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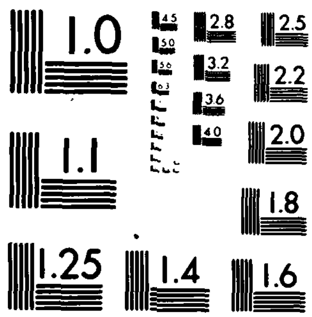

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LEVEL II

SUSQUEHANNA RIVER BASIN
WOLCOTT CREEK, BRADFORD COUNTY
PENNSYLVANIA

(6) National Dam Inspection Program

MACHAM DAM

(NDI I.D. [redacted] PA-00043
PENNDER I.D. [redacted] 8-56)

Susquehanna River Basin. Wolcott Creek, Bradford County, Pennsylvania

PHASE I INSPECTION REPORT,
NATIONAL DAM INSPECTION PROGRAM

PREPARED FOR

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

PREPARED BY (12) 1

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DACW31-80-C-0016
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DISCLAIMER NOTICE

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PREFACE

This report is prepared under guidance contained in the 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 investigation and analyses involving topograhic 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.

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 frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

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.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ABSTRACT

Macham Dam: NDI I.D. No. PA-00043

<u>Owner</u>:	Manley and Afton Chamberlain
<u>State Located</u>:	Pennsylvania (PennDER I.D. No. 8-56)
<u>County Located</u>:	Bradford
<u>Stream</u>:	Wolcott Creek
<u>Inspection Date</u>:	22 April 1980
<u>Inspection Team</u>:	GAI Consultants, Inc. 570 Beatty Road Monroeville, Pennsylvania 15146

Based on a visual inspection, operational history, and available engineering data, the dam is considered to be in fair condition.

The size classification of the facility is small and its hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) for the facility ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. Due to the high potential for damage to downstream structures and possible loss of life, the SDF is considered to be the PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass and/or store only about 43 percent of the PMF prior to embankment overtopping. A breach analysis indicates that failure under less than 1/2 PMF conditions could lead to increased downstream damage and potential for loss of life. Thus, based on the screening criteria contained in the recommended guidelines, the spillway is considered to be seriously inadequate and the facility unsafe, non-emergency.

It is recommended that the owner immediately:

a. Develop a formal emergency warning system to notify downstream residents should hazardous conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

b. Retain the services of a registered professional engineer experienced in the hydraulics and hydrology of dams to further assess the adequacy of the spillway facilities and take remedial measures deemed necessary to make the facility hydraulically adequate.

c. Repair the eroded upstream embankment slope and provide adequate riprap material to protect it against future damage.

d. Repair the damaged outlet conduit control mechanism and re-establish access to the manual operator.

e. Clean out weep holes, fill and seal all cracks and repair spalled portions of the concrete spillway. In addition, the condition of the concrete should be specifically addressed in all future inspections.

f. Develop formal manuals of operation and maintenance to ensure the future proper care of the facility.

GAI Consultants, Inc.

Bernard M. Mihalcin

Bernard M. Mihalcin, P.E.

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
BERNARD M. MIHALCIN
ENGINEER
20371-E

Date 10 July 1980

Approved by:

James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

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OVERVIEW PHOTOGRAPH

TABLE OF CONTENTS

		Page
PREFACE		i
ABSTRACT		ii
OVERVIEW PHOTOGRAPH		iv
TABLE OF CONTENTS		v
SECTION 1 - GENERAL INFORMATION		1
1.0	Authority	1
1.1	Purpose	1
1.2	Description of Project	1
1.3	Pertinent Data	2
SECTION 2 - ENGINEERING DATA		5
2.1	Design	5
2.2	Construction Records	6
2.3	Operational Records	6
2.4	Other Investigations	6
2.5	Evaluation	6
SECTION 3 - VISUAL INSPECTION		7
3.1	Observations	7
3.2	Evaluation	8
SECTION 4 - OPERATIONAL PROCEDURES		9
4.1	Normal Operating Procedure	9
4.2	Maintenance of Dam	9
4.3	Maintenance of Operating Facilities	9
4.4	Warning System	9
4.5	Evaluation	9
SECTION 5 - HYDROLOGIC/HYDRAULIC EVALUATION		10
5.1	Design Data	10
5.2	Experience Data	10
5.3	Visual Observations	10
5.4	Method of Analysis	10
5.5	Summary of Analysis	11
5.6	Spillway Adequacy	13
SECTION 6 - EVALUATION OF STRUCTURAL INTEGRITY		14
6.1	Visual Observations	14
6.2	Design and Construction Techniques	14
6.3	Past Performance	15
6.4	Seismic Stability	15
SECTION 7 - ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES		16
7.1	Dam Assessment	16
7.2	Recommendations/Remedial Measures	16

TABLE OF CONTENTS

APPENDIX A - VISUAL INSPECTION CHECKLIST AND FIELD SKETCHES
APPENDIX B - ENGINEERING DATA CHECKLIST
APPENDIX C - PHOTOGRAPHS
APPENDIX D - HYDROLOGY AND HYDRAULICS ANALYSES
APPENDIX E - FIGURES
APPENDIX F - GEOLOGY

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
MACHAM DAM
NDI# PA-00043, PENNDER# 8-56

SECTION 1
GENERAL INFORMATION

1.0 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.

1.1 Purpose.

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

1.2 Description of Project.

a. Dam and Appurtenances. Macham Dam is an earth embankment approximately 19 feet high and 575 feet long, including spillway. The facility is provided with an uncontrolled, rectangular, concrete chute channel spillway located at the left abutment. The spillway is constructed with a 75-foot long, broad crested weir having a 35-foot breadth. Drawdown capability is provided by means of an 18-inch diameter reinforced concrete conduit controlled at the inlet by an 18-inch diameter sluice gate.

b. Location. Macham Dam is located on Wolcott Creek in Athens Township, Bradford County, Pennsylvania. The structure is situated at the intersection of Wolcott Hollow and Kellogg Roads approximately five miles west of Greenes Landing, Pennsylvania. The dam, reservoir, and watershed are located within the Sayre and Bentley Creek, Pennsylvania 7.5 minute U.S.G.S. topographic quadrangles (see Figures 1 and 2, Appendix E). The coordinates of the dam are N41° 55.2' and W76° 37.2'.

c. Size Classification. Small (19 feet high, 550 acre-feet storage capacity at top of dam.

d. Hazard Classification. High (see Section 3.1.e).

e. Ownership. Manley and Afton Chamberlain
Box 122
R.D. 2
Wellsburg, N.Y. 14894

f. Purpose. Recreation.

h. Historical Data. Macham Dam is owned by Manley and Afton Chamberlain, a father and son partnership who conceived the project in the early 1960's as a private recreational facility. Herluf T. Larsen of Harrisburg, Pennsylvania conducted a complete soils and foundation investigation while David C. Meyer, P.E. of Sayre, Pennsylvania performed the actual design of the facility. A construction permit was issued by the state in May 1966. The facility was built entirely by the Chamberlains who apparently worked on weekends and in their spare time and was eventually completed in November 1970. No major modifications have been made to the facility since its completion.

1.3 Pertinent Data.

a. Drainage Area (square miles). 2.4

b. Discharge at Dam Site.

Discharge Capacity of Outlet Conduit - Discharge curves are not available.

Discharge Capacity of Spillway at Maximum Pool ≅ 2430 cfs (see Appendix D, Sheet 10).

c. Elevation (feet above mean sea level). The following elevations were obtained from design drawings and field measurements utilizing a base datum as defined in Appendix D, Sheet 2, Note 2 (also see Appendix D, Sheet 1).

Top of Dam	1309.0
Maximum Design Pool	1309.0
Maximum Pool of Record	1305.0 (Oct. 1975)
Normal Pool	1304.0
Spillway Crest	1304.0
Upstream Inlet Invert	1290.5
Downstream Outlet Invert	1289.9
Streambed at Dam Centerline	1290.0
Maximum Tailwater	Not known.

d. Reservoir Length (feet).

Top of Dam	3000
Normal Pool	2700

e. Storage (acre-feet).

Top of Dam	550
Normal Pool	310
Design Surcharge	240

f. Reservoir Surface (acres).

Top of Dam	52
Normal Pool	44

g. Dam.

Type	Homogeneous earth.
Length	500 feet (excluding spillway).
Height	19 feet (field measured; embankment crest to downstream outlet invert).
Top Width	15 feet.
Upstream Slope	2.5H:1V (field). 3H:1V (design).
Downstream Slope	2H:1V
Zoning	Homogeneous earth (see Figure 5).
Impervious Core	None indicated.
Cutoff	Trapezoidal shaped cutoff trench eight feet wide at the base with 1H:1V side slopes located just upstream of the embankment centerline (see Figure 5).
Grout Curtain	None indicated.

h. Diversion Canal and Regulating Tunnels. None.

i. <u>Spillway</u>.

Type	Uncontrolled, rectangular, concrete chute channel with a broad crested weir.
Crest Elevation	1304.0 feet.
Crest Length	75 feet.

j. <u>Outlet Conduit</u>.

Type	18-inch diameter reinforced concrete conduit.
Length	88 feet.
Closure and Regulating Facilities	Flow through the outlet is controlled via 18-inch diameter sluice gate at the inlet.
Access	Access bridge reportedly toppled by ice pressure (May 1973 photo indicates bridge down). Valve operation would currently require divers.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources. A subsurface investigation entitled, "Soils and Foundation Report on Site of Proposed Macham Dam," was prepared by Herluf T. Larsen, Consulting Engineer of Harrisburg, Pennsylvania in 1965 and is available from PennDER files. No formal design reports or calculations are available for the embankment or its appurtenances. Limited data pertaining to the design features of Macham Dam are contained within PennDER files in the form of design drawings, construction progress reports, dated photographs and miscellaneous correspondence. A state permit report dated May 13, 1966 aptly describes the pertinent design features of the facility.

b. Design Features.

1. Embankment. Information contained in PennDER files indicate the embankment is a homogeneous earthfill structure composed of impervious material (glacial till) placed in 6-inch layers and compacted with a sheepsfoot roller. A trapezoidal shaped cutoff trench has been provided just upstream of the embankment crest, but, parallel to the embankment centerline. The trench was excavated to a minimum depth of four feet with an 8-foot base width and 1H:1V side slopes (see Figure 5). The design slopes of the dam are 3H:1V on the upstream face and 2H:1V on the downstream face. The design crest width is 15 feet and along with the downstream slope is vegetated with grass. Design drawings and construction photographs indicate that upstream slope protection was accomplished by utilizing a cementitious soil mixture. A 4-inch diameter perforated pipe toe drain is indicated on Figure 4 at the extreme downstream toe.

c. Appurtenant Structures.

a) Spillway. The spillway is designed as an uncontrolled, rectangular, concrete chute channel with a broad crested overflow weir. The design crest is 75 feet in length and is set five feet below the top of the wingwalls. Concrete cutoff walls have been provided on each side of the spillway and extend into the embankment and left abutment hillside (see Figure 4). A 4-foot deep by 1-foot thick cutoff wall at the discharge end of the spillway is discussed in permit correspondence and shown on Figure 4. Photographs of spillway undercutting taken in 1973 indicate the cutoff was not constructed.

b) Outlet Conduit. The outlet conduit is an 18-inch diameter reinforced concrete pipe placed in a reinforced concrete cradle. Flows through the conduit are controlled by means of an 18-inch diameter Rodney Hunt circular sluice gate at the inlet. The gate is designed to be operated from a platform built on a steel tower and accessed by a steel bridge from the embankment crest (see Figure 5). A reinforced concrete stilling basin at the outlet end is indicated also in Figure 5; however, field observations indicate it was not constructed.

c. Specific Design Data and Criteria.

1. Hydrology and Hydraulics. No formal design reports or calculations are available. Information contained in PennDER files indicates the spillway was designed in accordance with state requirements. The design spillway capacity was reported as 2530 cfs.

2. Embankment. No design data other than the specifications included in Figure 4 are available.

3. Appurtenant Structures. No design data are available.

2.2 Construction Records.

Design drawings, construction progress reports prepared by the owners, and several construction photographs are available in PennDER files. No formal records of construction compliance are available.

2.3 Operational Records.

No records of the present day-to-day operation of the facility are maintained.

2.4 Other Investigations.

PennDER files contain brief letters concerning state inspections in 1973 and 1977 both of which noted erosion at the end of the spillway. No other formal investigations have been performed on the facility since its completion.

2.5 Evaluation.

The information available is considered adequate to make a reasonable Phase I assessment of the facility.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of the facility suggests the dam and its appurtenances are in fair condition.

b. Embankment. Observations made during the visual inspection indicate the embankment is in fair condition. No evidence of seepage through the embankment face, excess settlements, animal burrows, or signs of maintenance neglect were observed (see Photograph 1). Significant sloughing and erosion is evident across the upstream embankment face just above normal pool (see Photographs 2 and 3) indicating that the soil-cement slope protection has been ineffective.

c. Appurtenant Structures.

1. Spillway. The visual inspection indicates the spillway is in fair condition. Several weep holes in the spillway slab are debris filled and deterioration of the concrete surface is visible throughout the entire structure, particularly along the wingwalls (see Photographs 4 and 6). Evidence of prior damage due to undercutting of the discharge end of the channel was observed (see Photograph 5). Remedial measures appear adequate; however, the spillway should be observed regularly, especially after large flows.

2. Outlet Conduit. The outlet conduit is considered to be in fair condition. The steel access bridge from the embankment crest to the gate control mechanism was toppled (presumably by ice pressure) several years ago and has not yet been replaced. As a result, the current operability of the conduit is questionable. The stilling basin indicated on Figure 5 was not constructed. As a result, some erosion may occur upon operating the outlet conduit.

d. Reservoir Area. The general area surrounding the reservoir is characterized by gentle to moderate slopes that are primarily forested. No signs of slope distress were observed (see Photograph 4).

e. Downstream Channel. The channel downstream of Macham Dam is confined within a narrow valley with steep confining slopes. The valley contains several farms which appear sufficiently above the streambed so as to not be threatened by the high water that would be associated with an embankment breach. However, approximately five miles downstream, at Greenes Landing, a mobile trailer park is located adjacent the stream and could possibly incur extensive damage, including loss of life, as the result of an embankment breach. It is likely that as many as 50 persons could be affected by such an event. Thus, the hazard classification of the facility is considered to be high.

3.2 Evaluation.

The overall appearance of the facility suggests it to be in fair condition. For the most part, the facility is adequately maintained; however, remedial steps are required to repair the upstream embankment slope and protect it against future erosion from wave action. Efforts should also be undertaken to restore full operability to the outlet conduit control valve and provide easy access to its manual operator. In addition, the spillway concrete surfaces are deteriorating and in need of repair while the weep holes in the spillway slab should be cleaned of debris.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

Macham Dam is essentially a self-regulating facility with excess inflow automatically discharged through the uncontrolled spillway located at the left abutment. The outlet conduit is not operated on a regular basis nor are there any formal operating procedures. No formal operations manual is available.

4.2 Maintenance of Dam.

The embankment is maintained on an unscheduled and informal basis. Basic maintenance such as mowing the embankment and keeping the spillway clear is performed by the owner at his convenience.. Major maintenance such as providing adequate upstream slope protection, restoring the outlet access bridge, and repairing damaged spillway concrete, has been avoided apparently due to the time and cost required to alleviate the conditions. No formal maintenance manual is available.

4.3 Maintenance of Operating Facilities.

No maintenance has apparently been performed on the outlet conduit since the completion of the project.

4.4 Warning System.

No formal warning system is in effect.

4.5 Evaluation.

Routine maintenance of the facility appears adequate; however, installation of adequate riprap, restoration of the outlet conduit access bridge and repairs to concrete surfaces in the spillway are required. Formal manuals of maintenance and operation are also recommended to ensure that all needed maintenance is identified and performed annually regardless of its size and scope. In addition, a formal warning system for the protection of downstream inhabitants should be developed. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATIONS

5.1 Design Data.

No formal design reports or calculations are available. Information contained in PennDER files indicates the spillway was designed in accordance with state requirements. The design spillway capacity was reported as 2530 cfs.

5.2 Experience Data.

Information gathered from discussions with the owner indicate the largest flood of record at Macham Dam occurred in October 1975. At that time, flow over the spillway weir was estimated at approximately 1-foot (the spillway provides 5.0 feet of freeboard at the weir). The facility reportedly functioned adequately during the event; however, some damage was incurred when a portion of the discharge end of the spillway was undercut and collapsed. The spillway has been subsequently repaired by removing the damaged concrete section and replacing it with large boulders (see Photograph 5).

5.3 Visual Observations.

On the date of the inspection, no conditions were observed that would indicate the spillway could not function satisfactorily during a flood event, within the limits of its design.

5.4 Method of Analysis.

The facility has been analyzed in accordance with the procedures and guidelines established by the U.S. Army, Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. The analysis has been performed utilizing a modified version of the HEC-1 program developed by the U.S. Army, Corps of Engineers, Hydrologic Engineering Center, Davis, California. Analytical capabilities of the program are briefly outlined in the preface contained in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). In accordance with the procedures and guidelines contained in the National Guidelines for Safety Inspection of Dams for Phase I Investigations, the Spillway Design Flood (SDF) for Macham Dam ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. This classification is based on the relative size of the dam (small), and the potential hazard of dam failure due to downstream developments (high). Due to the high potential for damage to downstream structures and possibly loss of life, the SDF for this facility is considered to be the PMF.

b. Results of Analysis. Macham Dam was evaluated under near normal operating conditions. That is, the reservoir was initially at its normal pool or spillway elevation of approximately 1304.0 feet, with the spillway weir discharging freely. The outlet conduit was assumed to be non-functional for the purpose of analysis. In any event, the flow capacity of the outlet conduit is not such that it would significantly increase the total discharge capabilities of the dam and reservoir. The spillway consists of a rectangular concrete channel with discharges controlled by a broad-crested weir. All pertinent engineering calculations relative to the evaluation of this facility are provided in Appendix D.

Overtopping analysis (using the Modified HEC-1 Computer Program) indicated that the discharge/storage capacity of Macham Dam can accommodate only about 43 percent of the PMF (SDF) prior to embankment overtopping. Under PMF conditions, the low top of dam was inundated for about 4.8 hours, by depths of up to 1.5 feet. Under 0.5 PMF conditions, the dam was inundated for about 1.8 hours and by depths of up to 0.4 feet above the low top of dam (Appendix D, Summary Input/Output Sheets, Sheet G). Since the SDF for Macham Dam is the PMF, it can be concluded that the dam has a high potential for overtopping, and thus, for breaching under floods of less than SDF magnitude.

As Macham Dam cannot safely accommodate a flood of at least 1/2 PMF magnitude, the possibility of embankment failure under floods of less than 1/2 PMF intensity was investigated (in accordance with Corps directive ETL-1110-2-234). Several possible alternatives were examined, since it is difficult, if not impossible, to determine exactly how or if a specific dam will fail. The major concern of the breaching analysis is with the impact of the various breach discharges on increasing downstream water surface elevations above those to be expected if breaching did not occur.

The Modified HEC-1 Computer Program was used for the breaching analysis, with the assumption that the breaching of an earth dam would begin once the reservoir level reached the low top of dam elevation. Also, in routing the outflows downstream, the channel bed was assumed to be initially dry.

Five breach models were analyzed for Macham Dam. First, two sets of breach geometry were evaluated for each of two failure times. The two sets of breach sections chosen were considered to be the minimum and maximum probable failure sections. The two failure times (total time for each breach section to reach its final dimensions) under which the two breach sections were investigated were assumed to be a rapid time (0.5 hours) and a prolonged time (4.0 hours), so that a range of this most sensitive variable might be examined. In addition, an average possible set of breach conditions was analyzed, with a failure time of 2.0 hours (Appendix D, Sheet 16).

The peak breach outflows (resulting from 0.45 PMF conditions) ranged from about 2570 cfs for the minimum section-maximum failure time scheme to about 20,280 cfs for the maximum section-minimum failure time scheme (Appendix D, Sheet 18). The peak outflow resulting from the average breach scheme was about 6180 cfs, as compared to the non-breach 0.45 PMF peak outflow of approximately 2570 cfs (Summary Input/Output Sheets, Sheets O and G).

Two potential centers of damage were investigated in the analysis. The primary area of concern is at Section 6 (see Figure 2), about 5.4 miles downstream from the dam, where a trailer park is located. At this section, the peak water surface elevations corresponding to the maximum section-minimum fail time scheme and the average breach scheme were approximately 3.4 feet and 1.8 feet above the non-breach elevations, respectively, and well above the damage level of the trailers (see Appendix D, Sheet 19).

Another potential center of damage is located at Section 2 (Figure 2), about 3,560 feet downstream from Macham Dam. The nearby residences were found to be well above the maximum levels of the breach outflows. However, a dairy barn was inundated by depths of up to 2.4 feet under the maximum section-minimum fail time scheme, indicating the potential for some property damage should the dam fail (Appendix D, Sheet 19).

The consequences of dam failure can be better envisioned if not only the increase in the height of the floodwave is considered, but also the great increase in momentum of the larger and probably swifter moving volume of water.

Therefore, the failure of Macham Dam would most likely lead to increased property damage and possibly to loss of life in the downstream regions.

5.6 Spillway Adequacy.

As presented previously, Macham Dam can accommodate only about 43 percent of the PMF (SDF) prior to embankment overtopping. Should a 0.45 PMF or larger event occur, the dam would be overtopped and would possibly fail, endangering downstream residences and increasing the potential for loss of life in the downstream regions. Therefore, the spillway is considered to be seriously inadequate.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Based on visual observations, the embankment is in fair condition. Significant sloughing and erosion observed along the upstream embankment slope could eventually deteriorate into a major threat to embankment stability, if neglected. Consequently, immediate measures should be taken to repair the slope and adequately protect it against future damage.

b. Appurtenant Structures.

1. Spillway. The spillway is considered to be in fair condition. Concrete deterioration, particularly spalling at the joints, is considered significant and should be repaired. Weep holes in the spillway slab should also be cleaned to permit dissipation of uplift pressures.

2. Outlet Conduit. Prior to the collapse of the access bridge several years ago the outlet conduit was reportedly functional. In order to operate the conduit presently, divers would be required. A fully functional outlet conduit is considered vital to the safe operation of a water impounding facility. Consequently, repairs to the access bridge and outlet conduit control mechanism are recommended.

