

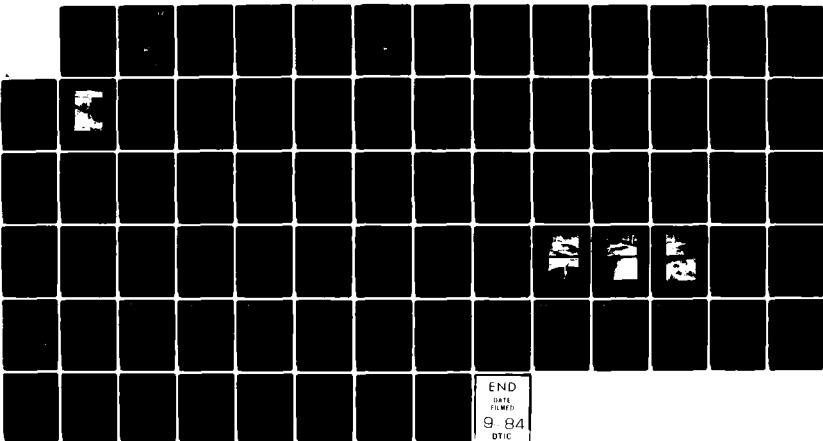
AD-A144 075

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
WARREN POND DAM (CT 0..(U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV AUG 80

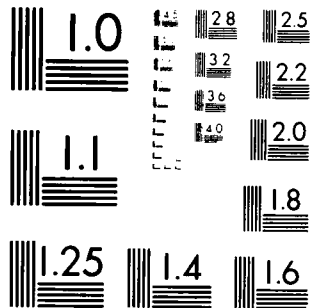
1/1

UNCLASSIFIED

F/G 13/13 NL

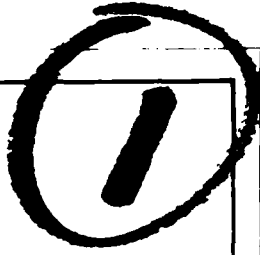


END
DATE
FILMED
9-84
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD-A144 075



THAMES RIVER BASIN

STAFFORD, CONNECTICUT
WARREN POND DAM
CT 00335

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DTIC FILE COPY

AUGUST 1980

DTIC
ELECT
AUG 13 1984
S D

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

84 08 09 041

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
|---|----------------------------------|---|
| 1. REPORT NUMBER CT 00335 | 2. GOVT ACCESSION NO. ADJNSCT | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle) Warren Pond Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS | | 5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT |
| 7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION | | 6. PERFORMING ORG. REPORT NUMBER |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS | | 8. CONTRACT OR GRANT NUMBER(s) |
| 11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) | | 12. REPORT DATE August 1980 |
| | | 13. NUMBER OF PAGES 55 |
| | | 15. SECURITY CLASS. (of this report) UNCLASSIFIED |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |
| 16. DISTRIBUTION STATEMENT (of this Report) APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED | | |
| 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) | | |
| 18. SUPPLEMENTARY NOTES Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report. | | |
| 19. KEY WORDS (Continue on reverse side if necessary and identify by block number) DAMS, INSPECTION, DAM SAFETY, Stafford, Connecticut Thames River Basin | | |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The project has a length of approximately 293 feet, consisting of a 113 foot long, broad-crested masonry spillway between two 90 foot long embankments with masonry downstream faces. Based upon the visual inspection at the site and past performances, the project is, judged to be in fair condition. Warren Pond Dam is classified as a high hazard, small size dam. The test flood range to be considered is from one-half to full PMF. The test flood is equivalent to 1/2 PMF. | | |



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

NEDED-E

OCT 28 1980

Honorable Ella T. Grasso
Governor of the State of Connecticut
State Capitol
Hartford, Connecticut 06115

Dear Governor Grasso:

Inclosed is a copy of the Warren Pond Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis. A brief assessment is included at the beginning of the report.

The preliminary hydrologic analysis has indicated that the spillway capacity for the Warren Pond Dam would likely be exceeded by floods greater than 8 percent of the Probable Maximum Flood (PMF), the test flood for spillway adequacy. Our screening criteria specifies that a dam of this class which does not have sufficient spillway capacity to discharge fifty percent of the PMF, should be adjudged as having a seriously inadequate spillway and the dam assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The term "unsafe" applied to a dam because of an inadequate spillway does not indicate the same degree of emergency as that term would if applied because of structural deficiency. It does indicate, however, that a severe storm may cause overtopping and possible failure of the dam, with significant damage and potential loss of life downstream.

It is recommended that within twelve months from the date of this report the owner of the dam engage the services of a professional or consulting engineer to determine by more sophisticated methods and procedures the magnitude of the spillway deficiency. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed. During periods of unusually heavy precipitation, round-the-clock surveillance should be provided.

NEDED-E

Honorable Ella T. Grasso

I have approved the report and support the findings and recommendations described in Section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the non-Federal Dam Inspection Program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. This report has also been furnished to the owner of the project, The Warren Corporation, Stafford Springs, Conn..

Copies of this report will be made available to the public, upon request to this office, under the Freedom of Information Act, thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for the cooperation extended in carrying out this program.

Sincerely,



MAX B. SCHEIDER

Colonel, Corps of Engineers
Division Engineer

| | |
|---------------|-------------------------------------|
| Accession For | |
| NTIS GRA&I | <input checked="" type="checkbox"/> |
| DTIC TAB | <input type="checkbox"/> |
| Unannounced | <input type="checkbox"/> |
| Justification | |

THAMES RIVER BASIN

STAFFORD, CONNECTICUT

By _____

Distribution/ _____

WARREN POND DAM
CT 00335

Availability Codes

| | |
|------|-------------------------|
| Dist | Avail and/or Special |
| A/1 | |



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DTIC
SELECTED

AUG 13 1984

AUGUST 1980

DISTRIBUTION STATEMENT X

Approved for public release;
Distribution Unlimited

D

BRIEF ASSESSMENT

PHASE I INSPECTION REPORT

NATIONAL PROGRAM OF INSPECTION OF DAMS

| | |
|---------------------|---|
| Name of Dam: | WARREN POND DAM |
| Inventory Number: | CT 00335 |
| State Located: | CONNECTICUT |
| County Located: | TOLLAND |
| Stream: | FURNACE BROOK |
| Owner: | WARREN CORPORATION |
| Date of Inspection: | MARCH 24, 1980 |
| Inspection Team: | PETER HEYNEN, P.E. HECTOR MORENO, P.E. MIRON PETROVSKY THEODORE STEVENS ROBERT JAHN |

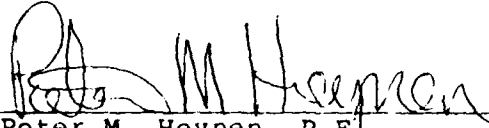
The project, built around 1852, has a total length of approximately 293 feet, consisting of a 113 foot long, broad-crested masonry spillway between two 90 foot long embankments with masonry downstream faces (See Sheet B-1). The top of the embankments, at elevation 519.0, are approximately 14 feet wide and 3 feet above the spillway crest. The dam is 22 feet in height above the streambed of Furnace Brook and, with the pond level to the top of the dam, impounds approximately 105 acre-feet of water. At the right end of the dam is a canal leading to the Warren Corporation mill downstream. The inlet to the canal is a 6 foot wide by 5.5 foot deep masonry arch culvert.

Based upon the visual inspection at the site and past performance, the project is, judged to be in fair condition. No evidence of instability of the project was observed. However, there are items which require maintenance and/or evaluation, such as deteriorated masonry at several locations on the dam and the absence of a low-level outlet for the dam.

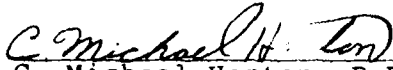
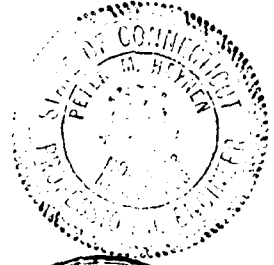
In accordance with the Army Corps of Engineer's Guidelines, Warren Pond Dam is classified as a high hazard, small size dam. The test flood range to be considered is from one-half to full Probable Maximum Flood (PMF). The test flood for Warren Pond Dam is equivalent to the 1/2 PMF. Peak inflow to the reservoir at the 1/2 PMF is 12,000 cubic feet per second (cfs); peak outflow is 12,000 cfs with the dam overtopped by 4.7 feet. The spillway capacity, with the reservoir level to the top of the dam, is 1,900 cfs, which is equivalent to 16% of the routed test flood outflow.

It is recommended that the owner retain the services of a registered professional engineer to perform a more detailed hydraulic/hydrologic analysis of the adequacy of the existing project discharge. Other items of importance are repair of deteriorated masonry and evaluation of existing outlet facilities. Recommendations made by the engineer should be implemented by the owner.

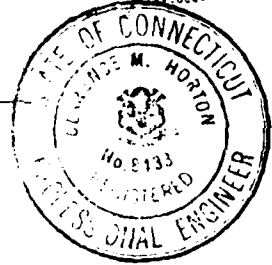
The above recommendations and further remedial measures presented in Section 7 should be instituted within one year of the owner's receipt of this report.



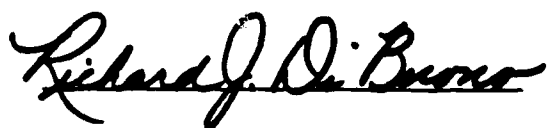
Peter M. Heynen, P.E.
Project Manager - Geotechnical
Cahn Engineers, Inc.



C. Michael Horton, P.E.
Department Head
Cahn Engineers, Inc.



This Phase I Inspection Report on Warren Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.



RICHARD DIBUONO, MEMBER
Water Control Branch
Engineering Division

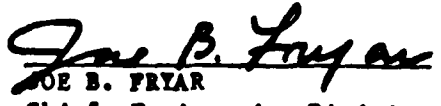


ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division



CARNEY M. TERZIAN, CHAIRMAN
Design Branch
Engineering Division

APPROVAL RECOMMENDED:



JOE B. FRYAR
Chief, Engineering Division

This Phase I Inspection Report on Warren Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Richard J. DiBuono

RICHARD DIBUONO, MEMBER
Water Control Branch
Engineering Division

Aramast Mahtesian

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, CHAIRMAN
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

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 inspection. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

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

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

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test 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.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

TABLE OF CONTENTS

| | <u>Page</u> |
|-----------------------------|-------------|
| Letter of Transmittal | |
| Brief Assessment | i, ii |
| Review Board Signature Page | iii |
| Preface | iv |
| Table of Contents | v-vii |
| Overview Photo | viii |
| Location Map | ix |

SECTION 1: PROJECT INFORMATION

| | |
|---|-----|
| 1.1 <u>General</u> | 1-1 |
| a. Authority | |
| b. Purpose of Inspection Program | |
| c. Scope of Inspection Program | |
| 1.2 <u>Description of Project</u> | 1-2 |
| a. Location | |
| b. Description of Dam and Appurtenances | |
| c. Size Classification | |
| d. Hazard Classification | |
| e. Ownership | |
| f. Operator | |
| g. Purpose of Dam | |
| h. Design and Construction History | |
| i. Normal Operational Procedures | |
| 1.3 <u>Pertinent Data</u> | 1-3 |
| a. Drainage Area | |
| b. Discharge at Damsite | |
| c. Elevations | |
| d. Reservoir Length | |
| e. Reservoir Storage | |
| f. Reservoir Surface | |
| g. Dam | |
| h. Diversion and Regulating Tunnel | |
| i. Spillway | |
| j. Regulating Outlets | |

SECTION 2: ENGINEERING DATA

| | |
|------------------------------------|-----|
| 2.1 <u>Design Data</u> | 2-1 |
| 2.2 <u>Construction Data</u> | 2-1 |
| 2.3 <u>Operations Data</u> | 2-1 |

| | | |
|---|---|-----|
| 2.4 | <u>Evaluation of Data</u> | 2-1 |
| | a. Availability | |
| | b. Adequacy | |
| | c. Validity | |
| SECTION 3: VISUAL INSPECTION | | |
| 3.1 | <u>Findings</u> | 3-1 |
| | a. General | |
| | b. Dam | |
| | d. Appurtenant Structures | |
| | d. Reservoir Area | |
| | e. Downstream Channel | |
| 3.2 | <u>Evaluation</u> | 3-2 |
| SECTION 4: OPERATIONAL AND MAINTENANCE PROCEDURES | | |
| 4.1 | <u>Operational Procedures</u> | 4-1 |
| | a. General | |
| | b. Description of Any Warning System in Effect | |
| 4.2 | <u>Maintenance Procedures</u> | 4-1 |
| | a. General | |
| | b. Operating Facilities | |
| 4.3 | <u>Evaluation</u> | 4-1 |
| SECTION 5: EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES | | |
| 5.1 | <u>General</u> | 5-1 |
| 5.2 | <u>Design Data</u> | 5-1 |
| 5.3 | <u>Experience Data</u> | 5-1 |
| 5.4 | <u>Visual Observations</u> | 5-1 |
| 5.5 | <u>Test Flood Analysis</u> | 5-1 |
| 5.6 | <u>Dam Failure Analysis</u> | 5-2 |
| SECTION 6: <u>EVALUATION OF STRUCTURAL STABILITY</u> | | |
| 6.1 | <u>Visual Observations</u> | 6-1 |
| 6.2 | <u>Design and Construction Data</u> | 6-1 |
| 6.3 | <u>Post Construction Changes</u> | 6-1 |
| 6.4 | <u>Seismic Stability</u> | 6-1 |

SECTION 7: ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

| | | |
|-----|---|-----|
| 7.1 | <u>Dam Assessment</u> | 7-1 |
| | a. Condition | |
| | b. Adequacy of Information | |
| | c. Urgency | |
| 7.2 | <u>Recommendations</u> | 7-1 |
| 7.3 | <u>Remedial Measures</u> | 7-2 |
| | a. Operation and Maintenance Procedures | |
| 7.4 | <u>Alternatives</u> | 7-2 |

APPENDICES

| | | <u>Page</u> |
|-------------|---|-------------|
| APPENDIX A: | <u>INSPECTION CHECKLIST</u> | A-1 to A-5 |
| APPENDIX B: | <u>ENGINEERING DATA AND CORRESPONDENCE</u> | |
| | Dam Plan, Profile and Sections | Sheet B-1 |
| | Summary of Data and Correspondence | B-1 |
| | Data and Correspondence | B-2 to B-8 |
| APPENDIX C: | <u>DETAIL PHOTOGRAPHS</u> | |
| | Photograph Location Plan | Sheet C-1 |
| | Photographs | C-1 to C-3 |
| APPENDIX D: | <u>HYDRAULIC/HYDROLOGIC COMPUTATIONS</u> | |
| | Drainage Area Map | Sheet D-1 |
| | Computations | D-1 to D-11 |
| | Preliminary Guidance for Estimating Maximum Probable Discharges | i to viii |
| APPENDIX E: | <u>INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS</u> | E-1 |



OVERVIEW PHOTO
February, 1980

US ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

CAHN ENGINEERS INC
WALLINGFORD, CONN
ENGINEER

NATIONAL PROGRAM OF
INSPECTION OF
NON-FED. DAMS

Warren Pond Dam
Furnace Brook
Stafford, Conn.
CE #27 785 KA
DATE May '80 PAGE viii

PHASE I INSPECTION REPORT

WARREN POND DAM

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority - Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Cahn Engineers, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Cahn Engineers, Inc. under a letter of April 14, 1980 from William E. Hodgson, Jr. Colonel, Corps of Engineers. Contract No. DACW 33-80-C 0052 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection Program - The purposes of the program are to:

1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.
2. Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dam.
3. To update, verify and complete the National Inventory of Dams.

c. Scope of Inspection Program - The scope of this Phase I inspection report includes:

1. Gathering, reviewing and presenting all available data as can be obtained from the owners, previous owners, the state and other associated parties.
2. A field inspection of the facility detailing the visual condition of the dam, embankments and appurtenant structures.
3. Computations concerning the hydraulics and hydrology of the facility and its relationship to the calculated flood through the existing spillway.
4. An assessment of the condition of the facility and corrective measures required.

It should be noted that this report does not pass judgement on the safety or stability of the dam other than on a visual basis. The inspection is to identify those features of the dam which need corrective action and/or further study.

