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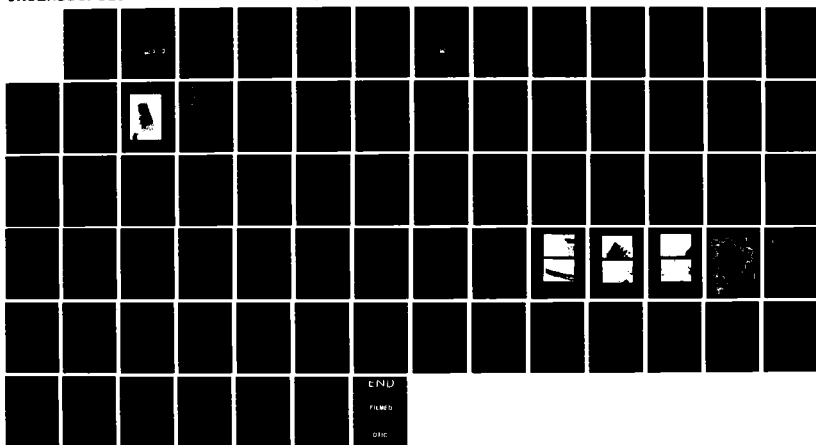
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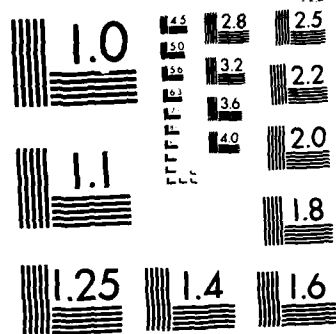
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AD-A156 739

NARRAGANSETT BAY BASIN
WEST WARWICK, RHODE ISLAND

ARCTIC DAM
RI 03802

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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

JANUARY 1981

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER RI 03802	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Arctic Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE January 1981
		13. NUMBER OF PAGES 44
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		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, Narragansett Bay Basin West Warwick Rhode Island South Branch Pawtuxet River		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The dam is 30 ft. high with a total length of 174 ft. long. It is small in size with a high hazard potential. The dam is considered to be in fair condition. No evidence of instability of the project was observed. There are items which require repair and/or maintenance.		

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

REPLY TO
ATTENTION OF:

NEDED

JUL 07 1981

Honorable J. Joseph Garrahy
Governor of the State of Rhode Island
State House
Providence, Rhode Island 02903

Dear Governor Garrahy:

Inclosed is a copy of the Arctic Dam (RI-03802) Phase I Inspection Report, prepared under the National Program for Inspection of Non-Federal Dams. This report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis.

The preliminary hydrologic analysis indicates that the spillway capacity for the Arctic Dam would likely be exceeded by floods greater than 13 percent of the Probable Maximum Flood (PMF). Our screening criteria specifies that a dam classified as high hazard with a spillway capacity insufficient to discharge fifty percent of the PMF be judged as having a seriously inadequate spillway. As a result this dam is 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 it 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.

We recommend that within twelve months from the date of this report the owner of the dam engage the services of a qualified registered engineer to determine further the potential of overtopping the dam and the need for and the means to increase project discharge capacity. 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 and round-the-clock surveillance be provided during periods of heavy precipitation or high project discharge.

JUL 07 1961

NEDED

Honorable J. Joseph Garrahy

I approve 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 program.

Copies of this report have been forwarded to the Department of Environmental Management and to the owner, Arctic Development Corporation, West Warwick, RI. Copies will be available to the public in thirty days.

I wish to thank you and the Department of Environmental Management for your cooperation in this program.

Sincerely,



C. E. EDGAR, III
Colonel, Corps of Engineers
Commander and Division Engineer

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NARRAGANSETT BAY BASIN
WEST WARWICK, RHODE ISLAND
ARCTIC DAM
RI 03802

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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

JANUARY 1981

BRIEF ASSESSMENT

PHASE 1 INSPECTION REPORT

NATIONAL PROGRAM OF INSPECTION OF DAMS

Name of Dam:	ARCTIC DAM
Inventory Number:	RI 03802
State:	RHODE ISLAND
County:	KENT
Town:	WEST WARWICK
Stream:	SOUTH BRANCH PAWTUXET RIVER
Owner:	ARCTIC DEVELOPMENT CORPORATION
Date of Inspection:	OCTOBER 8, 1980
Inspection Team:	PETER HEYNEN, P.E.
	HECTOR MORENO, P.E.
	THEODORE STEVENS
	FRANK SEGALINE

Arctic Dam was built around 1885 to generate electricity, but is not presently used for this purpose. The 30 foot high dam has a total length of 174 feet, consisting of a 110 foot long stone masonry spillway centered between two stone masonry and earthfill non-overflow sections. The top of the right non-overflow section is approximately 0.4 foot higher than the top of the left non-overflow section and 5.7 feet above the masonry spillway crest. Permanent stop planks, two feet in height, are mounted on the spillway crest. The low-level outlet for the dam is a 48 inch diameter steel pipe through the left non-overflow section. There are factory buildings adjacent to each end of the dam and masonry walls lining the downstream channel.

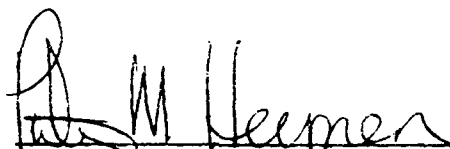
In accordance with Army Corps of Engineers' Guidelines, Arctic Dam is classified as a small size, high hazard dam. The test flood range to be considered is from one-half to full Probable Maximum Flood (PMF). The test flood for Arctic Dam is equivalent to the 1/2 PMF. Peak inflow to the impoundment at test flood is 16,500 cubic feet per second (cfs); peak outflow is 16,500 cfs with the dam overtopped by 7.6 feet. The spillway capacity above the permanent stop planks with the reservoir level to the top of the dam is 2200 cfs, which is equivalent to 13% of the routed test flood outflow.

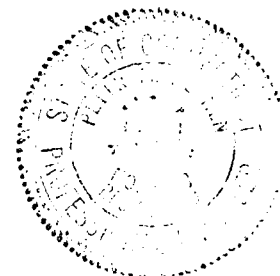
Based upon the visual inspection at the site and past performance, the project is in fair condition. No evidence of instability of the project was observed.

There are items which require repair and/or maintenance, such as the deteriorated low-level outlet, gate, and gate hoisting mechanism, leached out mortar joints on the downstream face of the left non-overflow section, undermining of the wall on the right side of the downstream channel, and brush, saplings and trees growing on the dam and appurtenances.

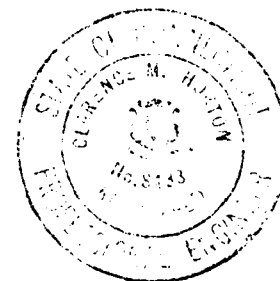
It is recommended that the owner retain the services of a registered professional engineer to perform a more detailed hydraulic/hydrologic analysis of the existing project discharge capacity. Other items of importance are the restoration of the low-level outlet facilities, repair of leached mortar joints, repair of the undermined channel wall, and removal of trees from the dam and appurtenances.

The above recommendations and further remedial measures presented in Section 7.3 should be implemented within one year of the owner's receipt of this report.

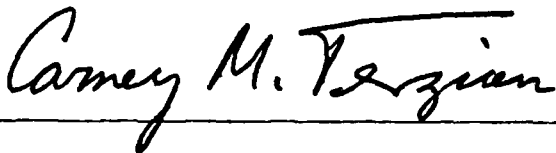

Peter M. Heynen, P.E.
Project Manager - Geotechnical
Cahn Engineers, Inc.



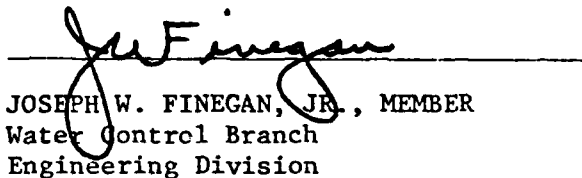

C. Michael Horton, P.E.
Chief Engineer
Cahn Engineers, Inc.



This Phase I Inspection Report on Arctic Dam (RI-03802) 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 judgement and practice, and is hereby submitted for approval.



CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

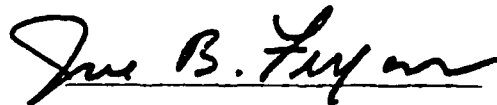


JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division



ARAMAST MAHTESIAN, CHAIRMAN
Geotechnical Engineering Branch
Engineering Division

APPROVAL RECOMMENDED:



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 fraction 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 ASMA rules and regulations is also excluded.

The information contained in this report is based on the limited investigation described above and is not warranted to indicate the actual condition of the dam. The integrity of the dam can only be determined by a means of a monitoring program and/or a detailed physical investigation. The accuracy of available data is assumed where not in obvious conflict with facts observable during the visual inspection.

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face. Other than the old bridge pier, from which several small trees are growing, there are no obstructions in the spillway approach channel. At the time of inspection, there was an accumulation of debris at the crest of the stop planks, 3 logs resting on the downstream face of the spillway, and various floating objects collected on the rocks at the toe of the spillway (Overview Photo, Photo 3).

c. Appurtenant Structures - The operability of the low-level outlet gate for the dam is questionable and the 48 inch steel low-level outlet pipe appears to be in poor condition. The control mechanism, a rack-with-pinion gate hoist mounted on the upstream wall of the left non-overflow section, is rusted and the wood gate support is rotting (Photo 4). The handle for the control mechanism is not in place and the owner is not sure of its location. Approximately 200 gallons per minute (gpm) or more were flowing from the downstream end of the low-level outlet pipe (Photo 2), indicating that either the gate leaks or that it is not tightly closed, or possibly that there is seepage from the body of the dam into the pipe. Observed from its downstream end, the pipe is in poor condition. Although it protrudes approximately 5 feet out from the downstream face of the dam, extensive corrosion of the bottom of the pipe allows some of the flow through the pipe to be discharged onto the masonry face of the dam, causing leaching of the mortar. Also, as previously mentioned, there is a clump of small trees growing on top of the pipe at its point of exit from the dam.