6.2 Design and Construction Techniques.

Based on information contained in PennDER files, it appears that the structure was generally designed in accordance with accepted modern engineering practice and techniques; however, no formal design reports or calculations are available for review. Design and/or construction of the soil-cement riprap, outlet works access bridge and spillway end sill are questionable in light of their performance records.

Available correspondence and photographs indicate that the methods of construction, although particularly slow, were found to be acceptable to state inspectors who were charged with reviewing the work. A memo dated June 26, 1970 does note, however, that the quality of concrete work was poor and the embankment fill very rocky. At that time these conditions were found acceptable due to the lack of downstream development. The number of downstream inhabitants has increased significantly since 1970 with the addition of a trailer park along Wolcott Creek at Greenes Landing.

6.3 Past Performance.

No formal records of past performance are available. Information gathered from discussions with the owner indicate the largest flood of record at Macham Dam occurred in October 1975. At that time, flow over the spillway weir was estimated at approximately 1-foot (the spillway provides 5.0 feet of freeboard at the weir). The facility reportedly functioned adequately during the event; however, some damage was incurred when a portion of the discharge end of the spillway was undercut and collapsed. No other flood damage has ever been recorded.

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1 and may be subject to minor earthquake induced dynamic forces. As the facility appears well constructed and sufficiently stable, it is believed that it can withstand the expected dynamic forces; however, no calculations and/or investigations were performed to confirm this opinion.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The visual inspection suggests the facility is in fair condition.

The size classification of the facility is small and its hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) for the facility ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. Due to the high potential for damage to downstream structures and possible loss of life, the SDF is considered to be the PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass and/or store only about 43 percent of the PMF prior to embankment overtopping. A breach analysis indicates that failure under less than 1/2 PMF conditions could lead to increased downstream damage and potential for loss of life. Thus, based on the screening criteria contained in the recommended guidelines, the spillway is considered to be seriously inadequate and the facility unsafe, non-emergency.

Deficiences noted by the inspection team included significant sloughing and erosion of the upstream embankment face, a damaged outlet conduit control mechanism and inaccessible manual operator and, a deteriorating concrete spillway.

b. Adequacy of Information. The available data are considered sufficient to make a reasonable Phase I assessment of the facility.

c. Urgency. The recommendations listed below should be implemented immediately.

d. Necessity for Additional Investigations. Additional hydrologic/hydraulic investigations are considered necessary to more accurately assess the adequacy of the spillway system of the facility.

7.2 Recommendations/Remedial Measures.

It is recommended that the owner immediately:

a. Develop a formal emergency warning system to notify downstream residents should hazardous conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

b. Retain the services of a registered professional engineer experienced in the hydraulics and hydrology of dams to further assess the adequacy of the spillway facilities and take remedial measures deemed necessary to make the facility hydraulically adequate.

c. Repair the eroded upstream embankment slope and provide adequate riprap material to protect it against future damage.

d. Repair the damaged outlet conduit control mechanism and re-establish access to the manual operator.

e. Clean out weep holes, fill and seal all cracks and repair spalled portions of the concrete spillway.

f. Develop formal manuals of operation and maintenance to ensure the future proper care of the facility.

APPENDIX A

VISUAL INSPECTION CHECKLIST AND FIELD SKETCHES

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Macham Dam STATE Pennsylvania COUNTY Bradford

NDI # PA — 00043 PENNDER # 8-56

TYPE OF DAM Earth SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION 22 April 80 WEATHER Clear; windy. TEMPERATURE 60° @ 2:00 p.m.

POOL ELEVATION AT TIME OF INSPECTION 1304.1 M.S.L.

TAILWATER AT TIME OF INSPECTION N/A M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
B. M. Mihalcin	Afton Chamberlain	
D. L. Bonk		
D. J. Spaeder		
W. J. Veon		

RECORDED BY B. M. Mihalcin

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA- 00043
SURFACE CRACKS	None observed.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Erosion and sloughing of the upstream embankment slope observed at and above normal pool level caused by wave action and inadequate slope protection.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal - good. Vertical - good.
RIPRAP FAILURES	No riprap. Owner claims wave protection was to be provided by soil-cement. Ineffective as evidenced by erosion.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00043
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	None observed on downstream face or along immediate toe area.
ANY NOTICEABLE SEEPAGE	None observed.
STAFF GAGE AND RECORDER	None.
DRAINS	None.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00043
INTAKE STRUCTURE	Submerged and unobserved. Steel framed foot bridge that provided access to the outlet conduit control mechanism was reportedly toppled by ice.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	18-inch diameter reinforced concrete pipe embedded within the embankment and not observed.
OUTLET STRUCTURE	Concrete headwall in good condition. Stilling basin not constructed as shown on design drawings.
OUTLET CHANNEL	Partially rock lined ditch. Unobstructed.
GATE(S) AND OPERATIONAL EQUIPMENT	18-inch diameter stainless steel sluice gate. Operating stem bent when bridge toppled. Operation would presently require divers.

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA- 00043
TYPE AND CONDITION	Uncontrolled, rectangular, concrete chute channel with a broad crested weir. Fair condition. Significant concrete deterioration in the form of cracking and spalling was observed.
APPROACH CHANNEL	No actual approach channel; however, the concrete overflow weir is quite broad (35 foot breadth) and may account for some head losses.
SPILLWAY CHANNEL AND SIDEWALLS	Channel concrete cracked in many areas. End sill undercut and failed during flood of October 1975. Weep holes clogged with debris. Surface moderately scaled. End section of right channel sidewall rotated and spalled.
STILLING BASIN PLUNGE POOL	None.
DISCHARGE CHANNEL	Lined with dumped rock reportedly in accordance with state recommendations subsequent to severe undercutting that resulted in the partial collapse of the spillway channel floor slab.
BRIDGE AND PIERS EMERGENCY GATES	None.

SERVICE SPILLWAY

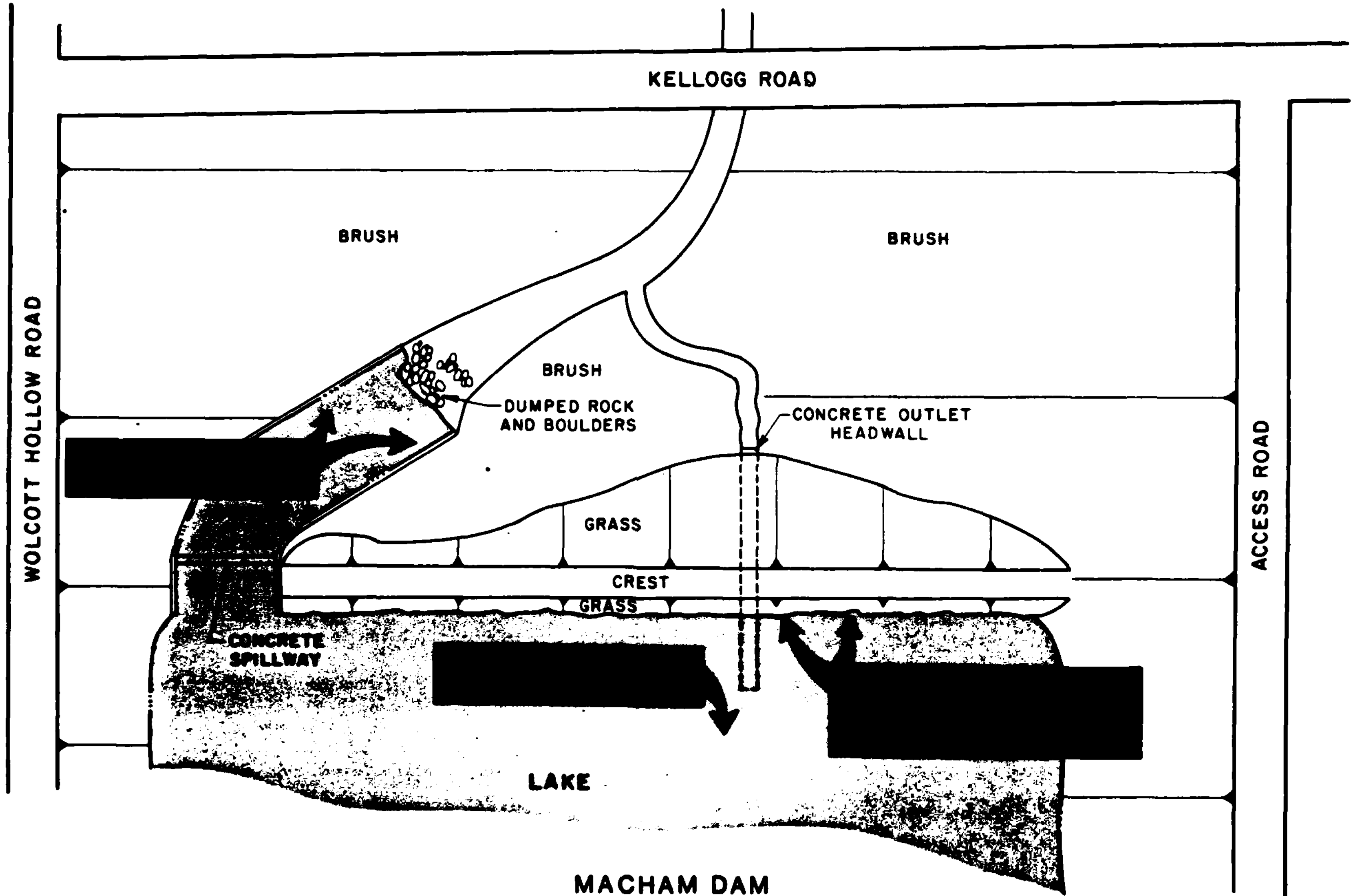
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00043
TYPE AND CONDITION	N/A
APPROACH CHANNEL	N/A
OUTLET STRUCTURE	N/A
DISCHARGE CHANNEL	N/A

INSTRUMENTATION

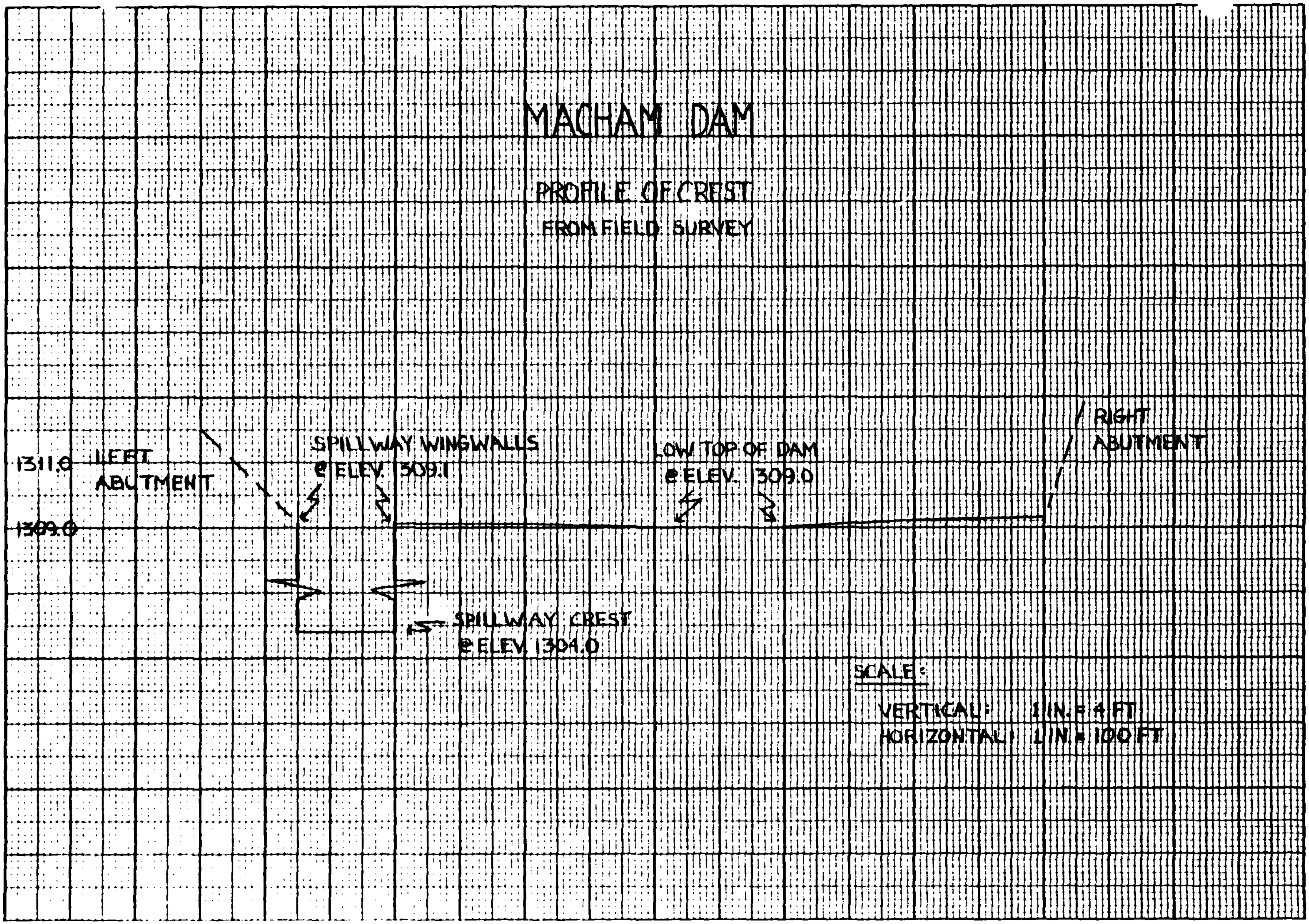
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00043
MONUMENTATION SURVEYS	None.
OBSERVATION WELLS	None.
WEIRS	None.
PIEZOMETERS	None.
OTHERS	None.

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00043
SLOPES: RESERVOIR	Steep and primarily forested.
SEDIMENTATION	None observed.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Culvert beneath Kellogg Road located several hundred feet downstream of the dam.
SLOPES: CHANNEL VALLEY	Narrow valley with steep confining slopes.
APPROXIMATE NUMBER OF HOMES AND POPULATION	At Greenes Landing, approximately 5 miles downstream of the dam, a mobile trailer park is located adjacent the stream. It is estimated that about 50 persons could inhabit this area.



MACHAM DAM
GENERAL PLAN - FIELD INSPECTION NOTES


MACHAM DAM
PROFILE OF CREST
FROM FIELD SURVEY
1311.0
LEFT ABUTMENT
1309.0
SPILLWAY WINGWALLS
@ ELEV. 1309.1
LOW TOP OF DAM
@ ELEV. 1309.0
RIGHT ABUTMENT
SPILLWAY CREST
@ ELEV. 1304.0
SCALE:
VERTICAL: 1 IN. = 4 FT
HORIZONTAL: 1 IN. = 100 FT

APPENDIX B

ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Macham Dam

ITEM	REMARKS NDI# PA - 00043
PERSONS INTERVIEWED AND TITLE	Afton Chamberlain - Owner
REGIONAL VICINITY MAP	See Figures 1 and 2, Appendix E.
CONSTRUCTION HISTORY	Constructed by Manley and Afton Chamberlain between the years 1966 and 1970. See Section 1.2.g.
AVAILABLE DRAWINGS	See Figures 3, 4, 5 and 6, Appendix E. Original drawings are available from both the owner and the PennDER.
TYPICAL DAM SECTIONS	See Figure 5, Appendix E.
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	See Figures 4 and 5, Appendix E. Discharge rating curves are not available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 00043
SPILLWAY: PLAN SECTION DETAILS	See Figure 4, Appendix E.
OPERATING EQUIPMENT PLANS AND DETAILS	See Figure 5, Appendix E.
DESIGN REPORTS	None available.
GEOLOGY REPORTS	General geology included in a report contained in PennDER files entitled "Soils and Foundation Report on Site of Proposed Macham Dam" dated October 11, 1965 by Herluf T. Larsen of Harrisburg, Pennsylvania.
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None available.
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	See "Soils and Foundation Report . . ."

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 00043
BORROW SOURCES	Within reservoir. See "Soils and Foundation Report . . ."
POST CONSTRUCTION DAM SURVEYS	None since construction.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
HIGH POOL RECORDS	1-foot over spillway in October 1975. Caused undermining of spillway discharge end.
MONITORING SYSTEMS	None.
MODIFICATIONS	None.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS — NDI# PA - 00043
PRIOR ACCIDENTS OR FAILURES	Spillway damaged during flood of October, 1975.
MAINTENANCE: RECORDS MANUAL	No formal records or manual.
OPERATION: RECORDS MANUAL	No formal records or manual. Control gate reportedly last opened in 1976. Access bridge reportedly toppled by ice. Photos in PennDER files indicate bridge down since mid-1973.
OPERATIONAL PROCEDURES	Self-regulating.
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None.
MISCELLANEOUS	

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CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-00043
PENNDER ID # 8-56

SIZE OF DRAINAGE AREA: 2.5 square miles.

ELEVATION TOP NORMAL POOL: 1304.0 STORAGE CAPACITY: 310 acre-feet.

ELEVATION TOP FLOOD CONTROL POOL: - STORAGE CAPACITY: -

ELEVATION MAXIMUM DESIGN POOL: 1309.0 STORAGE CAPACITY: 550 acre-feet.

ELEVATION TOP DAM: 1309.0 STORAGE CAPACITY: 550 acre-feet.

SPILLWAY DATA

CREST ELEVATION: 1304.0 feet.

TYPE: Uncontrolled, rectangular, concrete chute channel.

CREST LENGTH: 75 feet.

CHANNEL LENGTH: 140 feet (includes approach and discharge channels).

SPILLOVER LOCATION: Left abutment.

NUMBER AND TYPE OF GATES: None.

OUTLET WORKS

TYPE: 18-inch diameter reinforced concrete pipe.

LOCATION: Near embankment center.

ENTRANCE INVERTS: 1290.5 feet.

EXIT INVERTS: 1289.5 feet.

EMERGENCY DRAWDOWN FACILITIES: 18-inch diameter stainless steel gate valve at inlet end.

HYDROMETEOROLOGICAL GAGES

TYPE: None.

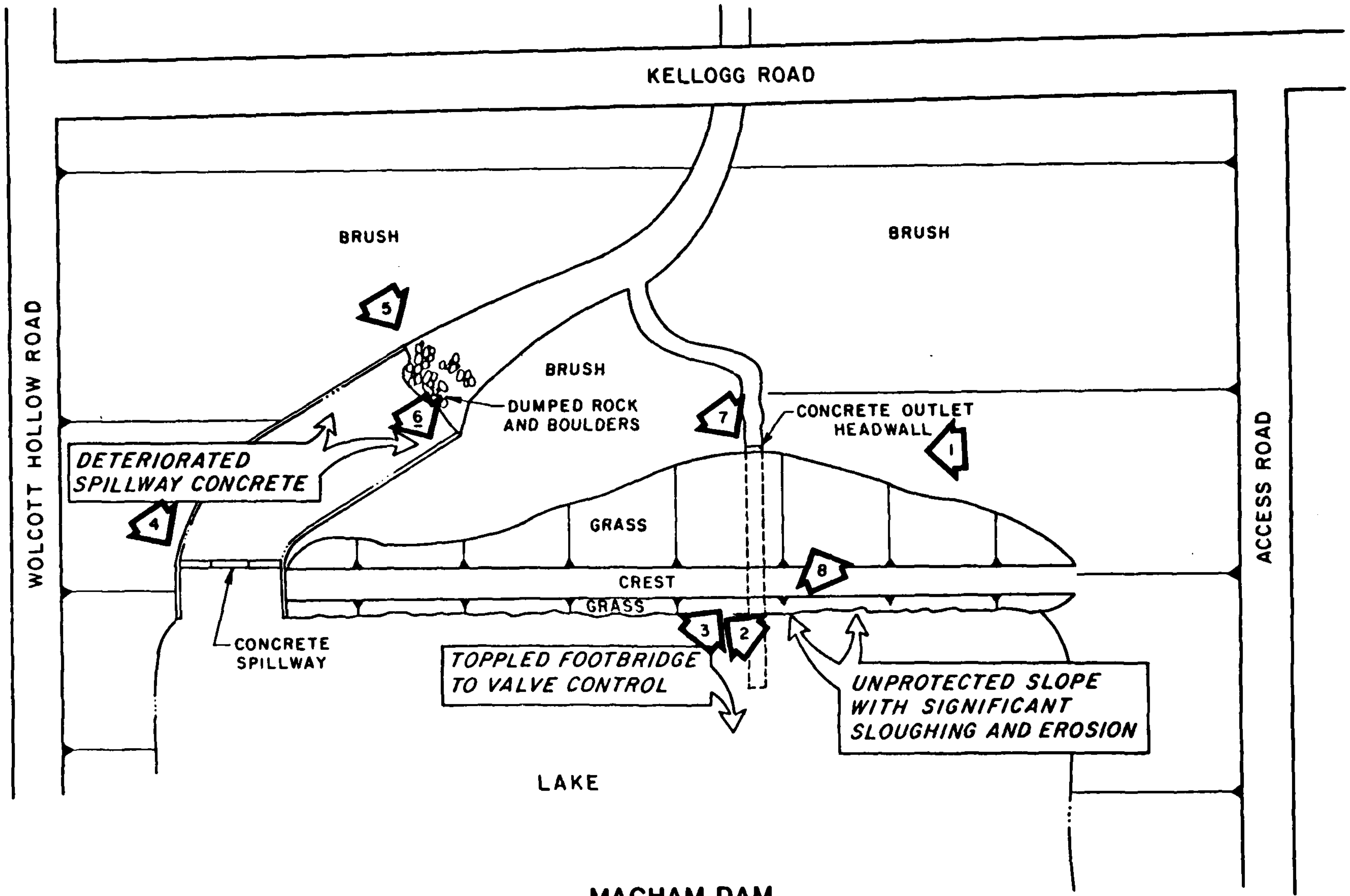
LOCATION: -

RECORDS: -

MAXIMUM NON-DAMAGING DISCHARGE: Not known.