1.2 DESCRIPTION OF PROJECT

a. Location - The dam is located on Furnace Brook in a rural area of the Town of Stafford, County of Tolland, State of Connecticut. The dam is shown on the Stafford Springs USGS Quadrangle Map, having coordinates latitude N41°57.6' and longitude W72°18.0'.

b. Description of Dam and Appurtenances - As shown on Sheet B-1, the approximately 22 foot tall dam is a stone masonry and earthfill gravity structure. The dam is approximately 293 feet long, consisting of a 113 foot long masonry spillway centered between two earthfill embankments, each approximately 90 feet in length. Near the right end of the dam are two sluice gate openings to a masonry arch culvert and a canal leading to the Warren Corporation factory downstream.

The spillway, at elevation 516 is a broad-crested masonry weir of trapezoidal cross-section with a shallow gravel bottom approach channel and a downstream face at an approximately 6 to 1 batter. Spillway discharge is onto a concrete and stone splash apron, where boulders have been placed as a baffle for energy dissipation. Masonry training walls extend upstream from the spillway, separating it from the embankments to either side.

The right and left embankments each consist of an upstream earthfill with a downstream masonry face at a batter of approximately 6 to 1. The tops of the embankments are a minimum of 3 feet above the spillway crest and gradually slope up towards the end abutments of the dam. The top of each embankment is grass covered and approximately 14 feet wide. The upstream slopes, at inclinations of approximately 3 horizontal to 1 vertical are protected by mortared riprap, except for the extreme right end of the dam, where erosion protection consists of dumped boulders.

Two sluice gate openings, located near the right end of the dam, are approximately 3 feet wide by 5.5 feet deep and feed a 6 foot wide stone arch culvert to the canal. No sluice gates or operating mechanism to control flow to the canal are in place. The approximately 5 foot deep canal is lined by masonry walls along its left side to a distance of approximately 65 feet from the dam and by an earth bank along its right side. Approximately 75 feet downstream of the dam is a 12 inch diameter cast iron drain pipe through the left canal wall. No operating mechanism for this outlet is in place, though mountings on the canal wall are in place.

c. Size Classification - (SMALL) - The dam impounds 135 acre-feet of water with the reservoir level to the top of the dam, which at elevation 519.0, is 22 feet above the streambed of Furnace Brook. According to recommended guidelines, a dam with maximum storage between 50 and 1,000 acre-feet is classified as small in size.

d. Hazard Classification - (HIGH) - If the dam were breached, there is potential for loss of more than a few lives and extensive property damage to residential, commercial and industrial buildings, including a post office and a sewage treatment plant, in an approximately 4000 foot reach through Stafford Springs (See Sheet D-1 & Page D-7).

- e. Ownership - The Warren Corporation
Mr. William L. Sorensen, Treasurer
99 Furnace Avenue
Stafford Springs, CT. 06076
(203) 684-2766

Reportedly, the dam was built around 1852 by a Converse Mill and acquired by the Warren Woolen Company in the 1880's. This company has now become the Warren Corporation.

- f. Operator - Mr. Bud Warrington (203) 684-2766

g. Purpose of Dam - The dam is used to supply process water to the textile mill downstream.

n. Design and Construction History - The following information is believed to be accurate, based on the available data and correspondence. The dam was originally constructed around 1852 by the Converse Mill of Stafford Springs. There is no record of any changes to the dam until 1956, when the spillway apron was reconstructed, riprap was placed on the upstream slopes and the left spillway training wall was repaired. In 1979, the riprap at the right end of the dam was dumped in place.

i. Normal Operational Procedures - Due to vandalism at the dam, the owner is not able to maintain sluice gates at the head of the canal. These gates are, however, kept at the Warren Corporation mill. Therefore, the flow of water to the mill is controlled solely by use of the gates at the downstream end of the canal. The pond level is normally maintained at the spillway crest and a steady flow of water through the canal to the mill is maintained, except for an annual draining of the canal, which is done each July.

1.3 PERTINENT DATA

a. Drainage Area - The drainage area is 16.0 square miles of relatively undeveloped, wooded, rolling terrain. There are five impoundments in the watershed upstream of Warren Pond. Starting from the upper reaches of the watershed, these are New City Pond; Staffordville Reservoir; an unnamed pond at Hydeville; Riverside Pond; and Glenville Pond, all within the Town of Stafford.

b. Discharge at Damsite - Discharge at the project is over the spillway and through the sluice gate openings to the canal.

- | | |
|---|---|
| 1. Outlet works (Conduits): | 350 cfs (with US water level at top of dam) |
| two +3' x +5.5' sluices to 6' arch culvert | |
| 2. Maximum flood @ damsite: | Not known |
| 3. Ungated spillway capacity @ top of dam el. 519.0: | 1,900 cfs |

| | |
|--|------------|
| 4. Ungated spillway capacity @ test flood el. 523.7: | 7,700 cfs |
| 5. Gated spillway capacity @ normal pool: | N/A |
| 6. Gated spillway capacity @ test flood: | N/A |
| 7. Total spillway capacity @ test flood el. 523.7: | 7,700 cfs |
| 8. Total project discharge @ top of dam el. 519.9: | 2,250 cfs |
| 9. Total project discharge @ test flood el. 523.7: | 12,000 cfs |

c. Elevations (National Geodetic Vertical Datum based on assumed spillway crest elevation of 516.0 taken from Stafford Springs USGS Quadrangle Map, 1970)

| | |
|--|-----------------------|
| 1. Streambed at toe of Dam: | 497.0 ₊ |
| 2. Bottom of cutoff: | N/A |
| 3. Maximum tailwater: | Not known |
| 4. Normal pool: | 516.0 ₊ |
| 5. Full flood control pool: | N/A |
| 6. Spillway crest (ungated): | 516.0 (assumed datum) |
| 7. Design surcharge (original design): | Not known |
| 8. Top of dam: | 519.0 ₊ |
| 9. Test flood surcharge: | 523.7 |

d. Reservoir Length

| | |
|-------------------------|------------|
| 1. Normal pool: | +2,400 ft. |
| 2. Flood control pool: | N/A |
| 3. Spillway crest pool: | +2,400 ft. |
| 4. Top of dam pool: | +2,700 ft. |
| 5. Test flood pool: | +3,100 ft. |

e. Reservoir Storage

| | |
|-----------------|---------------|
| 1. Normal pool: | +105 acre-ft. |
|-----------------|---------------|

- 2. Flood control pool: N/A
- 3. Spillway crest pool: + 105 acre-ft.
- 4. Top of dam pool: +135 acre-ft.
- 5. Test flood pool: +175 acre-ft.
- f. Reservoir Surface
 - 1. Normal pool: 9 acres
 - 2. Flood control pool: N/A
 - 3. Spillway crest pool: 9 acres
 - 4. Top of dam pool: 12 acres
 - 5. Test flood pool: +14 acres
- g. Dam
 - 1. Type: Masonry faced embankment
 - 2. Length: +293 ft. total
+113 ft. (Spillway)
+180 ft. (Embankments)
 - 3. Height: 22 ft.
 - 4. Top width: +10 ft.
 - 5. Side slopes: 3H to 1V Upstream
6V to 1H Batter on
downstream masonry face
 - 6. Zoning: N/A
 - 7. Impervious Core: N/A
 - 8. Cutoff: N/A
 - 9. Grout curtain: N/A
 - 10. Other: N/A
- h. Diversion and Regulating Tunnel - N/A
- i. Spillway
 - 1. Type: Broad crested masonry

- 2. Length of weir: +113 ft.
- 3. Crest elevation: 516.0
- 4. Gates: N/A
- 5. Upstream Channel: Shallow, gravelly
- 6. Downstream Channel: Concrete splash apron,
boulders for energy
dissipation
- 7. General: N/A

j. Regulating Outlets

Sluices to culvert and canal

- 1. Invert: 511.0+
- 2. Size: Two +3'x5.5'
- 3. Description: Masonry sluices
- 4. Control Mechanism: None in place
- 5. Other: Gates kept at mill-
installed annually to
drain canal

SECTION 2: ENGINEERING DATA

2.1 DESIGN DATA

The available data consists of inventory data by the State of Connecticut, correspondence concerning the 1956 repairs to the dam, and a 1972 inspection report on the dam (See Appendix B).

The available data and correspondence indicate the design features stated previously in this report.

2.2 CONSTRUCTION DATA

The 1956 repairs to the dam were approved, inspected and documented by the State of Connecticut Board for the Supervision of Dams (See pages B-4 to B-6).

2.3 OPERATIONS DATA

No formal operations records are known to exist.

2.4 EVALUATION OF DATA

a. Availability - Existing data was provided by the State of Connecticut, and Buck & Buck, Engineers. The owner made the project available for visual inspection.

b. Adequacy - The limited amount of detailed engineering data available is inadequate to perform an in-depth assessment of the dam, therefore, the assessment of this dam must be based primarily on visual inspection, performance history, hydraulic computations of spillway capacity and hydrologic estimates.

c. Validity - A comparison of record data and visual observations reveals no significant discrepancies in the record data.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General - The general condition of the project is fair. The inspection revealed several areas requiring maintenance and monitoring. At the time of the inspection, the pond level was at elevation 516.4, i.e. 2.6 feet below the crest of the dam with water flowing over the masonry spillway.

b. Dam

Top of Dam - The grass covered top of the dam is irregular and gradually sloping to the spillway walls from both abutments (Photos 1 and 2).

Upstream Slope - The upstream slope riprap, held in place by mortar, is slightly eroded and the mortar is cracked in places (Photo 6). Brush and saplings on the slope were noted on the left embankment.

Downstream Face - The masonry downstream face of the dam is mortared on the right embankment, but not on the left. Deteriorated masonry was observed on the downstream face of both embankment sections at a distance of 2 to 4 feet from the edges of the spillway. At these areas the mortar between the blocks is weathered and washed out. Water was observed to be flowing through the joints of the left masonry face at a rate of approximately 6 to 10 gallons per minute (Photo 4). A tree stump, 4 inches in diameter, was noted at the left section near the top of the dam causing a masonry block to be uplifted at this area (Photo 2). Some grass growing from the masonry joints was observed. The toe of the dam is a very heavily wooded area with brush and trees just behind the downstream face (Photo 5).

Spillway - The masonry spillway crest is in good condition. No substantial obstructions of the approach channel or crest were observed (Photos 1 and 2). The training walls adjacent to the spillway crest were cracked, with joint openings between blocks of up to 2 inches. The concrete apron at the toe of the spillway could not be observed, due to the amount of water flowing onto it from over the spillway. The energy dissipation boulders on the apron were sparse towards the right side of the channel and, consequently, there is extensive erosion and uprooted trees along the right side of the downstream channel (Photos 2 and 5).

c. Appurtenant Structures - The masonry culvert through the right embankment section of the dam and the outlet canal are both in poor condition (Photos 1 and 3). There is no gate hoisting mechanism on the upstream headwall of the culvert. Fallen masonry blocks at the right corner of the upstream headwall of the culvert were observed, leaving exposed and eroded earthfill. The left masonry wall of the outlet canal, with concrete coping on the top, was deteriorated with numerous cracks in the concrete and opened, weathered masonry joints. There is a 12 inch cast iron drain pipe

through the masonry canal wall; however, no gate operating mechanism is in place. Water was flowing at the rate of 4 to 6 gpm from the outlet of the drain, which is obstructed by various kinds of debris.

d. Reservoir Area - The area surrounding the pond is generally wooded and undeveloped. There is a bituminous road along the right bank of the pond.

e. Downstream Channel - The downstream channel is the natural streambed of Furnace Brook. It is steep-sided and wooded to the initial impact area.

3.2 EVALUATION

Based upon the visual inspection, the project is assessed as being in fair condition. The following features which could influence the future condition and/or stability of the project were identified.

1. The masonry on the downstream face of the embankment sections adjacent to the spillway can further deteriorate, with seepage increasing through the masonry.
2. Water can collect in the large cracks of the spillway training walls, leading to damage by freeze-thaw cycles.
3. The extensive erosion along the right side of the spillway channel could worsen, causing ponding of water at the toe of the spillway rather than directing spillway discharge to the downstream channel.
4. Blocks from the damaged masonry of the upstream and downstream headwalls of the culvert could fall, causing difficulties with the operation of the canal.

SECTION 4: OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 OPERATIONAL PROCEDURES

a. General - Lake level readings are not taken, but the pond level is normally maintained at or about the elevation of the spillway crest.

b. Description of Any Warning System in Effect - No formal warning system is in effect.

4.2 MAINTENANCE PROCEDURES

a. General - The owner performs regular maintenance of the dam, including cutting the grass and brush on the dam. The owner also performs periodic informal inspections of the dam.

b. Operating Facilities - Due to vandalism at the dam, the gates for the canal intake are kept at the Warren Corporation mill and only installed each July, when the canal is flushed out.

4.3 EVALUATION

The operation and maintenance procedures are generally fair. A formal program of operations and maintenance procedures should be implemented, including documentation to provide complete records for future reference. Also, a formal warning system should be developed and implemented within the time frame indicated in Section 7.1c. Remedial operation and maintenance recommendations are presented in Section 7.3.

SECTION 5: EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 GENERAL

The watershed is 16 square miles of undeveloped, flat to rolling, wooded terrain. Warren Pond is downstream of a series of relatively small ponds and the Staffordville Reservoir which has a watershed of 8.34 square miles.

Warren Pond Dam is a masonry gravity structure, which includes a masonry spillway and adjacent earth and masonry embankments. The dam is basically a low surcharge storage - high spillage project presently used for industrial purposes. The available surcharge storage is too small to have any impact on either the Probable Maximum Flood (PMF) of 24,000 cubic feet per second (cfs) or the $\frac{1}{2}$ PMF of 12,000 cfs.

5.2 DESIGN DATA

No computations could be found for the original design of the dam.

5.3 EXPERIENCE DATA

Extensive repairs were required in 1956, possibly due to damages incurred by the floods of 1955.

5.4 VISUAL OBSERVATIONS

No unusual hydrologic features of the project were observed.

5.5 TEST FLOOD ANALYSIS

Based upon the Army Corps of Engineers' "Preliminary Guidance for Estimating Maximum Probable Discharges", dated March 1978, the watershed classification (rolling), and a watershed area of 16 square miles, a PMF of 24,000 cfs, or 1,500 cfs per square mile, is estimated at the dam site. The range of test floods to be considered for this high hazard, small size dam is from $\frac{1}{2}$ to full PMF. Based on the degree of hazard associated with a breach of the dam, the test flood for Warren Pond Dam is equivalent to the $\frac{1}{2}$ PMF. Assuming the pond level at the spillway crest at the beginning of the test flood, peak inflow is 12,000 cfs; due to the minimal surcharge storage (Appendix D-5), peak outflow is also 12,000 cfs; and the dam is overtopped by 4.7 feet (Appendix D-2 and D-4). Based on hydraulics computations, the spillway capacity to the top of the dam is 1,900 cfs, which is equivalent to 16% of the routed test flood outflow.

5.6 DAM FAILURE ANALYSIS

The dam failure analysis is based on the April, 1978 Army Corps of Engineers "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs". Peak outflow before failure of the dam would be about 1,900 cfs and the peak failure outflow from the dam breaching would total about 18,000 cfs. A breach of the dam, with the pond level at the top of the dam, would result in a rise in the water level of the stream at the initial impact area, from a depth of about 2.5 feet just before the breach to a depth of about 13 feet shortly after the breach. This rapid, 10.5 foot increase in water level at the initial impact area would inundate some 10 or more buildings from 5 to 9.5 feet, causing severe economic loss and the loss of more than a few lives. Based on the dam failure analysis, Warren Pond Dam is classified as a high hazard dam.

SECTION 6: EVALUATION OF STRUCTURAL STABILITY

6.1 VISUAL OBSERVATIONS

The visual inspection did not reveal any indications of immediate stability problems. There are areas of seepage, deterioration, and erosion, as described in Section 3, however they are not considered stability concerns at the present time.

6.2 DESIGN AND CONSTRUCTION DATA

The drawings and data available and listed in Appendix B were not sufficient to perform an in depth stability analysis of the dam. No engineering assumptions, data or calculations could be found for the original design of the dam.