The factory buildings at each end of the dam appear to be in good condition, with no notable signs of deterioration. The old millrace channel under the factory to the right of the dam is filled in and now serves as a parking area. There were no observable problems in this area.

d. Reservoir Area - The reservoir has steep-sided, wooded banks and the land at the top of the banks is heavily developed.

e. Downstream Channel - The downstream channel is broad and deep, although the normal flow is shallow. The channel bottom is bouldery and the channel sides are masonry walls for about 100 feet to the bridge. Brush and small trees are growing from the benches of the walls on either side of the river and it appears that the right side wall is being undermined (Photos 5 and 6). The concrete arch bridge appears to be in good condition and does not appear to constrict the river channel.

1.2 EVALUATION

Based upon the visual inspection, the project is in fair condition. The manner in which the features identified in Section 1.1 could affect the future condition and/or stability of the project is as follows.

1. The root systems of the small trees on the left non-overflow section could provide paths for seepage through the dam, especially if they are allowed to grow to be large

SECTION 3: VISUAL INSPECTION

FINDINGS

a. General - The general condition of the project is fair. Inspection revealed several areas in need of maintenance. At the time of inspection the upstream water level was at elevation 8.2+, with approximately 2 inches of water flowing over the stop planks and masonry spillway.

b. Dam

Top of Dam - The top of the right non-overflow section is in good condition, with a regular surface and good grass cover (Photo 1). A wooden railing on top of the masonry wall and extending from the upstream edge of the dam to the bridge 100 feet downstream of the dam is in fair condition, with slight rotting of the wood.

The top of the left non-overflow section is in poor condition with a dense growth of small trees, saplings and underbrush and several footpaths due to trespassing (Overview Photo).

Upstream Face - The upstream faces of both the right and left non-overflow sections are in good condition with no displacement of masonry and only minor leaching and cracking of the mortar joints.

Downstream Face - The downstream face of the right non-overflow section is in good condition. No leaching or cracking of mortar joints or displacement of masonry was observed.

The downstream face of the left section is in poor condition. In the area beneath the low-level outlet pipe, mortar has been almost totally leached out of the joints in the masonry (Photo 2). This appears to be caused by leakage from the pipe onto the outside of the wall, rather than by seepage from the body of the dam through the wall. A clump of small trees, the roots of which extend through the masonry to the body of the dam, is growing on top of the outlet pipe. The exit from the dam, rather than in the area of the outlet pipe. The downstream face appears to be in good condition, although it is obscured by bushes and debris.

Spillway - Although it appears to be in good condition, the spillway prevented close inspection of the downstream crest and toe. No irregularities of the tiered downstream face were noted and the abutments with the non-overflow sections appeared good, except for some leaching of mortar due to contact with water flowing over the spillway. The masonry spillway crest appears to be in good condition, but the stop planks are somewhat leaky and deteriorated. The stop plank supports, though rusted on the inside, do not show any significant deterioration. Also, at approximately 4 feet apart, they are closely spaced, and all are in

SECTION 2: ENGINEERING DATA

2.1 DESIGN DATA

The available data consists of inventory data by the State of Rhode Island and inspection reports dated March 27, 1946 and September 11, 1978 by the State of Rhode Island (See Appendix B).

2.2 CONSTRUCTION DATA

No information is available.

2.3 OPERATIONS DATA

According to the 1946 inspection report a river gage was read every hour daily from 7 A.M. to 11 P.M. These records were not available.

2.4 EVALUATION OF DATA

a. Availability - Available data was provided by the State of Rhode Island and the owner. The owner made the project available for visual inspection.

b. Adequacy - The limited amount of detailed engineering data available was generally inadequate to perform an in-depth assessment of the dam, therefore, the final 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.

7. Regulating Outlets

Low-level outlet

- | | |
|-----------------------|---|
| 1. Invert | 93.8± |
| 2. Size: | 48 inch diameter |
| 3. Description: | Steel pipe |
| 4. Control mechanism: | Rack with pinion gate
hoist |
| 5. Other: | Operability questionable
Location of handle un-
known |

5. Test flood pool: 28+ acres
- g. Dam
1. Type: Stone masonry gravity and earthfill
 2. Length: 174 ft.
 3. Height: 30 ft.
 4. Top width: 70+ ft.
 5. Side slopes: Vertical
 6. Zoning: Upstream and downstream masonry walls with center earthfill
 7. Impervious core: N/A
 8. Cutoff: Not known
 9. Grout curtain: N/A
 10. Other: Adjacent factory buildings close overflow profile
- h. Diversion and Regulating Tunnel - N/A
- i. Spillway
1. Type: Broad-crested masonry weir with 2 feet high permanent stop planks
 2. Length of weir: 110 ft.
 3. Crest elevation: 108.0-top of stop planks
106.0-masonry crest
 4. Gates: N/A
 5. Upstream channel: Shallow, gravel bottom
 6. Downstream channel: Bouldery river bed with masonry retaining walls
 7. General: Tiered downstream face. Bridge pier in approach channel

3. Maximum tailwater:	Not known
4. Normal pool:	108.0
5. Full flood control pool:	N/A
6. Spillway crest (ungated)	
Top of stop planks:	108.0 (assumed datum)
Masonry crest:	106.0
7. Design surcharge (original design):	Not known
8. Top of dam:	111.3+
9. Test flood surcharge:	118.9
d. <u>Reservoir Length</u>	
1. Normal pool:	2300+ ft.
2. Flood control pool:	N/A
3. Spillway crest pool: (top of stop planks)	2300+ ft.
4. Top of dam pool:	2400+ ft.
5. Test flood pool:	3500+ ft.
e. <u>Reservoir Storage</u>	
1. Normal pool:	175+ acre-ft.
2. Flood control pool:	N/A
3. Spillway crest pool: (top of stop planks)	175+ acre-ft.
4. Top of dam pool:	230+ acre-ft.
5. Test flood pool:	425+ acre-ft.
f. <u>Reservoir Surface</u>	
1. Normal pool:	12+ acres
2. Flood control pool:	N/A
3. Spillway crest pool: (Top of stop planks)	12+ acres
4. Top of dam pool:	17+ acres

indicates that the gate is not closed tightly or that it leaks, or possibly that there is seepage from the body of the dam into the pipe. No formal operational procedures exist.

1.3 PERTINENT DATA

a. Drainage Area - The drainage area is 73.4 square miles of largely undeveloped to heavily developed, flat and coastal terrain including large swamps. Significant upstream impoundments are Tioque Lake, Stump Pond, Flat River Reservoir and Quidnik Reservoir.

b. Discharge at Damsite - Discharge is over the spillway and through the low-level outlet.

- | | |
|---|---|
| 1. Outlet Works (conduits)
48 inch diameter steel low-level
outlet pipe @ invert el. 93.8±: | 280 cfs (upstream water
level at top of dam) |
| 2. Maximum known flood at damsite: | Since 1960 to about
1 foot below top of
right non-overflow
section (See Section 5.3) |
| 3. Ungated spillway capacity @
top of dam el. 111.3: | 2200 cfs |
| 4. Ungated spillway capacity @
test flood el. 118.9: | 13,100 cfs |
| 5. Gated spillway capacity @
normal pool: | N/A |
| 6. Gated spillway capacity @
test flood: | N/A |
| 7. Total spillway capacity @
test flood el. 118.9: | 13,100 cfs |
| 8. Total project discharge @
top of dam el. 111.3: | 2,480 cfs |
| 9. Total project discharge @
test flood el. 118.9: | 16,500 cfs |

c. Elevations - Elevations are on National Geodetic Vertical Datum (NGVD), based on an assumed elevation of 108.0 at the top of the stop planks, corresponding to the upstream water level shown on the USGS Crompton Quadrangle Map, 1970.

- | | |
|-----------------------------|-----------|
| 1. Streambed at toe of dam: | 81.7± |
| 2. Bottom of cutoff: | Not Known |

overflow section is the low point of the top of the dam. At elevation 111.3, it is 3.3 feet higher than the top of the stop planks and 0.4 foot lower than the top of the right non-overflow section.

