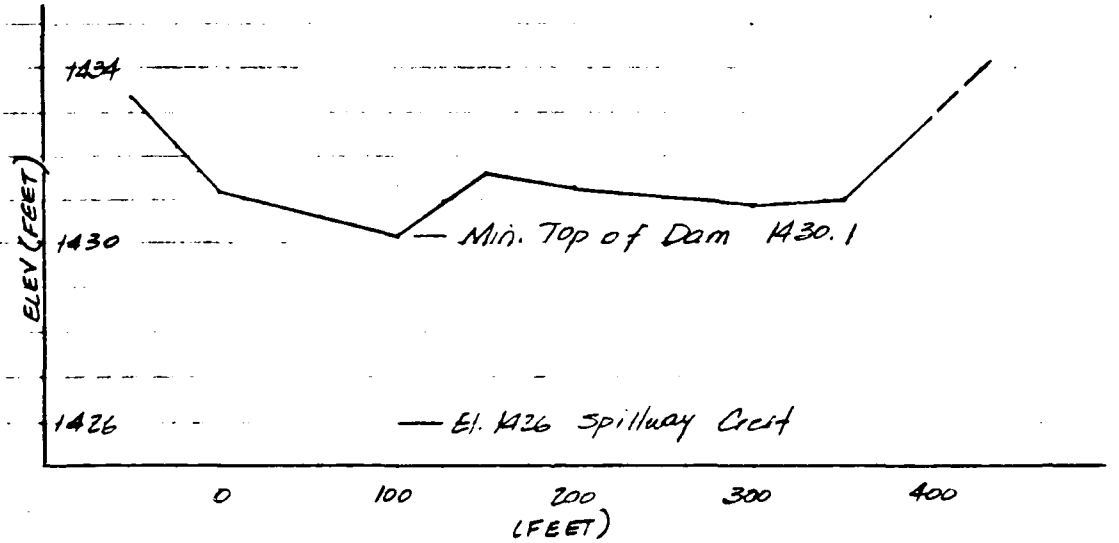


BY REH DATE 1/21/81 SUBJECT UPPER WILCOX POND SHEET NO ____ OF ____

CHKD BY ____ DATE ____ JOB NO ____

TOP OF DAM PROFILE

NOTE: The following elevations are referenced to the pool elevation shown on USGS quadrangle, Galike, PA.



℄ L	℄ V
0	1430.1
95	1430.9
380	1431.7
590	1432.0
440	1433.0
500	1434.0

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 million gals	Storage acre-ft		Remarks
1066	=ELEVO*	0		0	0		STREAMBED
1079	=ELEV1	37	=A1	52	160	=S1	NORMAL POOL
1083.2		51		110	339		TOP OF DAM
1100 **		108		—	—		

* ELEVO = ELEV1 - $(3S_1/A_1)$

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

Reservoir Area at Normal Pool is 2.1 percent of subarea watershed.

BREACH DATA: SEE PAGE D-14

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) x H) & A = L·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	1083.2	(N/A)
Spillway Crest Elevation	1079.0	
Spillway Head Available (ft)	4.2	
Type Spillway	CONCRETE BROAD CRESTED WEIR	
"C" Value - Spillway	2.65	
Crest Length - Spillway (ft)	116 (TOTAL - BOTH SIDES)	
Spillway Peak Discharge (cfs)	2475	
Auxiliary Spillway Crest Elev.	N/A	
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: SEE PAGE D-13

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
1079.0	0	N/A	N/A
1079.4	39		
1080.0	226		
1080.5	461		
1081.0	745		
1082.0	1446		
1083.0	2284		
1084.0	3241		
1085.0	4304		
1086.0	5463		

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	1075.4	(N/A)	(N/A)
Invert of Inlet	1076.1		
Type	SLUICEWAY		
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction=$29.1 N^2 L/R^{4/3}$	N/A SEE BELOW		
Sum of K			
$(1/K)^{0.5} = C$			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

$Q_{MAX} \cong CLH^{1.5} = 3.1(4.0)(1083.2-1076.1)^{1.5} = 235$ cfs.

BY REH DATE 1/22/81 SUBJECT BUNNELL'S POND DAM SHEET NO ____ OF ____
CHKD BY ✓ DATE ____ SPILLWAY RATING JOB NO ____

Two-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	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

L_1 = 58 feet
L_2 = 58 "

$Q_1 = 2.65(58)H_1^{3/2} = 154H_1^{3/2}$

$Q_2 = 2.65(58)H_2^{3/2} = 154H_2^{3/2}$

FLOW OVER TOP OF DAM: (AND ABUTMENTS)

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

BY _____ DATE _____
CHKD BY _____ DATE _____
SUBJECT BUNNELL'S POND DAM
SHEET NO _____ OF _____
JOB NO _____

BREACH ANALYSIS PARAMETERS

PLAN 1 - Non-failure

PLAN 2 - Failure

FIELD	VARIABLE	VALUE	REMARKS
0	ID	#B	
1	BRWID	35	WIDTH OF SUSCEPTIBLE SECTION OF DAM TO LEFT OF SPILLWAY
2	Z	0.5	
3	ELBM	1066	STREAMBED AT TOE OF DAM
4	TFAIL	1.0	
5	WSEL	1079	NORMAL POOL
6	FAILEL	1083.7	0.5 FT. ABOVE MINIMUM TOP OF DAM; BASED ON PAST EXPERIENCE, I.E. THE FAILURE OF THE RIGHT ABUTMENT IN 1952

BY _____ DATE _____ SUBJECT BUNNELL's POND DAM SHEET NO _____ OF _____

CHKD BY _____ DATE _____ JOB NO _____

SELECTED COMPUTER OUTPUT

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                A1                        NATIONAL DAM INSPECTION PROGRAM
    2                A2                    BALTIMORE DISTRICT CORPS OF ENGINEERS
    3                A3                          BUNNELLS POND DAM
    4                B     300        0       15        0        0        0        0        0       -4        0
    5                B1      5
    6                J       1        5        1
    7                J1    1.0      0.5      0.3      0.2      0.1
    8                K       0        1                                          1
    9                K1        INFLOW TO SCS PA-420
   10                M       1        1      0.9                11.0                                      1
   11                P                21.2      110      122      132      141
   12                T                                                          1     0.05
   13                W     1.23     0.45
   14                X     -1.5    -0.05      2.0
   15                K       1        1                                          1
   16                K1        ROUTE THROUGH SCS PA-420
   17                Y                                         1        0
   18                Y1      1                                                 6.7       -1
   19                Y4 1281.4   1282.5     1285     1290   1296.8   1298.4  1299.65   1300.6   1302.2   1304.3
   20                Y5      0        5       11       17       23      105      608     1288     2877     5720
   21                SA      0      2.3      5.2      7.1      9.3       12     14.5
   22                SE 1272.7   1281.4     1285     1290     1295     1300     1305
   23                SS 1298.4  (EMERGENCY SPILLWAY CREST)
   24                SD 1304.3
   25                K       1        2                                          1
   26                K1        STREAM REACH 1 (STATION 2)
   27                Y                                         1        0
   28                Y1      1                                                  -1
   29                Y6   0.08    0.045     0.08     1190     1205     3400    0.038
   30                Y7      0     1220       90     1200      110     1192      110     1190      115     1190
   31                Y7    115     1192      200     1200      310     1220
   32                K       0        3                                          1
   33                K1        INFLOW TO UPPER WILCOX POND
   34                M       1        1      0.6                11.0                                      1
   35                P                21.2      110      122      132      141
   36                T                                                          1     0.05                0.18
   37                W     0.82     0.45
   38                X     -1.5    -0.05      2.0
   39                K       1        3                                          1
   40                K1        ROUTE THROUGH UPPER WILCOX POND
   41                Y                                         1        0
   42                Y1      1                                                -1426       -1
   43                Y4   1426     1427     1428     1429     1430     1431     1432     1433     1434
   44                Y5      0       10       29       53       88      106      122      135      147
   45                SA      0       70       87
   46                SE   1412     1426     1440
   47                SS   1426
   48                SD 1430.1
   49                SL      0       95      380      390      440      500
   50                SV 1430.1  1430.9   1431.7   1432.0   1433.0   1434.0
```