6.3 POST CONSTRUCTION CHANGES

Post-construction changes of the project consisted of repairs to the spillway apron, placement of riprap, and repair of the left spillway training wall, all of which would help to enhance the structural stability of the project.

6.4 SEISMIC STABILITY

The project is in Seismic Zone 1 and according to the Recommended Guidelines, need not be evaluated for seismic stability.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 PROJECT ASSESSMENT

a. Condition - Based upon the visual inspection of the site and past performance, the project appears to be in fair condition. No evidence of immediate structural instability was observed in the embankments, spillway and appurtenant structures. However, there are areas which require maintenance, repair and monitoring.

Based upon the Army Corps of Engineers' "Preliminary Guidance for Estimating Maximum Probable Discharges" dated March, 1978, the watershed classification and hydraulic/hydrologic computations, peak inflow to the pond at test flood is 12,000 cubic feet per second (cfs); peak outflow is 12,000 cfs with the dam overtopped 4.7 feet. Based upon our hydraulic computations, the spillway capacity to the top of dam is 1,900 cfs, which is equivalent to approximately 16% of the routed test flood outflow.

b. Adequacy of Information - The information available is such that an assessment of the condition and stability of the project must be based solely on visual inspection, past performance and sound engineering judgement.

c. Urgency - It is recommended that the measures presented in Section 7.2 and 7.3 be implemented within one year of the owner's receipt of this report.

7.2 RECOMMENDATIONS

It is recommended that further studies be made by a registered professional engineer qualified in dam design and inspection pertaining to the following items. Recommendations made by the engineer should be implemented by the owner.

1. A detailed hydraulic analysis of the adequacy of the project discharge and existing outlet facilities, including an evaluation of the outlet culvert through the right section of the dam and the absence of a low-level outlet.
2. An inspection of the inside of the masonry arch culvert and the sluice gate openings through the right embankment of the dam for possible deterioration and an inspection of the outlet canal, its masonry training wall and 12 inch C.I. drain pipe to determine their condition. These inspections can be performed during the annual draining of the canal.
3. An inspection of the masonry spillway and spillway apron when no water is flowing over the spillway. This should include evaluation of seepage through the spillway, possible deterioration of the masonry downstream face of the spillway and possible undermining or erosion conditions at the toe.

4. Removal of trees within 15 feet from the toe of the dam, including removal of root systems and proper backfilling of the resultant cavities.

7.3 REMEDIAL MEASURES

a. Operation and Maintenance Procedures - The following measures should be undertaken by the owner within the length of time indicated in Section 7.1.c, and continued on a regular basis:

1. Round-the-clock surveillance should be provided during periods of heavy precipitation or high project discharge. A formal downstream warning system should be developed, to be used in case of emergencies at the dam.
2. A formal program of operation and maintenance procedures should be instituted and fully documented to provide accurate records for future reference.
3. A comprehensive program of inspection by a registered professional engineer qualified in dam inspection should be instituted on an annual basis.
4. Deteriorated masonry of the downstream face of the embankments adjacent to the spillway should be repaired.
5. Cracks in the masonry of the spillway training walls adjacent to the spillway crest and in the mortared riprap of the upstream slope of the right dam section should be sealed.
6. The cracked and damaged masonry of the culvert upstream headwall and canal training wall should be reinforced.
7. Additional boulders for energy dissipation should be placed at the right side of the spillway apron and other suitable measures should be undertaken to prevent erosion of the spillway downstream channel bank.
8. A plug should be installed in the inlet of the 12 inch C.I. drain pipe through the canal dike to stop the flow of water.
9. Removal of stumps and cutting of grass, brush and trees on the crest, slopes and within 10 feet of the toe of the dam should be continued as part of the routine maintenance procedures at the dam.

7.4 ALTERNATIVES

This study has identified no practical alternatives to the above recommendations.

APPENDIX A
INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Warren Pond Dam

DATE: March 24, 1980

TIME: 1:30 - 3:30 PM

WEATHER: Cloudy, 45°

W.S. ELEV. 516.4 U.S. 497 ± DN. S

PARTY:

INITIALS:

DISCIPLINE:

| | | |
|----------------------------|------------|---------------------|
| 1. <u>Peter Heynen</u> | <u>PH</u> | <u>Geotechnical</u> |
| 2. <u>Miron Petrovsky</u> | <u>MP</u> | <u>Geotechnical</u> |
| 3. <u>Theodore Stevens</u> | <u>TS</u> | <u>Geotechnical</u> |
| 4. <u>Hector Moreno</u> | <u>HAI</u> | <u>Hydraulics</u> |
| 5. <u>Robert Jahn</u> | <u>RJ</u> | <u>Hydraulics</u> |
| 6. <u>William Sorensen</u> | <u>WS</u> | <u>Owner</u> |

PROJECT FEATURE

INSPECTED BY

REMARKS

| | | |
|--|------------|--|
| 1. <u>Right & Left Embankments</u> | <u>All</u> | |
| 2. <u>Culvert Upstream Headwall</u> | <u>All</u> | |
| 3. <u>Downstream Headwall & Canal Wall</u> | <u>All</u> | |
| 4. <u>Spillway</u> | <u>All</u> | |
| 5. _____ | | |
| 6. _____ | | |
| 7. _____ | | |
| 8. _____ | | |
| 9. _____ | | |
| 10. _____ | | |
| 11. _____ | | |
| 12. _____ | | |

PERIODIC INSPECTION CHECK LIST

Page A-2

PROJECT Warren Pond Dam

DATE 3-24-80

PROJECT FEATURE Right & Left Earth Embankment by PH, AP, IS, HW, RJ

| AREA EVALUATED | CONDITION |
|---|---------------------------------------|
| <u>DAM EMBANKMENT</u> | |
| Crest Elevation | Varies 519.0 to 521.5 |
| Current Pool Elevation | 516.4 |
| Maximum Impoundment to Date | Not known |
| Surface Cracks | Cracking of US mortared riprap |
| Pavement Condition | N/A |
| Movement or Settlement of Crest | } None observed |
| Lateral Movement | |
| Vertical Alignment | } Appears good |
| Horizontal Alignment | |
| Condition at Abutment and at Concrete Structures | Fair |
| Indications of Movement of Structural Items on Slopes | None observed |
| Trespassing on Slopes | Yes - also comprise remnants on crest |
| Sloughing or Erosion of Slopes or Abutments | Some - minor |
| Rock Slope Protection-riprap Failures | Minor |
| Unusual Movement or Cracking at or Near Toes | None observed |
| Unusual Embankment or Downstream Seepage | No |
| Piping or Boils | No |
| Foundation Drainage Features | N/A |
| Toe Drains | N/A |
| Instrumentation System | N/A |

PERIODIC INSPECTION CHECK LIST

Page A-3

PROJECT _____

DATE 3-24-80

PROJECT FEATURE Culvert Upstream Headwall BY PH, MPTS, HA, RS

| AREA EVALUATED | CONDITION |
|---|---|
| <p><u>OUTLET WORKS-INTAKE CHANNEL AND INTAKE STRUCTURE</u></p> <p>a) <u>Approach Channel</u></p> <p>Slope Conditions</p> <p>Bottom Conditions</p> <p>Rock Slides or Falls</p> <p>Log Boom</p> <p>Debris</p> <p>Condition of Concrete Lining Masonry</p> <p>Drains or Weep Holes</p> <p>b) <u>Intake Structure</u></p> <p>Condition of Concrete Masonry</p> <p>Stop Logs and Slots</p> | <p>} Could not observe</p> <p>Some blockage by rocks</p> <p>None</p> <p>None observed</p> <p>Fair - Some deterioration</p> <p>None observed</p> <p>Fair - Some deterioration</p> <p>None in place - kept at mill downstream</p> |

PERIODIC INSPECTION CHECK LIST

Page 1-1

PROJECT Warren Flood Control

DATE 3-24-80

PROJECT FEATURE Downstream Headwall & Channel Wall

BY H. H. P. T. S.

| AREA EVALUATED | CONDITION |
|--|------------------------------------|
| <p><u>OUTLET WORKS-OUTLET STRUCTURE AND OUTLET CHANNEL</u></p> | |
| <p>General Condition of ^{Masonry} Concrete</p> | <p>Fair - some deterioration</p> |
| <p>Rust or Staining</p> | <p rowspan="4">} None observed</p> |
| <p>Spalling</p> | |
| <p>Erosion or Cavitation</p> | |
| <p>Visible Reinforcing</p> | |
| <p>Any Seepage or Efflorescence</p> | |
| <p>Condition at Joints</p> | <p>Fair</p> |
| <p>Drain Holes</p> | <p>None observed</p> |
| <p>Channel</p> | |
| <p>Loose Rock or Trees Overhanging Channel</p> | <p>Some - minor</p> |
| <p>Condition of Discharge Channel</p> | <p>Fair</p> |

1-1

PERIODIC INSPECTION CHECK LIST

Page A-5

PROJECT Warren Pond Dam

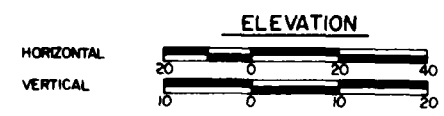
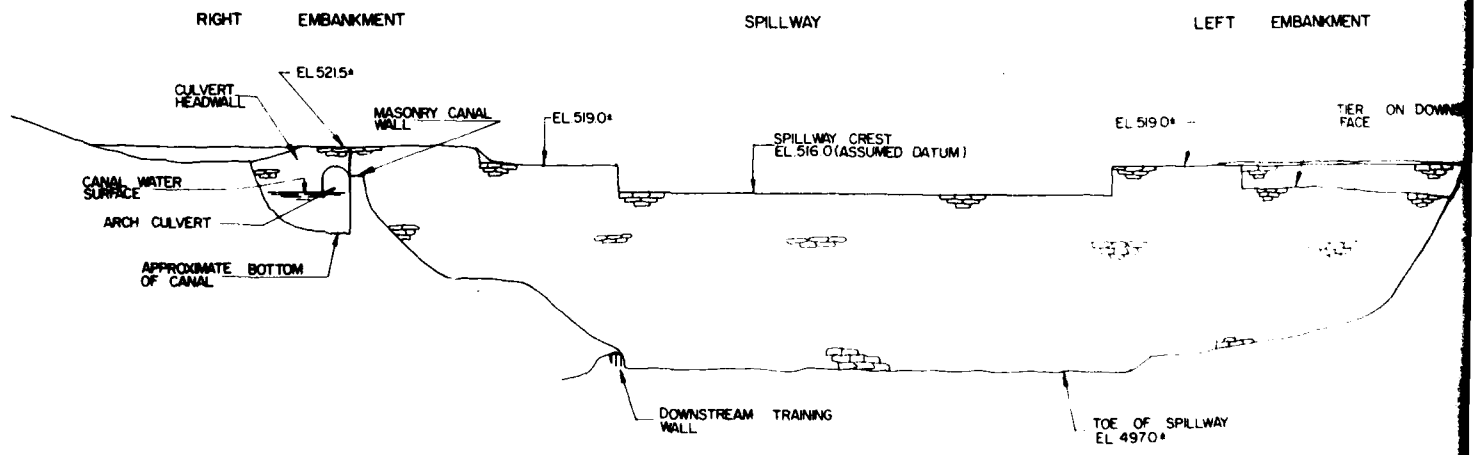
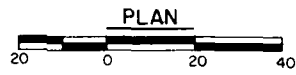
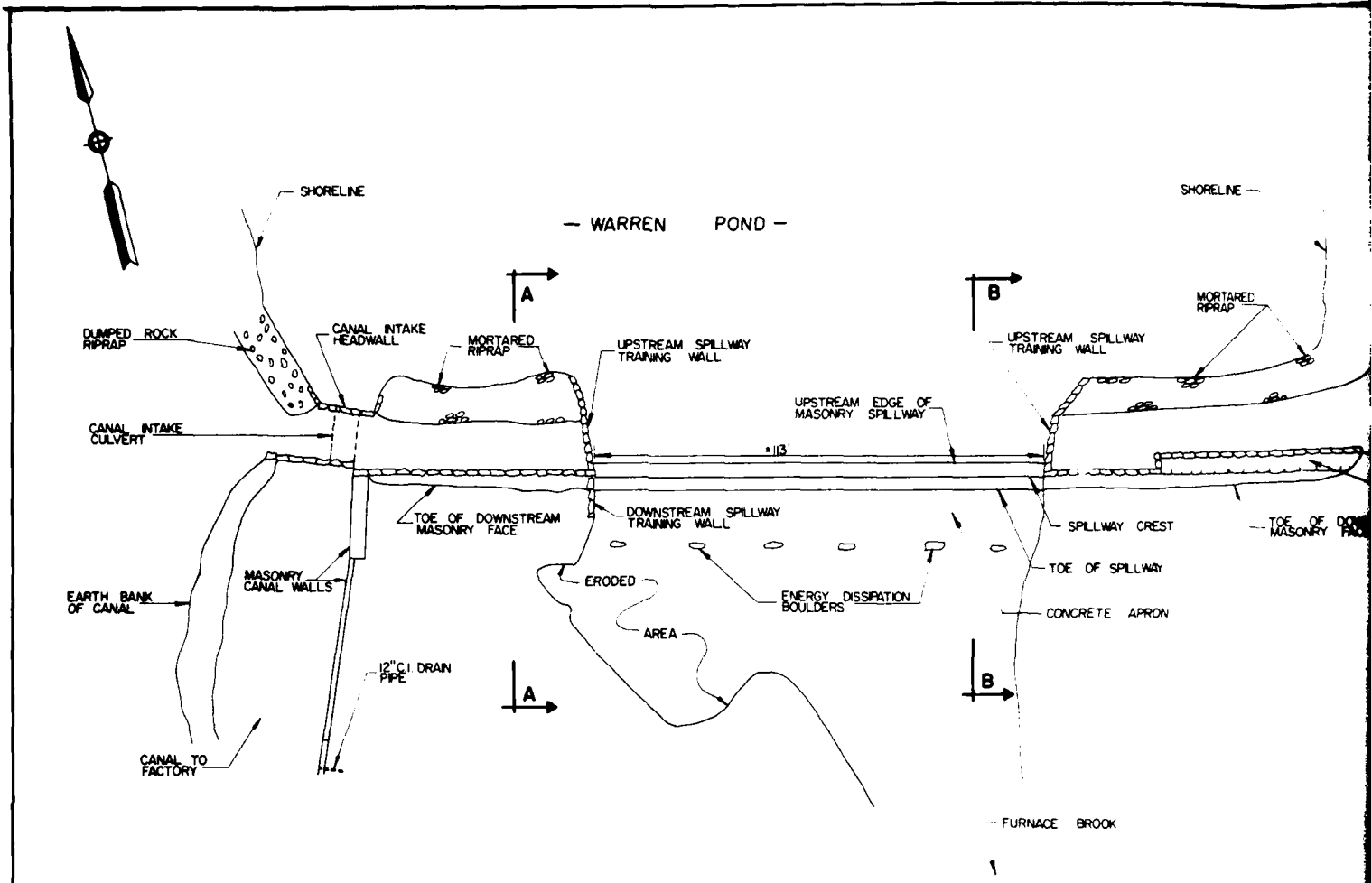
DATE 3-24-80

PROJECT FEATURE Spillway

BY PH, MPT, HLL, RJ

| AREA EVALUATED | CONDITION |
|--|--|
| <p><u>OUTLET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u></p> | |
| <p>a) <u>Approach Channel</u> General Condition Loose Rock Overhanging Channel Trees Overhanging Channel Floor of Approach Channel</p> | <p>Good No No Shallow, gravel</p> |
| <p>b) <u>Weir and Training Walls</u> General Condition of ^{Masonry}Concrete Rust or Staining Spalling Any Visible Reinforcing Any Seepage or Efflorescence Drain Holes</p> | <p>Fair - some deterioration } None observed</p> |
| <p>c) <u>Discharge Channel</u> General Condition Loose Rock Overhanging Channel Trees Overhanging Channel Floor of Channel Other Obstructions</p> | <p>Fair - Erosion of right bank No Some - minor Concrete apron, energy dissipation boulders, natural stream bed</p> |

APPENDIX B
ENGINEERING DATA AND CORRESPONDENCE



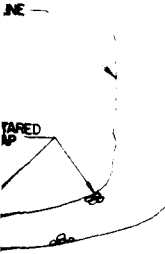
MORTARED RIPRAP

POND LEVEL
EL 516.4*

DOWNSTREAM MASONRY
FACE OF DAM

6

SECTION A-A



TIER ON DOWNSTREAM
MASONRY FACE

TOE OF DOWNSTREAM
MASONRY FACE

SPILLWAY TRAINING
WALL EL 519.0

POND LEVEL
EL 516.4*

MASONRY SPILLWAY
CREST EL 516.0 (ASSUMED DATUM)

GRAVEL APPROACH
CHANNEL

DOWNSTREAM MASONRY
FACE OF SPILLWAY

6

TAILWATER
EL 498.0*

ENERGY DISSIPATION
BOULDERS

SECTION B-B



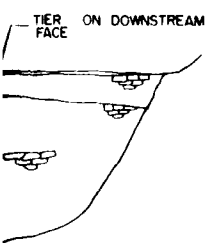
TOE OF SPILLWAY
EL 497.0*

STREAMBED

NOTES

1. THIS PLAN WAS COMPILED FROM A CAHN ENGINEER INSPECTION OF THE DAM DATED MARCH 19, 1980. DIMENSIONS SHOWN ARE APPROXIMATE. NOT ALL TOPOGRAPHIC AND/OR STRUCTURAL FEATURES ARE NECESSARILY IDENTIFIED.
2. NO ELEVATIONS WERE AVAILABLE FOR THE DAM, THEREFORE THE WATER SURFACE ELEVATION OF 516.0 FOR THE POND SHOWN ON THE U.S.G.S. STAFFORD SPRINGS QUADRANGLE MAP WAS ASSUMED TO BE THE ELEVATION OF THE SPILLWAY CREST. ALL OTHER ELEVATIONS SHOWN ARE REFERENCED TO THE ASSUMED SPILLWAY CREST ELEVATION.
3. WATER SURFACE ELEVATIONS, SHORELINE AND TAILWATER CONFIGURATIONS ARE APPROXIMATE, AS OBTAINED DURING THE DAM INSPECTION ON MARCH 19, 1980.