APPENDIX C

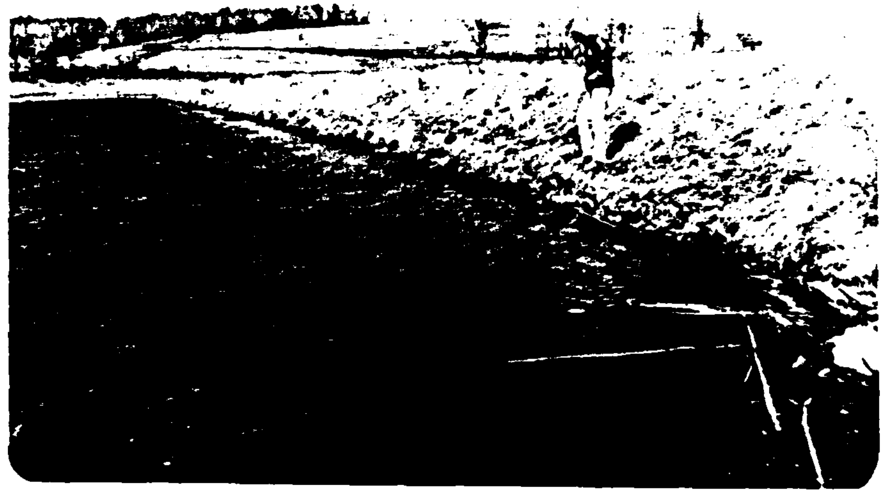
PHOTOGRAPHS



MACHAM DAM
PHOTOGRAPH KEY MAP

PHOTOGRAPH 1	View of the downstream embankment face looking toward the left abutment.
PHOTOGRAPH 2	View of the upstream embankment face as seen from the right abutment.
PHOTOGRAPH 3	Close-up view of erosion along the upstream embankment face above normal pool level.
PHOTOGRAPH 4	View of the emergency spillway and a portion of the reservoir as seen from the left abutment.

1



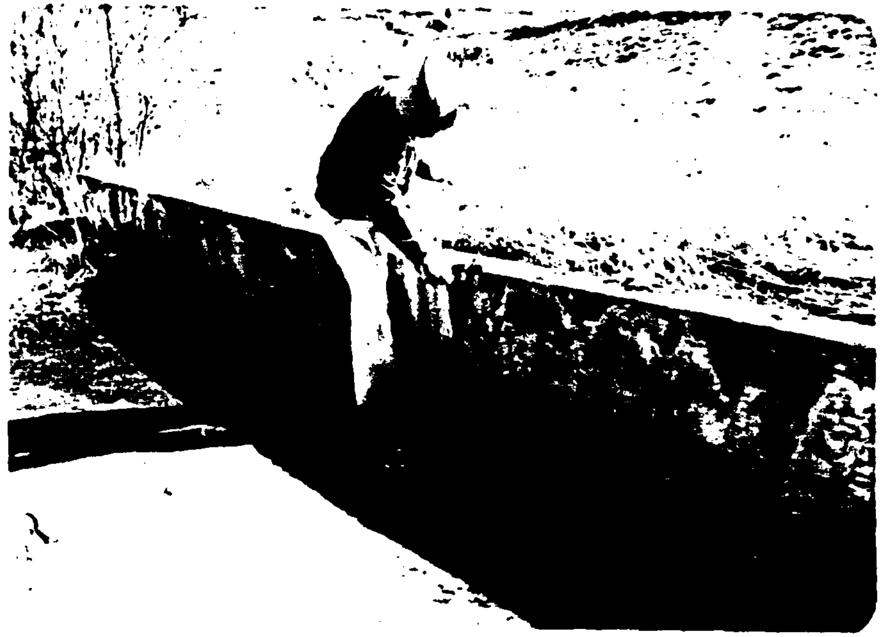
2

3

4

PHOTOGRAPH 5	View of the damaged discharge end of the emergency spillway.
PHOTOGRAPH 6	View of a deteriorated portion of the spillway right wingwall.
PHOTOGRAPH 7	View of the discharge end of the outlet conduit.
PHOTOGRAPH 8	View of the outlet conduit discharge channel as seen from the embankment crest.

5



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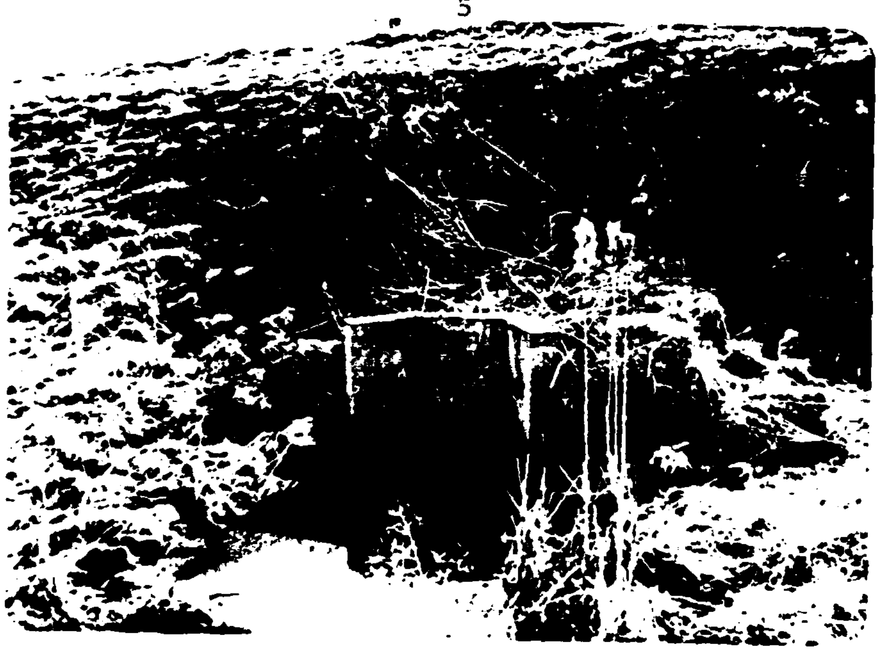

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8

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

PREFACE

The modified HEC-1 program is capable of performing two basic types of hydrologic analyses: 1) the evaluation of the overtopping potential of the dam; and 2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. Briefly, the computational procedures typically used in the dam overtopping analysis are as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

c. Routing of the outflow hydrograph(s) from the reservoir to desired downstream locations. The results provide the peak discharge(s), time(s) of the peak discharge(s), and the maximum stage(s) of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequences resulting from an assumed structural failure (breach) of the dam is typically performed as shown below.

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir.

c. Development of a failure hydrograph(s) based on specified breach criteria and normal reservoir outflow.

d. Routing of the failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge(s), time(s) to peak and maximum water surface elevations of failure hydrographs for each location.

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: MACHAM DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 22.2 INCHES/24 HOURS (1)

STATION	1	2	3
STATION DESCRIPTION	Macham Dam		
DRAINAGE AREA (SQUARE MILES)	2.4		
CUMULATIVE DRAINAGE AREA (SQUARE MILES)	-		
ADJUSTMENT OF PMF FOR DRAINAGE AREA LOCATION (%) (1)			
6 HOURS	114		
12 HOURS	123		
24 HOURS	132		
48 HOURS	138		
72 HOURS	-		
SNYDER HYDROGRAPH PARAMETERS			
ZONE (2)	11		
C_p (3)	0.62		
C_t (3)	1.50		
L (MILES) (4)	2.2		
L_{ca} (MILES) (4)	1.0		
$t_p = C_t (L \cdot L_{ca})^{0.3}$ (HOURS)	1.90		
SPILLWAY DATA			
CREST LENGTH (FEET)	75		
FREEBOARD (FEET)	5.0		

(1) HYDROMETEOROLOGICAL REPORT 40, U.S. WEATHER BUREAU, 1965.

(2) HYDROLOGIC ZONE DEFINED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT, FOR DETERMINATION OF SNYDER COEFFICIENTS (C_p AND C_t).

(3) SNYDER COEFFICIENTS

(4) L = LENGTH OF LONGEST WATERCOURSE FROM DAM TO BASIN DIVIDE.
L_{ca} = LENGTH OF LONGEST WATERCOURSE FROM DAM TO POINT OPPOSITE BASIN CENTROID.

SUBJECT: DAM SAFETY INSPECTION
MACHAM DAM

BY: DJS DATE: 5-16-80 PROJ. NO. 79-303-043
CHKD. BY: WJV DATE: 6-3-80 SHEET NO. 1 OF 19

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DAM STATISTICS

- HEIGHT OF DAM = 19 FT (FIELD MEASURED: DOWNSTREAM OUTLET INVERT TO LOW TOP OF DAM)

- NORMAL POOL STORAGE CAPACITY = 101 X10^6 GALLONS
  ≃ 310 ACRE-FEET (SEE NOTE 1)

- MAXIMUM POOL STORAGE CAPACITY = 550 ACRE-FEET (SHEET 4)
  (@ LOW TOP OF DAM)

- DRAINAGE AREA = 24 SQ. MI. (PLANIMETERED ON 7.5' U.S.G.S. TOPO QUADS, SAYRE AND BENTLEY CREEK, PA)

ELEVATIONS:

TOP OF DAM (DESIGN) =	1309.0	(FIG. 4, SEE NOTE 2)
TOP OF DAM (FIELD) =	1309.0	
NORMAL POOL =	1304.0	(FIG. 3, SEE NOTE 2)
UPSTREAM INLET INVERT (DESIGN) =	1290.5	(FIG. 5, SEE NOTE 2)
DOWNSTREAM OUTLET INVERT (DESIGN) =	1289.7	(FIG. 5, SEE NOTE 2)
DOWNSTREAM OUTLET INVERT (FIELD) =	1289.9	
STREAMBED AT DAM CENTERLINE ≃	1290.0	(FIG. 6, SEE NOTE 2)

NOTE 1: OBTAINED FROM "REPORT UPON THE APPLICATION OF MANLEY AND AFTON CHAMBERLAIN, TO CONSTRUCT AND MAINTAIN A DAM ACROSS WOLCOTT CREEK IN ATHENS TOWNSHIP, BRADFORD COUNTY," MAY 13, 1966; FOUND IN PENN DER FILES.

SUBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJS DATE 5-17-80 PROJ. NO. 79-203-043

CHKD. BY WJV DATE 6-3-80 SHEET NO. 2 OF 19

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NOTE 2: DESIGN DRAWINGS ARE BASED ON A NORMAL POOL OR SPILLWAY ELEVATION OF 100.0 FEET. THE USGS TOPO QUAD FOR SAYRE, PA, INDICATES THAT THE NORMAL POOL ELEVATION IS SOMEWHERE BETWEEN 1280.0 AND 1320.0. THE RESERVOIR SURFACE AREA AT ELEVATION 96.0, AS PLANIMETERED ON FIGURE 3, IS APPROXIMATELY 37 ACRES, WHICH IS ALSO THE VALUE OBTAINED AT ELEVATION 1300.0 ON THE USGS TOPO MAP. THUS, IT WILL BE ASSUMED THAT ELEVATION 96.0 ON THE DESIGN DRAWINGS CORRESPONDS TO ELEVATION 1300.0 ON THE USGS TOPO MAP. THEREFORE, A VALUE OF 1204.0 HAS BEEN ADDED TO ALL THE REPORTED ELEVATIONS ON THE DESIGN DRAWINGS. IT IS NOTED THAT THE ELEVATIONS USED IN THIS ANALYSIS ARE CONSIDERED ESTIMATES, AND ARE NOT NECESSARILY ACCURATE.

DAM CLASSIFICATION

DAM SIZE: SMALL	(REF 1, TABLE 1)
HAZARD CLASSIFICATION: HIGH	(FIELD OBSERVATION)
REQUIRED SDF: ½ PMF TO PMF	(REF 1, TABLE 3)

HYDROGRAPH PARAMETERS

- LENGTH OF LONGEST WATERCOURSE: $L = 2.2$ MILES
- LENGTH OF LONGEST WATERCOURSE FROM DAM TO A POINT OPPOSITE BASIN CENTROID: $L_{CA} = 1.0$ MILE (MEASURED ON U.S. TOPO QUAD, SAYRE, AND BENTLEY CREEK, P-

SUBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY RJS DATE 5-17-80 PROJ. NO. 79-203-043

CHKD. BY WJV DATE 6-3-80 SHEET NO. 3 OF 19

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$C_t = 1.50$
$C_p = 0.62$

(SUPPLIED BY C.O.E., ZONE 11, SUSQUEHANNA RIVER BASIN)

SNYDER'S STANDARD LAG : $t_p = C_t (L \cdot L_{ca})^{0.3}$
$= 1.50(2.2 \times 1.0)^{0.3}$
$= \underline{1.90}$ HOURS

(NOTE: HYDROGRAPH VARIABLES USED HERE ARE DEFINED IN REF 2, IN SECTION ENTITLED "SNYDER SYNTHETIC UNIT HYDROGRAPH.")

RESERVOIR CAPACITY

RESERVOIR SURFACE AREAS:

	RESERVOIR ELEVATION (FT)	SURFACE AREA* (ACRES)
	1290.0	0
	1292.0	1
	1294.0	7
	1296.0	19
	1298.0	29
	1300.0	37
	1302.0	41
(NORMAL POOL)	1304.0	44
	1320.0	68

* – SURFACE AREAS AT OR BELOW ELEVATION 1304.0 (NORMAL POOL) PLANIMETERED ON FIG. 3 (SEE NOTE 2); S.A. AT ELEV 1320 MEASURED ON USGS TOPO MAPS: SAYRE AND BENTLEY CREEK, PA.

JBJECT	DAM SAFETY INSPECTION
	MACHAM DAM
BY DJS	DATE 5-17-80
PROJ. NO.	79-203-043
CHKD. BY WJV	DATE 6-3-80
SHEET NO.	4 OF 19

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IT IS ASSUMED THAT THE MODIFIED PRISMOIDAL RELATIONSHIP ADEQUATELY MODELS THE RESERVOIR SURFACE AREA — STORAGE RELATIONSHIP. SINCE THE CAPACITY AT NORMAL POOL IS KNOWN, THE CALCULATED VOLUMES CAN BE ADJUSTED ACCORDINGLY.

$$\Delta V_{1-2} = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 \cdot A_2}\right) \qquad \text{(REF 14, p.15)}$$

WHERE ΔV_{1-2} = INCREMENTAL VOLUME BETWEEN ELEVATIONS 1 + 2, IN AC-FT,
h = ELEVATION 1 − ELEVATION 2, IN FT,
A_1 = SURFACE AREA AT ELEV 1, IN ACRES,
A_2 = SURFACE AREA AT ELEV 2, IN ACRES.

ALSO, IT WILL BE ASSUMED THAT THE SURFACE AREA VARIES LINEARLY BETWEEN ELEVATIONS 1304.0 AND 1320.0.

ELEVATION - STORAGE TABLE :

	RESERVOIR ELEVATION (FT)	A ① (ACRES)	ΔV_{1-2} (AC-FT)	INITIAL CALCULATED TOTAL VOLUME (AC-FT)	ADJUSTED ② FINAL VOLUME (AC-FT)
	1290.0	0	—	—	0
	1292.0	1	0.7	0.7	1
	1294.0	7	7.1	7.8	8
	1296.0	19	25.0	32.8	33
	1298.0	29	47.6	80.4	81
	1300.0	37	65.8	146.2	147
	1302.0	41	78.0	224.2	225
(NORMAL POOL)	1304.0	44	85.0	309.2	310
	1306.0	47	91.0	400.2	400
(LOW TOP OF DAM)	1309.0	52	148.4	548.6	549
	1310.0	53	52.5	601.1	601
	1311.0	55	54.0	655.1	655
	1312.0	56	55.5	710.6	711
	1313.0	58	57.0	767.6	768
	1314.0	59	58.5	826.1	826

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① SURFACE AREAS TAKEN FROM SHEET 3. BETWEEN ELEVATIONS 1304 AND 1320, SURFACE AREAS CALCULATED BY LINEAR INTERPOLATION.

② ADJUSTED FINAL VOLUME (BELOW NORMAL POOL) $\simeq$ INITIAL CALCULATED VOLUME × $\left(\frac{\text{KNOWN VOL. @ NORMAL POOL}}{\text{INITIAL CALC VOL. @ NORMAL P.}}\right)$

$\simeq$ INITIAL CALC. VOL. × $\left(\frac{310}{309.2}\right)$

- ZERO STORAGE ELEVATION TAKEN FROM FIG. 5 (SEE NOTE 2).

PMP CALCULATIONS

- FROM REF. 9, FIG. 2, OBTAIN PMP VALUE FOR A BASIN OF DRAINAGE AREA 200 SQ. MI., 24-HOUR DURATION: P = 22.2 IN.

- FROM REF 9, FIG. 1, GEOGRAPHIC ADJUSTMENT FACTOR $\simeq$ 97%
(@ N 41°-55.2', W76°-37.4')

- AREA CORRECTION FACTOR (REF 9):

DURATION (HRS):	6	12	24	48	72
FACTOR (%):	117.5	127.0	136.0	142.5	145.0

- TOTAL CORRECTION FACTOR (0.97 × AREA CORRECTION FACTOR):

DURATION (HRS):	6	12	24	48	72
FACTOR (%):	114	123	132	138	141

- HOP BROOK FACTOR (ADJUSTMENT FOR BASIN SHAPE AND FOR THE LESSER LIKELIHOOD OF A SEVERE STORM CENTERING OVER A SMALL BASIN) FOR A DRAINAGE AREA OF 2.5 SQUARE MILES IS 0.80

(REF 4, p. 48)

SUBJECT DAM SAFETY INSPECTION
MACHAM DAM

BY DJS DATE 5-19-80 PROJ. NO. 79-303-043

CHKD. BY WJV DATE 6-3-80 SHEET NO. 6 OF 19

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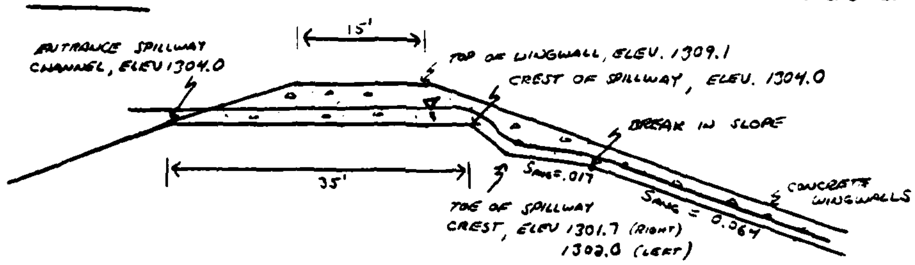
SPILLWAY CAPACITY

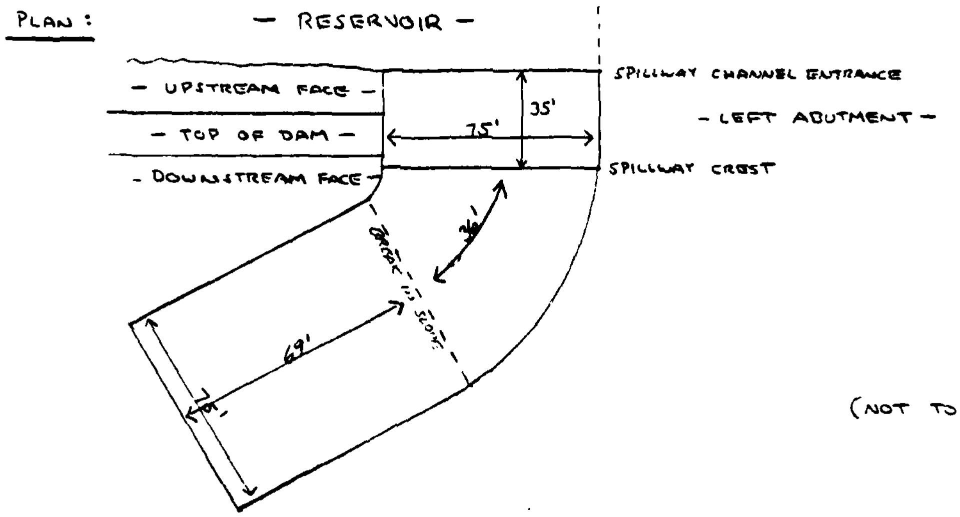
(SKETCHES BASED ON FIELD MEASUREMENTS AND FIG. 4)

PROFILE:



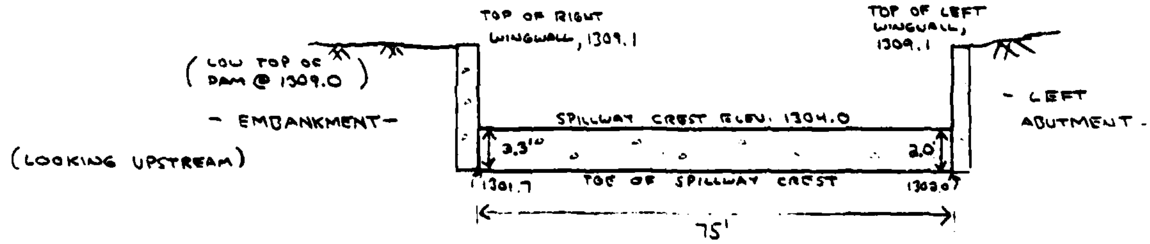
(NOT TO SCALE)

PLAN:



(NOT TO SCALE)

CROSS-SECTION:



(NOT TO SCALE)

SUBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJS DATE 5-19-80 PROJ. NO. 79-203-043

CHKD. BY WJV DATE 6-3-80 SHEET NO. 7 OF 19

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THE SPILLWAY ESSENTIALLY CONSISTS OF A BROAD-CRESTED WEIR WHICH DISCHARGES INTO A RECTANGULAR CONCRETE CHANNEL, AS SHOWN ON SHEET 6. DISCHARGE OVER THE WEIR CAN BE ESTIMATED BY THE RELATION:

$$Q = CLH^{3/2} \qquad \text{(REF 5, p. 5-23)}$$

WHERE
Q = DISCHARGE OVER THE WEIR, IN CFS,
H = EFFECTIVE HEAD ON THE WEIR, IN FT,
L = LENGTH OF WEIR CREST = 75 FT,
C = COEFFICIENT OF DISCHARGE. IT WILL BE ASSUMED THAT CRITICAL FLOW OCCURS NEAR THE SPILLWAY CREST; THUS, C = 3.087. (REF 5, p. 5-24).