```
K      1       4                                                    1
K1      STREAM REACH 2 (STATION 4)
Y                                    1       0
Y1     1                                                           -1
Y6  0.08    0.045     0.08     1360     1375     4000    0.052
Y7     0     1400       50     1380      115     1362      115     1360      120     1360
Y7   120     1362      200     1380      260     1400
K      1       5                                                    1
K1      STREAM REACH 3 (STATION 5)
Y                                    1       0
Y1     1                                                           -1
Y6  0.08    0.045     0.08     1180     1195     4500    0.008
Y7     0     1220      150     1200      300     1182      300     1180      307     1180
Y7   307     1182      790     1200      900     1220
K      1       6                                                    1
K1      STREAM REACH 4 (STATION 6)
Y                                    1       0
Y1     1                                                           -1
Y6  0.08    0.045     0.08     1149     1164     4200    0.006
Y7     0     1180      100     1160      675     1152      675     1149      685     1149
Y7   685     1152      910     1160     1000     1180
K      2       7                                                    1
K1      COMBINE HYDROGRAPHS AT CONFLUENCE CARLEY BROOK AND PA-420 OUTFLOW
K      1       8                                                    1
K1      STREAM REACH 5 (STATION 8)
Y                                    1       0
Y1     1                                                           -1
Y6  0.08    0.045     0.08     1120     1135     8100    0.007
Y7     0     1160      150     1140      390     1123      390     1120      400     1120
Y7   400     1123      550     1140      730     1160
K      0       9                                                    1
K1      INFLOW TO BUNNELLS POND
M      1       1       9.5              11.0                                             1
P              21.2     110      122      132      141
T                                                          1.0     0.05
W   3.27    0.45
X   -1.5   -0.05      2.0
K      2       9
K      1       9                                                    1
K1      ROUTE THROUGH BUNNELLS POND
Y                                    1       0
Y1     1                                                       -1079      -1
Y4  1079  1079.4     1080   1080.5     1081     1082     1083     1084     1085     1086
Y5     0      39      226      461      748     1446     2284     3241     4304     5463
$A     0      37      108
$E  1066    1079     1100
$$  1079
$D1083.2
$L     0     115      135      175      270      460
$V1083.2  1083.3  1083.5     1084     1085     1086
```

D-17

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	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .50	RATIO 3 .30	RATIO 4 .20	RATIO 5 .10	
HYDROGRAPH AT	1	.90	1	2242.	1121.	672.	448.	224.	SCS PA-420
	(	2.33)	(	63.47)(	31.74)(	19.04)(	12.69)(	6.35)(	
ROUTED TO	1	.90	1	2223.	1100.	580.	288.	21.	
	(	2.33)	(	62.94)(	31.15)(	16.43)(	8.15)(	.60)(	
ROUTED TO	2	.90	1	2218.	1100.	580.	283.	21.	
	(	2.33)	(	62.79)(	31.16)(	16.41)(	8.00)(	.60)(	
HYDROGRAPH AT	3	.60	1	1835.	918.	551.	367.	184.	Upper Wilcox
	(	1.55)	(	51.97)(	25.98)(	15.59)(	10.39)(	5.20)(	
ROUTED TO	3	.60	1	1095.	91.	43.	24.	9.	
	(	1.55)	(	30.99)(	2.56)(	1.21)(	.69)(	.25)(	
ROUTED TO	4	.60	1	1091.	91.	43.	24.	9.	
	(	1.55)	(	30.88)(	2.56)(	1.21)(	.69)(	.25)(	
ROUTED TO	5	.60	1	1046.	90.	43.	24.	9.	
	(	1.55)	(	29.63)(	2.56)(	1.21)(	.69)(	.25)(	
ROUTED TO	6	.60	1	968.	90.	43.	24.	9.	
	(	1.55)	(	27.42)(	2.56)(	1.21)(	.69)(	.25)(	
2 COMBINED	7	1.50	1	2541.	1136.	603.	302.	30.	
	(	3.88)	(	71.95)(	32.16)(	17.09)(	8.54)(	.85)(	
ROUTED TO	8	1.50	1	2493.	1037.	540.	259.	30.	
	(	3.88)	(	70.61)(	29.37)(	15.28)(	7.34)(	.85)(	
HYDROGRAPH AT	9	9.50	1	13358.	6679.	4008.	2672.	1336.	Bunnell's Pond
	(	24.60)	(	378.27)(	189.13)(	113.48)(	75.65)(	37.83)(	
2 COMBINED	9	11.00	1	15852.	7645.	4547.	2879.	1360.	
	(	28.49)	(	448.87)(	216.49)(	128.76)(	81.53)(	38.51)(	
ROUTED TO	9	11.00	1	15791.	7615.	4491.	2802.	1299.	
	(	28.49)	(	447.14)(	215.63)(	127.18)(	79.35)(	36.79)(	

SUMMARY OF DAM SAFETY ANALYSIS
SCS PA-420

PLAN 1 ....

	INITIAL VALUE	EMERGENCY SPILLWAY CREST	TOP OF DAM
ELEVATION	1281.41	1298.40	1304.30
STORAGE	7.	126.	201.
OUTFLOW	0.	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	1301.54	0.00	162.	2223.	0.00	41.00	0.00
.50	1300.34	0.00	149.	1100.	0.00	41.25	0.00
.30	1299.58	0.00	139.	580.	0.00	42.00	0.00
.20	1298.85	0.00	131.	288.	0.00	43.00	0.00
.10	1294.60	0.00	88.	21.	0.00	47.25	0.00

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2218.	1197.7	41.25
.50	1100.	1196.1	41.25
.30	580.	1194.9	42.00
.20	283.	1193.8	43.25
.10	21.	1190.9	47.50

stream section

D-19

Overtopping Summary

SUMMARY OF DAM SAFETY ANALYSIS

UPPER WILCOX

PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1426.00	1426.00	1430.10
STORAGE	327.	327.	623.
OUTFLOW	0.	0.	90.

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	1431.95	1.85	764.	1095.	15.50	42.25	0.00
.50	1430.14	.04	626.	91.	2.50	45.25	0.00
.30	1428.58	0.00	511.	43.	0.00	45.50	0.00
.20	1427.75	0.00	451.	24.	0.00	46.00	0.00
.10	1426.90	0.00	390.	9.	0.00	46.50	0.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	1091.	1366.4	42.50
.50	91.	1362.1	45.25
.30	43.	1361.2	45.75
.20	24.	1360.9	46.00
.10	9.	1360.3	46.75

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	1046.	1196.0	42.75
.50	90.	1182.7	46.00
.30	43.	1181.8	46.00
.20	24.	1181.2	46.25
.10	9.	1180.6	47.50

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	968.	1154.7	43.25
.50	90.	1151.5	46.25
.30	43.	1150.5	46.50
.20	24.	1150.0	46.75
.10	9.	1149.5	45.25

PLAN 1 STATION 8

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS

stream sections

1.00	2493.	1129.5	43.00
.50	1037.	1127.1	42.00
.30	540.	1125.7	43.00
.20	259.	1124.3	43.75
.10	30.	1121.1	48.50

stream section

12-0

SUMMARY OF DAM SAFETY ANALYSIS

BUNNELL'S POND DAM

PLAN 1 ••••••••••••••••

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

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	1087.68	4.48	585.	15791.	15.50	43.00	0.00
.50	1085.73	2.53	470.	7615.	10.25	43.00	0.00
.30	1084.53	1.33	405.	4491.	6.00	43.25	0.00
.20	1083.49	.29	353.	2802.	2.50	43.75	0.00
.10	1081.79	0.00	274.	1299.	0.00	43.75	0.00

Overtopping Summary

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1              A1                        NATIONAL DAM INSPECTION PROGRAM
    2              A2                    BALTIMORE DISTRICT CORPS OF ENGINEERS
    3              A3                              RUNNELLS POND DAM
    4              B    300       0       6       0       0       0       0       0      -4       0
    5              B1     5
    6              J      2       1       1
    7              J1  0.25
    8              K      0       1                                       1
    9              K1       INFLOW TO SCS PA-420
   10              M      1       1     0.9             11.0                                    1
   11              P             21.2     110     122     132
   12              T                                                       1   0.05
   13              W   1.23    0.45
   14              X   -1.5   -0.05     2.0
   15              K      1       1                                       1
   16              K1       ROUTE THROUGH SCS PA-420
   17              Y                                      1       1
   18              Y1     1                                                6.7      -1
   19              Y4 1281.4  1282.5    1285    1290  1296.8  1298.4 1299.65  1300.6  1302.2  1304.3
   20              Y5     0       5      11      17      23     105     608    1288    2877    5720
   21              $A     0     2.3     5.2     7.1     9.3      12    14.5
   22              $E 1272.7  1281.4    1285    1290    1295    1300    1305
   23              $S 1298.4
   24              $D 1304.3
   25              K      1       2                                       1
   26              K1       STREAM REACH 1 (STATION 2)
   27              Y                                      1       1
   28              Y1     1                                               -1
   29              Y6  0.08   0.045    0.08    1190    1205    3400   0.038
   30              Y7     0    1220      90    1200     110    1192     110    1190     115    1190
   31              Y7   115    1192     200    1200     310    1220
   32              K      0       3                                       1
   33              K1       INFLOW TO UPPER WILCOX POND
   34              M      1       1     0.6             11.0                                    1
   35              P             21.2     110     122     132
   36              T                                                       1   0.05            0.18
   37              W   0.82    0.45
   38              X   -1.5   -0.05     2.0
   39              K      1       3                                       1
   40              K1       ROUTE THROUGH UPPER WILCOX POND
   41              Y                                      1       1
   42              Y1     1                                              -1426    -1
   43              Y4  1426    1427    1428    1429    1430    1431    1432    1433    1434
   44              Y5     0      10      29      53      88     106     122     135     147
   45              $A     0      70      87
   46              $E  1412    1426    1440
   47              $S  1426
   48              $D 1430.1
   49              SL     0      95     380     390     440     500
   50              $V 1430.1  1430.9  1431.7  1432.0  1433.0  1434.0
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```
K      1       4                                                    1
K1      STREAM REACH 2 (STATION 4)
Y                                    1       1
Y1     1                                                           -1
Y6  0.08    0.045    0.08    1360    1375    4000   0.052
Y7     0     1400      50    1380     115    1362     115    1360      120    1360
Y7   120     1362     200    1380     260    1400
K      1       5                                                    1
K1      STREAM REACH 3 (STATION 5)
Y                                    1       1
Y1     1                                                           -1
Y6  0.08    0.045    0.08    1180    1195    4500   0.008
Y7     0     1220     150    1200     300    1182     300    1180      307    1180
Y7   307     1182     790    1200     900    1220
K      1       6                                                    1
K1      STREAM REACH 4 (STATION 6)
Y                                    1       1
Y1     1                                                           -1
Y6  0.08    0.045    0.08    1149    1164    4200   0.006
Y7     0     1180     100    1160     675    1152     675    1149      685    1149
Y7   685     1152     910    1160    1000    1180
K      2       7                                                    1
K1      COMBINE HYDROGRAPHS AT CONFLUENCE CARLEY BROOK AND PA-420 OUTFLOW
K      1       8                                                    1
K1      STREAM REACH 5 (STATION 8)
Y                                    1       1
Y1     1                                                           -1
Y6  0.08    0.045    0.08    1120    1135    8100   0.007
Y7     0     1160     150    1140     390    1123     390    1120      400    1120
Y7   400     1123     550    1140     730    1160
K      0       9                                                    1
K1      INFLOW TO BUNNELLS POND
H      1       1      9.5              11.0                                  1
P             21.2     110     122     132
T                                                          1.0    0.05
W   3.27    0.45
X   -1.5   -0.05     2.0
K      2       9
K      1       9                                                    1
K1      ROUTE THROUGH BUNNELLS POND
Y                                    1       1
Y1     1                                                        -1079      -1
Y4  1079  1079.4    1080  1080.5    1081    1082    1083    1084      1085    1086
Y5     0      39     226     461     748    1446    2284    3241      4304    5463
SA     0      37     108
SE  1066    1079    1100
SS  1079
SD1083.2
SL     0     115     135     175     270     460
SV1083.2  1083.3  1083.5    1084    1085    1086
SB    35     0.5    1066     1.0    1079    1085
SH    35     0.5    1066     1.0    1079  1083.7
```