MARKING



TIER ON DOWNSTREAM
FACE

| | |
|--|---|
| CAHN ENGINEERS INC WALLINGFORD, CONNECTICUT ENGINEER | U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS. |
|--|---|

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
PLAN ELEVATION & SECTIONS

WARREN POND DAM

FURNACE BROOK STAFFORD, CONNECTICUT

| | | | |
|-----------------------|-------------------------|----------------------------|----------------|
| DRAWN BY H. J. ... | CHECKED BY J. S. ... | APPROVED BY [Signature] | SCALE AS NOTED |
| DATE MAY 1980 | | | SHEET B |

SUMMARY OF DATA AND CORRESPONDENCE

| <u>DATE</u> | <u>TO</u> | <u>FROM</u> | <u>SUBJECT</u> | <u>PAGE</u> |
|--------------------------------|--|--|-------------------------------------|-------------|
| - | File | State Board for the Supervision of Dams | Inventory data | R-2 |
| Sept. 14, 1955 | Henry W. Buck | The Warren Woolen Co. | Proposal for repair of dam | B-3 |
| Sept. 16, 1955 | The Warren Woolen Co. | Henry W. Buck State Board of Dams | Granting of Construction Permit | B-4 |
| Oct. 24, 1956 (final entry) | File | Henry W. Buck | Construction Inspection Memos | B-5 |
| Oct. 26, 1956 | The Warren Woolen Co. | John J. Mozzochi State Board of Dams | Granting of Certificate of Approval | B-6 |
| Jan. 24, 1972 | William H. O'Brien, III Conn. Dept. of Environmental Protection | A. J. Macchi Macchi & Hoffman, Engineers | Inspection Report | B-7 |
| Jan. 25, 1972 | File | William H. O'Brien, III | Memo on dam inspection | B-8 |

Under Back
B

STATE BOARD FOR THE SUPERVISION OF DAMS
INVENTORY DATA

10-16
CT-335
R.M.
24-1-1960

NAME OF DAM OR POND _____

CODE NO. W240 F006

LOCATION OF STRUCTURE:

Town _____

Name of Stream _____

U.S.G.S. Quad. _____ Long. 72-18.0 Lat. 41-57.6

OWNER:

Warren Wooden Co.
Furnace Avenue
Stafford Springs, CT

687-2764

OK 12/18

Pond Used For: RECREATION DA = 16.0

Dimensions of Pond: Width _____ Length _____ Area 10.1

Depth of water below Spillway Level (Downstream) 20'

Total Length of Dam 260' Length of Spillway 100'

Height of Abutments above Spillway 3'

Type of Spillway Construction _____

Type of Dike Construction _____

Downstream Conditions _____

Summary of File Data _____

Remarks _____

1880?



THE WARREN WOOLEN CO.

FINE WOOLENS & SPECIALTY FABRICS

September 14, 1955

Mr. Henry W. Buck
850 Main Street
Hartford 3, Conn.

Dear Henry:

We were able to draw the pond down and inspect the dam and apron today. Water still covered the bottom of the lower apron, but by prodding with a long pole we believe there are spots where the apron has been undercut back four or five feet and a depth generally less than twelve inches. Joe Mottes (you will remember him as contractor on our toilet stack) proposes to bulldoze the stones back to within three or four feet of the edge of the apron and, then, using the pile of stones as more or less of a form, pour in concrete, throw in big stones, and prod the concrete into the undercut.

The stone abutment on the far side of the dam opening is not in as good shape as the one on the near side, and Joe has suggested that, in addition to pointing, it would be well to dig out a foot or two on the earth side and fill with concrete. The purpose would be to help hold the stones in position plus presenting a smoother surface for action of the earth in freezing and thawing.

You will recall that on the far side of the dam the outer tier of stone has not come up to the top of the dam. You suggested that we throw some stones in any low spots in this area. Joe has suggested that he cap this tier of stones with concrete and give it a pitch.

In building a rip rap on the pond side of the shoulders, Joe proposes to simply dump truckloads of large stones---many will be much more than one-hundred pounds---along this area.

The remainder of your recommendations, such as, filling all washed-out areas with gravel, adding loam, etc., will be carried out, but we would appreciate your advice on the items listed above.

If you feel you would like to have another "look see" at the apron, let us know, and we will make sure that the water is down.

Very truly yours,

THE WARREN WOOLEN CO.

wls/el

B-3

570 WOLCOTT HILL ROAD
WETHERSFIELD, CONNECTICUT

A-153-75

SEPTEMBER 16, 1955

THE WARREN WOOLEN COMPANY
STAFFORD SPRINGS, CONNECTICUT

GENTLEMEN:

REPLYING TO YOUR LETTER OF SEPTEMBER 14TH REGARDING THE REPAIRS TO YOUR DAM, I FEEL THAT ALL THE SUGGESTIONS MADE BY THE CONTRACTOR ARE EXCELLENT. THE CAP HE IS PROPOSING ON THE LOWER TIER OF STONES IN THE EAST ABUTMENT I DO NOT FEEL IS ESSENTIAL TO THE STABILITY OF THE DAM. HOWEVER, BY SHEDDING WATER IN THIS AREA IT WILL CERTAINLY REDUCE POSSIBLE MAINTENANCE OF THAT SECTION OF THE STONE WORK.

I AM ENCLOSING CONSTRUCTION PERMIT NO. 5-47 COVERING THIS WORK AND WOULD ASK THAT I BE NOTIFIED WHEN THE WORK IS COMPLETED SO THAT I MAY INSPECT IT AND ISSUE THE REQUISITE CERTIFICATE OF APPROVAL IF THE WORK IS FOUND IN SATISFACTORY CONDITION.

IF DURING THE COURSE OF THE REPAIRS, SITUATIONS DEVELOP ON WHICH YOU FEEL YOU WOULD LIKE TO HAVE ME INSPECT THE WORK OR CONSULT WITH THE CONTRACTOR, IF YOU WILL LET ME KNOW I WILL BE VERY GLAD TO VISIT THE WORK.

SINCERELY YOURS,

STATE BOARD OF SUPERVISION OF DAMS

HENRY WOLCOTT BUCK
STATE OF CONNECTICUT
BOARD OF SUPERVISION OF DAMS

5- 47

PRELIMINARY PERMIT

WETHERSFIELD, Conn.

SEPTEMBER 16, 1955

To Owner THE WARREN WOOLEN COMPANY

P. O. Address STAFFORD SPRINGS, CONN.

I have inspected the site and have examined the ~~plans and specifications~~

~~and the specifications~~ therefore, submitted by you to the Board of Supervision of Dams for REPAIR OF DAM

on FURNACE BROOK in the Town of STAFFORD

The same are approved, and such proposed construction work is hereby authorized.

[Signature]
Member, Board of Supervision of Dams

THIS PERMIT WILL BE VOID IF WORK IS STARTED PRIOR TO APRIL 15, 1956

COMM. 5516-3
WARREN WOOLEN COMPANY, W.A.

8/29/56 HWB

DICK RUGIN. THEY ARE NOT AT ALL SATISFIED WITH THE WAY THE RIP RAP IS GOING ON UPSTREAM FACE OF THE DYKE AT EITHER END OF THEIR DAM. AFTER DISCUSSION HE FELT THAT HE WOULD PREFER TO HAVE ME COME OUT RATHER THAN TURN IT OVER TO WHOEVER IS TAKING MY PLACE ON THE DAMS BOARD. ARRANGED A DATE TO VISIT THE WORK AND GO OVER IT WITH HIM.

8/30/56 HWB

JOB INSPECTION WITH DICK RUGIN, HIS MASTER MECHANIC, VALENTINE, JOE MOTTAS AND TWO MEN WORKING FOR JOE ON THE WORK. THE RIP RAP IS TO BE FINISHED WITH STONES NOT LESS THAN 150 LBS., LAID TO A LINE ALONG THE TOP. THIS LINE MUST BE DEAD LEVEL FOR THE EXTENT OF BOTH DYKES UP TO THE POINT WHERE THEY RISE ABRUPTLY. THE RIP RAP ON THE WEST SIDE IS TO BE PARTIALLY REMOVED WHERE THE STONES ARE TOO SMALL AND AT THE EDGE OF THE SPILLWAY IS TO BE EXTENDED FURTHER OUT INTO THE POND TO GET AT LEAST ONE FOOT BELOW MEAN LOW WATER. THE ENTIRE FACE OF THE RIP RAP IS THEN TO BE FLUSHED HEAVILY WITH A HEAVY HOSE STREAM TO SETTLE ALL OF THE FILL. IT IS THEN TO BE FLUSHED COMPLETELY WITH 5-BAG CONCRETE USING THIS TO FILL ALL OF THE CHINKS AND IS TO BE COVERED WITH SOIL AND KEPT WET FOR NOT LESS THAN TWO WEEKS. THE UPSTREAM EDGES OF BOTH ABUTMENTS AT THE MAIN SPILLWAY ARE TO HAVE THE JOINTS CUT OUT AND REPOINTED. ON THE EAST ABUTMENT THE LEDGE AT THE DOWNSTREAM FACE IS TO BE BUILT OUT AND CONCRETED, SLOPING SLIGHTLY DOWNSTREAM. PLUMBS ARE TO BE USED IN THIS. AT THE HIGHER LEVEL OF THE DYKE, THE DOWNSTREAM EDGE IS TO BE FLUSHED WITH CONCRETE AND THEN STONES ARE TO BE SET IN ALL OF THE LOW PLACES TO BRING A STONE EDGING ALONG THE LOWER FACE LEVEL. THERE IS TO BE NOT LESS THAN 6 INCHES OF TOP SOIL SPREAD OVER BOTH DYKES, ABSOLUTELY LEVEL AT THE STONE AT THE DOWNSTREAM FACE AND PITCHING SLIGHTLY TOWARD THE POND. THIS IS TO BE SEEDED WITH AT LEAST 50% OF PERENNIAL RYE, THE BALANCE FESCUE AND RED TOP AS THEY FEEL BEST. EVERYTHING SEEMS TO BE COMPLETELY UNDER CONTROL. THEY WILL CALL IF THEY NEED ANYTHING FURTHER.

9/4/56 HWB

WITH BILL DORENSEN AND HIS SUPERINTENDENT VISITED THE DAM. JOE MOTTAS HAS DONE AN EXCELLENT JOB ON FIXING THE RIP RAP AS WE ASKED FOR, FILLING IT WITH CONCRETE AND DRESSING THE SURFACE. THERE WERE THREE ITEMS WHICH ARE TO BE TAKEN CARE OF NEXT SPRING. ON THE EASTERLY ~~ABUTMENT~~ ^{DYKE} THERE IS ONE AREA THAT IS DOWN ABOUT 6 INCHES. THIS IS TO BE FILLED AND RE-SEEDING. AT THE EXTREME EASTERLY END THE TOP SOIL IS TO BE CARRIED FURTHER UP UNTIL IT REACHES THE HILLSIDE AND IS TO BE SEEDING. AT THE WEST SIDE IMMEDIATELY WEST OF THE SPILLWAY AND AT THE UPSTREAM FACE OF THE DAM, THERE IS A LUMP OF CONCRETED ROCK, PERHAPS 6 FEET IN DIAMETER, WHICH STANDS ABOVE THE GENERAL ELEVATION OF THE REST OF THE DYKE. THIS IS TO BE CUT OFF SO THAT THE WHOLE AREA IS LEVEL AND WILL PASS AN EVEN FLOW OF WATER IN CASE OF AN EXTREME STORM. SAID I WOULD TALK TO JOHN VOZZOCHI ABOUT HAVING A PERMIT ISSUED FOR APPROVAL.

HWB

10/24/56 HWB

CALLED JOHN VOZZOCHI. PROPOSED PROCEDURE ENTIRELY SATISFACTORY TO HIM. HE WILL ISSUE CR. OF APPROVAL

HWB

STATE OF CONNECTICUT
STATE BOARD FOR THE SUPERVISION OF DAMS
State Office Building, Hartford, Connecticut

October 26, 1956

The Warren Woolen Company
Stafford Springs, Connecticut

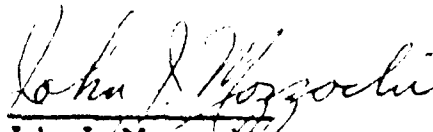
File - No. A-153-75

Gentlemen:

Henry W. Buck, former member of this Board, advises that he has made a final inspection of the repairs on your dam and has approved the work.

I am enclosing herewith, certificate of approval covering the work.

Very truly yours,


John J. Mozzochi
Member State Board of Dams

JJM:hk
enc.

cc: Mr. H. W. Buck
Mr. W. S. Wise

STATE OF CONNECTICUT
BOARD OF SUPERVISION OF DAMS

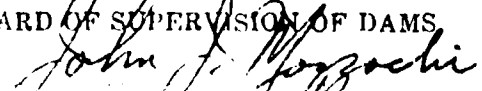
5- 47

CERTIFICATE OF APPROVAL

(Glastonbury, Conn.
October 26, 1956

To Owner The Warren Woolen Company
P. O. Address Stafford Springs, Conn.
Name of Structure

This is to certify that the following construction work: Repair of Dam
performed on property owned by you on
Furnace Brook in the Town of Stafford
for which preliminary permit was issued September 15, 1955 has been completed to the satisfaction
of this Board and that such structure is approved and has been found to be safe as of date of this certificate.

BOARD OF SUPERVISION OF DAMS
BY  Member

Note: The owner is required by law to record this certificate in the Land Records of the town or towns in which the dam or reservoir is located.

MACCHI & HOFFMAN • ENGINEERS

EXECUTIVE OFFICES • 44 GILLETT STREET • HARTFORD, CONN., 06105 • PHONE (203) 525-6631

A. J. MACCHI, P.E.
H. R. HOFFMAN, P.E.
MICHAEL GIRARD

ASSOCIATE CONSULTANT
PROF. C. W. DUNHAM

WATER & RELATED
RESOURCES
RECEIVED

JAN 26 1972

January 24, 1972

ANSWERED _____
REFERRED _____
FILED _____

State of Connecticut
Department of Environmental Protection
165 Capitol Avenue
Hartford, Connecticut

Attention: Mr. William H. O'Brien, III

Re: Warren Pond Dam
Stafford Springs, Conn.
Code W24.0 FV0.6

Gentlemen:

An inspection of the above-referenced dam was made by William H. O'Brien, Victor Galgowski and A. J. Macchi on Friday, January 21, 1972.