A rack-with-pinion gate hoist is located on the top of the upstream masonry wall near the left end of the dam. The gate controls flow through a 48 inch diameter steel pipe which exits at invert elevation 93.8+ from the downstream face of the left non-overflow section. The type and size of the gate are not known, but judging from the operating mechanism, it is probably a sluice gate.

c. Size Classification - (SMALL) - The dam is approximately 30 feet in height and with the upstream water level to the top of the dam, it impounds approximately 230 acre-feet of water. According to recommended guidelines, a dam between 25 and 40 feet in height and with a storage capacity between 50 and 1000 acre-feet is classified as small in size.

d. Hazard Classification - (HIGH) - If the dam were breached, there is potential for extensive property damage and economic loss as well as potential for loss of more than a few lives at industrial buildings located approximately 2500 and 3900 feet downstream of the dam. A breach of the dam could cause these buildings to be rapidly inundated with as much as 5 feet of water.

e. Ownership - Arctic Development Corporation
33 Factory Street
West Warwick, Rhode Island
Mr. Robert Galkin, President
Mr. Warren Galkin, Vice President
(401) 828-0300

The present owner purchased the dam from American Tourister Company in 1960. Westover Fabric Company was an earlier owner.

f. Operator - The owners are responsible for the operations of the project.

g. Purpose of Dam - Although the dam is not presently in use, a feasibility study to restore its hydroelectric generation capabilities is in progress.

h. Design and Construction History - Very little is known of the design and construction of the project. It is estimated that the dam was built around 1885. Originally there was a bridge across the spillway approach channel. The bridge was later removed but the date of removal is not known. The power generation facilities were shut down sometime before 1960 and the headrace channel filled around 1972.

i. Normal Operational Procedures - It appears that the low-level outlet for the dam is kept in a closed position and normal flow is over the stop planks. However, observed flow from the pipe

1.2 DESCRIPTION OF PROJECT

a. Location - The project is located on the South Branch of the Pawtuxet River in an industrial area of the City of West Warwick, County of Kent, State of Rhode Island. The dam is shown on the U.S.G.S. Crompton Quadrangle Map having coordinates latitude N 41° 42.4' and longitude W 71° 31.3'.

b. Description of Dam and Appurtenances - As shown on Sheet B-1, the 30 foot high dam is a stone-masonry gravity structure probably founded on bedrock for its entire length. The project is approximately 174 feet in length, consisting of a 110 foot long masonry spillway section centered between left and right masonry and earthfill non-overflow sections 42 and 22 feet in length, respectively. The low-level outlet is a 48 inch steel pipe through the left non-overflow section of the dam. Abandoned appurtenances are an old masonry bridge pier near the center of the spillway approach channel, and a filled-in headrace channel at the right end of the dam. Factory buildings are adjacent to both ends of the dam, masonry walls line the downstream channel, and a concrete arch roadway bridge crosses the river approximately 100 feet downstream of the dam.

The factory buildings at each end of the dam have first floor elevations approximately level with the top of the dam. It appears that these buildings are built on embankments which extend slightly in from the original river banks and are contiguous with the dam. The degree to which these structures contribute to the impoundment of water on the upstream side of the dam is not determined, but for this inspection the exterior walls of the buildings are considered to be the endpoints of the dam; i.e., the length of the dam is equal to the distance between the two buildings.

The spillway is a broad crested masonry weir of trapezoidal cross-section, with permanently attached wooden stop planks. The top of the stop planks, at elevation 108, are approximately 2 feet higher than the masonry spillway crest. The spillway approach channel is shallow and gently sloping with an approximately 20 foot long by 5 foot wide masonry bridge pier near the center of the approach channel. The downstream face of the spillway is tiered and spillway discharge is onto the boulder-strewn natural river bottom. The river banks on each side of the downstream channel, between the dam and the roadway bridge consist of approximately 30 foot high vertical masonry retaining walls, with 5 to 8 foot wide benches at mid-height.

The right and left non-overflow sections of the dam each consist of upstream, downstream, and spillway-facing vertical masonry walls and a center earthfill. The masonry faces adjacent to each end of the spillway serve as training walls, the downstream faces connect to the retaining walls on each side of the downstream channel, and the upstream face of the right non-overflow section connects to the old headrace channel. The top of the left non-

PHASE I INSPECTION REPORT

ARTIC 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.

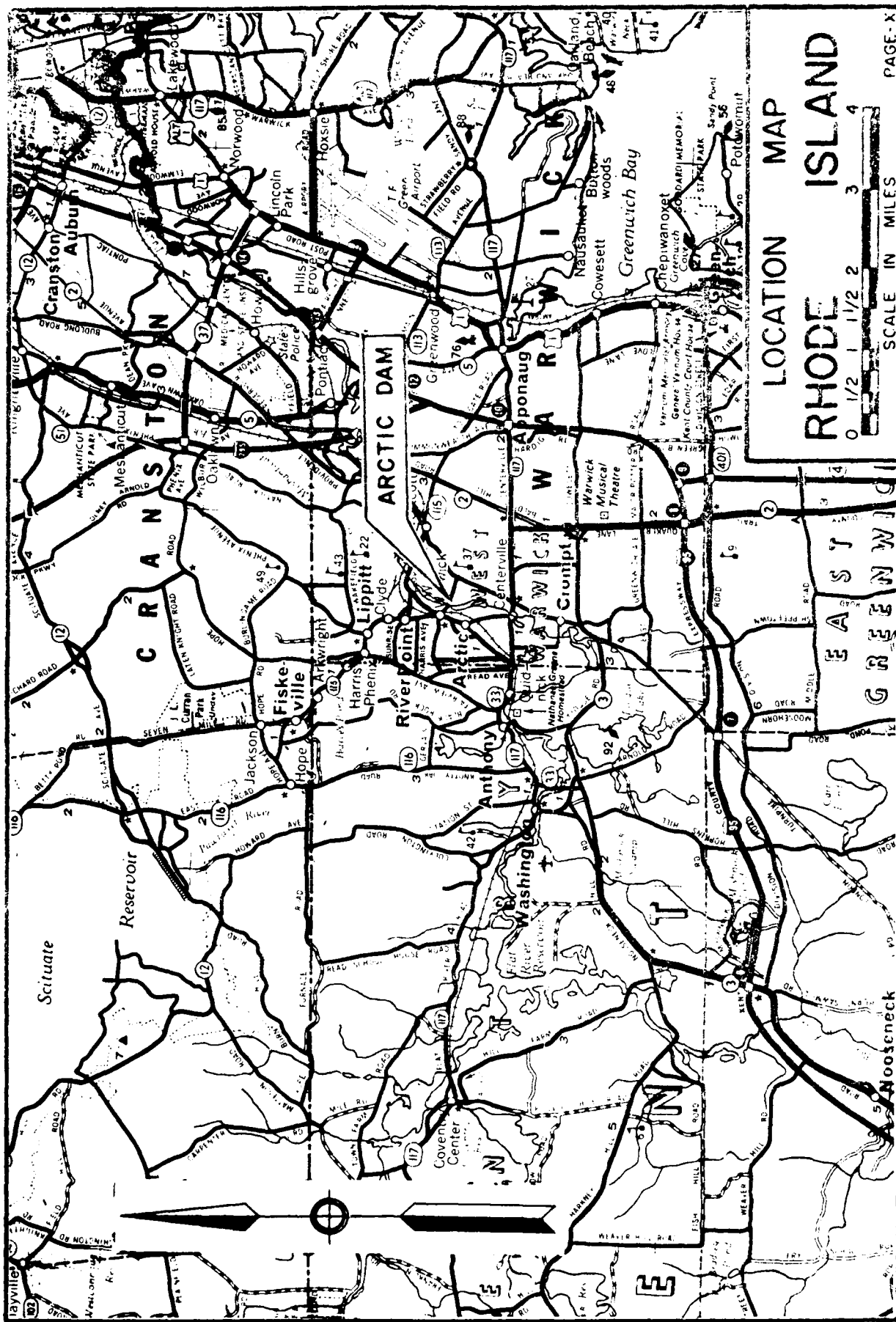
b. Purpose of Inspection Program - The purposes of the program are to:

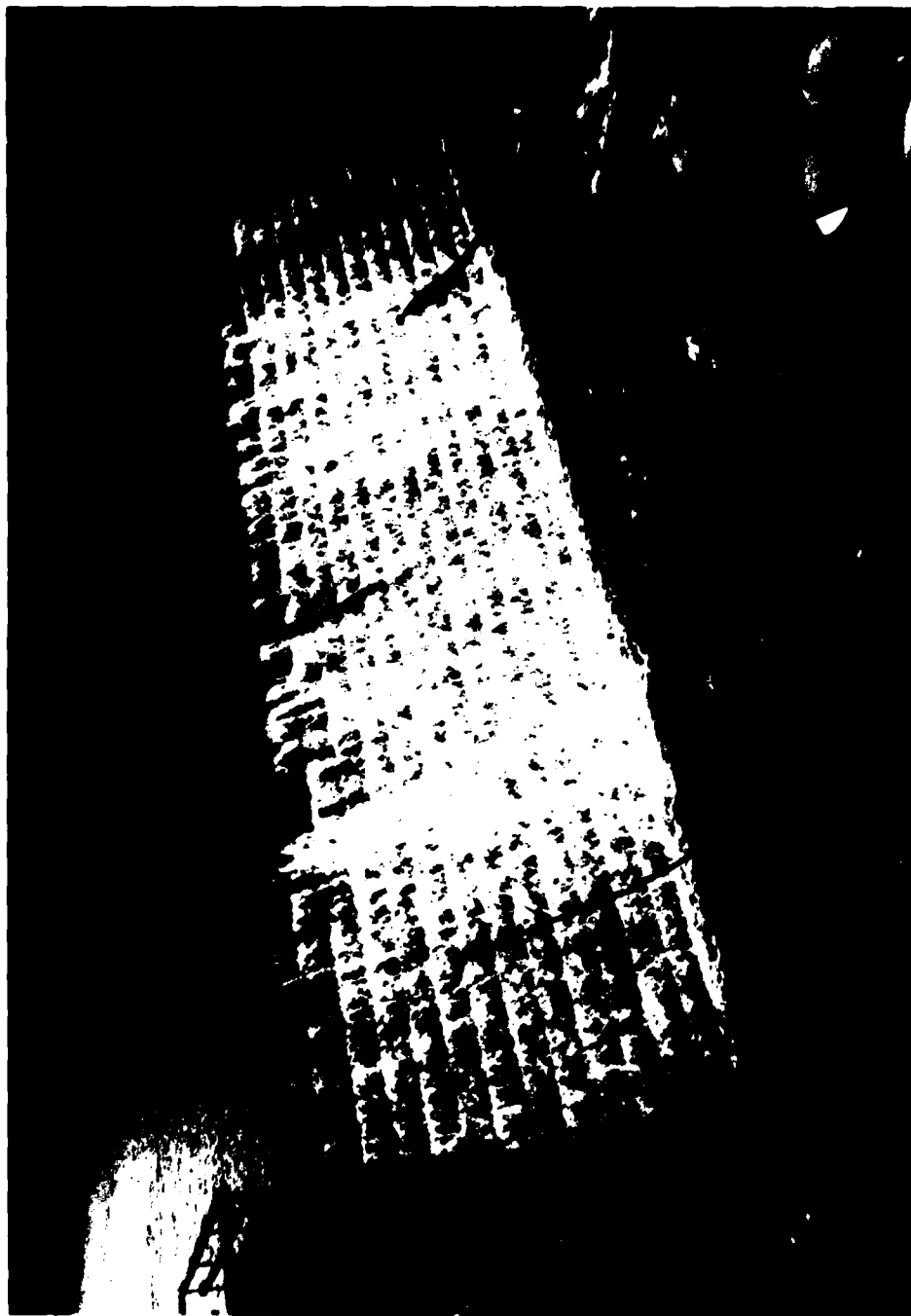
1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.
2. Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dams.
3. To update, verify and complete 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 passes judgment only on those factors of safety and stability which can be determined by a visual surface examination. The inspection is to identify those visually apparent features of the dam which evidence the need for corrective action and/or further study and investigation.