D-24

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	RATIOS APPLIED TO FLOWS RATIO 1 .25	
HYDROGRAPH AT	1	.90	1	562.	SCS PA-420
	(	2.33)	(	15.92)(	
			2	562.	
			(	15.92)(	
ROUTED TO	1	.90	1	427.	
	(	2.33)	(	12.08)(	
			2	427.	
			(	12.08)(	
ROUTED TO	2	.90	1	423.	
	(	2.33)	(	11.99)(	
			2	423.	
			(	11.99)(	
HYDROGRAPH AT	3	.60	1	467.	Upper Wilcox
	(	1.55)	(	13.21)(	
			2	467.	
			(	13.21)(	
ROUTED TO	3	.60	1	31.	
	(	1.55)	(	.88)(	
			2	31.	
			(	.88)(	
ROUTED TO	4	.60	1	31.	
	(	1.55)	(	.88)(	
			2	31.	
			(	.88)(	
ROUTED TO	5	.60	1	31.	
	(	1.55)	(	.88)(	
			2	31.	
			(	.88)(	
ROUTED TO	6	.60	1	31.	
	(	1.55)	(	.88)(	
			2	31.	
			(	.88)(	
2 COMBINED	7	1.50	1	444.	
	(	3.88)	(	12.58)(	
			2	444.	
			(	12.58)(	

			2	389.	
			(	11.01)(	
HYDROGRAPH AT	9	9.50	1	3315.	Bunnell's Pond
	(	24.60)	(	93.86)(	
			2	3315.	
			(	93.86)(	
2 COMBINED	9	11.00	1	3680.	
	(	28.49)	(	104.21)(	
			2	3680.	
			(	104.21)(	
ROUTED TO	9	11.00	1	3612.	Non-failure
	(	28.49)	(	102.27)(	
			2	8277.	Failure
			(	234.37)(	

SUMMARY OF DAM SAFETY ANALYSIS

BUNNELL's POND DAM

PLAN 1 ••••••••••••••••
(Non-failure)

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

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
.25	1084.06	.86	381.	3612.	4.50	19.40	0.00