The dam is owned by Stafford Water Power Co., c/o Warren Woolen Co.

This dam is constructed with a slightly battered wall of heavy random masonry stones. It is about 120 feet long by 20 feet high. The spillway is about 100 feet long with about 3 feet of freeboard at each abuttment.

This dam and appurtenant structures were found in good condition and not in need of repair.

Very truly yours,

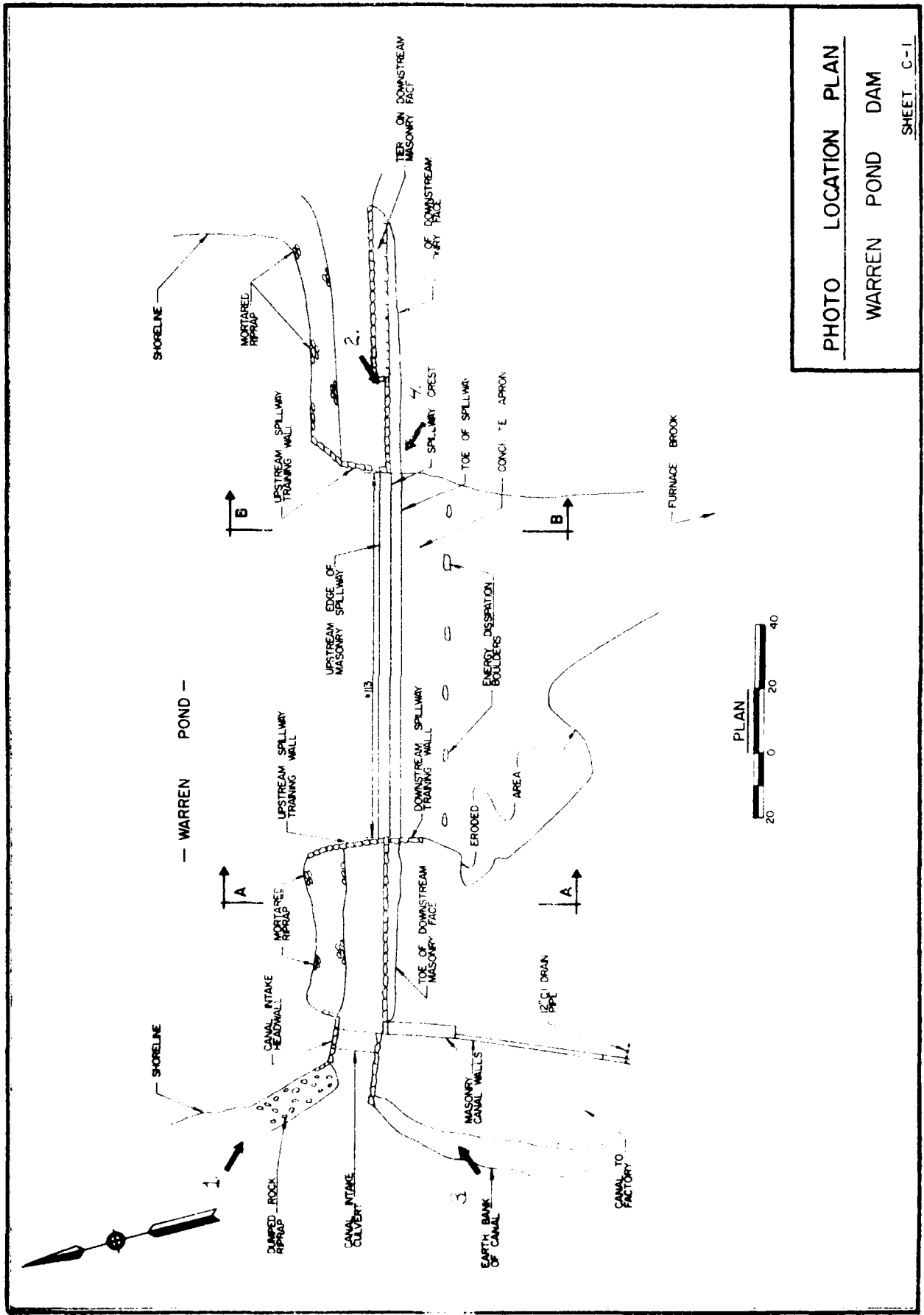
MACCHI & HOFFMAN, ENGINEERS


A. J. MACCHI

vmc

B-7

APPENDIX C
DETAIL PHOTOGRAPHS



— WARREN POND —

PHOTO LOCATION PLAN

WARREN POND DAM

SHEET C-1



Photo 1 - Upstream slope and top of dam. Upstream headwall of canal intake culvert in foreground (3/24/80).



Photo 2 - Spillway and spillway discharge apron. Note tree stump and uplifted masonry block in foreground (3/24/80).

| | | |
|---|--|--|
| US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WASHINGTON, MASS. | NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS | Warren Pond Dam Furnace Brook Stafford, Conn. CE# 27 785 PA DATE May 1980 PAGE 6-1 |
| CAHN ENGINEERS INC WASHINGTON, CONN. ENGINEER | | |



Photo 3 - Downstream headwall of arch culvert and masonry canal wall (3/24/80).

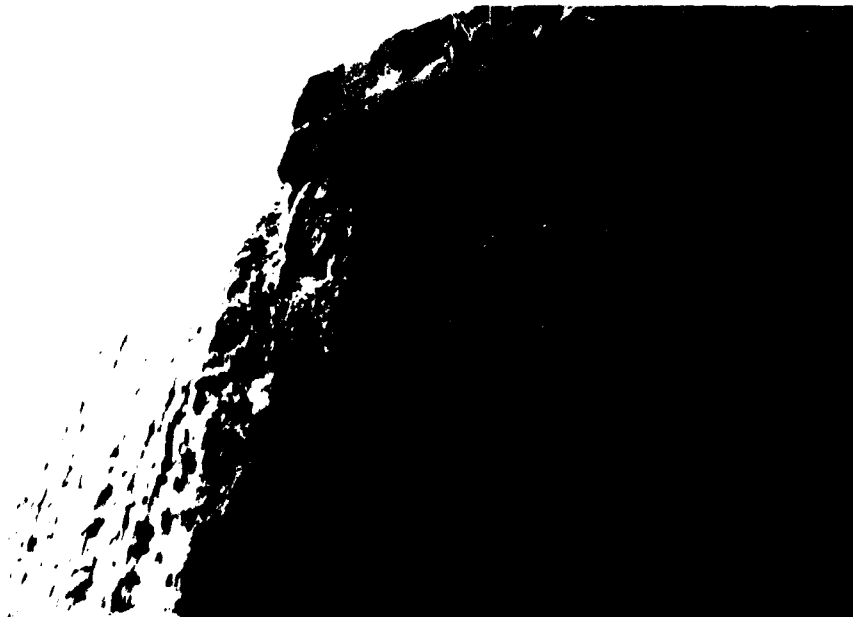


Photo 4 - Seepage from downstream face of left embankment adjacent to spillway (3/24/80).

US ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

CAHN ENGINEERS INC.
WALLINGFORD, CONN
ENGINEER

NATIONAL PROGRAM OF
INSPECTION OF
NON-FED. DAMS

Warren Pond Dam

Furnace Brook

Stafford, CT

CE# 27 785 KA

DATE May '80 PAGE C-2



Photo 5-Downstream face of right embankment. Note trees near toe of embankment and erosion of channel bank (3/24/80).



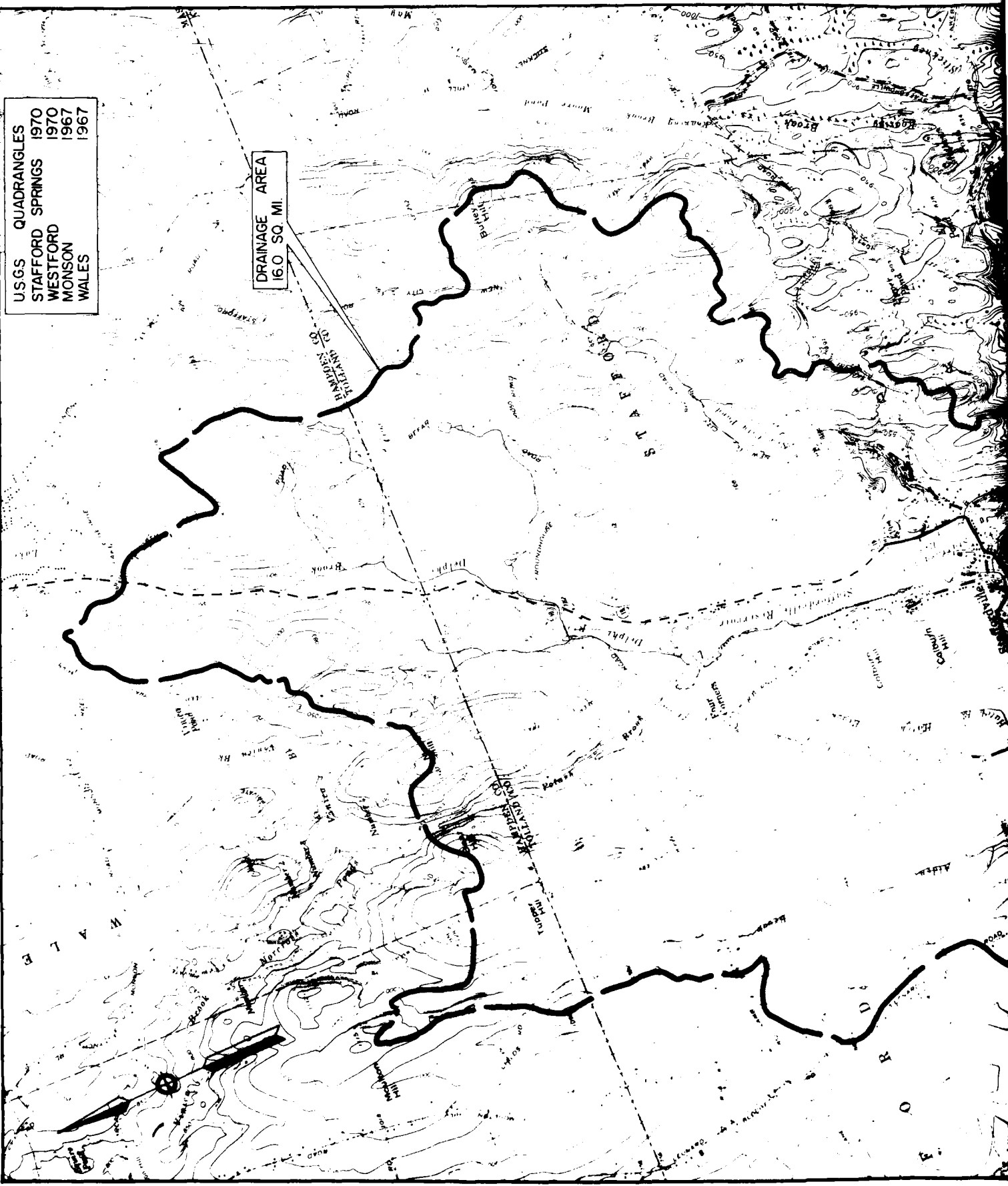
Photo 6 - Cracked mortar of upstream slope riprap. Note small stump with new growth (3/24/80).

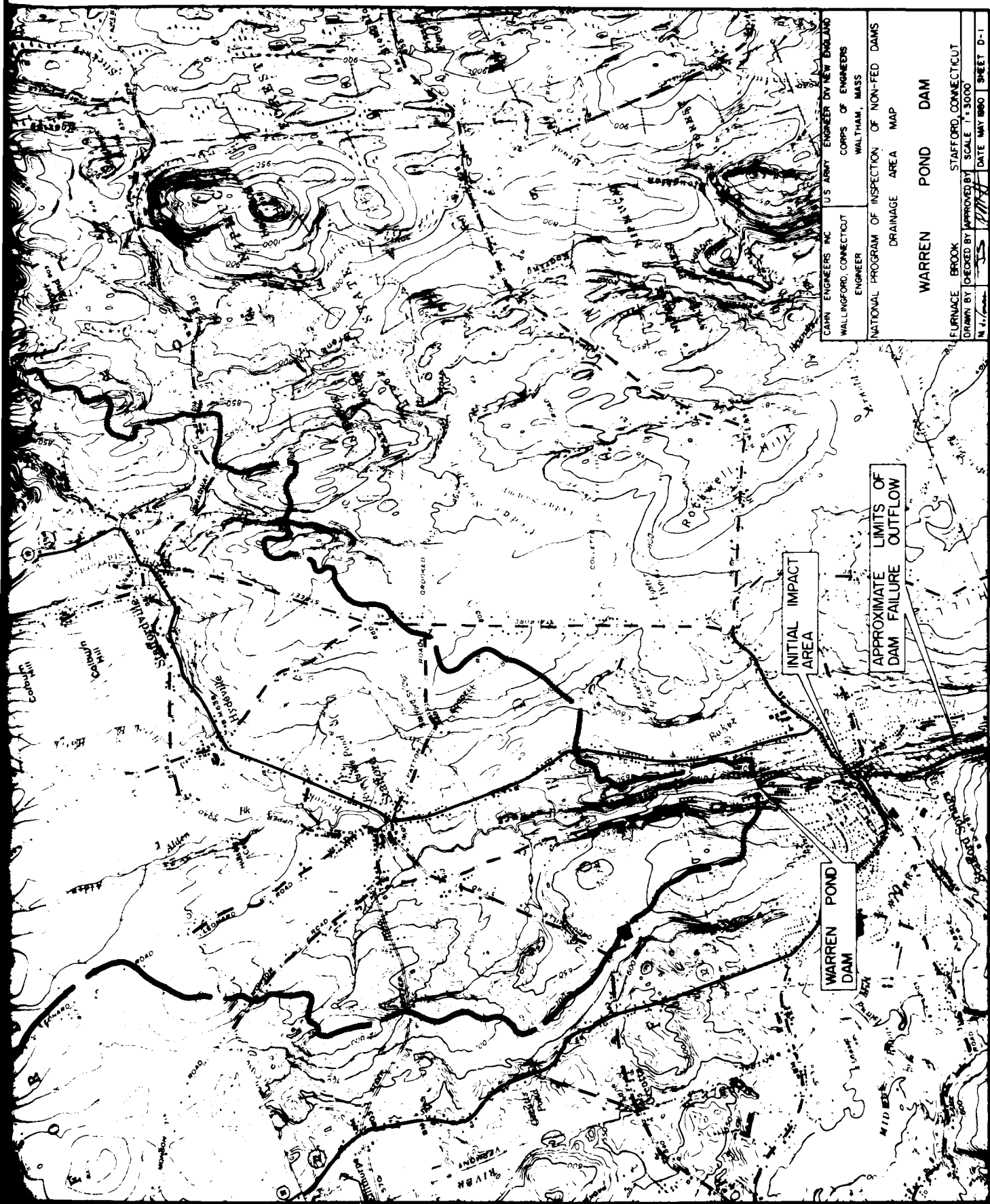
| | | |
|---|---|---|
| US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS | NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS | Warren Pond Dam Furnace Brook Stafford, Connecticut CE# 27 785 KA DATE May '80 PAGE C-3 |
| CAHN ENGINEERS INC WALLINGFORD, CONN ENGINEER | | |

APPENDIX D
HYDRAULICS/HYDROLOGIC COMPUTATIONS

USGS QUADRANGLES
STAFFORD SPRINGS 1970
WESTFORD 1967
MONSON 1967
WALES 1967

DRAINAGE AREA
16.0 SQ. MI.





| | |
|--|--|
| CARR ENGINEERS INC WALLINGFORD, CONNECTICUT ENGINEER | U.S. ARMY ENGINEER DISTRICT NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS |
| NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS | |
| DRAINAGE AREA MAP | |
| WARREN POND DAM | WARREN POND DAM |
| FURNACE BROOK DRAWN BY [initials] | STAFFORD, CONNECTICUT |
| CHECKED BY [initials] | SCALE 1" = 3000' |
| DATE MAY 1980 | SHEET D-1 |

INITIAL IMPACT AREA

APPROXIMATE LIMITS OF DAM FAILURE OUTFLOW

WARREN POND DAM

Project INSPECTION OF NEW FEDERAL DAM IN NEW ENGLAND Sheet 2-1 of 11
 Computed By HLL Checked By GAB Date 4/8/80
 Field Book Ref. _____ Other Refs CE # 27-785-11A Revisions _____

HYDROLOGIC / HYDRAULIC INSPECTION

WARREN POND DAM, STAFFORD, CT

1) PERFORMANCE AT PEAK FLOOD CONDITIONS

1) PROBABLE MAXIMUM FLOOD (PMF)

a) WATERSHED CLASSIFIED AS "ROLLING"

b) WATERSHED AREA:

LOCATED ON FURNACE BROOK 1/2 MILE FROM A SERIES OF RELATIVELY SMALL POND AND THE STAFFORDVILLE RESERVOIR. THE TOTAL WATERSHED IS SUBDIVIDED AS FOLLOWS:

- i) D.A. TO STAFFORDVILLE RESERVOIR. $(DA)_{SR} = 8.34^{sqmi}$
- ii) INCREMENT TO WARREN POND DAM $\Delta(DA) = 7.66^{sqmi}$
- iii) TOTAL D.A. TO WARREN POND DAM. $DA = \underline{16.0^{sqmi}}$

*NOTE: DRAINAGE AREAS FROM CONN. DEP. BULLETIN N-1, 1972 (GARETICE) OF NATURAL DRAINAGE AREAS 1, 3.

c) PEAK FLOODS: (FROM NED-ACE GUIDELINES - GUIDE CURVES FOR PMF):

- i) FROM GUIDE CURVES $CSM = 1550^{cfs/sqmi}$ (TOTAL D.A.)