APPROACH LOSSES: SPILLWAY CHANNEL: ESTIMATE LOSSES AT ELEV 1309.1, OR TOP OF SPILLWAY WINGWALLS:

LENGTH OF CHANNEL = 35 FT
WIDTH OF CHANNEL = 75 FT

AT ELEV. 1309.1,

AVG. DEPTH = 5.1 FT,
∴ FLOW AREA = (5.1)(75) = 382.5 FT

- INITIAL ESTIMATE OF DISCHARGE:

$$Q = CLH^{3/2} = (3.087)(75)(5.1)^{3/2} = \underline{2667} \text{ CFS}$$

- AVERAGE VELOCITY IN CHANNEL:

$$V = Q/A = \frac{2667}{382.5} = \underline{7.0} \text{ FPS}$$

$$\text{- VELOCITY HEAD} = V^2/2g = \frac{(7.0)^2}{64.4} = \underline{0.76} \text{ FT}$$

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- ASSUME THAT THE ENTRANCE LOSS = $0.1\,h_a$ (REF 4, p. 379),

$$h_e = 0.1\,h_a = 0.1\,(0.76) = \underline{0.08}\ \text{FT}.$$

- CALCULATE FRICTION LOSS, h_F:

$$h_F = \left[\frac{V n}{1.486\,R^{2/3}}\right]^2 \times L_c \qquad \text{(REF 4, p. 379)}$$

WHERE L_c = LENGTH OF CHANNEL = 35 FT,
n = MANNING'S ROUGHNESS COEFFICIENT = 0.015
R = HYDRAULIC RADIUS = FLOW AREA / WETTED PERIMETER.

- WETTED PERIMETER:

$$\text{AVG. HT OF WINGWALL} = \frac{\left[\left(\frac{5.1+3.5}{2}\right)(5) + (5.1)(15) + (2.6)(15)\right]}{35}$$

$$= \underline{3.9}\ \text{FT}$$

$$\therefore\ P_w = 2(3.9) + 75 = \underline{82.8}\ \text{FT}$$

$$\therefore\ R = A/P_w = \frac{382.5}{82.8} = \underline{4.6}\ \text{FT}$$

$$h_F = \left[\frac{(7.0)(0.015)}{(1.486)\,(4.6)^{2/3}}\right]^2 \times 35 = \underline{0.02}\ \text{FT}$$

$$\therefore\ h_{L\text{-TOTAL}} = h_e + h_F = 0.08 + 0.02 = \underline{0.10}$$

$$\text{EFFECTIVE HEAD}\quad H_E = 5.1 - 0.1 = \underline{5.0}\ \text{FT}$$

$$Q = (3.087)(75)(5.0)^{3/2} = \underline{2590}\ \text{CFS}$$

SUBJECT	DAM SAFETY INSPECTION MACHAM DAM		
BY	DJS	DATE 5-19-80	PROJ. NO. 79-203-043
CHKD. BY	WJV	DATE 6-3-80	SHEET NO. 9 OF 19

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FOR OTHER HEADS, THE APPROACH LOSSES ARE ASSUMED TO BE PROPORTIONAL TO THOSE CALCULATED ABOVE:

$$h_L = \left(\frac{H}{5.1}\right)(0.10)$$

WHERE h_L = TOTAL APPROACH LOSS
H = RESERVOIR ELEVATION − 1304.0

EFFECT OF DOWNSTREAM APRON INTERFERENCE:

BECAUSE OF THE POSITION OF THE APRON FLOOR IN RELATION TO THE CREST, THERE IS THE POSSIBILITY OF APRON INTERFERENCE, WHICH WOULD REDUCE THE DISCHARGE CAPABILITIES OF THE SPILLWAY. IT WILL BE ASSUMED THAT TAILWATER EFFECTS ARE NEGLIGIBLE, AND THUS, THE ONLY DOWNSTREAM EFFECTS WILL BE DUE TO APRON INTERFERENCE. AT ELEVATION 1309.1,

$$\frac{h_d + d}{H_e} = \frac{7.15}{5.0} = \underline{1.43}$$

WHERE H_e = EFFECTIVE HEAD ON WEIR CREST, IN FT,
$h_d + d = H_e + 2.15$ (SEE SHEET 6 AND REF 4, FIG. 253).

ASSUMING THAT THE RELATIONSHIP GIVEN IN REF 4, FIG. 253, FOR OGEE WEIRS, MAY BE APPLIED HERE:

FOR $\frac{h_d + d}{H_e} = 1.43$, $\frac{C_s}{C} = \underline{0.97}$

WHERE C_s = COEFFICIENT OF DISCHARGE CORRECTED FOR APRON EFFECT,
$C = 3.087$.

$$\therefore C_s = (0.97)(3.087) = \underline{2.99}$$

$$\therefore Q = (2.99)(75)(5.0)^{3/2} = \underline{2510} \text{ CFS}$$

SUBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJS DATE 5-19-80 PROJ. NO. 79-203-043

CHKD. BY WJV DATE 6-3-80 SHEET NO. 10 OF 19

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SPILLWAY RATING TABLE:

RESERVOIR ELEVATION (FT)	H (FT)	h_L ① (FT)	H_E ② (FT)	$\frac{h_d + d}{H_E}$ ③ (FT)	C_s/C ④	C_s ⑤	Q ⑥ (CFS)
1304.0	0	—	—	—	—	—	0
1305.0	1.0	0.02	0.98	3.19	1.00	3.09	220
1306.0	2.0	0.04	1.96	2.10	1.00	3.09	640
1307.0	3.0	0.06	2.94	1.73	1.00	3.09	1170
1308.0	4.0	0.08	3.92	1.55	0.99	3.06	1780
(LOW TOP OF DAM) 1309.0	5.0	0.10	4.90	1.44	0.97	2.99	2430
(TOP OF WINGWALLS) 1309.1	5.1	0.10	5.00	1.43	0.97	2.99	2510
1309.5	5.5	0.11	5.39	1.40	0.96	2.96	2780
1310.0	6.0	0.12	5.88	1.37	0.96	2.96	3170
1310.5	6.5	0.13	6.37	1.34	0.95	2.93	3530
1311.0	7.0	0.14	6.86	1.31	0.94	2.90	3910
1312.0	8.0	0.16	7.84	1.27	0.93	2.87	4730
1313.0	9.0	0.18	8.82	1.24	0.92	2.84	5580
1314.0	10.0	0.20	9.80	1.22	0.91	2.81	6470

① $h_L = \left(\frac{H}{5.1}\right)(0.10)$

② $H_E = H - h_L$

③ $h_d + d = H_E + 2.15$

④ FROM FIG 253, REF. 4

⑤ $C_s = (C_s/C) \times 3.087$

⑥ $Q = C_s L H_E^{3/2}$, WHERE L = 75 FT.

SUBJECT	DAM SAFETY INSPECTION MACHAM DAM		
BY	DSS	DATE	5-20-80
PROJ. NO.	79-203-043		
CHKD. BY	WJV	DATE	6-3-80
SHEET NO.	11	OF	19

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EMBANKMENT RATING CURVE

- ASSUME THAT THE EMBANKMENT BEHAVES ESSENTIALLY AS A BROAD-CRESTED WEIR WHEN OVERTOPPING OCCURS. THUS, THE DISCHARGE CAN BE ESTIMATED BY THE RELATIONSHIP

$$Q = CLH^{3/2}$$ (REF. 5, p. 5-23)

WHERE Q = DISCHARGE OVER EMBANKMENT, IN CFS,
L = LENGTH OF EMBANKMENT OVERTOPPED, IN FT,
H = HEAD ON WEIR, IN FEET; IN THIS CASE IT IS THE AVERAGE "FLOW-AREA" WEIGHTED HEAD ABOVE THE CREST, USING THE LOW TOP OF THE DAM AS A DATUM;
C = COEFFICIENT OF DISCHARGE, DEPENDENT UPON THE HEAD AND THE WEIR BREADTH.

LENGTH OF EMBANKMENT INUNDATED VS. RESERVOIR ELEVATION:

RESERVOIR ELEVATION (FT)	EMBANKMENT LENGTH (FT)
1309.0	100
1309.1	350
1309.2	400
1309.3	500
1309.5	510
1310.0	530
1310.5	540
1311.0	560
1312.0	590
1313.0	610
1314.0	650

(FROM FIELD SURVEY AND USGS TOPO QUAD: SAYRE, PA; RT SIDE SLOPES = 9:1 LT SIDE SLOPES = 22:1)

SUBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJJ DATE 5-20-80 PROJ. NO. 79-203-043

CHKD. BY WJV DATE 6-3-80 SHEET NO. 12 OF 19

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ASSUME THAT INCREMENTAL DISCHARGES FOR SUCCESSIVE RESERVOIR ELEVATIONS ARE APPROXIMATELY TRAPEZOIDAL IN CROSS-SECTIONAL FLOW AREA. THEN ANY INCREMENTAL AREA OF FLOW CAN BE ESTIMATED AS $H_i\left[(L_1+L_2)/2\right]$, WHERE L_1 = LENGTH OF OVERTOPPED EMBANKMENT AT HIGHER ELEVATION, L_2 = LENGTH AT LOWER ELEVATION, H_i = DIFFERENCE IN ELEVATIONS. THUS, THE TOTAL AVERAGE "FLOW-AREA" WEIGHTED HEAD CAN BE ESTIMATED AS $H_w \doteq$ (TOTAL FLOW AREA$/L_1$).

EMBANKMENT RATING TABLE:

RESERVOIR ELEVATION (FT)	L_1 (FT)	L_2 (FT)	INCREMENTAL HEAD, H_i (FT)	① INCREMENTAL FLOW AREA, A_i (FT²)	TOTAL FLOW AREA, A_T (FT²)	② WEIGHTED HEAD, H_w (FT)	③ H_w/ℓ	④ C	⑤ Q (CFS)
1309.00	0	—	—	—	—	—	—	—	—
1309.01	100	0	0	—	—	—	—	—	0
1309.1	350	100	0.1	23	23	0.1	0.01	2.93	30
1309.2	400	350	0.1	38	61	0.2	0.01	2.97	110
1309.3	500	400	0.1	45	106	0.2	0.01	2.97	130
1309.5	510	500	0.2	101	207	0.4	0.03	3.01	390
1310.0	530	510	0.5	260	467	0.9	0.06	3.03	1370
1310.5	540	530	0.5	268	735	1.4	0.09	3.04	2750
1311.0	560	540	0.5	275	1010	1.8	0.12	3.04	4110
1312.0	590	560	1.0	575	1585	2.7	0.18	3.07	8040
1313.0	620	590	1.0	605	2190	3.5	0.23	3.08	12,500
1314.0	650	620	1.0	635	2825	4.3	0.29	3.09	17,910

① $A_i = H_i\left[\frac{(L_1+L_2)}{2}\right]$

② $H_w = A_T/L_1$

③ ℓ = BREADTH OF CREST = 15 FT (FIELD MEASURED)

④ $C = f(H,\ell)$; FROM REF 12, FIG. 24.

⑤ $Q = CL_1H_w^{3/2}$

UBJECT DAM SAFETY INSPECTION
MACHAM DAM

BY DJS DATE 5-20-80 PROJ. NO. 79-203-043

CHKD. BY WJV DATE 6-3-80 SHEET NO. 13 OF 19

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TOTAL FACILITY RATING TABLE

$Q_{TOTAL} = Q_{SPILLWAY} + Q_{EMBANKMENT}$

	RESERVOIR ELEVATION (FT)	① $Q_{SPILLWAY}$ (CFS)	② $Q_{EMBANKMENT}$ (CFS)	Q_{TOTAL} (CFS)
	1304.0	0	–	0
	1305.0	220	–	220
	1306.0	640	–	640
	1307.0	1170	–	1170
	1308.0	1780	–	1780
(LOW TOP OF DAM)	1309.0	2430	0	2430
	1309.1	2510	30	2540
	1309.2	2580 *	110	2690
	1309.3	2650 *	130	2780
	1309.5	2780	390	3170
	1310.0	3170	1370	4540
	1310.5	3530	2720	6250
	1311.0	3910	4110	8020
	1312.0	4730	8040	12,770
	1313.0	5580	12,500	18,080
	1314.0	6470	17,910	24,380

① SHEET 10

② SHEET 12

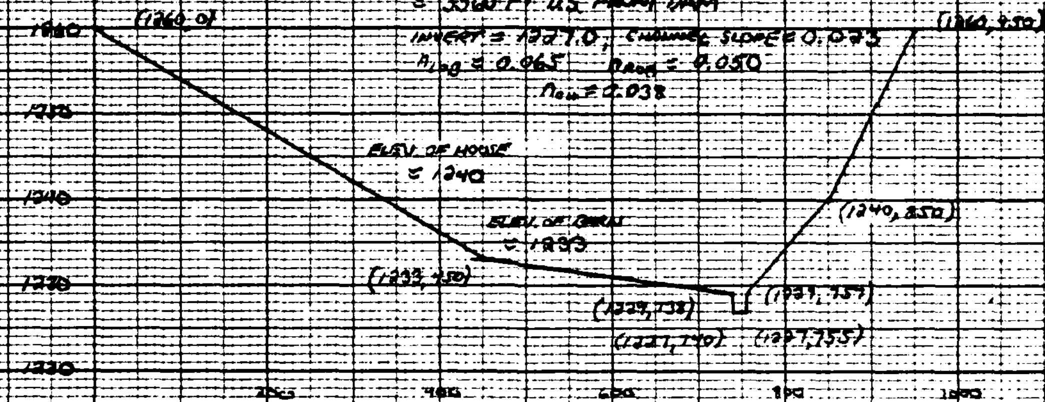
* – BY LINEAR INTERPOLATION.

SUBJECT MACHAM DAM
BY DJS DATE 5-21-80 SHEET NO. 29 OF 29
CHKD. BY WJV DATE 6-3-80 PROJECT NO. 79-208-043

DOWNSTREAM ROUTING SECTIONS

SECTION 2.0

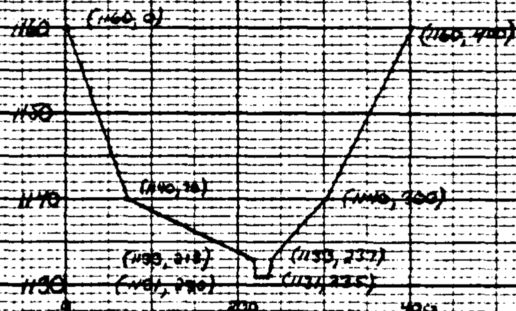
≅ 3560 FT D.S. FROM DAM
INVERT = 1227.0, CHANNEL SLOPE = 0.023
$n_{lob} = 0.065$ $n_{rob} = 0.050$
$n_{ch} = 0.038$



(NOTE: SECTIONS BASED ON FIELD NOTES AND OBSERVATIONS AND USGS TOPO QUAD – SAYRE, PA.; IT IS NOTED HERE THAT THESE ELEVATIONS ARE ESTIMATED OFF THE USGS TOPO QUAD AND ARE NOT NECESSARILY ACCURATE.)

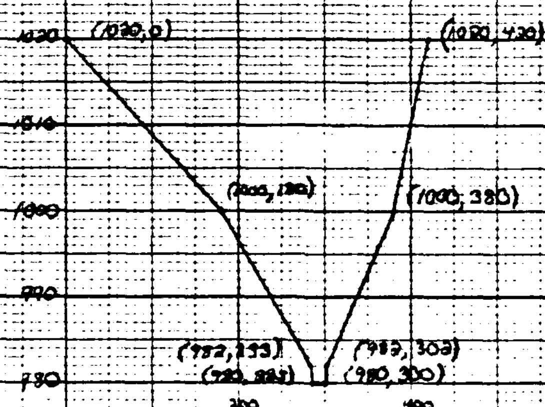
SECTION 3.0

≅ 9460 FT D.S. FROM DAM
REACH LENGTH = 5900 FT
INVERT = 1131.0
CHANNEL SLOPE = 0.013
$n_{lob} = n_{rob} = 0.050$
$n_{ch} = 0.033$



SECTION 4.0

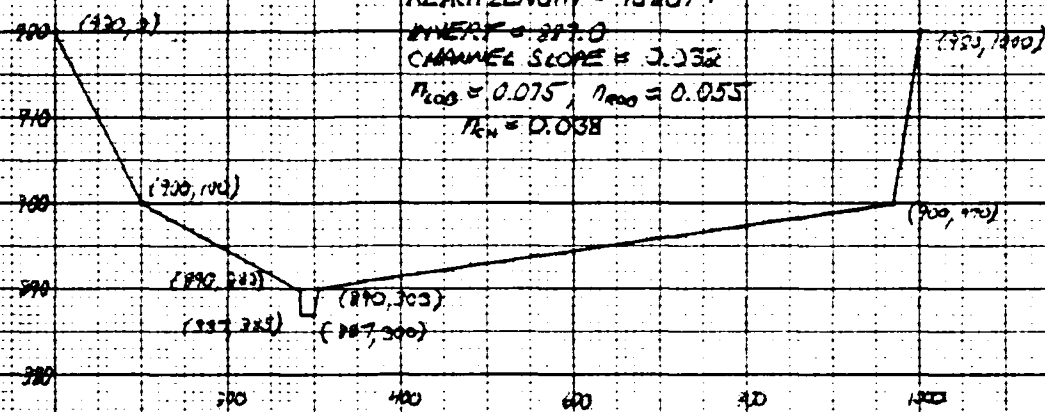
≅ 17,600 FT D.S. FROM DAM
REACH LENGTH = 8140 FT
INVERT = 980.0
CHANNEL SLOPE = 0.017
$n_{lob} = n_{rob} = 0.070$
$n_{ch} = 0.033$



SUBJECT Macham Dam
BY [illegible] DATE [illegible] SHEET NO. [illegible] OF [illegible]
CHKD. BY WDY DATE 6-3-[illegible] PROJECT NO. [illegible]

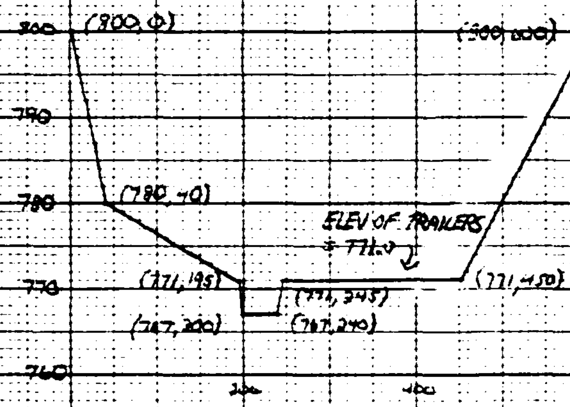
SECTION 5.0

≈ 22,120 FT D.S. FROM DAM
REACH LENGTH = 4520 FT
INVERT = [illegible].0
CHANNEL SLOPE = 0.032
n_{LOB} = 0.075, n_{ROB} = 0.055
n_{CH} = 0.038



SECTION 6.0

≈ 28,560 FT D.S. FROM DAM
REACH LENGTH = 6440 FT
INVERT = 767.0
CHANNEL SLOPE = 0.016
n_{LOB} = 0.050; n_{ROB} = 0.090
n_{CH} = 0.035



SUBJECT DAM SAFETY INSPECTION
MACHAM DAM

BY RJS DATE 6-4-80 PROJ. NO. 79-203-043

CHKD. BY WJV DATE 6-10-80 SHEET NO. 16 OF 19

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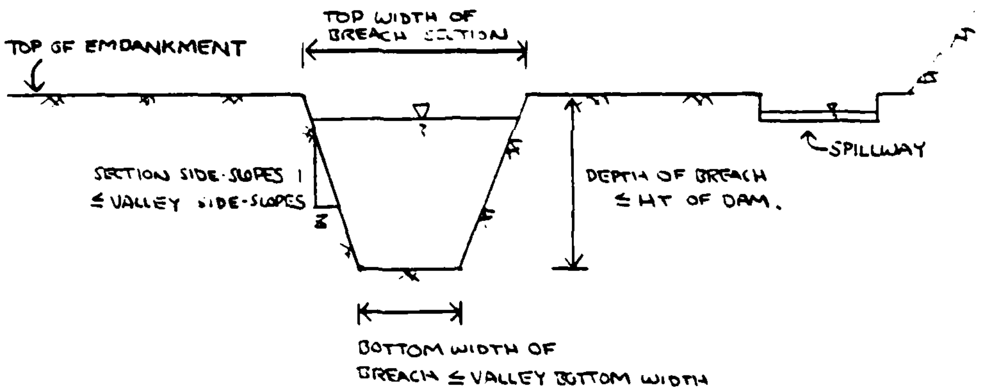
BREACH ASSUMPTIONS

TYPICAL BREACH SECTION:



HEC-1 BREACHING ANALYSIS INPUT:

(BREACHING BEGINS WHEN RESERVOIR LEVEL REACHES LOW TOP OF DAM ELEVATION: 1309.0)

PLAN	BREACH BOTTOM WIDTH (FT)	MAX. BREACH DEPTH (FT)	SECTION SIDE SLOPES	BREACH TIME (HRS)	WSEL AT START OF FAILURE (FT)
① MIN. BREACH SECTION, MIN. FAIL TIME.	0	19	1H:1V	0.5	1309.0
② MAX BREACH SECTION, MIN. FAIL TIME.	250	19	6.5H:1V	0.5	1309.0
③ MIN. BREACH SECTION, MAX. FAIL TIME.	0	19	1H:1V	4.0	1309.0
④ MAX. BREACH SECTION MAX. FAIL TIME.	250	19	6.5H:1V	4.0	1309.0
⑤ AVERAGE POSSIBLE CONDITIONS.	75	19	1H:1V	2.0	1309.0

SUBJECT DAM SAFETY INSPECTION
MACHAM DAM

BY DJS DATE 6-4-80 PROJ. NO. 79-203-043

CHKD. BY WJV DATE 6-10-80 SHEET NO. 17 OF 19

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– THE BREACH ASSUMPTIONS LISTED ON THE PREVIOUS SHEET ARE BASED ON THE SUGGESTED RANGES PROVIDED BY THE C.O.E. (BALTIMORE DISTRICT), AND ON THE PHYSICAL CONSTRAINTS OF THE DAM AND THE SURROUNDING TERRAIN:

- DEPTH OF BREACH OPENING ≃ 19 FT (HEIGHT OF DAM)
- LENGTH OF BREACHABLE EMBANKMENT ≃ 500 FT (FIELD MEASURED)
- VALLEY BOTTOM WIDTH ≃ 250 FT (FIELD OBSERVATION)
- VALLEY SIDE SLOPES ADJACENT TO DAM:

  RIGHT: ≃ 7.5H : 1V (USGS TOPO - SAYRE, PA)

  LEFT: ≃ 10H : 1V

UBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJS DATE 6-6-80 PROJ. NO. 79-303-043

CHKD. BY WJV DATE 6-10-80 SHEET NO. 18 OF 19

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HEC-1 DAM BREACHING ANALYSIS OUTPUT :

RESERVOIR DATA: (UNDER 0.45PMF BASE FLOW CONDITIONS)

PLAN NUMBER *	VARIABLE BREACH BOTTOM WIDTH (FT)	ACTUAL MAX. FLOW DURING FAIL TIME (CFS)	CORRESPONDING TIME OF PEAK (HRS)	INTERPOLATED OR HEC-1 ROUTED MAX FLOW DURING FAIL TIME (CFS)	CORRESPONDING TIME OF PEAK (HRS)	ACTUAL PEAK FLOW THROUGH DAM (CFS)	CORRESPONDING TIME OF PEAK (HRS)	TIME OF INITIAL BREACH (HRS)
1	0	5530	42.33	5530	42.33	5530	42.33	41.83
2	250	20,277	42.28	18,975	42.17	20,277	42.28	41.83
3	0	2568	42.25	2566	42.33	2568	42.25	41.83
4	250	4419	42.92	4418	42.83	4419	42.92	41.83
5	75	6178	43.50	6178	43.50	6178	43.50	41.83

* - SEE SHEET 16.