PLAN 2 ••••••••••••••••
(Failure)

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

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
.25	1083.84	.64	370.	8277.	1.36	19.40	18.40

Dam Breach Summary

BY _____ DATE _____ SUBJECT BUNNELL'S POND DAM SHEET NO _____ OF _____

CHKD BY _____ DATE _____ JOB NO _____

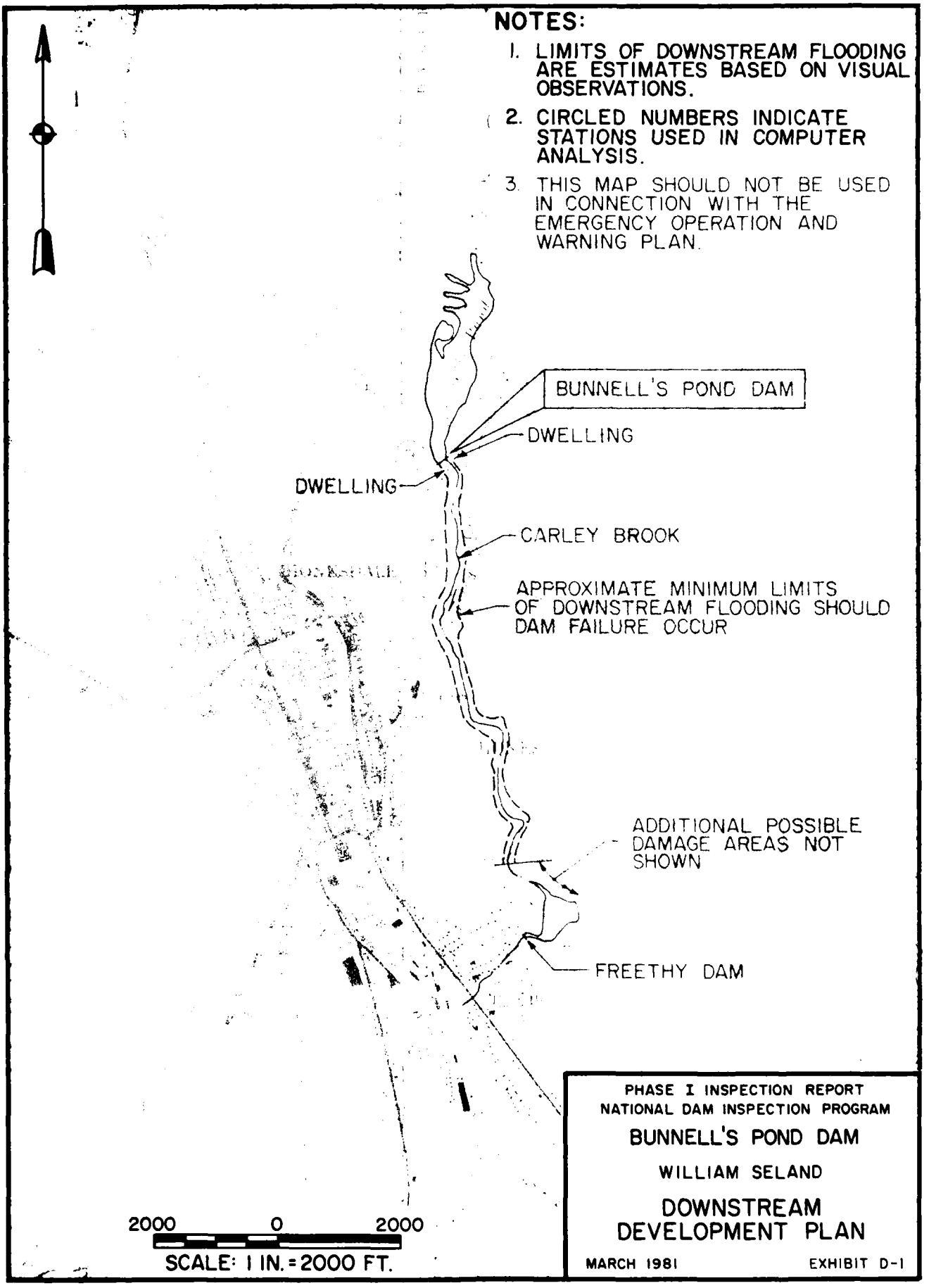
SUMMARY OF PERTINENT RESULTS

Multi-ratio Analysis

	PMF	½ PMF	25% PMF
Rainfall (inches)	24.01	–	–
Runoff (inches)	21.65	10.83	5.41
Peak inflow (cfs)	15,852	7645	3680
Peak outflow (cfs.)	15,791	7615	3612
Depth of overtopping (feet)	4.48	2.53	0.86
Duration of overtopping (hours)	15.50	10.25	4.50

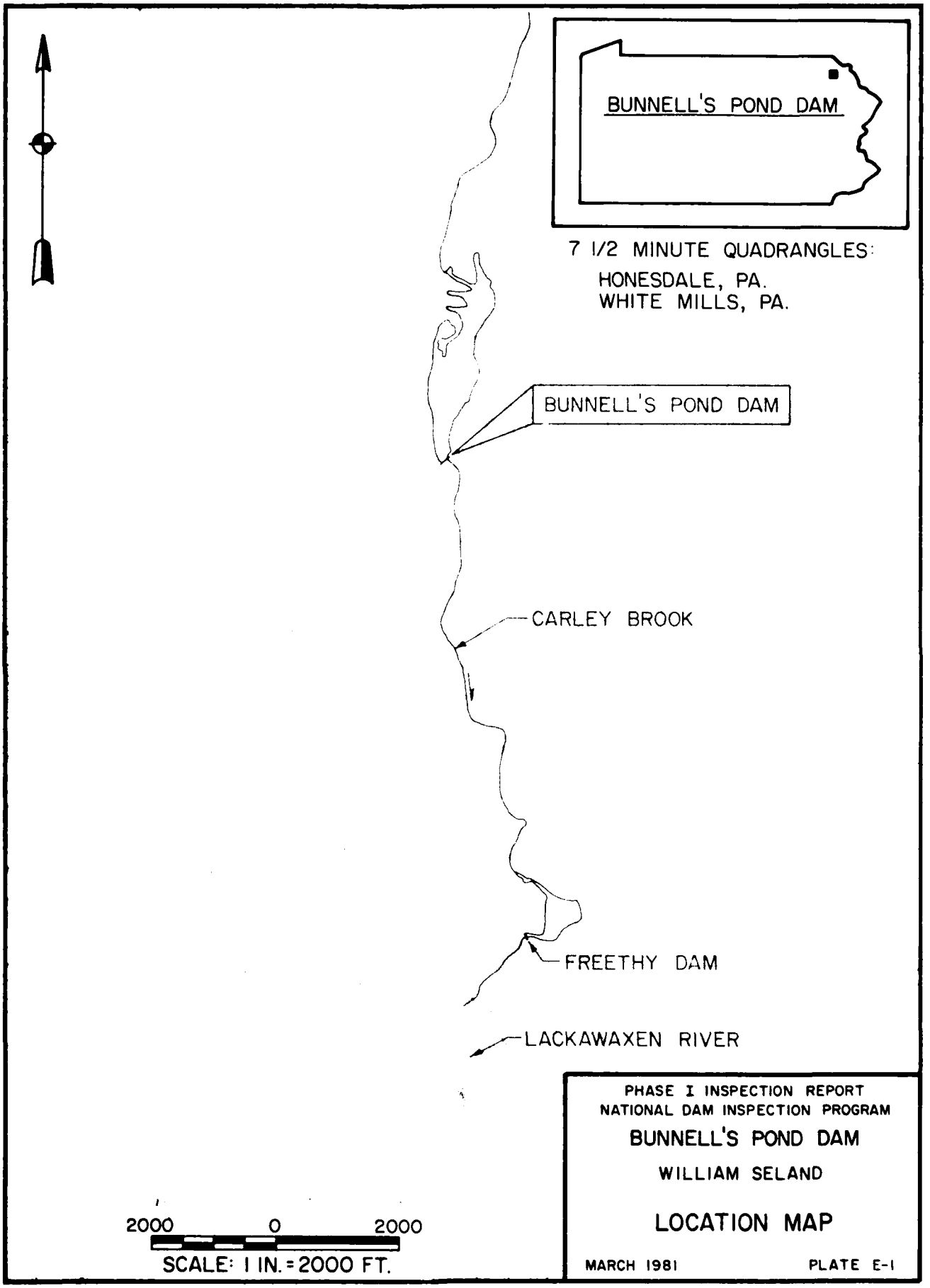
Breach and Routing Analysis (25% PMF)