THE PEAK FLOOD REDUCTION AT WARREN FROM STAFFORDVILLE RESERVOIR REGULATION ($A = 160^{ac}$) IS RELATIVELY SMALL AND THEREFORE, IT WILL BE TAKEN INTO CONSIDERATION BY REDUCING THE CSM TO:

$$(CSM)_{ADJ.} = \underline{1500^{cfs/sqmi}}$$

- ii) $PMF = 1500 \times 16 = \underline{24000^{cfs}}$
- iii) $1/2 PMF = \underline{12000^{cfs}}$

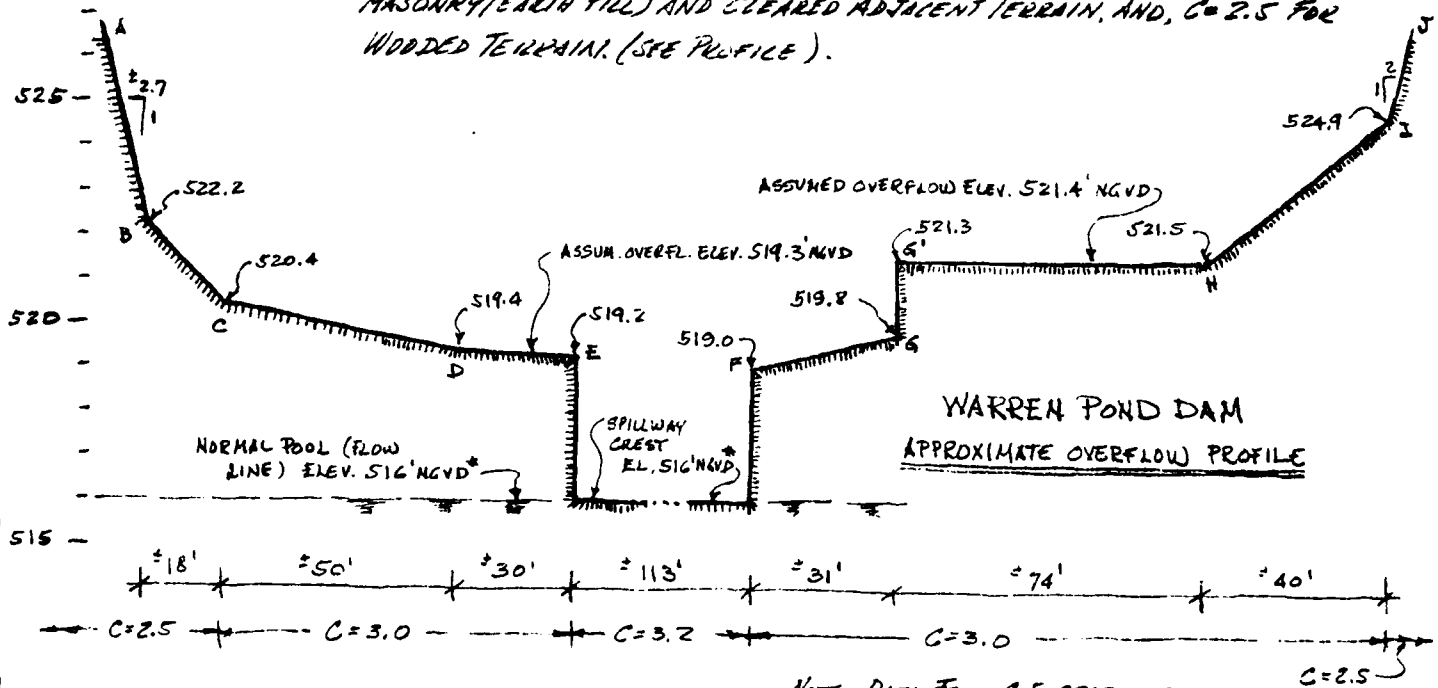
Project NON-FEDERAL DAMS INSPECTION Sheet D-2 of 11
 Computed By [Signature] Checked By GAB Date 4/8/80
 Field Book Ref. _____ Other Refs. CE # 27-785-HA Revisions _____

2) SURCHARGE AT PEAK INFLOWS

a) OUTFLOW RATING CURVE

i) SPILLWAY AND OVERFLOW PROFILE FOR SURCHARGES OVERTOPPING THE DAM:

SPILLWAY (3) 113' LONG, BROADCRESTED U/S FACE ON (2) 9" TO 1" SLOPE; VERTICAL P/S FACE. (SEE OVERFLOW PROFILE BELOW)
 ASSUME $C=3.2$ FOR THE SPILLWAY FLOW; $C=3.0$ FOR THE DAM (STONE MASONRY/EARTH FILL) AND CLEARED ADJACENT TERRAIN, AND, $C=2.5$ FOR WOODED TERRAIN. (SEE PROFILE).



NOTE: DATA FROM C.E. OBSERVATIONS ON 4/1/80 BY H.W. & R.J.

*NOTE: W.S. ELEV. 516' ON THE U.S.G.S. STAFFORD SPRINGS, CT. QUADRANGLE SHEET (REV. 1970) IS ASSUMED TO BE THE SPILLWAY CREST ELEVATION ON NATIONAL GEODETIC VERTICAL DATUM (NGVD)

Project NEW FEDERAL DAMS INSPECTION Sheet D-3 of 11
 Computed By HLL Checked By GAS Date 4/9/80
 Field Book Ref. _____ Other Refs. CE # 27-785-HA Revisions _____

ii) THEREFORE, ASSUMING EQUIVALENT CHANNELS FOR THE ZOPING TERRAIN, THE OVERFLOW CURVE CAN BE APPROXIMATED AS FOLLOWS (SEE PROFILE P. D-2) - SURCHARGE (H) FROM SPILLWAY CREST:

1') SECTION AB : $Q_{AB} = \frac{2}{3} \times 27 \times 2.5 (H-6.2)^{5/2} = \underline{4.5 (H-6.2)^{5/2}}$

2') SECTION BC :

$(Q_{BC})_1 = \frac{2}{3} \times 10 \times 2.5 (H-4.4)^{5/2} = \underline{16.7 (H-4.4)^{5/2}} \quad H \leq 6.2'$

$(Q_{BC})_2 = 2.5 \times 18 \times (H-4.83)^{3/2} = \underline{45 (H-4.83)^{3/2}} \quad H > 6.2'$

3') SECTION CD:

$(Q_{CD})_1 = \frac{2}{3} \times 50 \times 3 (H-3.3)^{5/2} = \underline{100 (H-3.3)^{5/2}} \quad H \leq 4.4'$

$(Q_{CD})_2 = 3 \times 50 (H-3.51)^{3/2} = \underline{150 (H-3.51)^{3/2}} \quad H > 4.4'$

4') SECTION DE:

$Q_{DE} = 3 \times 30 \cdot (H-3.3)^{3/2} = \underline{90 (H-3.3)^{3/2}}$

5') SPILLWAY (SECTION EF):

$Q_5 = Q_{EF} = 3.2 \times 113 \times H^{3/2} = \underline{362 H^{3/2}}$

6') SECTION FG:

$(Q_{FG})_1 = \frac{2}{3} \times 31.8 \times 3 (H-3)^{5/2} = \underline{77.5 (H-3)^{5/2}} \quad H \leq 3.8'$

$(Q_{FG})_2 = 3 \times 31 (H-3.19)^{3/2} = \underline{93 (H-3.19)^{3/2}} \quad H > 3.8'$

7') SECTION GH:

$Q_{GH} = 3 \times 74 \cdot (H-5.4)^{3/2} = \underline{222 (H-5.4)^{3/2}}$

8') SECTION HI

$(Q_{HI})_1 = \frac{2}{3} \times 40 / 13.4 \times 3 \times (H-5.4)^{5/2} = \underline{23.5 (H-5.4)^{5/2}} \quad H \leq 8.9'$

$(Q_{HI})_2 = 3 \times 40 \times (H-6.18)^{3/2} = \underline{120 (H-6.18)^{3/2}} \quad H > 8.9'$

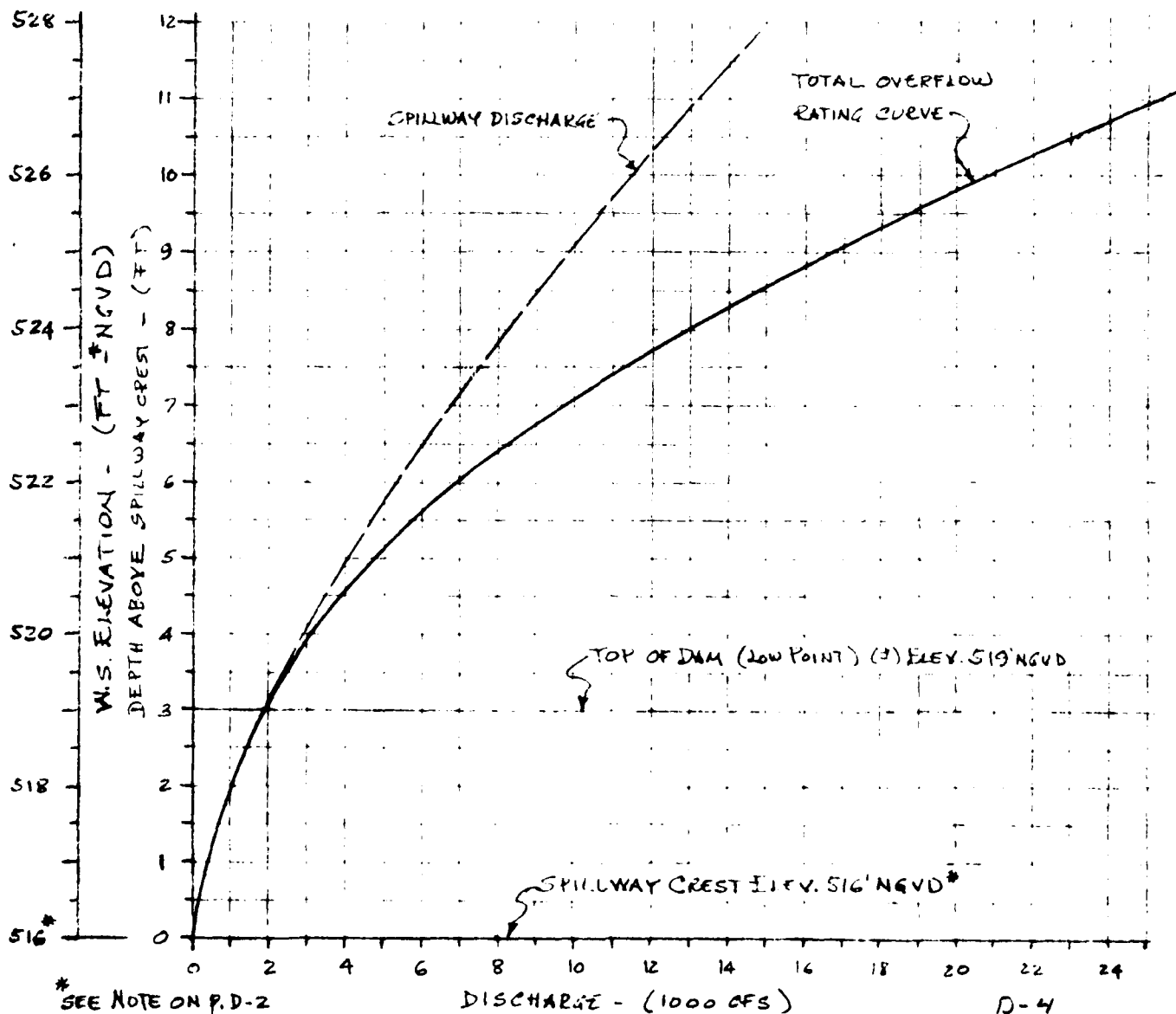
Project NON-FEDERAL DAMS INSPECTION Sheet D-4 of 11
 Computed By JLL Checked By JAB Date 4/9/80
 Field Book Ref. _____ Other Refs. CE # 27-785-HA Revisions _____

9') SECTION JJ :

$$Q_{JJ} = \frac{2}{3} \times 2 \times 2.5 (H - 8.9)^{3/2} = \underline{3.33 (H - 8.9)^{3/2}}$$

THEREFORE, THE TOTAL OUTFLOW IS APPROXIMATED BY THE SUM OF ALL THE APPLICABLE FORMULAE ON JTEAS (1') TO (9').

(iii) WARREN POND DAM - OUTFLOW RATING CURVE



Project NON-FEDERAL DAMS INSPECTION Sheet D-5 of 11
 Computed By HLL Checked By SRM Date 4/10/80
 Field Book Ref. _____ Other Refs. CE #27-785-HA Revisions _____

b) SURCHARGE HEIGHT TO PARS PEAK TIME $(I_p \text{ & } Q_p)$

i) @ $Q_p = PMF = 24000 \text{ cfs}$ $H_1 = 10.7' \text{ SAY, } H_1 = \underline{11'}$

ii) @ $I_p = \frac{1}{2} PMF = 12000 \text{ cfs}$ $H_1' = \underline{7.7'}$

c) EFFECT OF SURCHARGE STORAGE - PEAK OUTFLOWS

i) AVE LAKE AREA WITHIN EXPECTED SURCHARGE (\bar{A})

1) LAKE AREA AT FLOODLINE (EL 516' NGVD): $\bar{A}_{516} = 9^{\text{ac}}$

2) AREA AT 2000K (EL 520' NGVD)* $A_{520} = 13^{\text{ac}}$

3) AREA AT 1000K (EL 527' NGVD) (MIL)* $A_{527} = 17^{\text{ac}}$

AREA AT ELEV 527' NGVD (= MAX EXPECTED SURCH.) $A_{527} = 16^{\text{ac}}$

AVE AREA WITHIN EXPECTED SURCHARGE $\bar{A} = \underline{14^{\text{ac}}}$ (BY GRAPHICAL INTERPOLATION: $\pm A_{520}$)

*NOTE: AREAS FROM USGS STAFFORD SPRINGS, CT. QUAD. SHEET (SCALE 1" = 2000')

ii) PEAK OUTFLOWS ($I_p \text{ & } Q_p$)

BECAUSE THE LAKE SIZES AND TOPOGRAPHY, THE SURCHARGE STORAGE OF WARDEN POND ARE RELATIVELY SMALL, NO APPRECIABLE REDUCTION TO THE PEAK INFLOW IS EXPECTED.