OVERVIEW PHOTO

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS	Arctic Dam S. Br. Pawtuxet River	W. Warwick Rhode Island	DATE Jan. '81 CE # 27 785 KG PAGE ix
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER				

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trees. Also, they could be uprooted, causing damage to the dam.

2. The footpaths on the left non-overflow section are susceptible to erosion should this portion of the dam be overtopped.
3. The downstream masonry wall of the left non-overflow section could be weakened by leaching of the mortar joints.
4. Roots of the clump of small trees growing on top of the low-level outlet pipe could further penetrate the adjacent downstream wall of the dam, causing displacement of masonry.
5. Branches and debris at the toe of the left non-overflow section prevent close inspection of this area.
6. Further leaching of mortar joints of the masonry walls adjacent to each end of the spillway could weaken these walls.
7. Small trees growing on the masonry pier in the spillway approach channel could reduce the spillway capacity, especially if allowed to grow to be large trees.
8. If the low-level outlet gate is inoperable, it prevents lowering of the upstream water level should the need occur.
9. Continued rusting of the low-level outlet pipe along with possible leakage of the outlet gate could cause water to leak from the pipe into the body of the dam, possibly causing internal erosion of the dam.
10. The roots of brush and trees growing from the walls on each side of the downstream channel could cause displacement of masonry.
11. Undermining of the masonry wall along the right side of the downstream channel could threaten the stability of this wall.

SECTION 4: OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 OPERATIONAL PROCEDURES

a. General - Lake level readings are not taken and no regulating procedures are followed at the dam.

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

4.2 MAINTENANCE PROCEDURES

a. General - Other than the regular cutting of grass on the right non-overflow section, and periodic removal of debris from the area of the spillway, there is no formal program of maintenance. The dam was inspected in September, 1978 by the State of Rhode Island Department of Environmental Management.

b. Operating Facilities - No formal program for maintenance of the operating facilities is in effect. It is not known when the low-level outlet gate was last operated.

4.3 EVALUATION

The operation and maintenance procedures are generally poor. 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 Arctic Dam watershed is 73.4 square miles of flat and coastal wooded terrain, typically containing large swamps and impoundments (Tiogue Lake, Stump Pond, Flat River and Quidnick Reservoirs) which contribute to the sluggish runoff characteristics of the watershed.

The dam is a masonry and earthfill dam with a masonry spillway. It is basically a low surcharge storage - high spillage type project. The reservoir area of approximately 12 acres is small in relation to the drainage area and consequently the surcharge storage of the project is too small to have an appreciable effect in reducing the $\frac{1}{2}$ PMF outflow of 16,500 cubic feet per second (cfs).

5.2 DESIGN DATA

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

5.3 EXPERIENCE DATA

The owner reports that since 1960, the highest observed water level was approximately 1 foot below the top of the right non-overflow section. This water level is about $\frac{1}{2}$ foot below the first point of overtopping of the left non-overflow section and may correspond to the flow of 2,000 cfs recorded on the river in 1968.

5.4 TEST FLOOD ANALYSIS

Based upon the watershed classification (Flat and Coastal), and the watershed area of 73.4 square miles; and utilizing the guide curve (Appendix D, p. v) in the U.S. Army Corps of Engineers "Preliminary Guidance for Estimating Maximum Probable Discharges", a PMF of 33,000 cfs or 450 cfs per square mile is estimated at the damsite. In accordance with the size (small) and hazard (high) classification, the range of test floods to be considered is from the $\frac{1}{2}$ PMF to the PMF. Based on the degree of hazard associated with a breach of the dam, the test flood for Arctic Dam is equivalent to the $\frac{1}{2}$ PMF. The pond level at the start of the test flood is considered to be at the top of the stop planks at elevation 108.0. The peak outflow for the test flood is estimated at 16,500 cfs and this flow will overtop the dam by 7.6 feet. Based on hydraulics computations, the spillway capacity above the stop planks to the top of the dam is 2,200 cfs which is equivalent to 13% of the routed test flood outflow (Appendix D-4).

5.5 DAM FAILURE ANALYSIS

Upon failure of Arctic Dam, the downstream impact area consists of two industrial buildings located 2500 and 3900 feet downstream of Arctic Dam. Both of these buildings are constructed adjacent to dams and portions of both buildings extend along the upstream impoundments as well as along the downstream discharge channels of their respective dams. At each location, the first floor elevation of the portion of the building upstream of the dam is approximately level with the top of the dam and 5 feet above the spillway crest. On the downstream side of each dam, the elevation above the spillway discharge channel of the first floors of these buildings is 7 feet at the upper dam and 11 feet at the lower dam.

The dam failure analysis is based on the April, 1978 Army Corps of Engineers "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs". With the pond level at the top of the dam, peak outflow before failure of the dam would be about 2,200 cfs and the peak failure outflow from the dam breaching would total about 18,300 cfs.

Prior to failure of Arctic Dam the depth of flow over the spillway at the upper of the two downstream impoundments would be approximately 3.2 feet, or 1.8 feet below the first floor elevation of the adjacent building. Failure of Arctic dam would result in a 6.7 foot increase in water level to a depth of 9.9 feet above the spillway crest. This rapid increase in water level will inundate the building by approximately 4.9 feet.

At the spillway of the lower downstream impoundment, the prefailure flow depth would be approximately 3.6 feet, or 1.4 feet below the first floor elevation of the adjacent building. Failure of Arctic Dam would result in a 5.1 foot increase in water level to a depth of 8.7 feet above the spillway crest, inundating the building by approximately 3.7 feet.

Inundation of portions of these buildings has the potential to cause economic losses and the loss of more than a few lives. Therefore, Arctic Dam is classified as a high hazard dam (Appendix D-9).

SECTION 6: EVALUATION OF STRUCTURAL STABILITY

6.1 VISUAL OBSERVATIONS

The dam is a masonry gravity structure and appears to be founded on bedrock. The configuration of the upstream face of the spillway is not known and the downstream face is tiered, giving the masonry spillway section a base width of at least 15 feet, if the upstream face is vertical. The non-overflow sections of the dam have vertical masonry walls around their perimeters and inner earthfill. The masonry walls have top widths of approximately 3 feet, but their base widths are not known. Although several design features are not known, there are no visual indications of a structurally unstable design.

The areas of deterioration described in Section 3 are not considered to be stability concerns at the present time. However, if left unchecked, leaching of mortar joints and leakage from the low-level outlet pipe could cause instability of the left non-overflow section, and continued undermining of the masonry wall along the right side of the downstream channel could cause it to become unstable.

6.2 DESIGN AND CONSTRUCTION DATA

No information is available.

6.3 POST-CONSTRUCTION CHANGES

Post-construction changes to the project include filling of the headrace channel at the right end of the dam and removal of a bridge across the spillway approach channel. Neither of these changes appears to affect the stability of the structure. No other post-construction changes are known.

6.4 SEISMIC STABILITY

The project is located near the boundary between Seismic Zones 1 and 2 and, according to U.S. Army Corps of Engineers Recommended Guidelines, need not be evaluated for seismic stability.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Condition - Based upon the visual inspection of the site and past performance, the dam is in fair condition. No evidence of immediate structural instability was observed in the dam or appurtenances; however, there are areas which require repair and/or maintenance.

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 16,500 cubic feet per second (cfs); peak outflow is 16,500 cfs with the dam overtopped 7.6 feet. Based upon our hydraulic computations, the spillway capacity to the top of dam is 2200 cfs, which is equivalent to approximately 13% of the routed test flood outflow. This indicates an inadequate spillway capacity.

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 pertaining to the following items be made by a registered professional engineer qualified in dam design and inspection. Recommendations made by the engineer should be implemented by the owner.

1. A detailed hydraulic/hydrologic analysis to determine the adequacy of the project discharge capacity and overtopping potential.
2. Inspection of the downstream face and toe of the spillway section with the upstream water level just below the spillway crest.
3. Inspection of the inside of the 48 inch steel low-level outlet pipe, determination of the source of leakage through the pipe, and repair or replacement of the pipe.
4. Determination of the cause of leaching of the mortar from joints in the masonry, particularly near the low-level outlet pipe's exit from the downstream face of the dam and repair of the mortar joints.