	No failure	Failure	Difference
Peak outflow (cfs.)	3612	8277	4665


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.
BUNNELL'S POND DAM
DWELLING
DWELLING
CARLEY BROOK
APPROXIMATE MINIMUM LIMITS OF DOWNSTREAM FLOODING SHOULD DAM FAILURE OCCUR
ADDITIONAL POSSIBLE DAMAGE AREAS NOT SHOWN
FREETHY DAM
2000 0 2000
SCALE: 1 IN. = 2000 FT.
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
BUNNELL'S POND DAM
WILLIAM SELAND
DOWNSTREAM DEVELOPMENT PLAN
MARCH 1981
EXHIBIT D-1

APPENDIX E

PLATES



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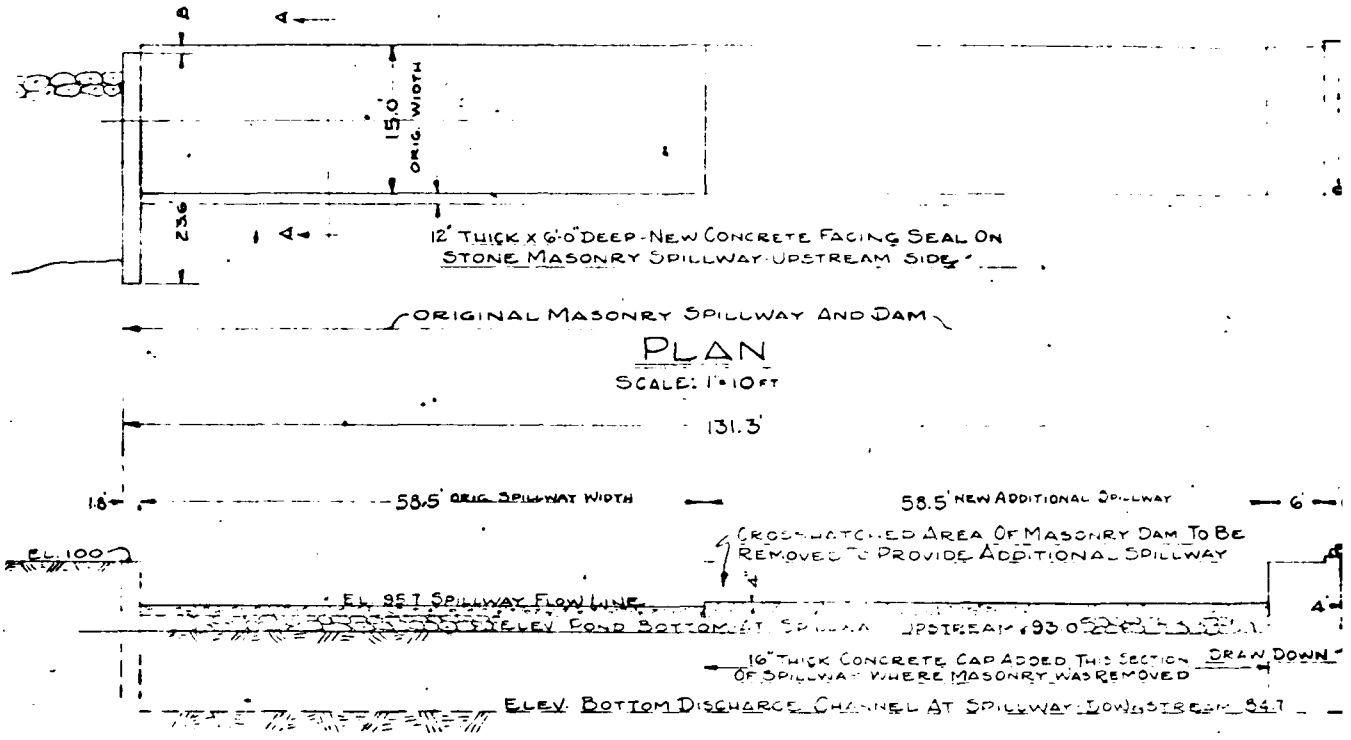
NATIONAL DAM INSPECTION PROGRAM