THEREFORE:

$I_p = I_p = 24000 \text{ cfs}$ $H_3 = 10.7' \text{ SAY, } H_3 = \underline{11'}$

$I_p = I_p = 12000 \text{ cfs}$ $H_3' = \underline{7.7'}$

(SEE RATING CURVE P. D-4)

Cahn Engineers Inc.

Consulting Engineers

Project NON-FEDERAL DAMS INSPECTION Sheet D-6 of 11
 Computed By ML Checked By GR Date 4/10/80
 Field Book Ref. _____ Other Refs. CE # 27-785-HA Revisions _____

3) SPILLWAY CAPACITY RATIO TO PEAK INFLOWS AND OUTFLOWS

| SPILLWAY CAPACITY TD: | SURCH.* H (FT) | W.S. ELEV. (FT-NGVD) | SPILLWAY CAPACITY (CFS) | SPILLWAY CAPACITY AS % OF INFLOWS AND OUTFLOWS | |
|-----------------------------|----------------------|----------------------------|-------------------------------|---|----------------------------------|
| | | | | $Q_p \approx Q_p$ (24000 CFS) | $Q_p \approx Q_p$ (12000 CFS) |
| TOP OF DAM | 3 | 519 | 1900 | 7.9 | 16 |
| 1/2 PMF | 7.7 | 523.7 | 7700 | — | 64 |
| PMF | 11 | 527 | 13000 | 54 | — |

*SURCHARGE ABOVE SPILLWAY CREST (ELEV. 516' NGVD)

Project NON-FEDERAL DAMS INSPECTION Sheet D-7 of 11
 Computed By HLL Checked By CE # 27-785-HA Date 4/18/80
 Field Book Ref. _____ Other Refs. _____ Revisions _____

WARREN POND DAM

II) DOWNSTREAM FAILURE HAZARD

1) POTENTIAL IMPACT AREA

JUST DOWNSTREAM FROM WARREN POND, FURNACE BROOK CROSSES A LARGE PORTION OF THE STAFFORD SPRINGS, CT. COMMERCIAL AND INDUSTRIAL AREA. A CONSIDERABLE NUMBER OF THE BUILDINGS BORDERING THE BROOK HAVE FIRST FLOORS BETWEEN (±) 3.5' AND (±) 11' (THE MAJORITY, INCLUDING THE POST OFFICE, (±) 8') ABOVE THE STREAMBED. APPROX. 2000' P/L FROM WARREN POND (ALSO, P/L FROM A SMALLER POND) THE REACH OF FURNACE BROOK AT BOTH SIDES OF TOLLAND AVE/STAFFORD ST. IS A 30' WIDE CONCRETE LINED RECTANGULAR CHANNEL WITH 8' HIGH WALLS AND (±) 1.7% SLOPE (APPROX. MEASURE BY CE. ON 4/1/80).

2) FAILURE AT WARREN POND DAM

ASSUME SURCHARGE TO TOP OF DAM (EL. 519' NGVD)

a) HEIGHT OF DAM*. $H = 22'$

b) MID-HEIGHT LENGTH*. $L = 240'$

c) BREACH WIDTH (SEE NED-ACE 1/2 DAM FAILURE GUIDELINES)

$$W = 0.4 \times 240 = 96'$$

ASSUME $W_b = \underline{96'}$

BECAUSE THE LONGEST ABUTMENT TO MID-HEIGHT IS (±) 77' THE ASSUMED BREACH WIDTH WILL OVERLAP A MIN. OF 19' OF SPILLWAY SECTION.

*FROM CE MEASUREMENTS ON 4/1/80 BY HLL & RJ

Cahn Engineers Inc.

Consulting Engineers

Project NON-FEDERAL DAMS INSPECTION Sheet D-8 of 11
Computed By WLL Checked By SAB Date 4/14/80
Field Book Ref. _____ Other Refs. CE# 27-785-HA Revisions _____

d) ASSUMED WATER DEPTH AT TIME OF FAILURE: $y_0 = \underline{22'}$

e) SPILLWAY DISCHARGE AT TIME OF FAILURE.

i) PREVIOUS TO FAILURE: $Q_s = 1900$ cfs (SEE P. D-6)

ii) AFTER FAILURE (REMAIN. SWY - $L = 94'$): $Q_s' = 1600$ cfs

f) BREACH OUTFLOW (SEE NED-ACE GUIDELINES)

$$Q_b = 8/67 W_b \sqrt{y} y^{3/2} = 16700 \text{ cfs}$$

g) PEAK FAILURE OUTFLOW (Q_p) TO FURNACE BROOK:

$$Q_p = Q_s' + Q_b = 18300 \text{ cfs} \quad \text{SAY, } Q_p = \underline{18000} \text{ cfs}$$

3) FLOOD DEPTH* IMMEDIATELY D/8 FROM DAM.

$$y = 0.44 y_0 = 9.7' \quad \text{SAY, } y = \underline{10'}$$

*(FROM RETREATING WAVE THEORY APPLIED TO DAM FAILURE)

4) ESTIMATE OF D/8 FAILURE CONDITIONS AT POTENTIAL IMPACT AREA

(SEE NED-ACE GUIDELINES FOR ESTIMATING D/8 FAILURE HYDROGRAPHS)

a) CHANNEL D/8 FROM WARREN POND DAM.

i) TO D/G POND (UNNAMED) - (\pm) 1500' ASSUME WL CONTROLLED BY OVERFLOW AT THIS SMALL DAM OF NORMAL POOL ELEV. 492' NGVD.

ACTUAL DIMENSIONS/DETAIL OF THIS D/8 DAM ARE NOT AVAILABLE. HOWEVER, ASSUME A TRAPEZOIDAL OVERFLOW SECTION (FROM USGS RIND. SHEET) (3) 150' LONG AND 2.5" AND 10" TO 1" SIDE SLOPES. ASSUME AN OVERALL DISCHARGE COEFFICIENT $C = 2.7$ AND EQUIVALENT
D-8

Project NON-FEDERAL DAMS INSPECTION Sheet D-9 of 11
 Computed By HELL Checked By GM Date 4/19/80
 Field Book Ref. _____ Other Refs. CE # 27-785-HA Revisions _____

LENGTHS FOR THE SCOURING PITS. THEREFORE, THE OVERFLOW IS APPROXIMATED AS:

$$Q = 400 H^{3/2} + 23 H^{5/2} \quad \text{AND NO STORAGE EFFECT.} \\ (Q_1 \approx Q_2)$$

$$\therefore 1') @ Q_1 = 1900 \text{ cfs} \quad (y_1)_1 \approx 2.6' \quad (\text{PREV. TO FAILURE})$$

$$2') @ Q_2 = 18000 \text{ cfs} \quad (y_1)_2 = (y_3)_2 \approx 9.5' \quad (\text{AFTER FAILURE})$$

NOTE: ONE INDUSTRIAL STRUCTURE W/ FF ELEV. (+) 10' ABOVE THE CHANNEL IS LOCATED IN THIS CHANNEL REACH.

(ii) CHANNEL 2/3 FROM THE SMALL (UNNAMED) POND

ASSUME THE CONCRETE LINED RECTANGULAR CHANNEL SECTION DESCRIBED IN SECT. (II, 1) p. D-7 AS TYPICAL WITH THE SIDES ABOVE THE 8' LINED WALLS FORMED BY THE WALLS OF ADJACENT BUILDINGS (+) 8' AWAY FROM THE CHANNEL (I.E. (+) 46' APART).

ASSUME: $n = 0.013$ FOR DEPTHS $\leq 8'$ ($b = 30'$) AND,

$n = 0.018$ FOR DEPTHS $> 8'$ ($b = 46'$)

$S_0 \approx 1.7\%$

NO APPRECIABLE CHANNEL STORAGE ($Q_1 \approx Q_2$)

$$\therefore 1') @ Q_1 = 1900 \text{ cfs} \quad (y_1)_1 \approx 2.5' \quad (\text{PREV. TO FAILURE})$$

$$2') @ Q_2 = 18000 \text{ cfs} \quad (y_1)_2 = (y_3)_2 \approx 13' \quad (\text{AFTER FAILURE})$$

b) RAISE IN STAGE AT IMPACT AREA $\Delta y \approx 10.5'$

Project NON-FEDERAL DAMS INSPECTION Sheet D-10 of 11
Computed By [Signature] Checked By GAB Date 4/16/80
Field Book Ref. _____ Other Refs. CE # 27-785-HA Revisions _____

III) SELECTION OF TEST FLOOD

1) CLASSIFICATION OF DAM ACCORDING TO NED-ACE GUIDELINES:

a) SIZE: *STORAGE (MAX) = 135 AC-FT (50 < S < 1000^{AC-FT})
HEIGHT = 22' (H < 25 FT)

* STORAGE: C.E. ESTIMATED BY $S = .5AH = .5 \times 12 \times 22 = 132$ AC-FT (A = 12' @ TOP OF DAM); ALSO, BY GRAPHICAL EXTRAPOLATION AND BY CORRELATION W/ DATA ON U.S. ACE INVENTORY OF DAMS, DATED 1/25/80, P. 36: $S_{100} = 100$ AC-FT

HEIGHT: SEE p. D-7

∴ SIZE CLASSIFICATION: SMALL

b) HAZARD POTENTIAL: AS A RESULT OF THE PK FAILURE ANALYSIS AND IN VIEW OF THE IMPACT THAT FAILURE OF WARREN POND DAM MAY HAVE ON THE POTENTIAL IMPACT AREA (P. D-7), THE DAM IS CLASSIFIED AS HAVING:

HAZARD CLASSIFICATION: HIGH

2) TEST FLOOD: $\frac{1}{2}$ PMF = 12000 CFS

THIS SELECTION IS BASED ON THE RESULTS OF THE PREVIOUS ANALYSIS AND CLASSIFICATION.

Project NON-FEDERAL DAM INSPECTION Sheet D-11 of 11
 Computed By WY Checked By SAF Date 4/16/80
 Field Book Ref. _____ Other Refs SE # 27-785-HA Revisions _____

WARREN POND DAM

IV) SUMMARY

- 1) TEST FLOOD = $\frac{1}{2}$ PMF = 12000 cfs
 (PARALLEL COMPUTATIONS HAVE BEEN MADE FOR PMF = 24000 cfs AND ARE ALSO SUMMARIZED BELOW)
- 2) PERFORMANCE AT PEAK FLOOD CONDITIONS:
 - a) PEAK INFLOWS/OUTFLOWS:

$$Q_p = Q_p = PMF = 24000 \text{ cfs} \quad Q_p' = Q_p' = \frac{1}{2} PMF = 12000 \text{ cfs}$$
 - b) SPILLWAY CAPACITY (SEE TABLE P.D.6)
 - i) TO TOP OF DAM (H=3'). $(Q_s)_1 = 1700 \text{ cfs}$ (7.9% of Q_p ; 16% of Q_p')
 - ii) TO $\frac{1}{2}$ PMF SURCHARGE (H=7.7'). $(Q_s)_2 = 7700 \text{ cfs}$ (34% of Q_p')
 - iii) TO PMF SURCHARGE (H=11'). $(Q_s)_3 = 13000 \text{ cfs}$ (54% of Q_p')
 - c) PERFORMANCE:
 - i) @ TEST FLOOD: OVERTOPPED (\pm) 4.7' (W.S. EL. 533.7 NGVD)
 - ii) @ PMF: OVERTOPPED (\pm) 8' (W.S. EL. 527 NGVD)
- 3) DOWNSTREAM FAILURE CONDITIONS:
 - a) PEAK FAILURE OUTFLOW: $Q_p = 18000 \text{ cfs}$
 - b) FLOOD DEPTH IMMEDIATELY $\frac{1}{2}$ FROM DAM: $Y_0 = 10'$
 - c) CONDITIONS AT THE INITIAL IMPACT AREA (FURNACE BROOK):
 - i) $\frac{1}{2}$ FROM SMALL (UNNAMED) POND:

STAGE BEFORE FAILURE: $(Y_1)_1 = 2.6'$ ($Q_s = 1900 \text{ cfs}$)

STAGE AFTER FAILURE: $(Y_1)_2 = 9.5'$ ($Q_s = 18000 \text{ cfs}$)

RAISE IN STAGE AFTER FAILURE: $\Delta Y_1 = 6.9'$
 - ii) $\frac{1}{2}$ FROM SMALL (UNNAMED) POND (LINED CHANNEL):

STAGE BEFORE FAILURE: $(Y_1)_2 = 2.5'$ ($Q_s = 1900 \text{ cfs}$)

STAGE AFTER FAILURE: $(Y_1)_2 = 13'$ ($Q_s = 18000 \text{ cfs}$)

RAISE IN STAGE AFTER FAILURE: $\Delta Y_2 = 10.5'$

PRELIMINARY GUIDANCE
FOR ESTIMATING
MAXIMUM PROBABLE DISCHARGES
IN
PHASE I DAM SAFETY
INVESTIGATIONS

New England Division
Corps of Engineers

March 1978

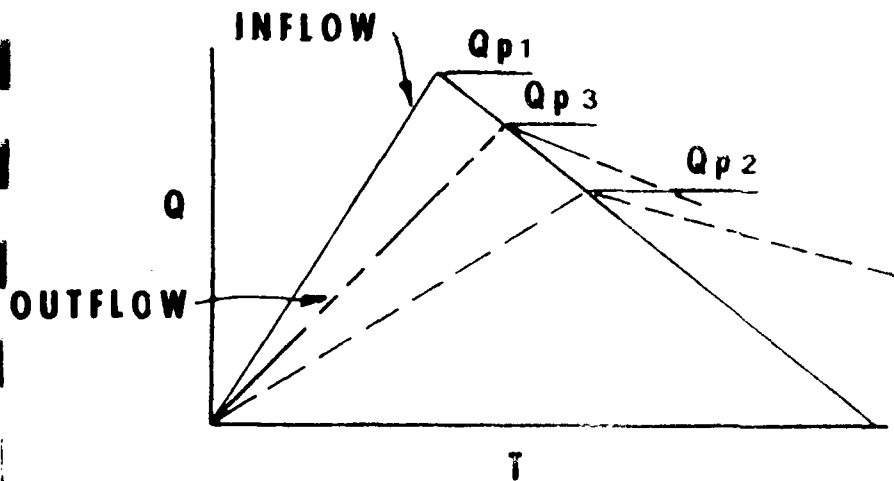
MAXIMUM PROBABLE FLOOD INFLOWS
NED RESERVOIRS

| <u>Project</u> | <u>Q</u> (cfs) | <u>D.A.</u> (sq. mi.) | <u>MPF</u> cfs/sq. mi. |
|-----------------------|-------------------|--------------------------|---------------------------|
| 1. Hall Meadow Brook | 26,600 | 17.2 | 1,546 |
| 2. East Branch | 15,500 | 9.25 | 1,675 |
| 3. Thomaston | 158,000 | 97.2 | 1,625 |
| 4. Northfield Brook | 9,000 | 5.7 | 1,580 |
| 5. Black Rock | 35,000 | 20.4 | 1,715 |
| 6. Hancock Brook | 20,700 | 12.0 | 1,725 |
| 7. Hop Brook | 26,400 | 16.4 | 1,610 |
| 8. Tully | 47,000 | 50.0 | 940 |
| 9. Barre Falls | 61,000 | 55.0 | 1,109 |
| 10. Conant Brook | 11,900 | 7.8 | 1,525 |
| 11. Knightville | 160,000 | 162.0 | 987 |
| 12. Littleville | 98,000 | 52.3 | 1,870 |
| 13. Colebrook River | 165,000 | 118.0 | 1,400 |
| 14. Mad River | 30,000 | 18.2 | 1,650 |
| 15. Sucker Brook | 6,500 | 3.43 | 1,895 |
| 16. Union Village | 110,000 | 126.0 | 873 |
| 17. North Hartland | 199,000 | 220.0 | 904 |
| 18. North Springfield | 157,000 | 158.0 | 994 |
| 19. Ball Mountain | 190,000 | 172.0 | 1,105 |
| 20. Townshend | 228,000 | 106.0(278 total) | 820 |
| 21. Surry Mountain | 63,000 | 100.0 | 630 |
| 22. Otter Brook | 45,000 | 47.0 | 957 |
| 23. Birch Hill | 88,500 | 175.0 | 505 |
| 24. East Brimfield | 73,900 | 67.5 | 1,095 |
| 25. Westville | 38,400 | 99.5(32 net) | 1,200 |
| 26. West Thompson | 85,000 | 173.5(74 net) | 1,150 |
| 27. Hodges Village | 35,600 | 31.1 | 1,145 |
| 28. Buffumville | 36,500 | 26.5 | 1,377 |
| 29. Mansfield Hollow | 125,000 | 159.0 | 786 |
| 30. West Hill | 26,000 | 28.0 | 928 |
| 31. Franklin Falls | 210,000 | 1000.0 | 210 |
| 32. Blackwater | 66,500 | 128.0 | 520 |
| 33. Hopkinton | 135,000 | 426.0 | 316 |
| 34. Everett | 68,000 | 64.0 | 1,062 |
| 35. MacDowell | 36,300 | 44.0 | 825 |

MAXIMUM PROBABLE FLOWS
BASED ON TWICE THE
STANDARD PROJECT FLOOD
(Flat and Coastal Areas)

| <u>River</u> | <u>SPF</u> (cfs) | <u>D.A.</u> (sq. mi.) | <u>MPF</u> (cfs/sq. mi.) |
|-------------------------|---------------------|--------------------------|-----------------------------|
| 1. Pawtuxet River | 19,000 | 200 | 190 |
| 2. Mill River (R.I.) | 8,500 | 34 | 500 |
| 3. Peters River (R.I.) | 3,200 | 13 | 490 |
| 4. Kettle Brook | 8,000 | 30 | 530 |
| 5. Sudbury River. | 11,700 | 86 | 270 |
| 6. Indian Brook (Hopk.) | 1,000 | 5.9 | 340 |
| 7. Charles River. | 6,000 | 184 | 65 |
| 8. Blackstone River. | 43,000 | 416 | 200 |
| 9. Quinebaug River | 55,000 | 331 | 330 |

ESTIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES



STEP 1: Determine Peak Inflow (Q_{p1}) from Guide Curves.