5. Repair or replacement of the low-level outlet gate and gate hoisting mechanism.
6. Repair of undermined areas of the masonry wall along the right side of the downstream channel.
7. Removal of all trees from the dam and from within 10 feet of the toe of the dam, including proper backfilling with selected material.

7.3 REMEDIAL MEASURES

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. Brush and saplings should be removed from the dam and appurtenant structures and from within 10 feet of the toe of the dam.
5. Grass cover should be established on the left non-overflow section.
6. Branches and debris should be removed from an area extending to approximately 10 feet from the toe of the left non-overflow section so that the toe can be inspected.
7. Leached or cracked mortar joints on the dam and appurtenant structures should be repaired and maintained as part of normal maintenance procedures at the dam.
8. The practice of clearing debris from the spillway crest, from the downstream face of the spillway, and from the toe of the spillway should be continued as part of normal maintenance procedures at the site.
9. The rotted wooden railing along the top of the right non-overflow section should be repaired.

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 Arctic Dam

DATE: Oct. 8, 1980

TIME: 9:30 am

WEATHER: Fair 50°

W.S. ELEV. 1082± U.S. 82.0± DN.S

PARTY:

INITIALS:

DISCIPLINE:

1. <u>Peter Heynen</u>	<u>PH</u>	<u>Geotechnical</u>
2. <u>Theodore Stevens</u>	<u>TS</u>	<u>Geotechnical</u>
3. <u>Hector Moreno</u>	<u>HM</u>	<u>Hydraulics</u>
4. <u>Frank Segeline</u>	<u>FS</u>	<u>Survey</u>
5. _____	_____	_____
6. _____	_____	_____

PROJECT FEATURE

INSPECTED BY

REMARKS

1. <u>Right Non-overflow Section</u>	<u>TS, PH, HM</u>	
2. <u>Left Non-overflow Section</u>	<u>TS, PH, HM</u>	
3. <u>Intake Structure</u>	<u>TS, PH, HM</u>	
4. <u>Low-level Outlet</u>	<u>TS, PH, HM</u>	
5. <u>Spillway</u>	<u>TS, PH, HM</u>	
6. _____	_____	
7. _____	_____	
8. _____	_____	
9. _____	_____	
10. _____	_____	
11. _____	_____	
12. _____	_____	

PERIODIC INSPECTION CHECK LIST

Page A-2

PROJECT Arctic DamDATE 10-8-80PROJECT FEATURE Right Non-overflow Section BY J.S. PH, HM

AREA EVALUATED	CONDITION
<u>DAM EMBANKMENT</u>	
Crest Elevation	111.7±
Current Pool Elevation	108.2±
Maximum Impoundment to Date	110.4± (since 1960)
Surface Cracks	None observed
Pavement Condition	N/A
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	Appears good
Horizontal Alignment	Appears good
Condition at Abutment and at Concrete Structures	Appears good-at building
Indications of Movement of Structural Items on Slopes	N/A
Trespassing on Slopes	N/A
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection-Riprap Failures	N/A
Unusual Movement or Cracking at or Near Toes	None observed
Unusual Embankment or Downstream Seepage	None observed
Piping or Boils	None observed
Foundation Drainage Features	N/A
Toe Drains	N/A
Instrumentation System	N/A

PERIODIC INSPECTION CHECK LIST

Page A-3

PROJECT Arctic DamDATE 10-8-80PROJECT FEATURE Left Non-overflow Section BY TS PH, HM

AREA EVALUATED	CONDITION
<u>EMBANKMENT</u>	
Crest Elevation	111.3 ±
Front Pool Elevation	108.2 ±
Water Impoundment to Date	110.4 ± (since 1960)
Surface Cracks	None observed
Seepage Condition	N/A
Settlement or Settlement of Crest	None observed
Lateral Movement	None observed
Critical Alignment	Appears good
Horizontal Alignment	Appears good
Location at Abutment and at Concrete Structures	Appears good-at building
Locations of Movement of Structural Elements on Slopes	N/A
Footpaths on Slopes	Footpaths on top
Vegetation on Slopes or Embankment	None observed
Structural Failures	N/A
Toe Movement or Cracking at or near toe	Toe obscured by debris
Seepage through low-level outlet onto D/S face of dam causing leaching of joints	Seepage through low-level outlet onto D/S face of dam causing leaching of joints
Seepage through joints	None observed
Seepage through concrete	N/A
Seepage through foundation	N/A
Drainage system	N/A

PERIODIC INSPECTION CHECK LIST

Page A-4

PROJECT Arctic Dam

DATE 10-8-80

PROJECT FEATURE Intake Structure

BY TS, PH, HM

AREA EVALUATED	CONDITION
<u>OUTLET WORKS-INTAKE CHANNEL AND INTAKE STRUCTURE</u> a) <u>Approach Channel</u> Slope Conditions Bottom Conditions Rock Slides or Falls Log Boom Debris Condition of Concrete Lining Drains or Weep Holes b) <u>Intake Structure</u> Condition of Concrete Stop Logs and Slots	Approach channel under water - could not observe Masonry intact - no deterioration Gate-hoisting mechanism (rack-with-pinion) in poor condition - rusted steel, rotting wood. Location of handle not known

PERIODIC INSPECTION CHECK LIST

Page A-5

PROJECT Arctic DamDATE 10-2-80PROJECT FEATURE Low-level OutletBY TS, PH, HM

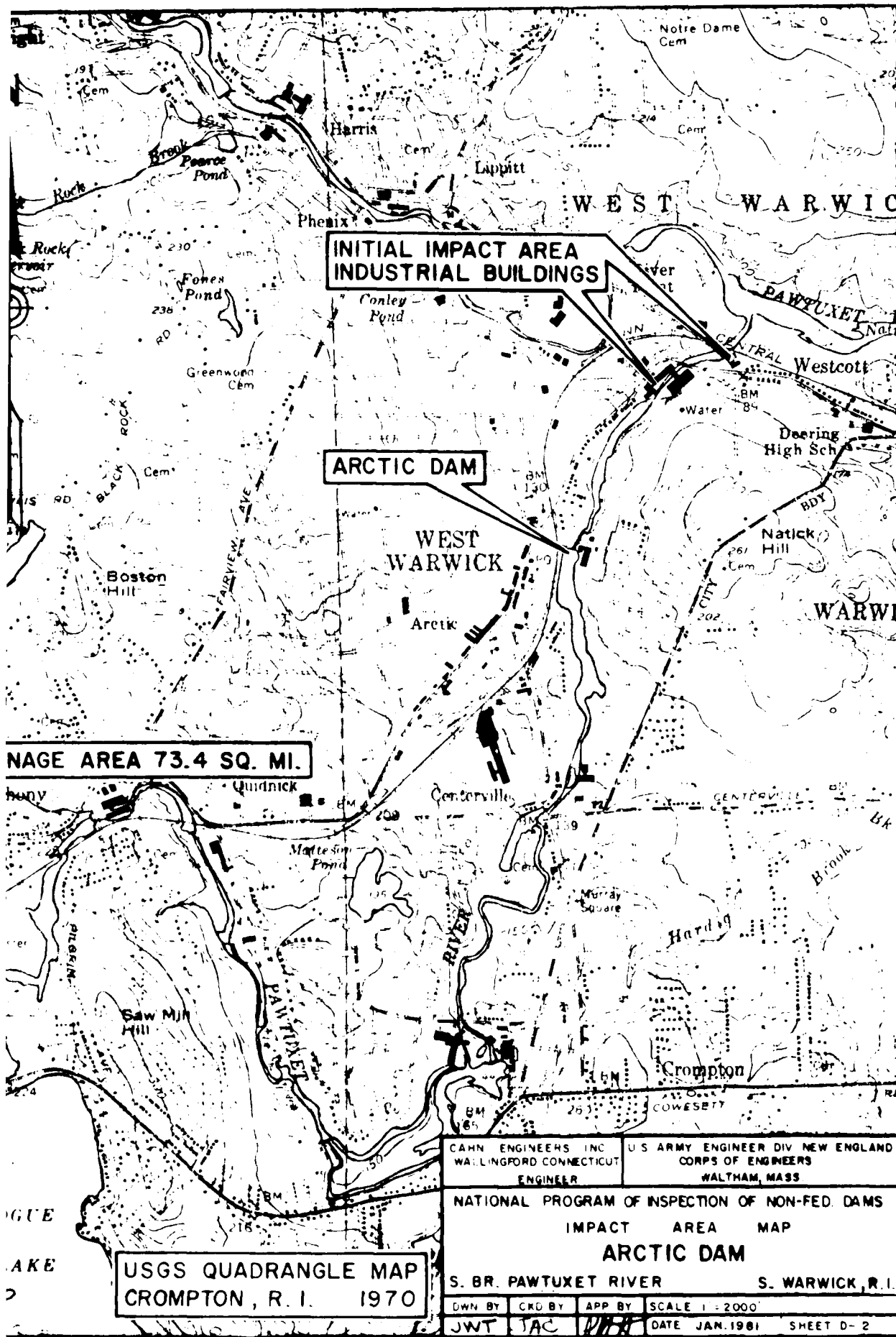
AREA EVALUATED	CONDITION
<u>SPUR WORKS-OUTLET STRUCTURE AND OUTLET CHANNEL</u>	
Condition of Concrete	Masonry - fair condition -
or staining	leaching of mortar joints
Cracks	Severe rusting of 48" pipe
Corrosion or Cavitation	N/A
Reinforcing	None observed
Seepage or Efflorescence	N/A
Damage at Joints	None observed
Leaks	Poor - leached out
Obstructions	N/A
Large Rock or Trees Overhanging Channel	Many small trees near outlet
Condition of Discharge Channel	N/A - Discharge almost directly to D/S channel

PERIODIC INSPECTION CHECK LIST

Page 4-1

PROJECT Arctic DamDATE 10-18-80PROJECT FEATURE SpillwayBY TIS, PE, RM

AREA EVALUATED	CONDITION
<u>LET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
<u>Approach Channel</u>	
General Condition	Good
Loose Rock Overhanging Channel	No
Trees Overhanging Channel	Small trees on pier
Floor of Approach Channel	Shallow, sandy
<u>Weir and Training Walls</u>	
General Condition of ~~Concrete~~ ^{Masonry}	Good
Rust or Staining	Minor staining of walls-from spray
Spalling	None observed
Any Visible Reinforcing	N/A
Any Seepage or Efflorescence	None observed
Drain Holes	N/A
<u>Discharge Channel</u>	
General Condition	Shallow, broad, bouldery
Loose Rock Overhanging Channel	No
Trees Overhanging Channel	Minor
Floor of Channel	Boulders
Other Obstructions	None observed



WATER DRAINAGE AREA 73.4 SQ. MI.