BUNNELL'S POND DAM

WILLIAM SELAND

LOCATION MAP

MARCH 1981 PLATE E-1

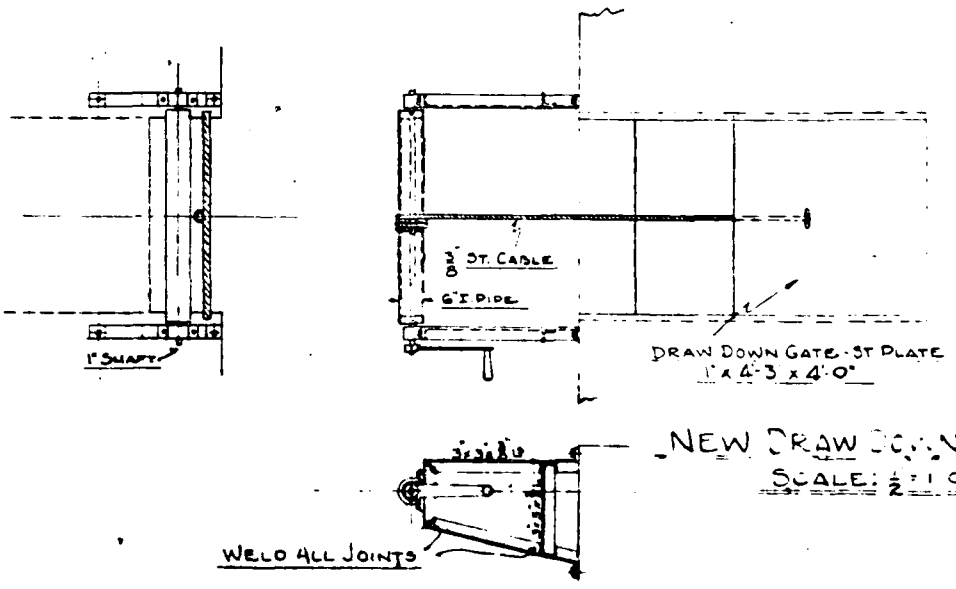


PLAN

SCALE: 1" = 10 FT

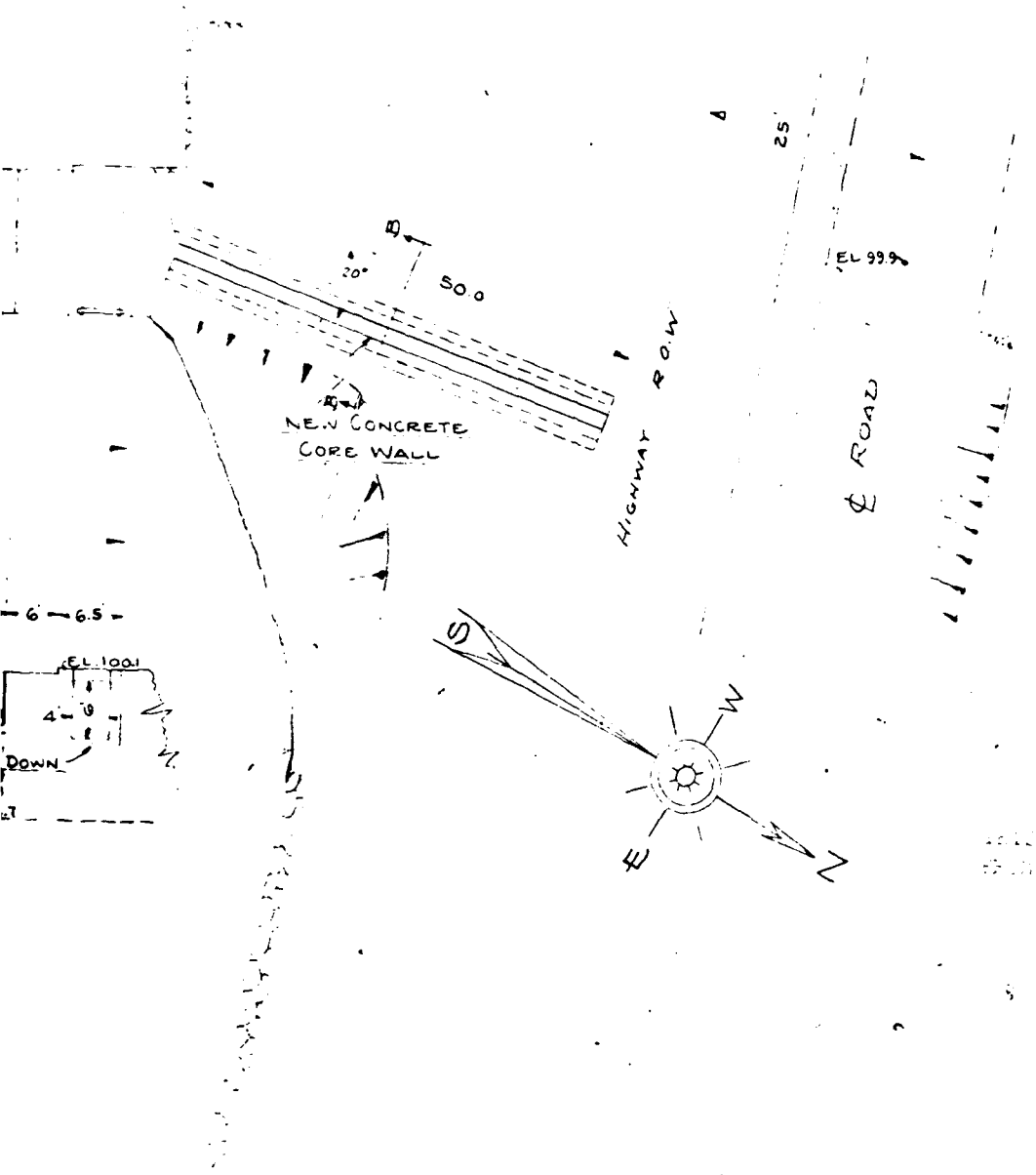
ELEVATION

SCALE: 1" = 10 FT.



NEW DRAW DOWN GATE D

SCALE: 1/2" = 1'-0"



DETAILS

AS SHOWN

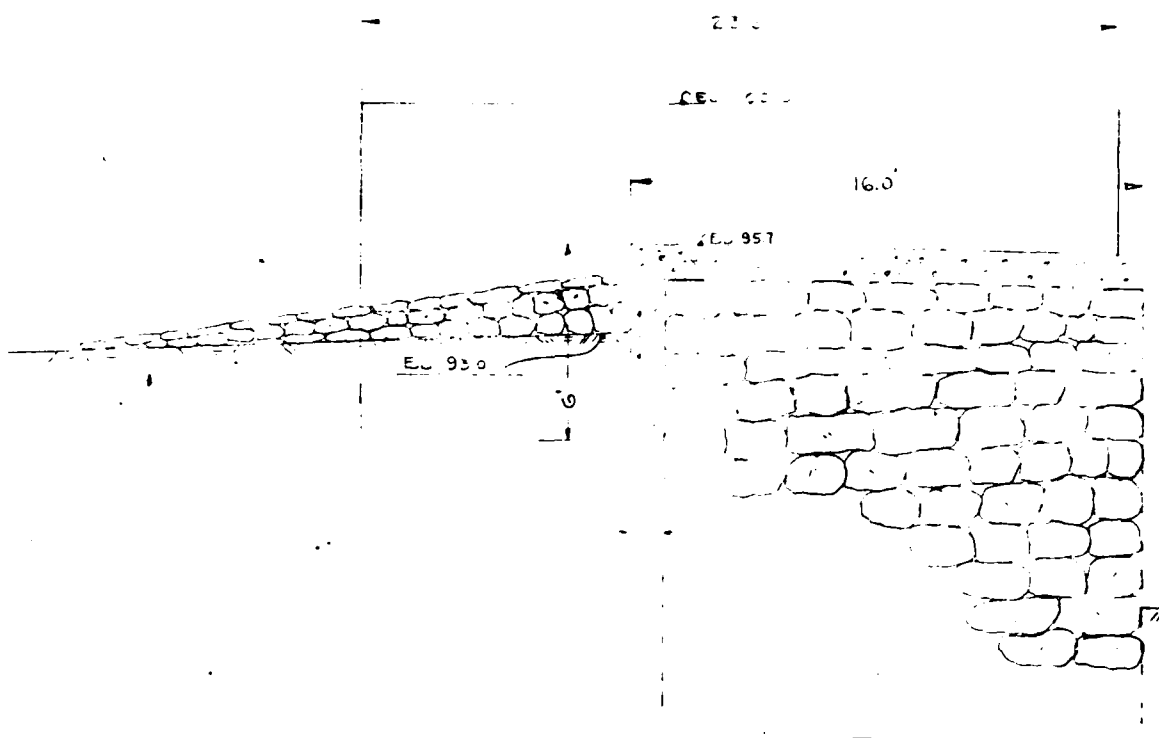
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BUNNELL'S POND DAM