STEP 2: a. Determine Surcharge Height To Pass " Q_{p1} ".

b. Determine Volume of Surcharge ($STOR_1$) In Inches of Runoff.

c. Maximum Probable Flood Runoff In New England equals Approx. 19", Therefore:

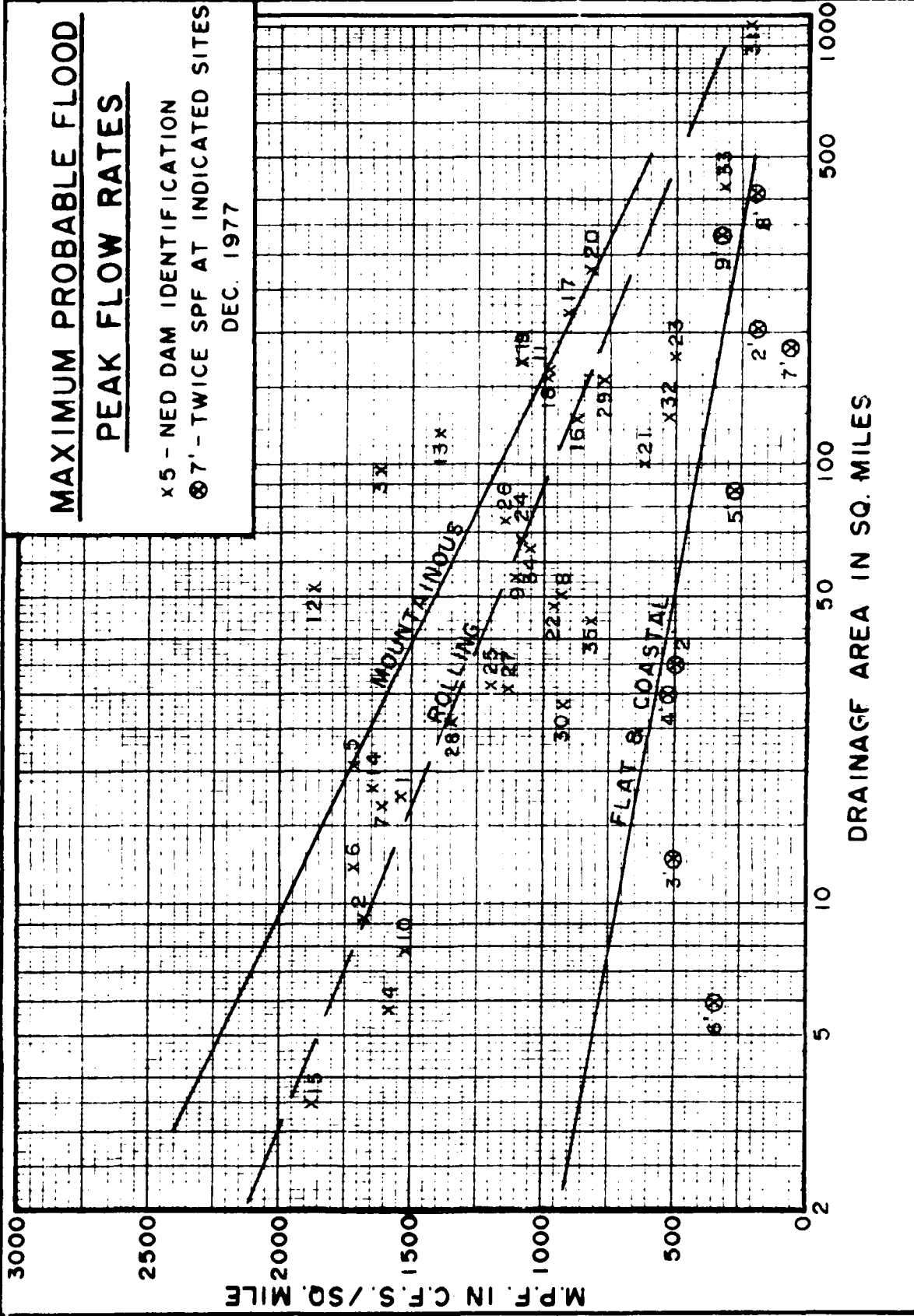
$$Q_{p2} = Q_{p1} \times \left(1 - \frac{STOR_1}{19} \right)$$

STEP 3: a. Determine Surcharge Height and " $STOR_2$ " To Pass " Q_{p2} "

b. Average " $STOR_1$ " and " $STOR_2$ " and Determine Average Surcharge and Resulting Peak Outflow " Q_{p3} ".

**MAXIMUM PROBABLE FLOOD
PEAK FLOW RATES**

X 5 - NED DAM IDENTIFICATION
 ⊗ 7' - TWICE SPF AT INDICATED SITES
 DEC. 1977



DRAINAGE AREA IN SQ. MILES

M.P.F. IN C.F.S./SQ. MILE

SURCHARGE STORAGE ROUTING SUPPLEMENT

**STEP 3: a. Determine Surcharge Height and
"STOR₂" To Pass "Q_{p2}"**

**b. Avg "STOR₁" and "STOR₂" and
Compute "Q_{p3}".**

**c. If Surcharge Height for Q_{p3} and
"STOR_{AVG}" agree O.K. If Not:**

**STEP 4: a. Determine Surcharge Height and
"STOR₃" To Pass "Q_{p3}"**

**b. Avg. "Old STOR_{AVG}" and "STOR₃"
and Compute "Q_{p4}"**

**c. Surcharge Height for Q_{p4} and
"New STOR_{AVG}" should Agree
closely**

SURCHARGE STORAGE ROUTING ALTERNATE

$$Q_{p2} = Q_{p1} \times \left(1 - \frac{\text{STOR}}{19} \right)$$

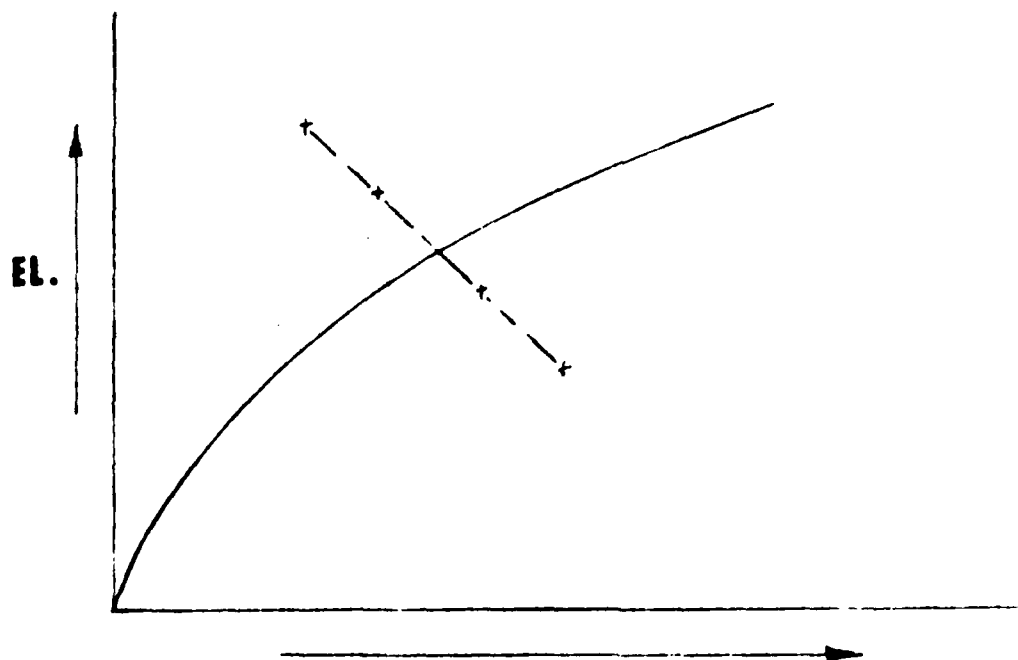
$$Q_{p2} = Q_{p1} - Q_{p1} \left(\frac{\text{STOR}}{19} \right)$$

FOR KNOWN Q_{p1} AND 19" R.O.

Q_{p2}

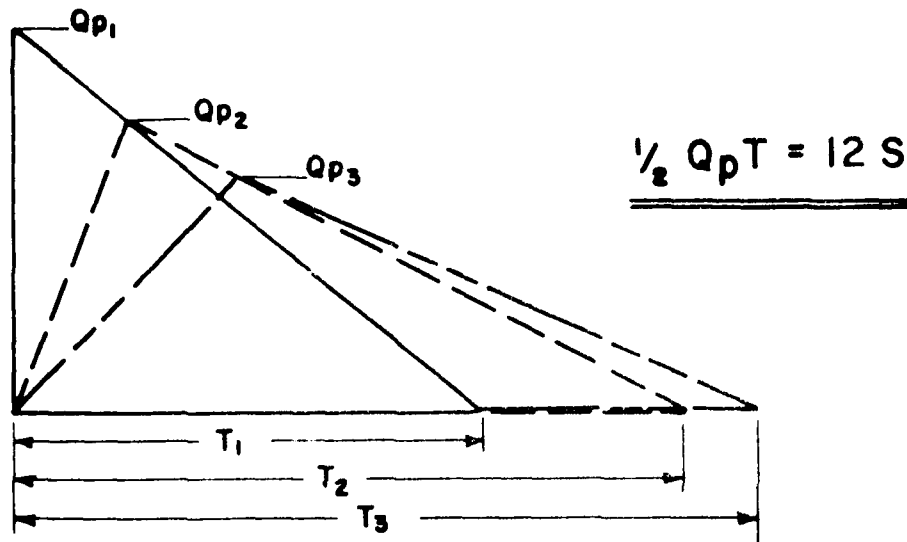
STOR

EL.



Q

"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS



STEP 1: DETERMINE OR ESTIMATE RESERVOIR STORAGE (S) IN AC-FT AT TIME OF FAILURE.

STEP 2: DETERMINE PEAK FAILURE OUTFLOW (Q_{p1}).

$$Q_{p1} = \frac{8}{27} W_b \sqrt{g} Y_0^{3/2}$$

W_b = BREACH WIDTH - SUGGEST VALUE NOT GREATER THAN 40% OF DAM LENGTH ACROSS RIVER AT MID HEIGHT.

Y_0 = TOTAL HEIGHT FROM RIVER BED TO POOL LEVEL AT FAILURE.

STEP 3: USING USGS TOPO OR OTHER DATA, DEVELOP REPRESENTATIVE STAGE-DISCHARGE RATING FOR SELECTED DOWNSTREAM RIVER REACH.

STEP 4: ESTIMATE REACH OUTFLOW (Q_{p2}) USING FOLLOWING ITERATION.

A. APPLY Q_{p1} TO STAGE RATING, DETERMINE STAGE AND ACCOMPANYING VOLUME (V_1) IN REACH IN AC-FT. (NOTE: IF V_1 EXCEEDS 1/2 OF S, SELECT SHORTER REACH.)

B. DETERMINE TRIAL Q_{p2} .

$$Q_{p2} (\text{TRIAL}) = Q_{p1} \left(1 - \frac{V_1}{S}\right)$$

C. COMPUTE V_2 USING Q_{p2} (TRIAL).

D. AVERAGE V_1 AND V_2 AND COMPUTE Q_{p2} .

$$Q_{p2} = Q_{p1} \left(1 - \frac{V_{\text{avg}}}{S}\right)$$

STEP 5: FOR SUCCEEDING REACHES REPEAT STEPS 3 AND 4.

APRIL 1978

APPENDIX E

INFORMATION AS CONTAINED IN
THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

| | | | | | |
|-----------------|------------------------------|-----------------|------------------|------------------|-------------------------|
| IDENTITY NUMBER | CONGR DIST STATE COUNTY DIST | NAME | LATITUDE (NORTH) | LONGITUDE (WEST) | REPORT DATE (DAY MO YR) |
| CT 535 REV 02 | | MARLEN POND DAM | 4157.0 | 7219.0 | 2/24/80 |

| | | | | |
|--------------|---------------------|--------------------------------------|-----------------------|------------|
| POPULAR NAME | NAME OF IMPROVEMENT | | | |
| | MARLEN POND | | | |
| REGION/BASIN | RIVER OR STREAM | NEAREST DOWNSTREAM CITY-TOWN-VILLAGE | DIST FROM DAM (MILES) | POPULATION |
| CT 10 | RUPACE RIVER | STAFFORD SPRINGS | 1 | 3500 |

| | | | | | | | | | |
|-------------|----------|-------------------------|------------------------|--------------------------------------|----------|-------|---------|-------|----------|
| TYPE OF DAM | PURPOSES | HYDRAULIC HEIGHT (FEET) | SPILLWAY HEIGHT (FEET) | MAXIMUM FLOODING CAPACITY (ACRES FT) | DIST OWN | FED R | PRV/FED | SCS A | VER/DATE |
| MEDGCT | 1920 0 | 22 | 22 | 135 | 105 | N | N | N | N |

REMARKS

20-ESTIMATE PROBABLY 22-ESTIMATE

| | | | | | | | | | |
|---------|---------------|-------------------------|--------------------|---------------------|-----------|-----------|------------|--------------|------------------|
| D/S HAS | SPILLWAY TYPE | MAXIMUM DISCHARGE (CFD) | VOLUME OF DAM (CY) | POWER CAPACITY (KW) | INSULATED | PROCESSED | INDUSTRIAL | AGRICULTURAL | NAVIGATION LOCKS |
| 1 | 203 11 | 113 | 1900 | | | | | | |

| | | |
|--------------------|----------------|-----------------|
| OWNER | ENGINEERING BY | CONSTRUCTION BY |
| MARLEN CORPORATION | | |

| | | | |
|--------------------|--------------------|--------------------|--------------------|
| DESIGN | CONSTRUCTION | OPERATION | MAINTENANCE |
| CT WATER RESOURCES | CT WATER RESOURCES | CT WATER RESOURCES | CT WATER RESOURCES |

| | | |
|--------------------|-----------------------------|--------------------------|
| INSPECTION BY | INSPECTION DATE (DAY MO YR) | AUTHORITY FOR INSPECTION |
| CAMP ENGINEERS INC | 24-1980 | PLD-107 |

REMARKS

DATE
ILME