USGS QUADRANGLE MAP
CROMPTON, R. I. 1970

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 IMPACT AREA MAP ARCTIC DAM			
S. BR. PAWTUXET RIVER			
S. WARWICK, R. I.			
OWN BY	CHK BY	APP BY	SCALE 1" = 2000'
JWT	TAC	PHH	DATE JAN. 1981 SHEET D-2

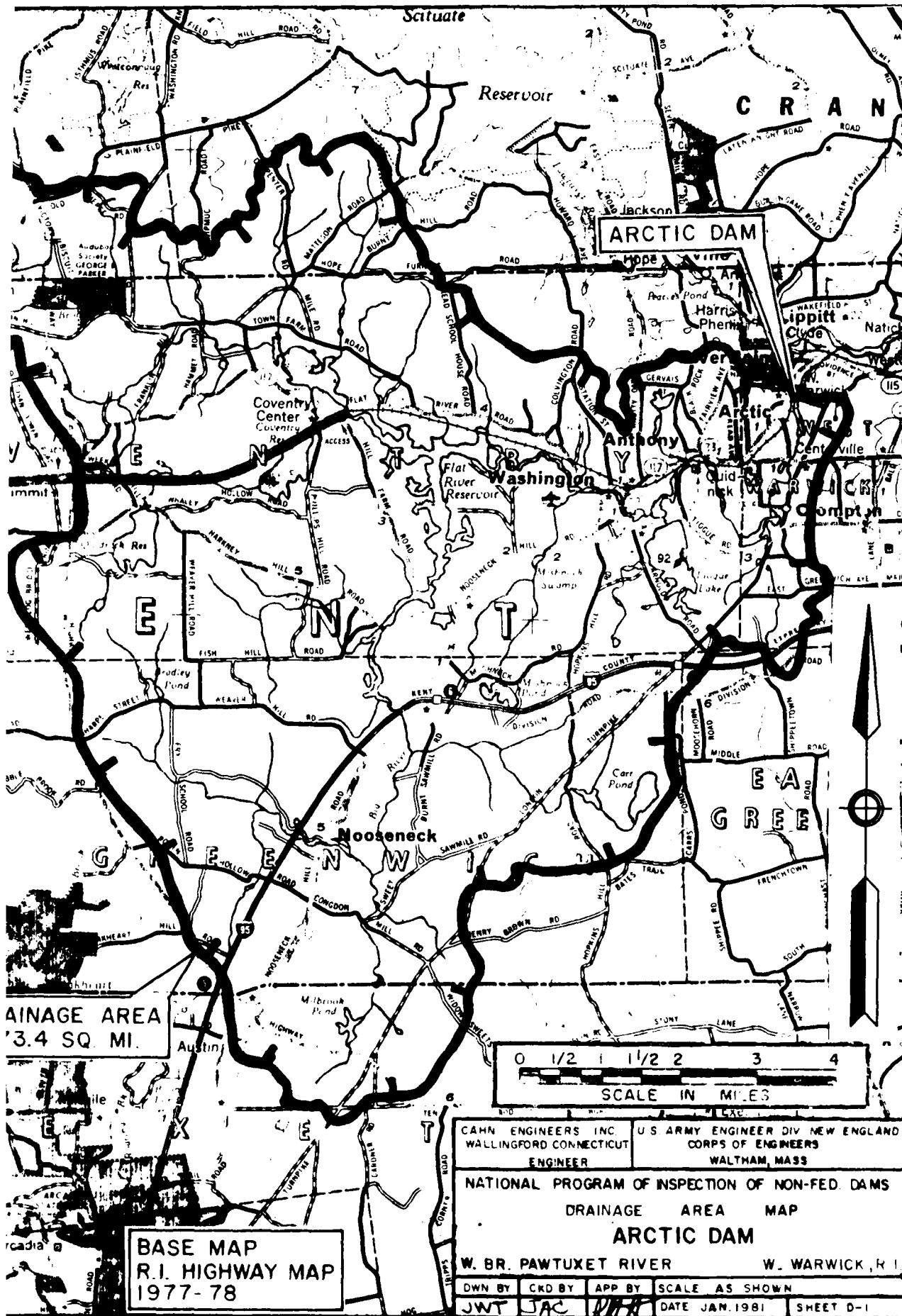




Photo 5 - Benched channel bank retaining wall between arch bridge at left and dam at right (10/8/80).



Photo 6 - Undermining at base of retaining wall. Note depth of flow and pattern of current under wall (10/8/80).

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

Arctic Dam
S. B. Pawtuxet River
W. Warwick, R.I.
CE # 27 785 KG
DATE Jan. '81 PAGE C-3



Photo 3 - Downstream face of spillway, spillway crest with permanent stop planks, and bridge pier in approach channel (10/8/80).

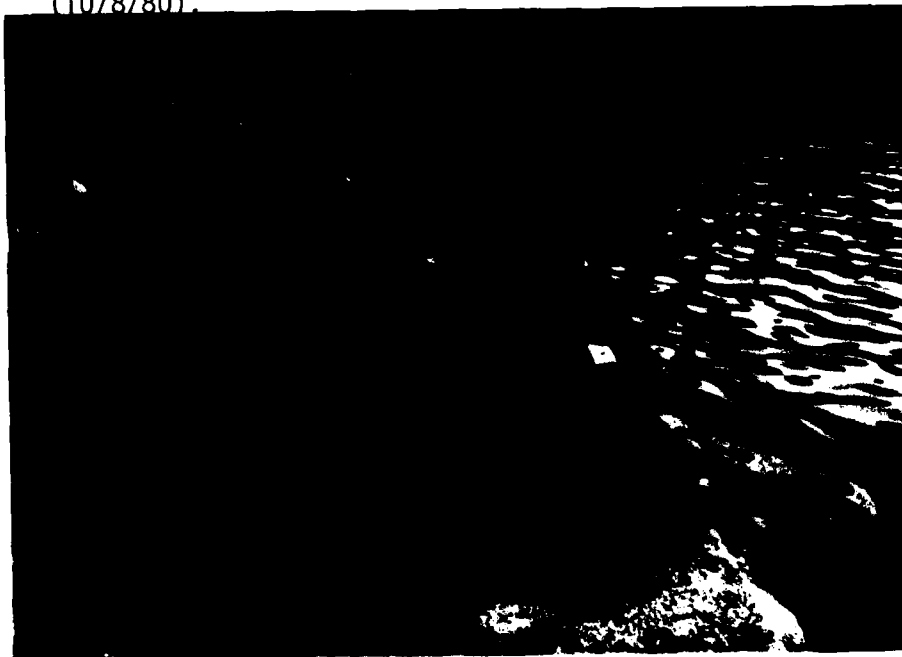


Photo 4 - Rack-with-pinion gate hoisting mechanism (10/8/80).

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WALLINGFORD, CONN.
ENGINEER

NATIONAL PROGRAM OF
INSPECTION OF
NON-FED. DAMS

Arctic Dam

S. Br. Pawtuxet River
W. Warwick, R.I.

CE # 27 785 KG

DATE Jan. '81 PAGE C-2



Photo 1 - Right non-overflow section of dam and adjacent factory building (10/8/80).



Photo 2 - Downstream end of low-level outlet pipe. Note deterioration of pipe and leached-out mortar joints on left (10/8/80).

U.S. ARMY ENGINEER DIV. NEW ENGLAND HPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROJECT #	Arctic Dam No. 100-100-100 W. WADSWICK, R.I.
CAHN ENGINEERS, INC. WALLINGFORD, CONN. ENGINEER	INSPECTION OF NON-FED. DAMS	FEB 27 1985 DATE Jan. 1981 PAGE 1

WICKIATUK RIVER
SOUTH BRANCH

WICKIATUK RIVER
NORTH BRANCH

WICKIATUK RIVER
MIDDLE BRANCH

WICKIATUK RIVER
WEST BRANCH

PHOTO LOCATION PLAN

ARCTIC DAM

Scale

4

3

2

5

6

APPENDIX C
DETAIL PHOTOGRAPHS

DAM INSPECTION REPORT

Arctic Development Corp. OTHER INTERESTED PARTY: Natco Products Corp.
63 Factory Street c/o Arctic Development Corp.
West warwick, RI

[illegible]

Dam Name	Arctic (Factor, SI)	River point Upper	River point Lower
Dam No.	148	147	146
Area of Watershed (nearest % sq mi)	73.4	73.7	73.8
Peak Discharge Rate of Watershed (cfs)	4894	4864	4761
Height of Dam to Water Surface 1st Pool (ft)	108.0		
Height of Dam to Water Surface (nearest ft)	14	6	4
Height of Dam to Spillway (ft)	110.5	79.1	51.3
Height of Dam to Base of Spillway (ft)			5.0
Height of Dam to Top of Spillway (ft)	100	120	100
Capacity of Spillway (cfs)			3900
Maximum Discharge Capacity (cfs)			5844
Structural Height (ft)	27		
Structural Height (ft)	24		
Structural Capacity (Max)	194 acm ft		
Structural Capacity (Normal)	173 acm ft		
Maximum Drawoff (ft)	20	40	40
Number of Wholes	2	1	
Dam to Water (ft)	28	22	
Distance to Dam	500 ft	300 ft	
Distance to Dam (ft)	29		5
Distance to Dam (ft)			50 ft

DIVISION OF SOIL CONSERVATION

SURVEY OF DAMS IN RHODE ISLAND

Pawtuxet River Basin (South Branch)

#148 Arctic

Drainage Area 73.4 Sq. Mi.