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DOWNSTREAM ROUTING DATA:

(UNDER 0.45 PMF BASE FLOW CONDITIONS)

① PLAN NUMBER	VARIABLE BREACH BOTTOM WIDTH (FT)	OUTPUT @ SECTION 2, 3560 FT D.S. FROM DAM				OUTPUT @ SECTION 6, 28,560 FT D.S. FROM DAM			
		PEAK FLOW (CFS)	CORRESPONDING WSEL ② (FT)	WSEL W/O BREACH ③ (FT)	ELEVATION DIFFERENCE ④ (FT)	PEAK FLOW (CFS)	CORRESPONDING WSEL ② (FT)	WSEL W/O BREACH ③ (FT)	ELEVATION DIFFERENCE ④ (FT)
①	0	5081	1232.4	1231.3	+ 1.1	3954	772.0	771.0	+1.0
②	250	19,191	1235.4	1231.3	+4.1	10,825	774.4	771.0	+3.4
③	0	2559	1231.3	1231.3	0.0	2511	771.0	771.0	0.0
④	250	4411	1232.2	1231.3	+ 0.9	4240	772.2	771.0	+1.2
⑤	75	6166	1232.7	1231.3	+1.4	5800	772.8	771.0	+1.8

① SEE SHEET 16

② WATER SURFACE ELEVATION CORRESPONDING TO BREACH OUTFLOW (SUMMARY INPUT/OUTPUT SHEETS, SHEET O)

③ BASE FLOW ELEVATION CORRESPONDING TO THE PEAK 0.45 PMF AS INTERPOLATED FROM SHEET H, SUMMARY INPUT/OUTPUT SHEETS.

④ ELEV. DIFF = (CORRESPONDING WSEL) − (WSEL W/O BREACH).

NOTE: → DAMAGE ELEVATIONS @ SECTION 2: BARN ≃ 1233.0
RESIDENCES ≃ 1240.0

→ DAMAGE ELEVATION @ SECTION 6: TRAILERS ≃ 771.0

SUBJECT DAM SAFETY INSPECTION
MACHAM DAM

BY DJS DATE 6-10-80 PROJ. NO. 79-203-043
CHKD. BY DLB DATE 6-11-80 SHEET NO. A OF O

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SUMMARY INPUT/OUTPUT SHEETS

OVERTOPPING ANALYSIS

```
              DAM SAFETY INSPECTION
              MACHAM DAM ***** OVERTOPPING ANALYSIS *****
              10-MINUTE TIME STEP AND 48-HOUR STORM DURATION

                                   JOB SPECIFICATION
       NQ      NHR     NMIN     IDAY     IHR     IMIN    METRC     IPLT     IPRT    NSTAN
      288        0       10        0       0        0        0        0        0        0
                                JOPER     NWT    LROPT    TRACE
                                    5       0        0        0

                           MULTI-PLAN ANALYSES TO BE PERFORMED
                              NPLAN= 1 NRTIO= 5 LRTIO= 1
          RTIOS=     .30     .40     .50     .60    1.00

**********       **********       **********       **********       **********

                              SUB-AREA RUNOFF COMPUTATION

        RESERVOIR INFLOW COMPUTATION

                  ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                      1       0       0       0       0       0       1       0       0

                                     HYDROGRAPH DATA
      IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
          1       1    2.40    0.00    2.40    0.00   0.000       0       1       0

                                       PRECIP DATA
                     SPFE     PMS      R6     R12     R24     R48     R72     R96
                     0.00   22.20  114.00  123.00  132.00  138.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800
                                                        INITIAL + CONSTANT
                                     LOSS DATA         (RAINFALL LOSS (COE)
   LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
       0    0.00    0.00    1.00    0.00    0.00    1.00    1.00     .05    0.00    0.00

                              UNIT HYDROGRAPH DATA
                         TP=  1.90     CP= .62     NTA=  0
                                                           BASEFLOW PARAMETERS
                                 RECESSION DATA                   (COE)
                   STRTQ=   -1.50     ORCSN=    -.05    RTIOR= 2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=12.51 AND R=10.48 INTERVALS

      UNIT HYDROGRAPH 63 END-OF-PERIOD ORDINATES, LAG=   1.88 HOURS, CP=  .63  VOL= 1.00
      14.      51.     103.     163.     229.     299.     368.     430.     477.     509.
     526.     527.     504.     463.     421.     383.     348.     316.     287.     261.
     238.     216.     196.     178.     162.     147.     134.     122.     111.     101.
      91.      83.      76.      69.      62.      57.      52.      47.      43.      39.
```

SUBJECT DAM SAFETY INSPECTION
MACHAM DAM
BY DJS DATE 6-10-80 PROJ. NO. 79-203-043
CHKD. BY DLB DATE 6-11-80 SHEET NO. 8 OF 0

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35.	32.	29.	26.	24.	22.	20.	18.	16.	15.
14.	12.	11.	10.	9.	8.	8.	7.	6.	6.
5.	5.	4.							

END-OF-PERIOD FLOW

O MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.51	22.25	2.25	201046.
										(623.)	(565.)	(57.)	(5692.99)

RESERVOIR INFLOW HYDROGRAPHS

0.40 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2561.	1722.	557.	279.	80333.
CMS	73.	49.	16.	8.	2275.
INCHES		6.68	8.64	8.65	8.65
MM		169.55	219.53	219.69	219.69
AC-FT		854.	1106.	1107.	1107.
THOUS CU M		1053.	1364.	1365.	1365.

0.50 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3201.	2153.	697.	349.	100416.
CMS	91.	61.	20.	10.	2843.
INCHES		8.34	10.80	10.81	10.81
MM		211.93	274.41	274.61	274.61
AC-FT		1067.	1382.	1383.	1383.
THOUS CU M		1317.	1705.	1706.	1706.

PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6403.	4305.	1394.	697.	200831.
CMS	181.	122.	39.	20.	5687.
INCHES		16.69	21.61	21.62	21.62
MM		423.86	548.82	549.22	549.22
AC-FT		2135.	2764.	2766.	2766.
THOUS CU M		2633.	3410.	3412.	3412.

SUBJECT DAM SAFETY INSPECTION
MACHAM DAM

BY DJS DATE 6-10-80 PROJ. NO. 79-203-043
CHKD. BY DLB DATE 6-11-80 SHEET NO. C OF O

GAI CONSULTANTS, INC
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HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR:

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
101	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	310.	-1

STAGE	1304.00	1305.00	1306.00	1307.00	1308.00	1309.00	1309.10	1309.20	1309.30
	1310.00	1310.50	1311.00	1312.00	1313.00	1314.00			
FLOW	0.00	220.00	640.00	1170.00	1780.00	2430.00	2540.00	2690.00	2780.00
	4540.00	6250.00	8020.00	12770.00	18080.00	24380.00			

CAPACITY=	0.	1.	8.	33.	81.	147.	225.	310.	400.	549.
	601.	655.	711.	768.	826.					
ELEVATION=	1290.	1292.	1294.	1296.	1298.	1300.	1302.	1304.	1306.	1309.
	1310.	1311.	1312.	1313.	1314.					

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1304.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1309.0	0.0	0.0	0.

RESERVOIR OUTFLOW HYDROGRAPHS

PEAK OUTFLOW IS 2234. AT TIME 42.33 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2234.	1634.	527.	264.	75976.
CMS	63.	46.	15.	7.	2151.
INCHES		6.33	8.17	8.18	8.18
MM		160.80	207.64	207.77	207.77
AC-FT		810.	1046.	1046.	1046.
THOUS CU M		999.	1290.	1291.	1291.

0.40 PMF

PEAK OUTFLOW IS 2954. AT TIME 42.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2954.	2054.	667.	331.	95459.
CMS	84.	58.	19.	9.	2703.
INCHES		7.96	10.27	10.28	10.28
MM		202.17	260.88	261.05	261.05
AC-FT		1018.	1314.	1315.	1315.
THOUS CU M		1256.	1621.	1622.	1622.

0.50 PMF

PEAK OUTFLOW IS 6342. AT TIME 41.67 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6342.	4193.	1342.	671.	193380.
CMS	180.	119.	38.	19.	5476.
INCHES		16.25	20.81	20.82	20.82
MM		412.77	528.50	528.84	528.84
AC-FT		2079.	2662.	2664.	2664.

PMF

SUBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DSS DATE 6-10-80 PROJ. NO. 79-203-043

CHKD. BY DLB DATE 6-11-80 SHEET NO. D OF 0

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HYDROGRAPH ROUTING

ROUTE FROM DAM TO SECTION 2; 3560 FT D.S. FROM DAM

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	102	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0650	.0380	.0500	1227.0	1260.0	3560.	.02300

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1260.00 450.00 1232.00 738.00 1229.00 740.00 1227.00 755.00 1227.00
757.00 1229.00 850.00 1240.00 950.00 1260.00

STORAGE	0.00	2.38	14.34	51.62	102.55	159.53	222.56	291.63	366.64
	532.44	623.13	719.01	820.10	926.37	1037.84	1154.61	1276.37	1403.43
OUTFLOW	0.00	222.45	1096.47	4264.34	11151.14	21096.15	34072.76	50142.43	69551.47
	118419.31	147881.57	180815.42	217316.95	257485.06	301420.35	349224.31	400998.81	456845.77
STAGE	1227.00	1228.74	1230.47	1232.21	1233.95	1235.68	1237.42	1239.16	1240.89
	1244.37	1246.11	1247.84	1249.58	1251.32	1253.05	1254.79	1256.53	1258.26
FLOW	0.00	222.45	1096.47	4264.34	11151.14	21096.15	34072.76	50142.43	69551.47
	118419.31	147881.57	180815.42	217316.95	257485.06	301420.35	349224.31	400998.81	456845.77

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HYDROGRAPH ROUTING

ROUTE FROM SECTION 2 TO SECTION 3; 9460 FT D.S. FROM DAM

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	203	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

SUBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJS DATE 6-10-80 PROJ. NO. 79-203-043

CHKD. BY DLB DATE 6-11-80 SHEET NO. E OF O

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NORMAL DEPTH CHANNEL ROUTING
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     QN(1)   QN(2)   QN(3)  ELNVT   ELMAX   RLNTH     SEL
     .0500   .0380   .0500 1131.0  1160.0   5900.  .01300

     CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
       0.00 1160.00   70.00 1140.00  218.00 1133.00  220.00 1131.00  235.00 1131.00
     237.00 1133.00  300.00 1140.00  400.00 1160.00

STORAGE      0.00       3.42       9.58      24.82      49.57      83.84     127.58     176.75     228.59
           340.34     400.23     462.81     528.07     596.01     666.64     739.94     815.93     894.60
OUTFLOW      0.00     134.72     495.05    1340.63    2936.83    5501.08    9287.51   14857.47   21624.21
         38650.15   48896.32   60302.58   72878.47   86636.70  101592.24  117761.75  135163.16  153815.38

STAGE     1131.00    1132.53    1134.05    1135.58    1137.11    1138.63    1140.16    1141.68    1143.21
          1144.26    1147.79    1149.32    1150.84    1152.37    1153.89    1155.42    1156.95    1158.47

FLOW         0.00     134.72     495.05    1340.63    2936.83    5501.08    9287.51   14857.47   21624.21
         38650.15   48896.32   60302.58   72878.47   86636.70  101592.24  117761.75  135163.16  153815.38
      **********           **********           **********           **********           **********

                                HYDROGRAPH ROUTING

              ROUTE FROM SECTION 3 TO SECTION 4: 17,600 FT D.S. FROM DAM

                    ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                      304       1       0       0       0       0       1       0       0
                                          ROUTING DATA
             QLOSS  CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
               0.0  0.000    0.00       1       1       0       0               0

                    NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                        1       0       0   0.000   0.000   0.000     -1.       0

NORMAL DEPTH CHANNEL ROUTING
----------------------------

     QN(1)   QN(2)   QN(3)  ELNVT   ELMAX   RLNTH     SEL
     .0900   .0380   .0900  980.0  1020.0   8140.  .01700

     CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
       0.00 1020.00  180.00 1000.00  283.00  982.00  285.00  980.00  300.00  980.00
     302.00  982.00  380.00 1000.00  420.00 1020.00

STORAGE      0.00       6.74      18.79      39.18      67.89     104.93     150.30     203.99     266.02
           415.15     502.94     599.85     705.86     820.98     945.22    1078.56    1221.02    1372.58
OUTFLOW      0.00     266.55     981.94    2206.77    4030.99    6538.29    9807.84   13915.14   18932.54
         31921.99   40026.99   49369.44   60007.61   72002.31   85415.14  100307.68  116741.03  134775.65

STAGE      980.00     982.11     984.21     986.32     988.42     990.53     992.63     994.74     996.84
          1001.05    1003.16    1005.26    1007.37    1009.47    1011.58    1013.68    1015.79    1017.89