WILLIAM SELAND

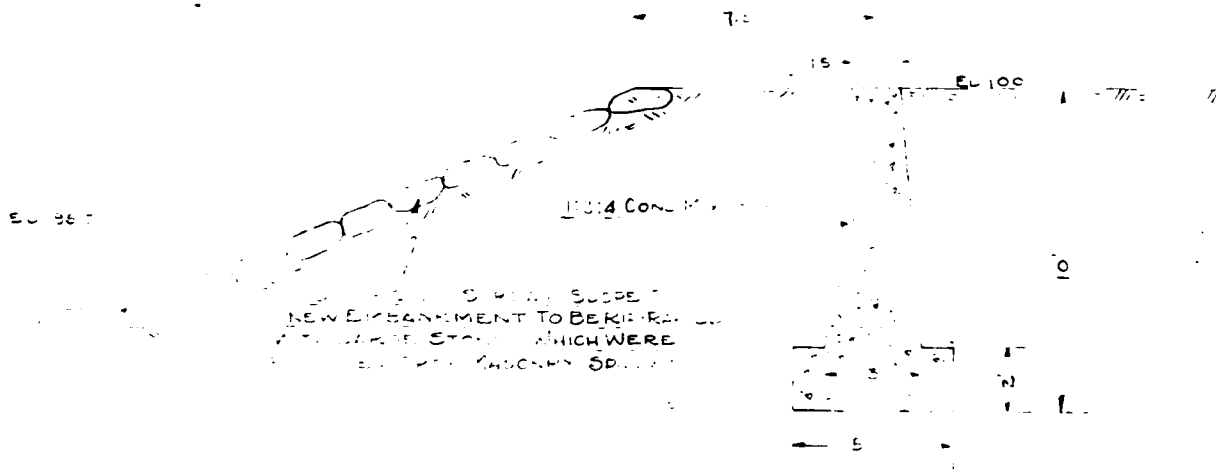
1952 MODIFICATIONS
SHEET 1 OF 2

MARCH 1981 PLATE E-2



SECTION THRU SPILLWAY

SCALE: 1" = 3FT



SECTION B-B THRU CORE WALL & EMBANK

SCALE: 1" = 3FT

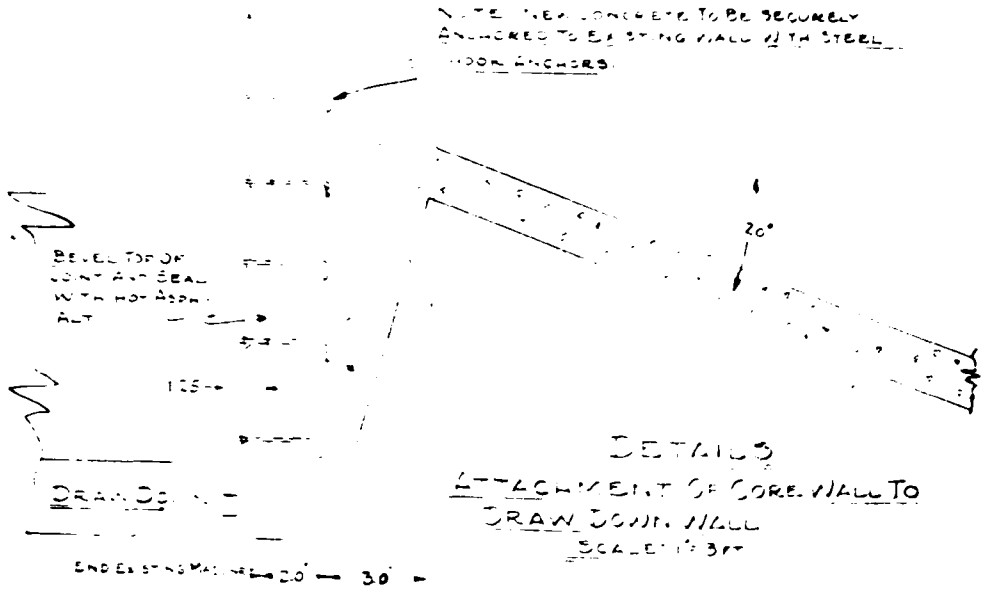
DETAILS

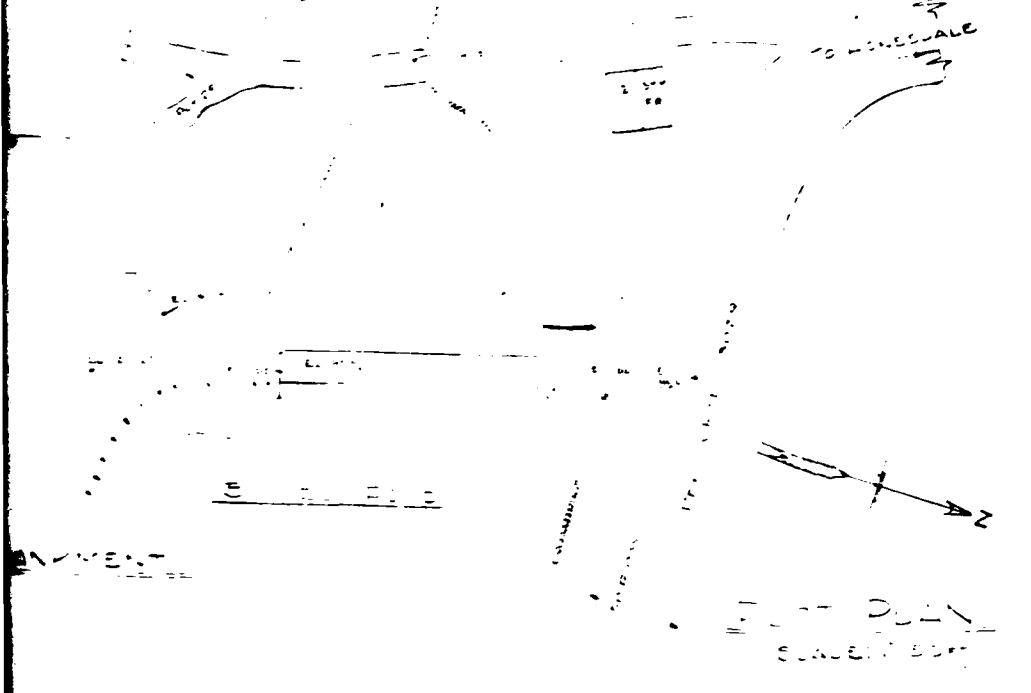
REPAIRS TO BUNNELL POND DAM & SPILLWA

JOHN BEHRENS HONESDALE PA R.D. OWNER

AUG 1952 SCALE: AS SHOWN

L. F BUR[illegible] RE. ENG





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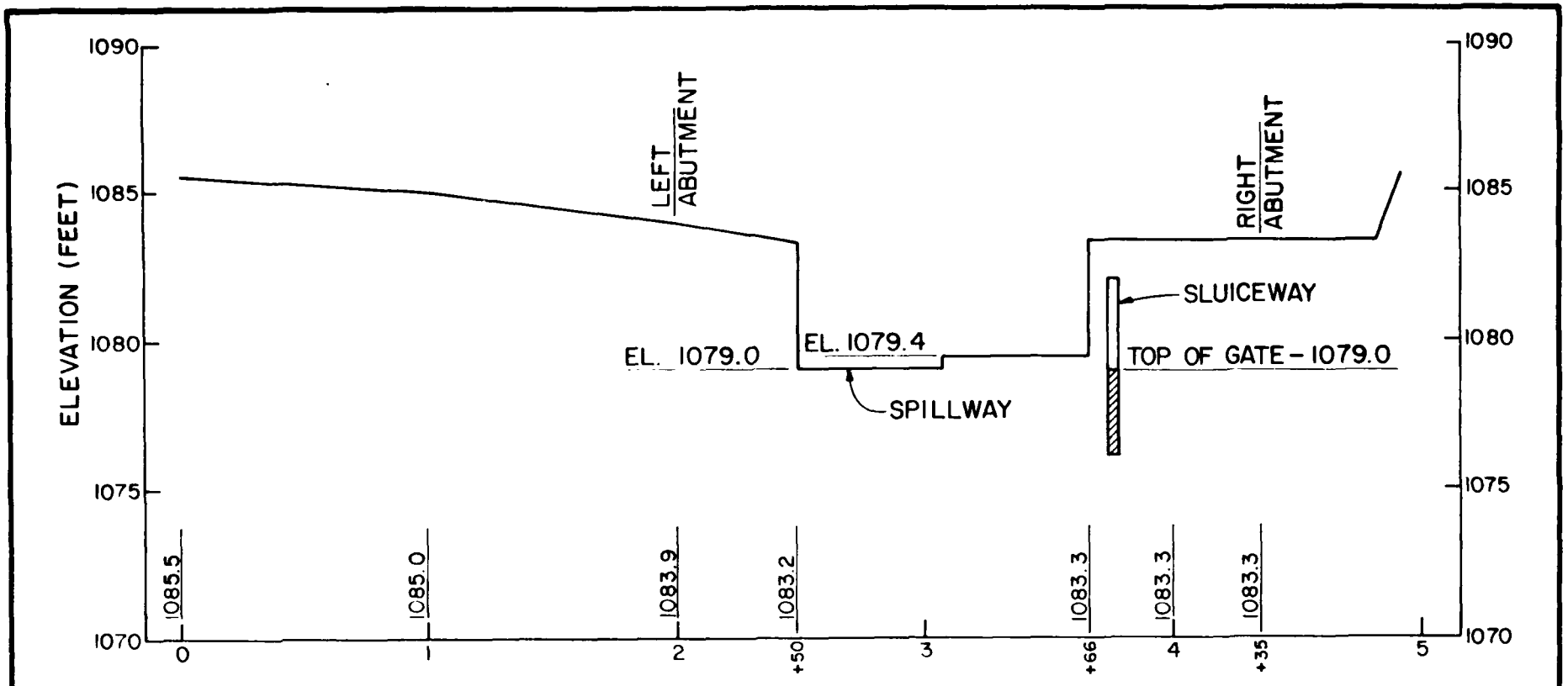
NATIONAL DAM INSPECTION PROGRAM