February 1948

Spillway

Estimated extreme freshet 4844 c.f.s.

QAM NO. 40

REMARKS:

ON RIVER FLOWING IN THE
1
1-1-1950

WATERBURY 220700Z

WELLS WARWICK, P. 1., TEL. ~~WAB. 0800~~ Ja 1-

REPAIRS

INSPECTION ONLY

NEW CONSTRUCTION

APPENDIX

CONFIDENTIAL

1. INTRODUCTION

.. Policy Reasoning

DATE: 11/11/2011

2. REMARKS:

1. ~~WILLIAM McNEELY, 1411 E. 10TH AVE., DENVER, CO. 80202~~
2. WILLIAM JENKINS, SUPT., POTTER AVE., WEST WARWICK, R. I.
3. ~~HARRY STORRY, 1140 E. 10TH AVE., DENVER, CO. 80202~~

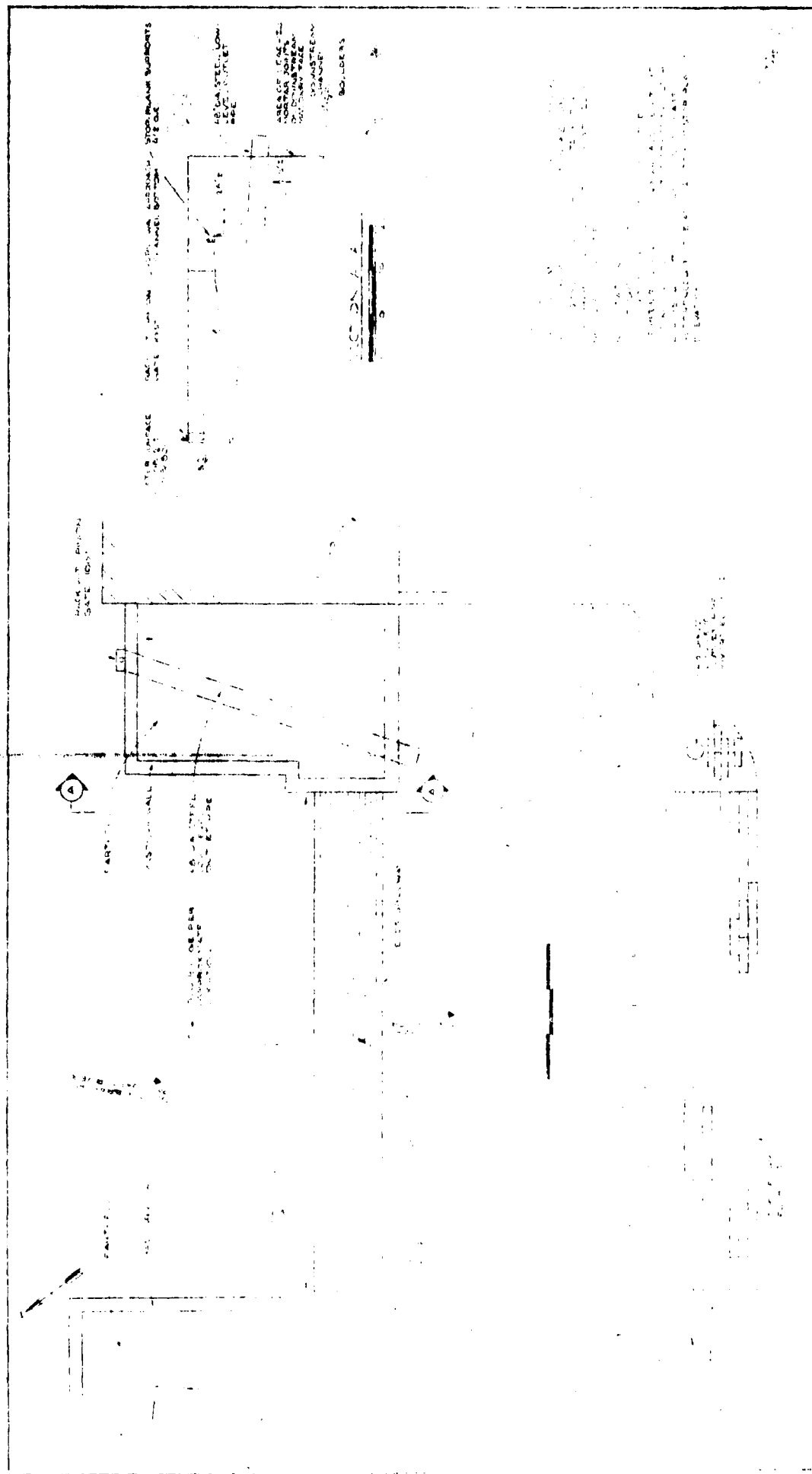
CONDITION GOOD. HEAVY GRANITE SPILLWAY BETWEEN MASSIVE GRANITE ABUTMENTS SPAN ENTIRE RIVER. TRENCH ON EAST SIDE OF RIVER LEADS TO WATER WHEELS IN MILL AND IS CONTROLLED BY TWO SETS OF GATES (ALL IN GOOD OPERATING CONDITION - REPAIRED 1945). 29' PERMANENT FLASH BOARD NOW IN PLACE (WOODEN WITH IRON SUPPORTS). TWO WHEELS AVAILABLE FOR POWER CAN DEVELOP 500 H.P. (ONE NEW IN 1940). DAM UNDER CONSTANT SUPERVISION OF MASTER MECHANIC AND FLOWGAGE READ EVERY HOUR DAILY FROM 7 A. M. TO 11 P. M.

8/14/44

REQUEST FROM ATTY. GULMAN FOR ARTISTIC FOUNDATION CO. (AT RIVERPOINT FINISHING CO. PLANT, NEXT BELOW - #147) AS TO OUR KNOWLEDGE OF A BREAK IN FLASH BOARD AT WESTOVER #148 ON MARCH 2, 1947, CAUSING LOSS OF CONSIDERABLE CLOTH AND FLOODING OF THEIR MILL. THIS OFFICE HAD RECEIVED NO NOTICE OF THIS FAILURE.

SUMMARY OF DATA AND CORRESPONDENCE

<u>DATE</u>	<u>TO</u>	<u>FROM</u>	<u>SUBJECT</u>	<u>PAGE</u>
Mar. 27, 1946	File	J. V. Keily R. I. Dept. of Public Works Division of Harbors and Rivers	Inspection Report	B-2
Feb. 1948	File	Division of Harbors and Rivers	Hydraulic/Hydrologic Data	B-3
Sept. 11, 1978	File	Earle F. Prout, Jr. R.I. Dept. of Environmental Manage- ment	Inspection Report	B-5



ARCHITECTURAL FLOOR PLAN
 DRAWN BY: [illegible]
 DATE: [illegible]
 SCALE: 1/4" = 1'-0"
 SHEET NO. 1 OF 1

APPENDIX B
ENGINEERING DATA AND CORRESPONDENCE

Project INSPECTION OF NON-FEDERAL DAMS IN NEW ENGLAND Sheet 2-1 of 1
 Computed By JH Checked By JH Date 10/20/81
 Field Book Ref. _____ Other Refs. DE 927085-48 Revisions _____

HYDROLOGIC, HYDRAULIC INSPECTIONS

ARCTIC DAM, WEST HARTFORD, CT.

1) PERFORMANCE AT PEAK FLOOD CONDITIONS

1) PROBABLE MAXIMUM FLOOD (PMF)

2) WATERSHED CLASSIFIED AS "PEAT AND MARSH", TYPICALLY CONTAINING LARGE
 SWAMPS AND IMPOUNDMENTS (TROUT LAKE, CHANTON AND FLAT RIVER AND FLOODING TERRACE)

3) WATERSHED AREA: $A.A. = 73.4 \text{ sq. mi.}$

NOTE: D.A. FROM U.S. DEPARTMENT OF WATER RESOURCES, DIV. OF DAM SAFETY, "SURVEY OF DAMS IN RHODE ISLAND" DAM #148 - 2.8 APRIL 1968, "ARCTIC"

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

(1) FROM GUIDE CURVES: $PMF = 450 \text{ cfs/mi.}$

(2) $PMF = 73.4 \times 450 = 33000 \text{ cfs}$

(3) $PMF = 16500 \text{ cfs}$

3) DISCHARGE AT PEAK INFLOW (PMI AND PMF)