FLOW         0.00     266.55     981.94    2206.77    4030.99    6538.29    9807.84   13915.14   18932.54
```

SUBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJJ DATE 6-10-80 PROJ. NO. 79-203-043

CHKD. BY DLB DATE 6-11-80 SHEET NO. F OF O

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HYDROGRAPH ROUTING

ROUTE FROM SECTION 4 TO SECTION 5: 22,120 FT D.S. FROM DAM

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	405	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0750	.0380	.0550	887.0	920.0	4520.	.03200

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 920.00 100.00 900.00 282.00 890.00 285.00 887.00 300.00 887.00
303.00 890.00 970.00 900.00 1000.00 920.00

STORAGE	0.00	3.02	7.62	31.94	82.84	160.31	264.36	394.98	548.92
	868.67	1031.60	1196.57	1363.56	1532.60	1703.66	1876.77	2051.90	2229.07
OUTFLOW	0.00	262.39	891.27	2868.55	7864.20	17181.58	31933.43	53123.13	84772.89
	175386.84	230475.82	291662.85	358715.98	431447.15	509700.72	593345.81	682270.96	776380.34
STAGE	887.00	888.74	890.47	892.21	893.95	895.68	897.42	899.16	900.89
	904.37	906.11	907.84	909.58	911.32	913.05	914.79	916.53	918.26
FLOW	0.00	262.39	891.27	2868.55	7864.20	17181.58	31933.43	53123.13	84772.89
	175386.84	230475.82	291662.85	358715.98	431447.15	509700.72	593345.81	682270.96	776380.34

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HYDROGRAPH ROUTING

ROUTE FROM SECTION 5 TO SECTION 6: 20,560 FT D.S. FROM DAM

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	506	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

SUBJECT DAM SAFETY INSPECTION
MACHAM DAM

BY DJS DATE 6-10-80 PROJ. NO. 79-203-043

CHKD. BY DLB DATE 6-11-80 SHEET NO. G OF O

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NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0500	.0350	.0900	767.0	800.0	6440.	.01600

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 800.00 40.00 780.00 195.00 771.00 200.00 767.00 240.00 767.00
245.00 771.00 450.00 771.00 600.00 800.00

STORAGE	0.00	10.83	22.77	74.67	152.11	239.53	336.94	444.33	560.82
	804.97	931.85	1061.93	1195.20	1331.68	1471.35	1614.22	1760.29	1909.56
OUTFLOW	0.00	541.26	1730.30	4186.11	8946.72	15803.13	24795.30	36010.84	49954.99
	85300.03	106124.46	128969.26	153793.60	180567.14	209267.35	239877.76	272386.65	306786.14
STAGE	767.00	768.74	770.47	772.21	773.95	775.68	777.42	779.16	780.89
	784.37	786.11	787.84	789.58	791.32	793.05	794.79	796.53	798.26
FLOW	0.00	541.26	1730.30	4186.11	8946.72	15803.13	24795.30	36010.84	49954.99
	85300.03	106124.46	128969.26	153793.60	180567.14	209267.35	239877.76	272386.65	306786.14

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1304.00	1304.00	1309.00
STORAGE	310.	310.	549.
OUTFLOW	0.	0.	2430.

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
.30	1307.79	0.00	489.	1654.	0.00	42.33	0.00
.40	1308.70	0.00	534.	2234.	0.00	42.33	0.00
* .43	1309.00	0.00	549.	2430.	—	—	—
.50	1309.39	.39	569.	2954.	1.83	42.00	0.00
.60	1309.70	.70	586.	3730.	2.83	41.83	0.00
1.00	1310.53	1.53	629.	6342.	4.83	41.67	0.00

MACHAM DAM
OVERTOPPING OCCURS
@ ≈ 0.43 PMF

* INTERPOLATED VALUES

JBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJS DATE 6-10-80 PROJ. NO. 79-203-043

CHKD. BY DLB DATE 6-11-80 SHEET NO. H OF O

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PLAN 1 STATION 102

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	1650.	1230.8	42.50
.40	2228.	1231.1	42.50
.50	2933.	1231.5	42.17
.60	3700.	1231.9	42.00
1.00	6328.	1232.7	41.67

SECTION 2
@ ≈ 3560 FT
D.S. FROM DAM

PLAN 1 STATION 203

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	1642.	1135.9	42.67
.40	2218.	1136.4	42.67
.50	2898.	1137.1	42.33
.60	3667.	1137.5	42.17
1.00	6297.	1139.0	41.83

SECTION 3
@ ≈ 9460 FT
D.S. FROM DAM

PLAN 1 STATION 304

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	1633.	985.3	43.00
.40	2206.	986.3	42.83
.50	2874.	987.1	42.67
.60	3624.	988.0	42.33
1.00	6243.	990.3	42.00

SECTION 4
@ ≈ 17,600 FT
D.S. FROM DAM

PLAN 1 STATION 405

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	1628.	891.1	43.00
.40	2200.	891.6	43.00
.50	2860.	892.2	42.83
.60	3607.	892.5	42.50
1.00	6223.	893.4	42.17

SECTION 5
@ ≈ 22,120 FT
D.S. FROM DAM

PLAN 1 STATION 506

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	1626.	770.3	43.17
.40	2187.	770.8	43.33
.50	2819.	771.2	43.00
.60	3535.	771.7	42.83
1.00	6161.	772.9	42.33

SECTION 6
@ ≈ 28,560 FT
D.S. FROM DAM

SUBJECT DAM SAFETY INSPECTION
MACHAM DAM

BY ZTS DATE 6-10-80 PROJ. NO. 79-203-043
CHKD. BY DLB DATE 6-11-80 SHEET NO. I OF O

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BREACHING ANALYSIS (INPUT SAME AS FOR OVERTOPPING ANALYSIS, WITH THE ADDITION OF THE BREACHING DATA GIVEN HERE)

DAM SAFETY INSPECTION
MACHAM DAM **** BREACHING ANALYSIS ***
10-MINUTE TIME STEP AND 48-HOUR STORM DURATION

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 5 NRTIO= 1 LRTIO= 1
RTIOS= .45

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HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
101	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	310.	-1

STAGE	1304.00	1305.00	1306.00	1307.00	1308.00	1309.00	1309.10	1309.20	1309.30
	1310.00	1310.50	1311.00	1312.00	1313.00	1314.00			
FLOW	0.00	220.00	640.00	1170.00	1780.00	2430.00	2540.00	2690.00	2780.00
	4540.00	6250.00	8020.00	12770.00	18080.00	24380.00			

CAPACITY=	0.	1.	8.	33.	81.	147.	225.	310.	400.	549.
	601.	655.	711.	768.	826.					
ELEVATION=	1290.	1292.	1294.	1296.	1298.	1300.	1302.	1304.	1306.	1309.
	1310.	1311.	1312.	1313.	1314.					

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
1304.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1309.0	0.0	0.0	0.

JBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJS DATE 6-10-80 PROJ. NO. 79-203-043

CHKD. BY DLB DATE 6-11-80 SHEET NO. J OF O

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PLAN (1)

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
0.	1.00	1290.00	.50	1304.00	1309.00

STATION 101, PLAN 1, RATIO 1

BEGIN DAM FAILURE AT 41.83 HOURS
PEAK OUTFLOW IS 5530. AT TIME 42.33 HOURS

PLAN (2)

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
250.	6.50	1290.00	.50	1304.00	1309.00

STATION 101, PLAN 2, RATIO 1

BEGIN DAM FAILURE AT 41.83 HOURS
PEAK OUTFLOW IS 20277. AT TIME 42.27 HOURS

PLAN (3)

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
0.	1.00	1290.00	4.00	1304.00	1309.00

STATION 101, PLAN 3, RATIO 1

BEGIN DAM FAILURE AT 41.83 HOURS
PEAK OUTFLOW IS 2568. AT TIME 42.25 HOURS

PLAN (4)

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
250.	6.50	1290.00	4.00	1304.00	1309.00