BUNNELL'S POND DAM

WILLIAM SELAND

1952 MODIFICATIONS
SHEET 2 OF 2

MARCH 1981 PLATE E-3



PROFILE - TOP OF DAM

SCALE - HORIZ.: 1 IN. = 60 FT.
VERT.: 1 IN. = 5 FT.

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NATIONAL DAM INSPECTION PROGRAM

BUNNELL'S POND DAM

WILLIAM SELAND

PROFILE - TOP OF DAM

MARCH 1981

PLATE E-4

APPENDIX F

GEOLOGY

BUNNELL'S POND DAM

APPENDIX F

GEOLOGY

Bunnell's Pond 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.

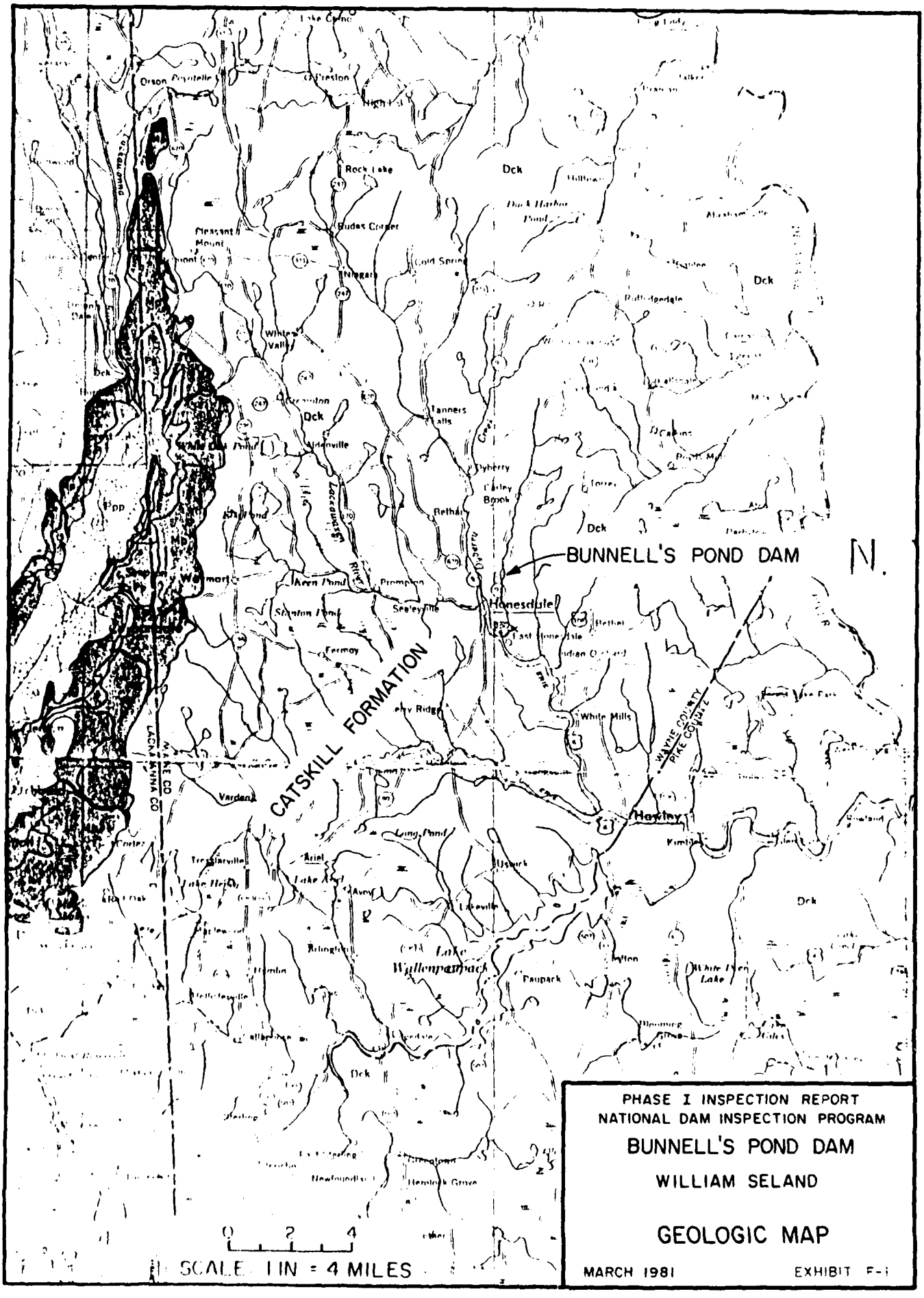
East of the escarpment is the Glaciated Low Plateaus Section of the province. This area is characterized by preglacial erosional topography with locally-thick glacial deposits. Local relief is generally 100 to 300 feet.

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.

Bunnell's Pond 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.



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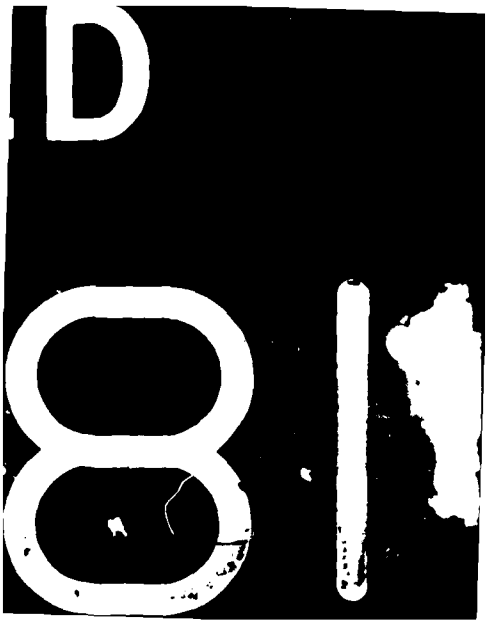
BUNNELL'S POND DAM

WILLIAM SELAND

GEOLOGIC MAP

MARCH 1981 EXHIBIT F-1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