STATION 101, PLAN 4, RATIO 1

BEGIN DAM FAILURE AT 41.83 HOURS
PEAK OUTFLOW IS 4419. AT TIME 42.92 HOURS

PLAN (5)

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
75.	1.00	1290.00	2.00	1304.00	1309.00

STATION 101, PLAN 5, RATIO 1

BEGIN DAM FAILURE AT 41.83 HOURS
PEAK OUTFLOW IS 6178. AT TIME 43.50 HOURS

SUBJECT	DAM SAFETY ANALYSIS		
	MACHAM DAM		
BY	DJS	DATE	6-10-80
PROJ. NO.	79-203-043		
CHKD. BY	DLB	DATE	6-11-80
SHEET NO.	K	OF	O

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THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .010 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .167 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

PLAN ②

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	- COMPUTED BREACH HYDROGRAPH (CFS)	= ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
41.833	0.000	2466.	2466.	0.	0.	0.
41.843	.010	3026.	2666.	360.	360.	0.
41.853	.020	3586.	3000.	586.	946.	1.
41.863	.029	4146.	3418.	728.	1674.	1.
41.873	.039	4706.	3899.	806.	2480.	2.
41.882	.049	5265.	4433.	833.	3313.	3.
41.892	.059	5825.	5009.	816.	4129.	3.
41.902	.069	6385.	5615.	770.	4900.	4.
41.912	.078	6945.	6242.	702.	5602.	5.
41.922	.088	7504.	6885.	620.	6222.	5.
41.931	.098	8064.	7536.	528.	6749.	5.
41.941	.108	8624.	8192.	432.	7182.	6.
41.951	.118	9184.	8846.	338.	7520.	6.
41.961	.127	9744.	9495.	249.	7768.	6.
41.971	.137	10303.	10136.	168.	7936.	6.
41.980	.147	10863.	10765.	98.	8034.	7.
41.990	.157	11423.	11380.	43.	8077.	7.
42.000	.167	11983.	11983.	-0.	8077.	7.
42.010	.176	12394.	12570.	-176.	7901.	6.
42.020	.186	12805.	13138.	-333.	7568.	6.
42.029	.196	13217.	13686.	-470.	7098.	6.
42.039	.206	13628.	14214.	-586.	6513.	5.
42.049	.216	14039.	14719.	-680.	5833.	5.
42.059	.225	14450.	15216.	-765.	5067.	4.
42.069	.235	14862.	15693.	-831.	4236.	3.
42.078	.245	15273.	16148.	-875.	3361.	3.
42.088	.255	15684.	16581.	-896.	2465.	2.
42.098	.265	16096.	16980.	-884.	1581.	1.
42.108	.275	16507.	17294.	-787.	794.	1.
42.118	.284	16918.	17589.	-670.	124.	0.
42.127	.294	17330.	17865.	-535.	-412.	-0.
42.137	.304	17741.	18148.	-407.	-819.	-1.
42.147	.314	18152.	18443.	-290.	-1109.	-1.
42.157	.324	18564.	18718.	-154.	-1263.	-1.
42.167	.333	(18975)	18975.	0.	-1263.	-1.
42.176	.343	18966.	19209.	-244.	-1507.	-1.
42.186	.353	18956.	19427.	-470.	-1978.	-2.
42.196	.363	18947.	19629.	-681.	-2659.	-2.
42.206	.373	18938.	19816.	-878.	-3537.	-3.
42.216	.382	18929.	19989.	-1060.	-4597.	-4.
42.225	.392	18919.	20149.	-1229.	-5826.	-5.
42.235	.402	18910.	20199.	-1289.	-7115.	-6.
42.245	.412	18901.	20222.	-1321.	-8436.	-7.
42.255	.422	18892.	20242.	-1351.	-9787.	-8.
42.265	.431	18882.	20261.	-1378.	-11165.	-9.
42.275	.441	18873.	(20277.)	-1404.	-12569.	-10.
42.284	.451	18864.	20193.	-1329.	-13898.	-11.
42.294	.461	18855.	19951.	-1096.	-14994.	-12.
42.304	.471	18846.	19732.	-887.	-15881.	-13.
42.314	.480	18836.	19535.	-699.	-16580.	-13.
42.324	.490	18827.	19358.	-530.	-17111.	-14.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-14

JBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJS DATE 6-10-80 PROJ. NO. 79 203-043

CHKD. BY DLB DATE 6-11-80 SHEET NO. L OF O

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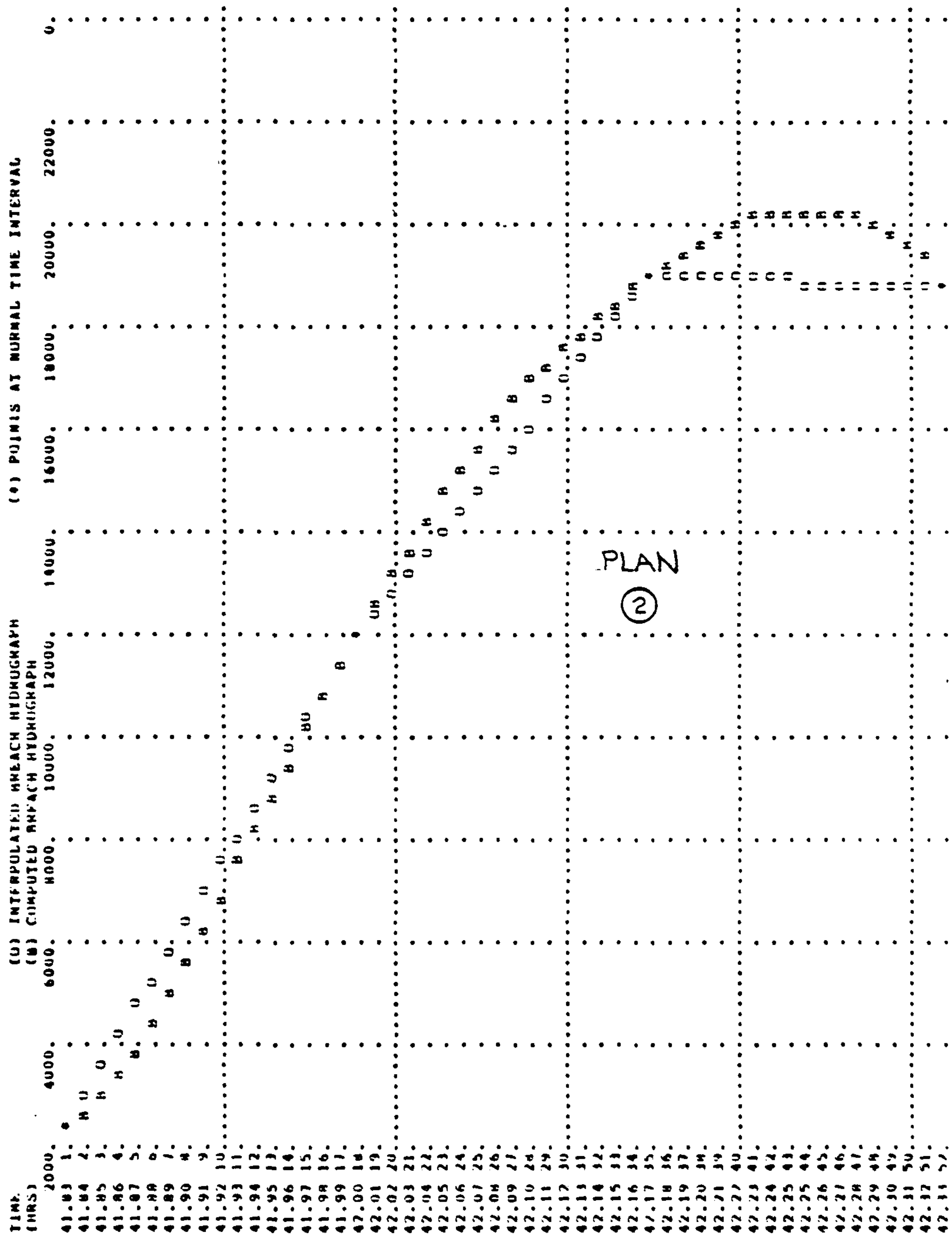

JBJECT DAM SAFETY INSPECTION
MACHAM DAM
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THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .042 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .167 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

PLAN 5

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
41.833	0.000	2464.		2464.		0.	0.	0.
41.875	.042	2587.		2549.		39.	39.	0.
41.917	.083	2711.		2670.		40.	79.	0.
41.958	.125	2834.		2809.		25.	104.	0.
42.000	.167	2957.		2957.		0.	104.	0.
42.042	.208	3117.		3109.		9.	112.	0.
42.083	.250	3278.		3269.		9.	121.	0.
42.125	.292	3438.		3434.		3.	125.	0.
42.167	.333	3598.		3598.		0.	125.	0.
42.208	.375	3747.		3756.		-9.	116.	0.
42.250	.417	3897.		3910.		-13.	103.	0.
42.292	.458	4047.		4057.		-10.	93.	0.
42.333	.500	4197.		4197.		-0.	93.	0.
42.375	.542	4317.		4329.		-12.	81.	0.
42.417	.583	4438.		4453.		-15.	66.	0.
42.458	.625	4559.		4569.		-10.	56.	0.
42.500	.667	4680.		4680.		0.	56.	0.
42.542	.708	4773.		4785.		-12.	44.	0.
42.583	.750	4867.		4883.		-16.	28.	0.
42.625	.792	4960.		4972.		-12.	16.	0.
42.667	.833	5054.		5054.		0.	16.	0.
42.708	.875	5128.		5128.		-0.	16.	0.
42.750	.917	5203.		5209.		-6.	10.	0.
42.792	.958	5277.		5284.		-7.	4.	0.
42.833	1.000	5351.		5351.		0.	4.	0.
42.875	1.042	5397.		5412.		-15.	-11.	-0.
42.917	1.083	5443.		5464.		-22.	-33.	-0.
42.958	1.125	5489.		5502.		-14.	-46.	-0.
43.000	1.167	5535.		5535.		0.	-46.	-0.
43.042	1.208	5584.		5562.		22.	-24.	-0.
43.083	1.250	5634.		5605.		29.	5.	0.
43.125	1.292	5683.		5673.		10.	15.	0.
43.167	1.333	5733.		5733.		0.	15.	0.
43.208	1.375	5803.		5784.		19.	34.	0.
43.250	1.417	5874.		5868.		6.	41.	0.
43.292	1.458	5945.		5946.		-1.	39.	0.
43.333	1.500	6016.		6016.		0.	39.	0.
43.375	1.542	6056.		6077.		-20.	19.	0.
43.417	1.583	6097.		6129.		-32.	-13.	-0.
43.458	1.625	6138.		6175.		-37.	-50.	-0.
43.500	1.667	6178.		6178.		0.	-50.	-0.
43.542	1.708	6173.		6178.		-4.	-54.	-0.
43.583	1.750	6168.		6174.		-5.	-60.	-0.
43.625	1.792	6164.		6168.		-4.	-64.	-0.
43.667	1.833	6159.		6159.		0.	-64.	-0.
43.708	1.875	6078.		6071.		8.	-56.	-0.
43.750	1.917	5998.		5986.		11.	-45.	-0.
43.792	1.958	5917.		5909.		8.	-37.	-0.
43.833	2.000	5836.		5836.		0.	-17.	-0.

JBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJS DATE 6-10-80 PROJ. NO. 79-203-043

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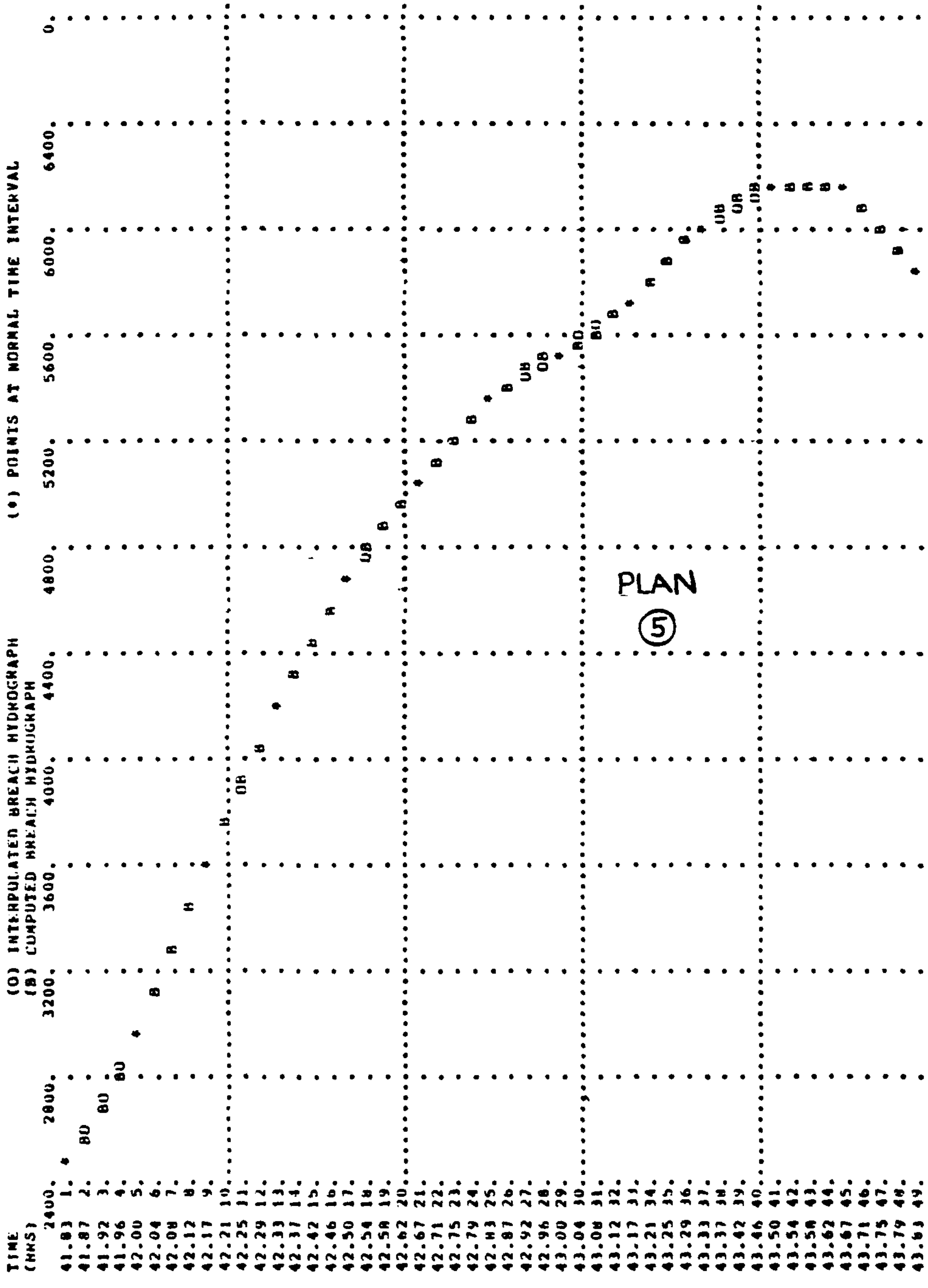

SUBJECT DAM SAFETY INSPECTION

MACHAM DAM

BY DJS DATE 6-10-80 PROJ. NO. 79-203-043

CHKD. BY DLB DATE 6-11-80 SHEET NO. 0 OF 0

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SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1304.00	1304.00	1309.00
STORAGE	310.	310.	549.
OUTFLOW	0.	0.	2430.

PLAN	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	.45	1309.07	.07	553.	5530.	.44	42.33	41.83
2	.45	1309.03	.03	551.	20277.	.21	42.27	41.83
3	.45	1309.11	.11	555.	2568.	1.00	42.25	41.83
4	.45	1309.05	.05	552.	4419.	.33	42.92	41.83
5	.45	1309.05	.05	552.	6178.	.38	43.50	41.83

STATION 102

SECTION 2

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.45	5081.	1232.4	42.50
2	.45	19191.	1235.4	42.33
3	.45	2559.	1231.3	42.50
4	.45	4411.	1232.2	43.00
5	.45	6166.	1232.7	43.67

STATION 203

SECTION 3

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.45	4588.	1138.1	42.67
2	.45	16478.	1142.0	42.33
3	.45	2546.	1136.7	42.67
4	.45	4370.	1138.0	43.17
5	.45	6088.	1138.9	43.83

STATION 304

SECTION 4

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.45	4292.	988.6	42.83
2	.45	13699.	994.6	42.50
3	.45	2533.	986.7	42.83
4	.45	4321.	988.7	43.33
5	.45	5991.	990.1	43.83

STATION 405

SECTION 5

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.45	4207	892.7	43.00
2	.45	12528.	894.8	42.67
3	.45	2528.	891.9	43.17
4	.45	4303.	892.7	43.50
5	.45	5932.	893.3	44.00

STATION 506

SECTION 6

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.45	3954.	772.0	43.33
2	.45	10825.	774.4	42.83
3	.45	2511.	771.0	43.33
4	.45	4240.	772.2	43.83
5	.45	5800.	772.8	44.17

LIST OF REFERENCES

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2. "Unit Hydrograph Concepts and Calculations," by Corps of Engineers, Baltimore District (L-519).

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10. <u>Flood Hydrograph Package (HEC-1) Dam Safety Version</u>, Hydrologic Engineering Center, U. S. Army, Corps of Engineers, Davis, California, July 1978.

11. "Simulation of Flow Through Broad Crest Navigation Dams with Radial Gates," R. W. Schmitt, U. S. Army, Corps of Engineers, Pittsburgh District.

12. "Hydraulics of Bridge Waterways," BPR, 1970, Discharge Coefficient Based on Criteria for Embankment Shaped Weirs, Figure 24, page 46.

13. Applied Hydraulics in Engineering, Morris, Henry M. and Wiggert, James N., Virginia Polytechnic Institute and State University, 2nd Edition, The Ronald Press Company, New York, 1972.

14. Standard Mathematical Tables, 21st Edition, The Chemical Rubber Company, 1973, page 15.

15. Engineering Field Manual, U. S. Department of Agriculture, Soil Conservation Service, 2nd Edition, Washington, D. C. 1969.

APPENDIX E

FIGURES

LIST OF FIGURES

Figure	Description/Title
1	Regional Vicinity and Watershed Boundary Map
2	Downstream Channel Map
3	Reservoir Plan
4	Dam and Spillway Plan
5	Embankment Cross Section
6	Embankment Profile

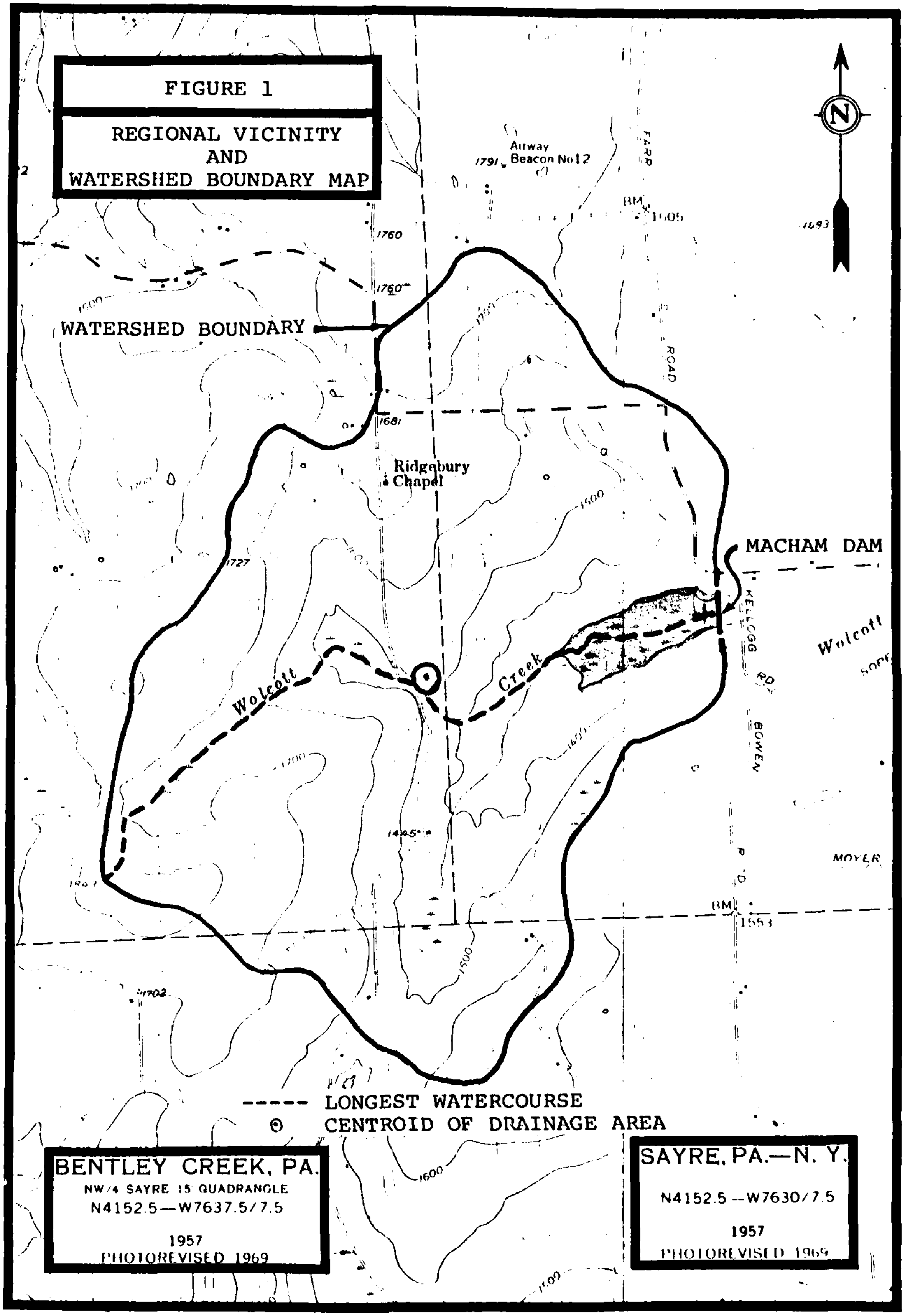
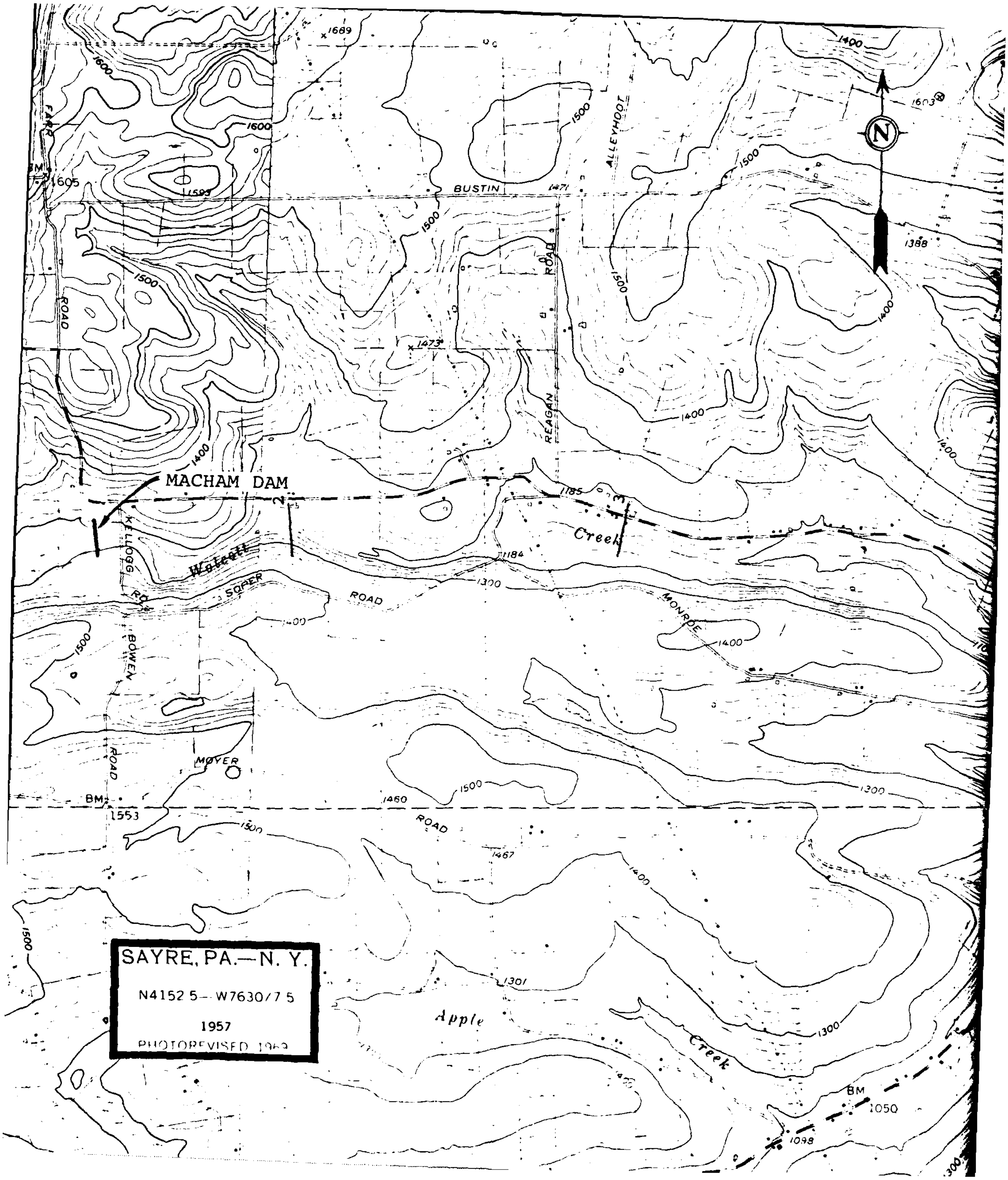


FIGURE 1
REGIONAL VICINITY
AND
WATERSHED BOUNDARY MAP
WATERSHED BOUNDARY
Airway
Beacon No12
1791
1760
1681
Ridgebury
Chapel
1727
MACHAM DAM
Wolcott
Creek
Wolcott
KELLOGG
RD
BOWEN
ROAD
FARR
MOYER
BM
1553
1605
1445
1500
1600
1700
1702
LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA
BENTLEY CREEK, PA.
NW/4 SAYRE 15' QUADRANGLE
N4152.5—W7637.5/7.5
1957
PHOTOREVISED 1969
SAYRE, PA.—N. Y.
N4152.5—W7630/7.5
1957
PHOTOREVISED 1969



MACHAM DAM
SAYRE, PA.—N. Y.
N4152 5—W7630/7 5
1957
PHOTOREVISED 1969
BUSTIN
ALLEYHOOT
ROAD
REAGAN
KELLOGG
SOPER
ROAD
MONROE
BOWEN
ROAD
MOYER
ROAD
FARR
Wolcott
Creek
Apple
Creek
BM
1605
BM
1553
BM
1050
1689
1593
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1600
1500
1400
1300

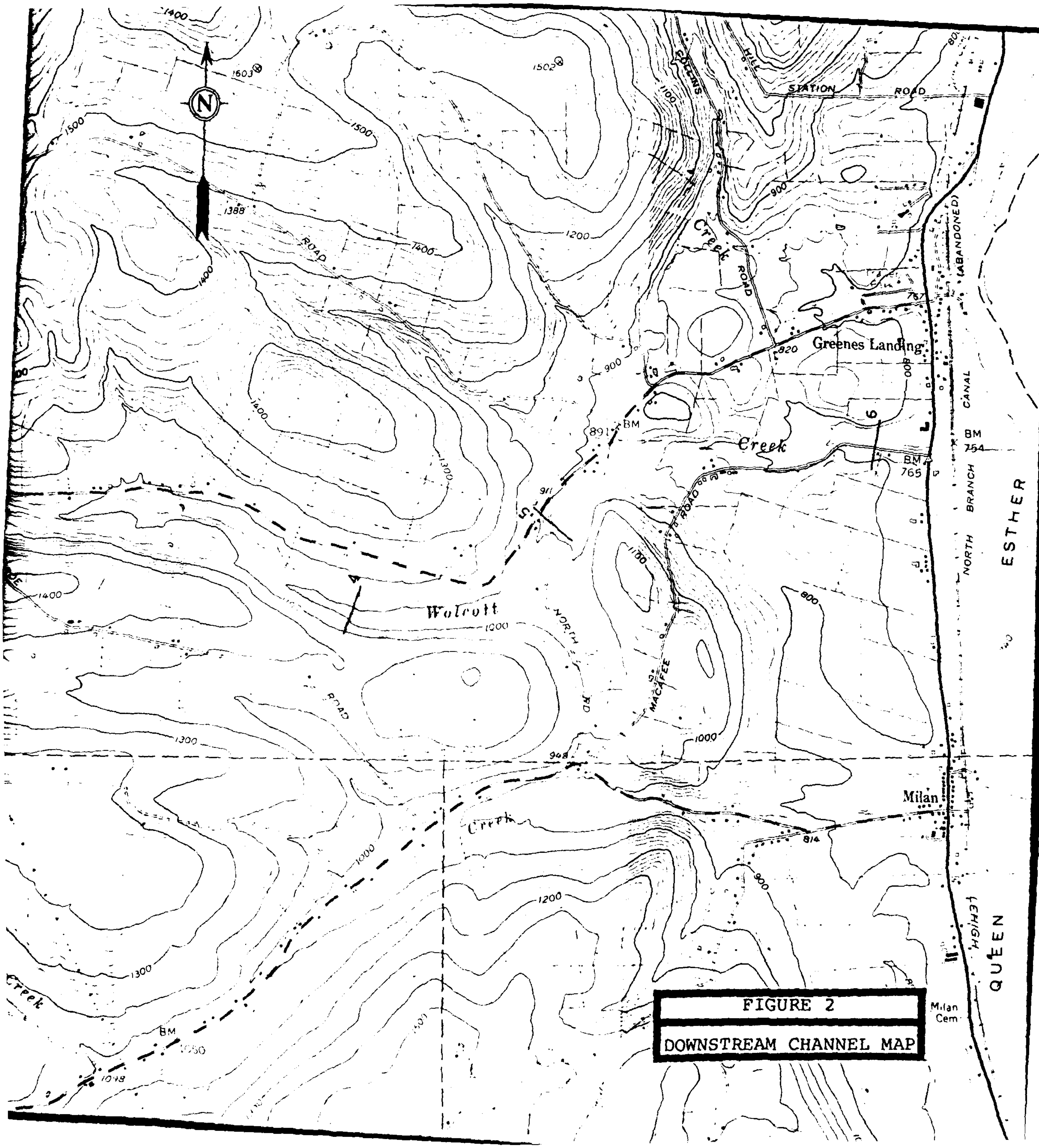
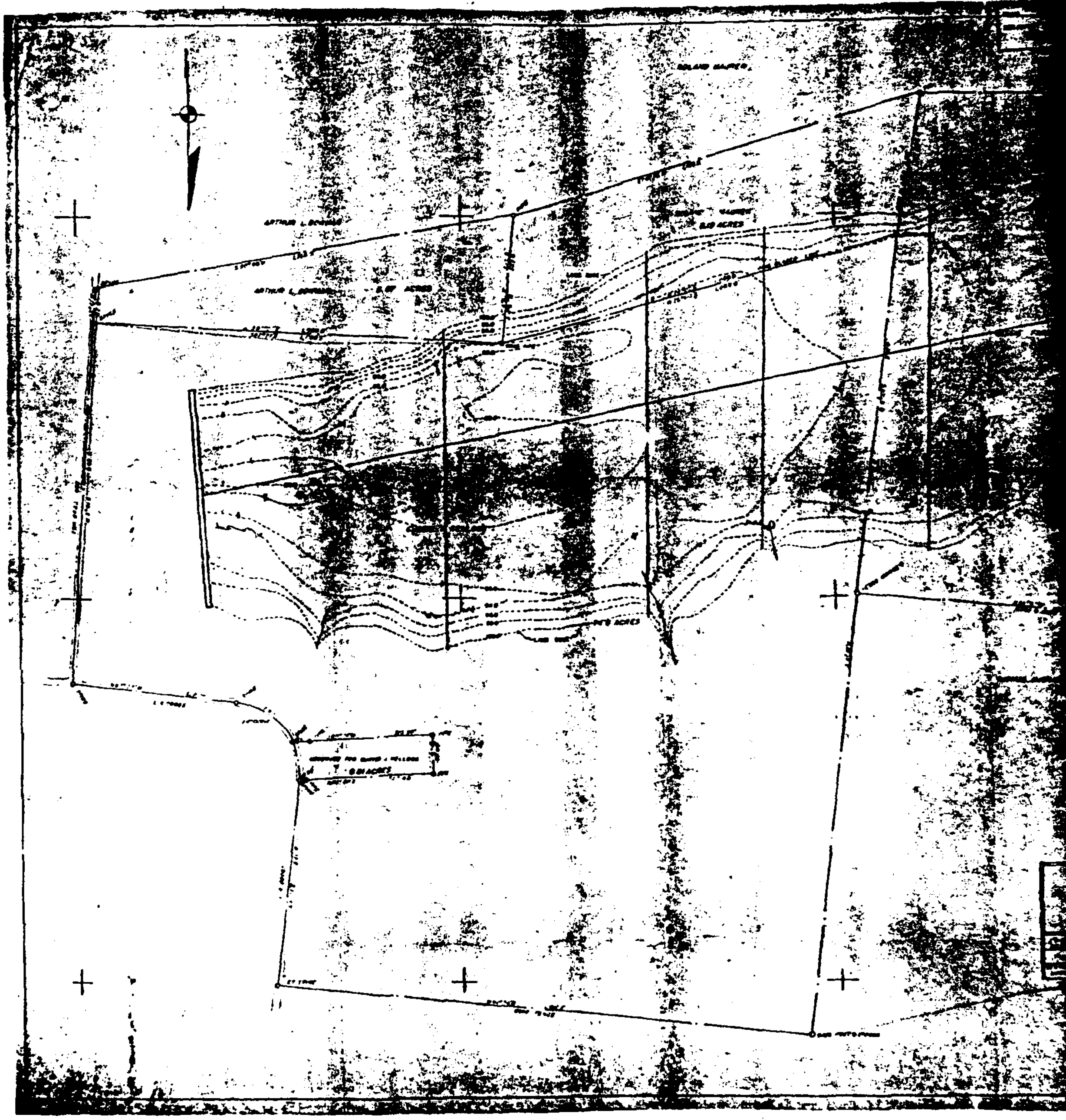


FIGURE 2

DOWNSTREAM CHANNEL MAP



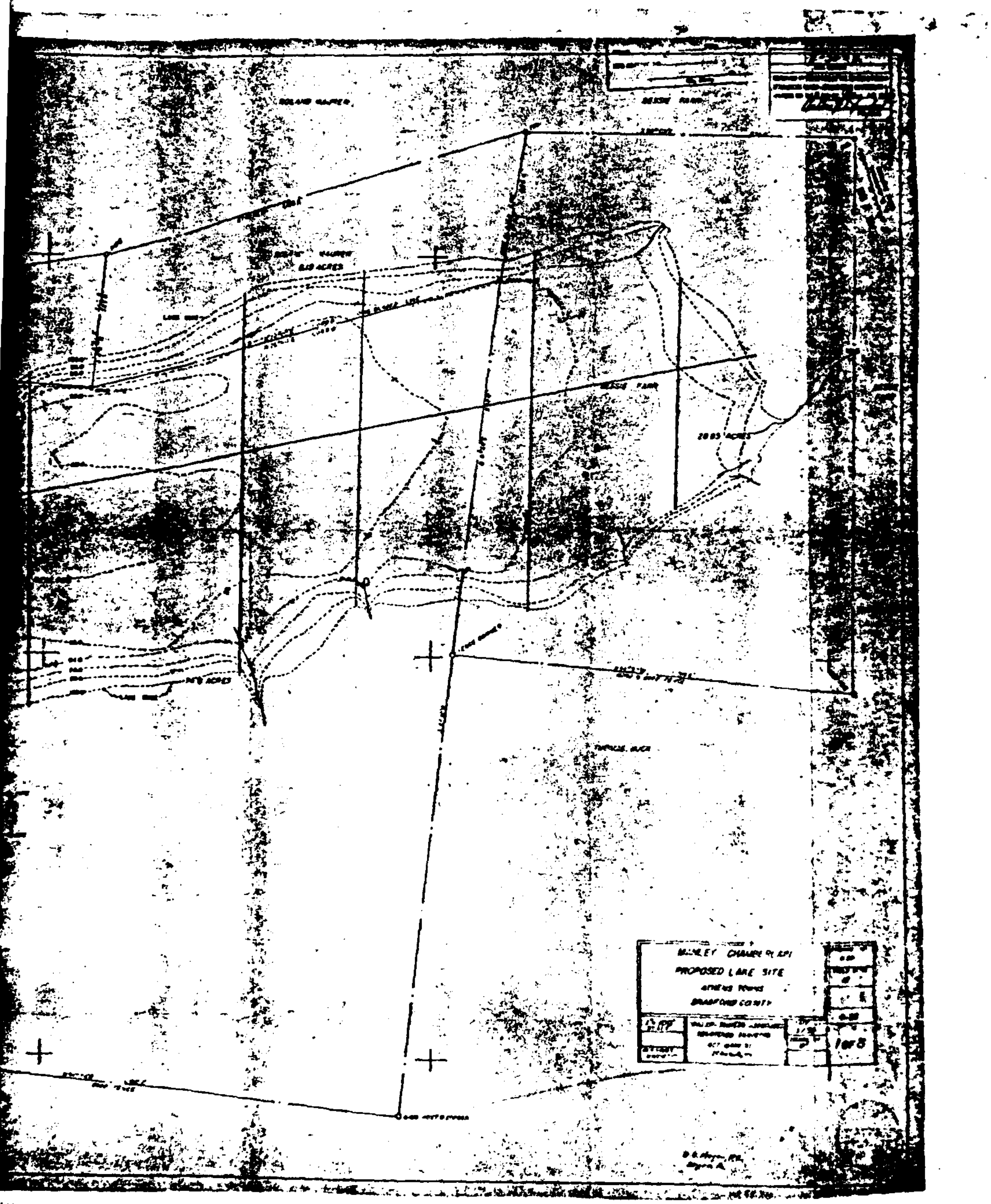


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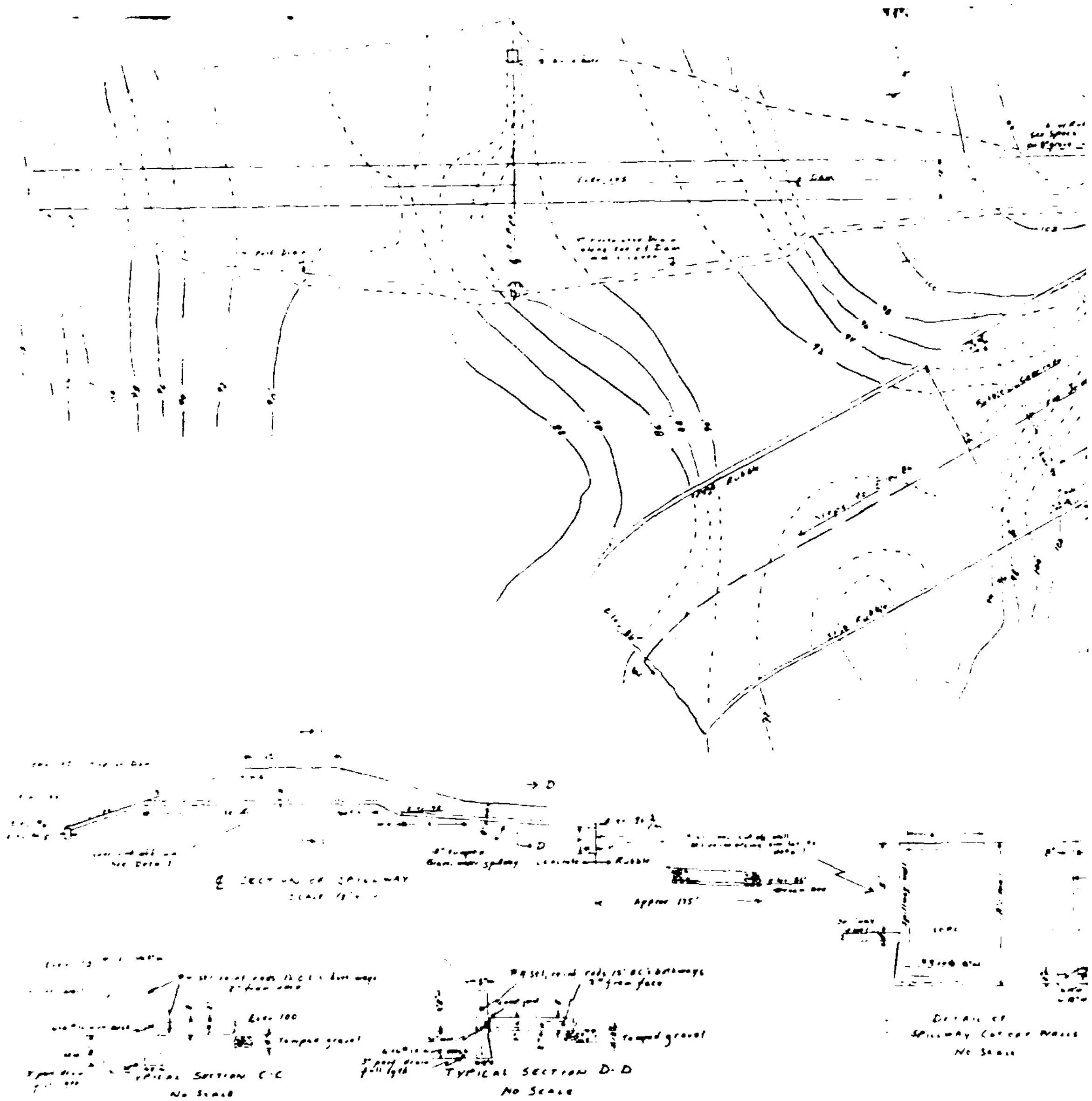
FIGURE 3



Dam
Rubble
Tamped gravel
Typical Section C-C
No Scale
Typical Section D-D
No Scale
No Scale

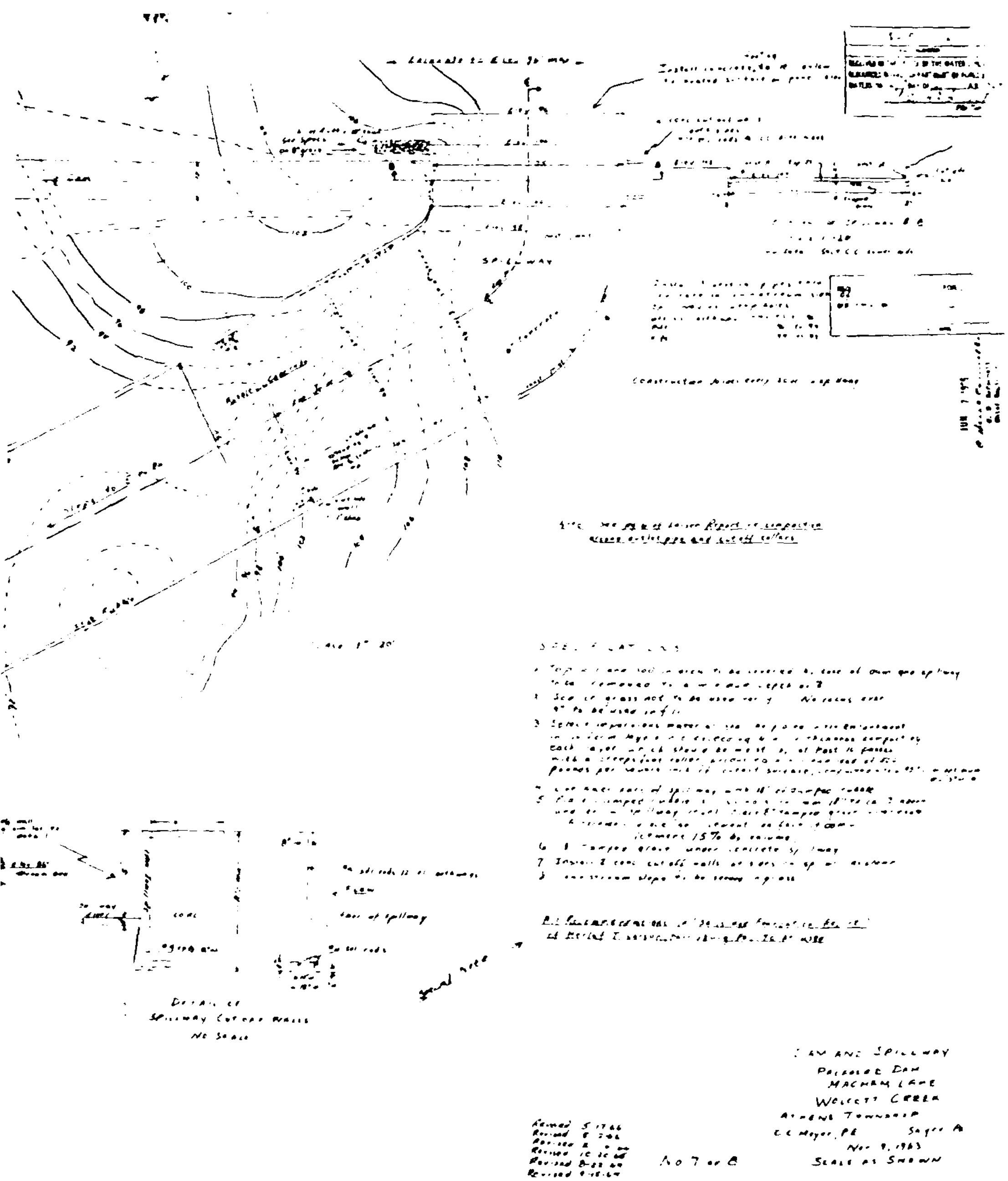


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FIGURE

AD-A087 760 GAI CONSULTANTS INC MONROEVILLE PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. MACHAM DAM (NDI I.D. NUMBER PA--ETC(U)
JUL 80 B M MIHALCIN DACW31-80-C-0016
UNCLASSIFIED NL

2 2

END
DATE FILMED
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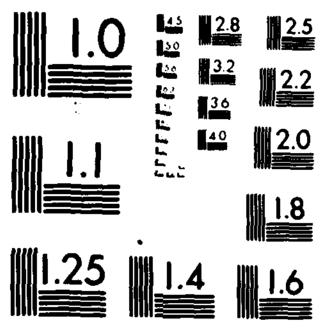
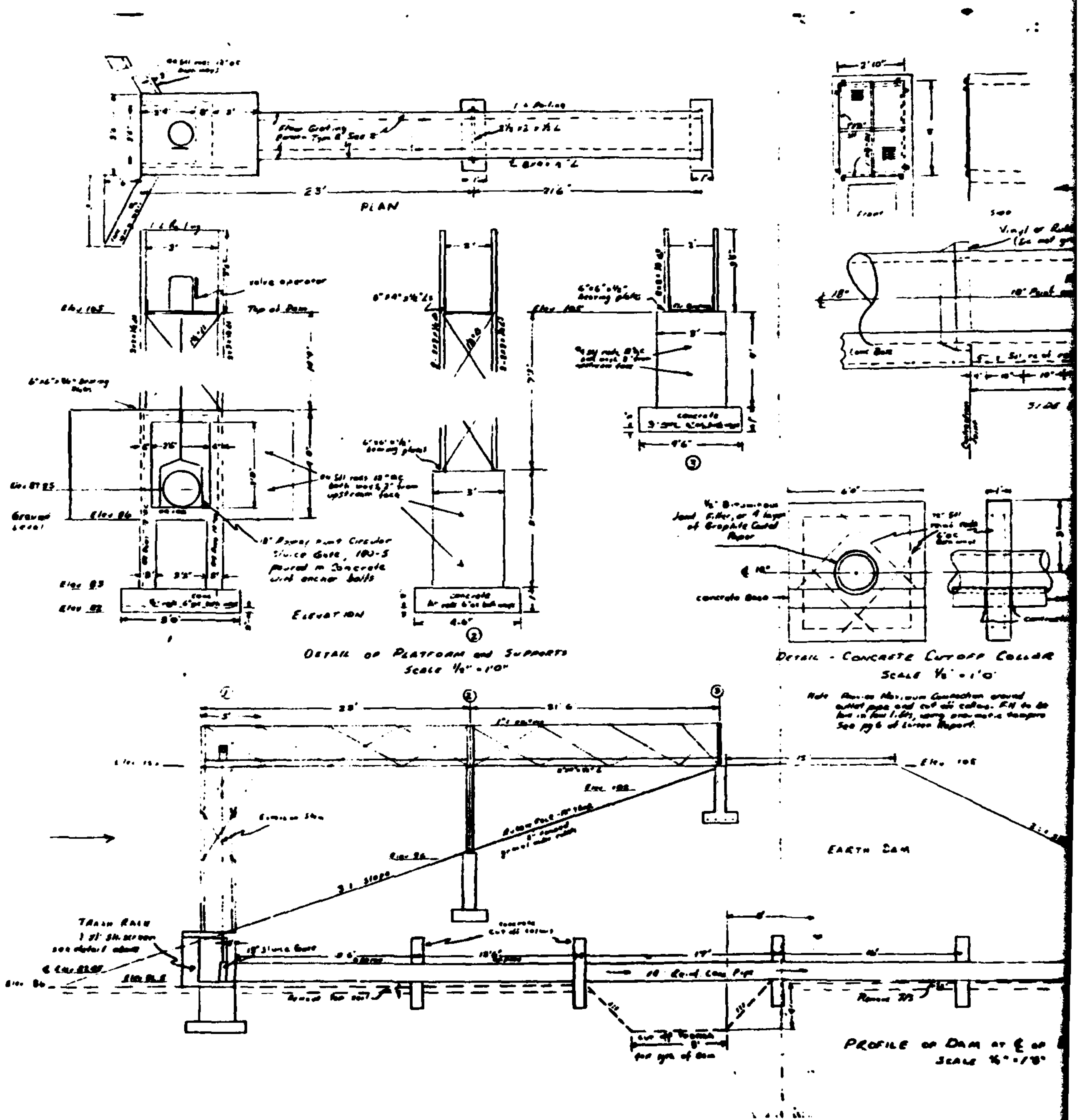


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A



PLAN
valve operator
Top of Dam
ELEVATION
DETAIL OF PLATFORM AND SUPPORTS
DETAIL - CONCRETE CUTOFF COLLAR
concrete Base
EARTH DAM
TRASH RACK
PROFILE OF DAM AT ℄ OF

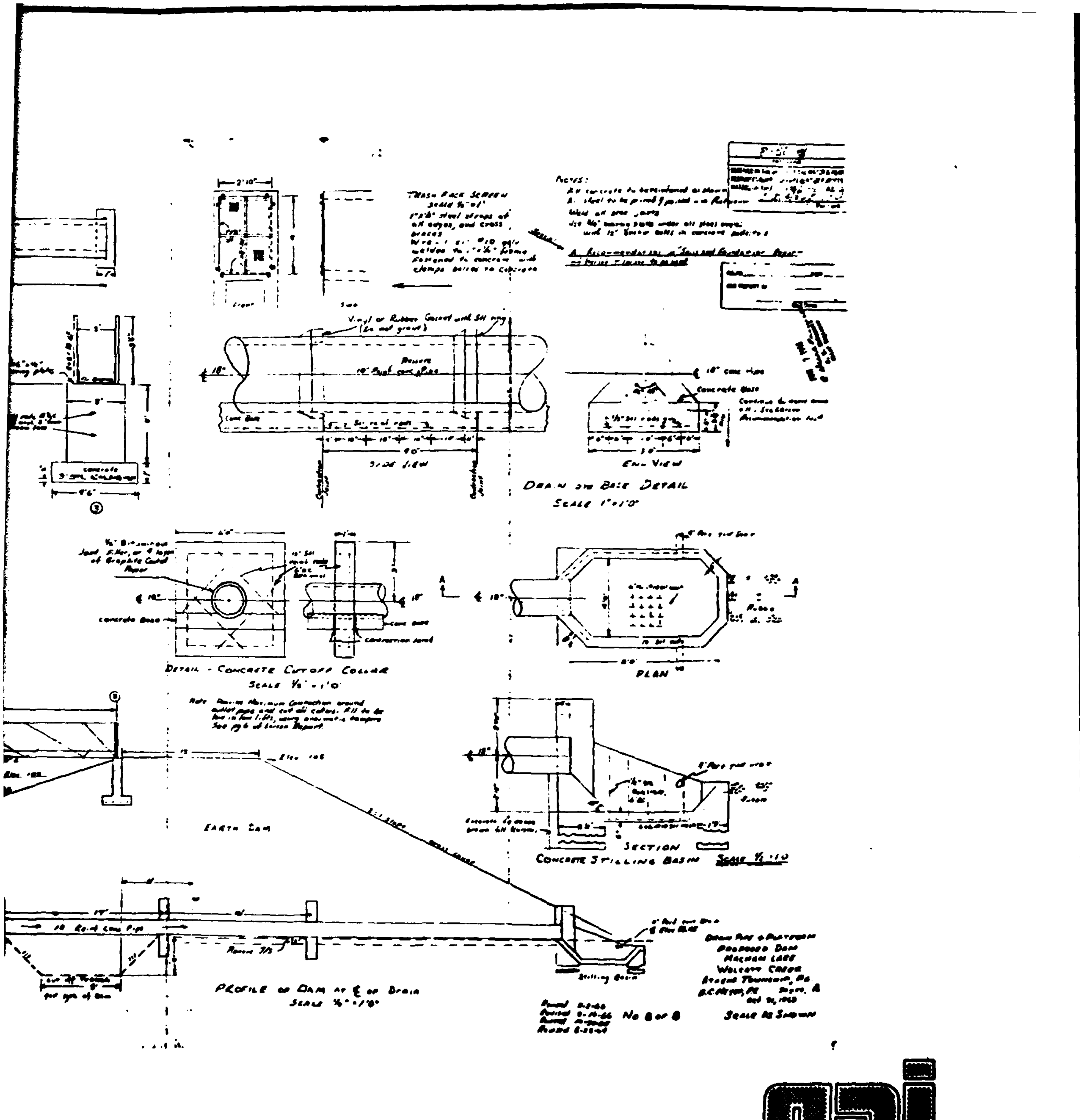


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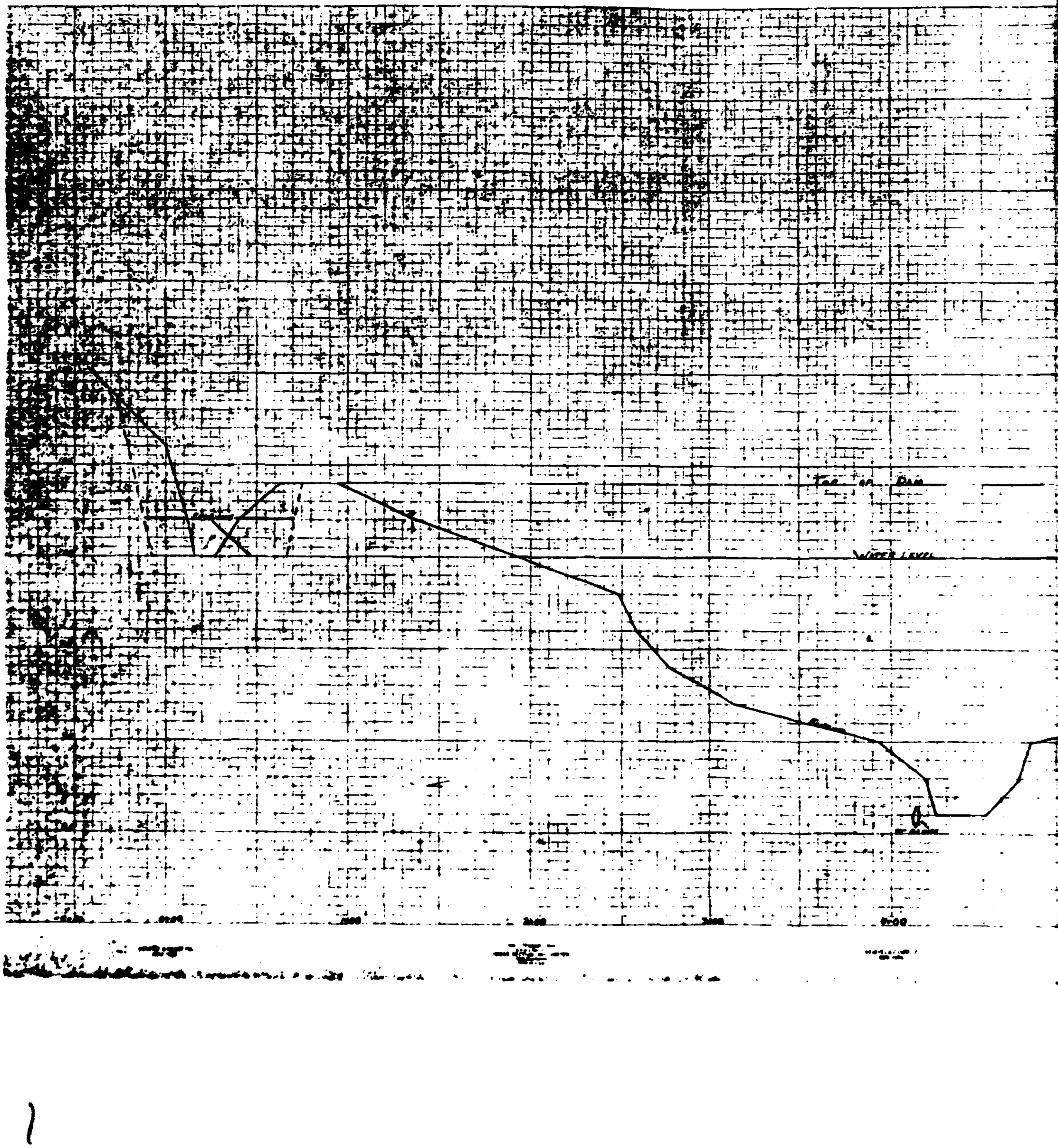
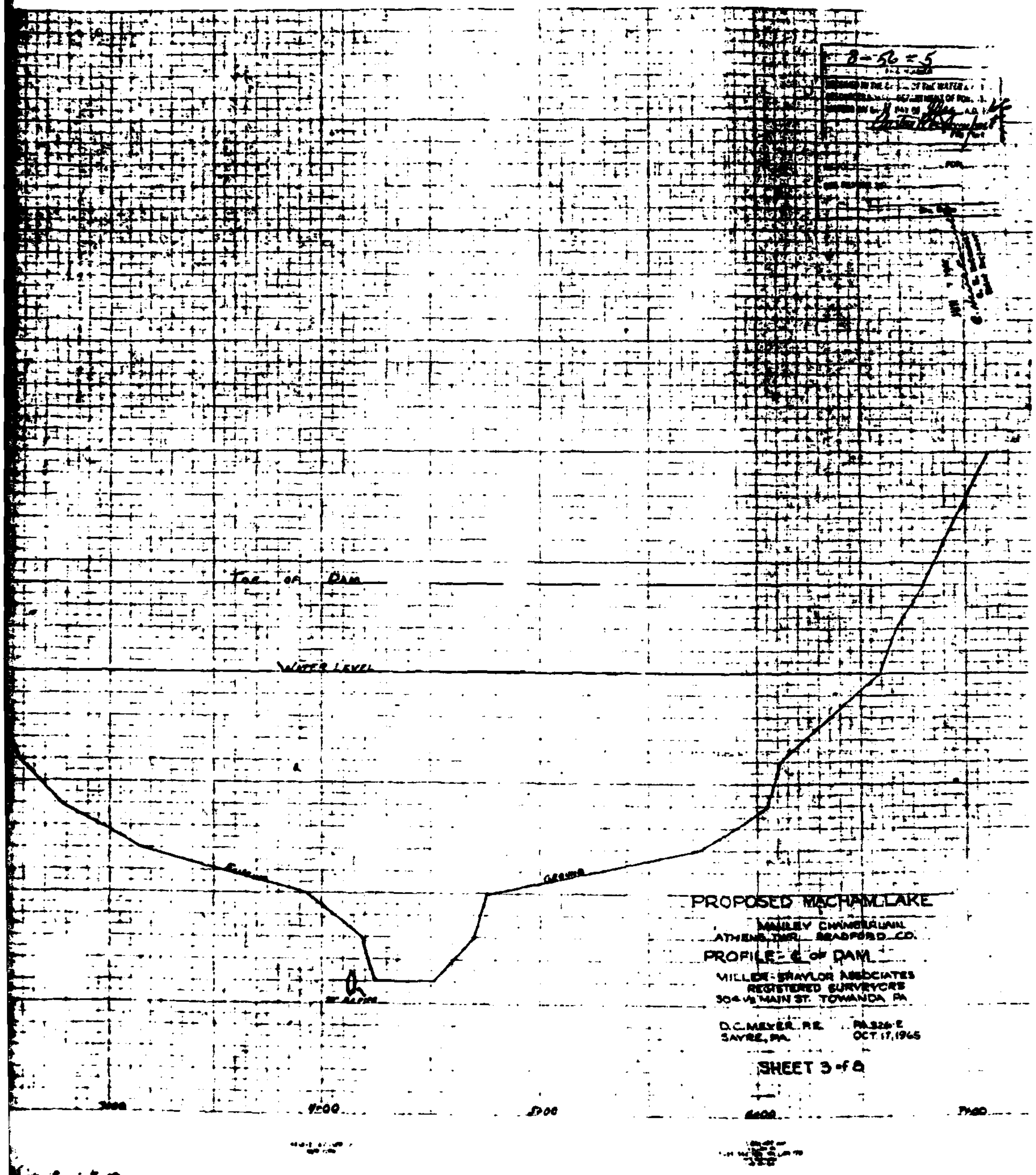
FIGURE 5


TOP OF DAM
WATER LEVEL



2

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FIGURE 6

APPENDIX F

GEOLOGY

Geology.

Macham Dam is located within the Low Plateaus section of the Appalachian Plateau Physiographic Province of northeastern Pennsylvania. In this area, the Low Plateaus section is characterized by flat lying sedimentary rock strata of Upper Devonian age, which are maturely disected, glaciated and of moderate relief. Overlying rock strata is a variable thickness of glacial drift deposited during the Illinonian and Wisconsian Glacial Epochs. The general direction of ice movement in this area, was about S30°W.

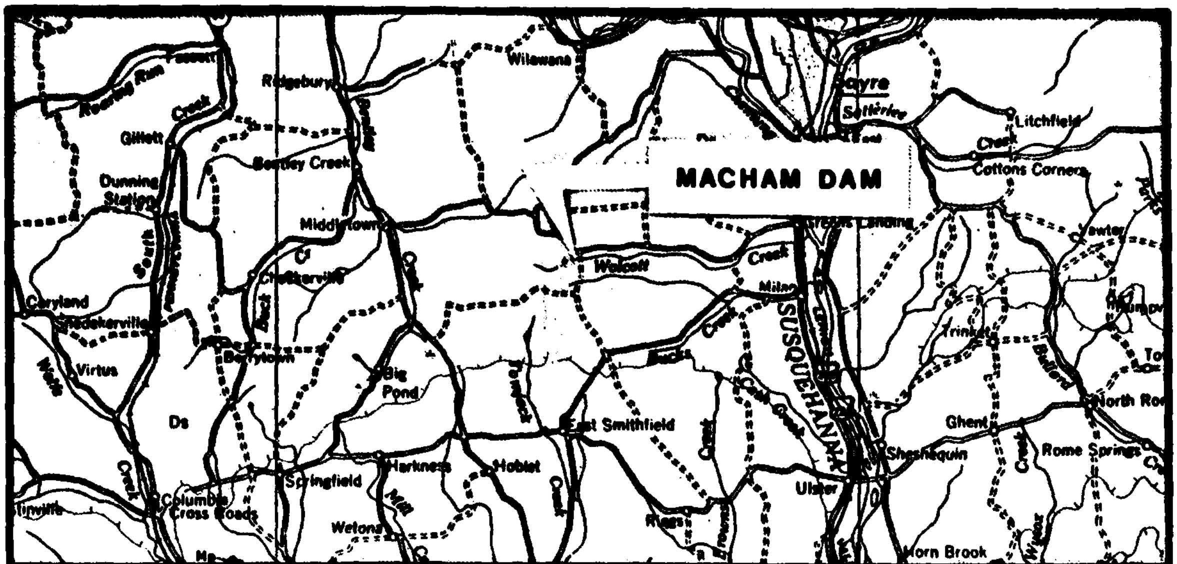
From the report entitled, "Soils and Foundation Report on Site of Proposed Macham Dam," information from three borings and seven test pits, none of which were drilled or dug to a depth greater than 25 feet, indicate that the material underlying the dam consists of glacial till ranging from a poorly graded gravel to a silty clay of medium plasticity.

The sedimentary rocks underlying the glacial material in the area of the dam and reservoir, are members of the Susquehanna Group of Upper Devonian age. These rocks are characterized by red to brownish shales and sandstones with some gray and greenish sandstones.

---

[1] Larsen, H. T., Soils and Foundation Report on Site of Proposed Macham Dam Athens Township, Bradford County Pennsylvania, 1965.

[2] Lohman, S. W., Groundwater in Northeastern Pennsylvania, Pennsylvania Geological Survey, Fourth Series, Bulletin WA 1937.



LEGEND

DEVONIAN

Dm	**Oswayo Formation** *Brownish and greenish gray, fine and medium grained sandstones with some shales and scattered calcareous lenses; includes red shales which become more numerous eastward. Relation to type Oswayo not proved.*
Dck	**Catskill Formation** *Chiefly red to brownish shales and sandstones; includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east.*
Dm	**Marine beds** *Gray to olive brown shales, graywackes, and sandstones; contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock; Tully Limestone at base.*

Ds

Susquehanna Group

barbed line is "Chemung-Catskill" contact of Second Pennsylvania Survey County reports; barbs on "Chemung" side of line.

Note:

The bedrock surface is covered with Pleistocene age Wisconsin and Illinoian till composed of sands, gravels and silty clays of variable thicknesses.

Scale

0 2 4 6 8 10 MILES

GEOLOGY MAP

REFERENCE:
GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA. DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

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