4) DISCHARGE RATING CURVE

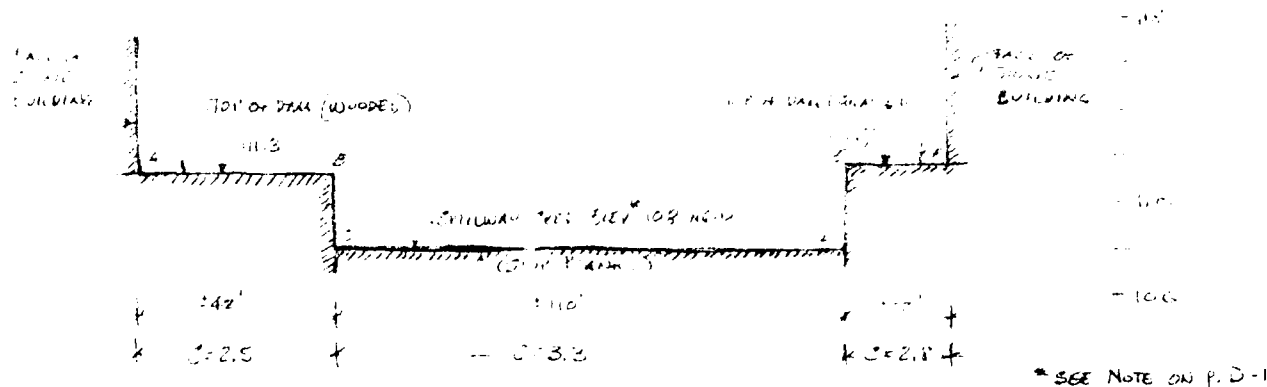
5) DISCHARGE AND LEVELS - PROPOSED DAM

STONE MASONRY BUILDING (18) WITH TOP FRANK ELEVATION 100.00
 STONE MASONRY AND EARTH FILL BUILDING AT BOTH SIDES OF CHANNEL
 ADJACENT STONE BUILDING WHICH CURVE THE FLOW SECTION (18) IN AND 18.00

* NOTE: U.S. ELEVATION 100' MSL ON THE U.S. NAVY CHART OF 1911 IS ASSUMED TO BE TOP OF 181 FRANK ELEVATION ON NATIONAL GEODETIC DATUM (NGVD).

Project ARCTIC DAM PROJECT Sheet 2-2 of 2
 Computed By WHL Checked By WHL Date 11/8/52
 Drawn By WHL Other Refs. CE 457-105 HB Revisions

ASSUME $C=3.3$ FOR THE SPILLWAY (STILL CHANNEL) AND $C=2.5$ AND $C=3.7$ FOR THE RIGHT & LEFT ABUTMENT OVERFLOWS



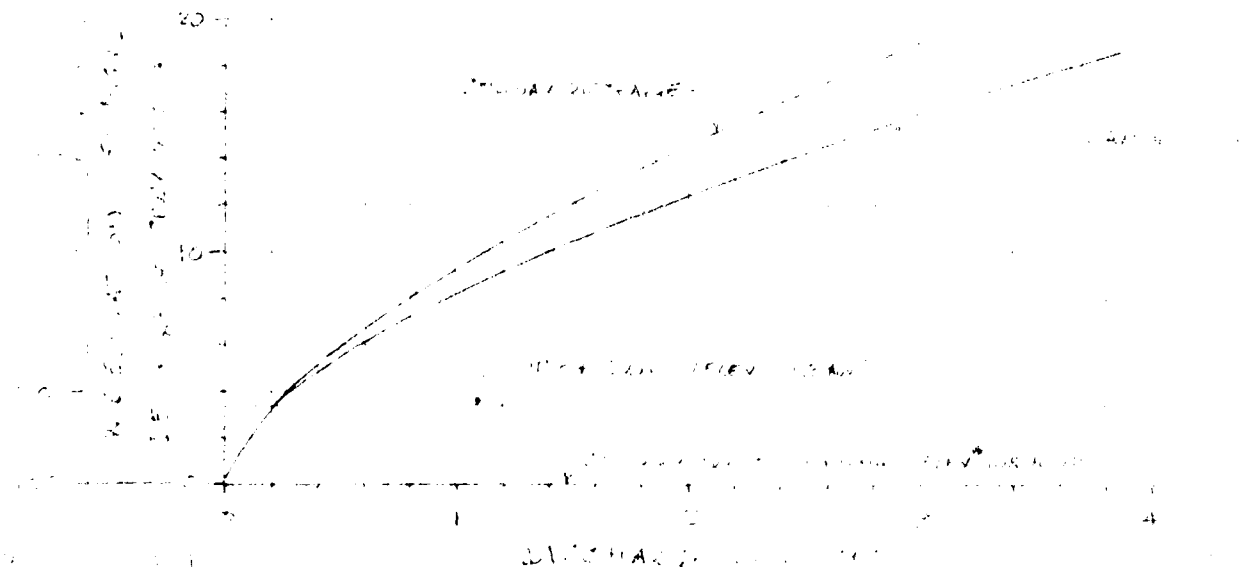
NOTE: DATA FROM CE OBSERVATIONS ON 10/4/50 BY WHL, F.S. & T.S.

ARCTIC DAM APPROXIMATE OVERFLOW PROFILE

(1) THE OVERFLOW RATING CURVE CAN BE DERIVED BY THE FOLLOWING:

$$Q = 3.53 H^{3/2} + 105 (H - 111.3)^{3/2} + 615 (H - 112.5)^{3/2} \quad Q = Q_{spill} + Q_{right} + Q_{left}$$

(2) AS THE DAM IS OUTFLOWS TO THE SEA



Project ADAMS RIVER DAM PROJECT Sheet 2-5 of 10
 Computed By CH Checked By CHS Date 1-1-72
 Field Book Ref. _____ Other Refs. US F.S. 15-1-72 Revisions _____

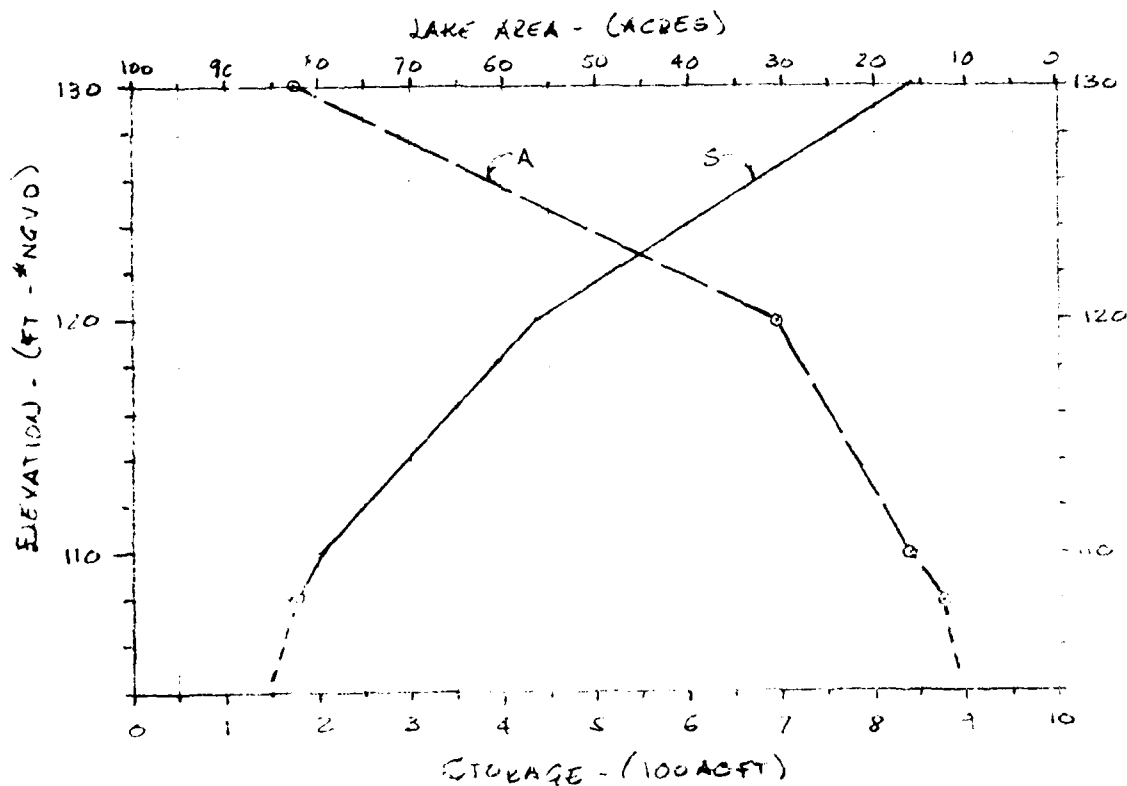
6) SURCHARGE DURING TO PASS PEAK INFLOWS Q_p & Q_p'

a) @ $Q_p = PAF = 23,000 \text{ CFS}$ $H_s = 14.5'$

u) @ $Q_p' = \frac{1}{2} PAF = 11,500 \text{ CFS}$ $H_s' = 12.1'$

7) EFFECT OF SURCHARGE - PEAK OUTFLOW

8) LAKE AREA / STORAGE RATING CURVES - ARCTIC DAM



A - DATA FROM U.S. DEPT. OF PUBLIC WORKS, DIV. OF HARBOUR & RIVERS - (TABULATION FOR DAM #192)

ALSO ON ACE US. INVENTORY OF DAMS, - NORMAL STORAGE: 3-173 ac-ft

B - AREAS MEASURED ON U.S.S. DRAUGHTON, U.S. SURVEYING SHEET (REV. 1910)

* SEE NOTE P. D-1

Cahn Engineers Inc.

Consulting Engineers

Des. W. J. Cahn 10/1/65 10/1/65
 Computed By W. J. Cahn Checked By W. J. Cahn Date 10/1/65
 Des Book Ref 10/1/65 Other Refs 10/1/65 Revision 10/1/65

(U) CIRCLED S.A. ≈ 73.4 ³⁰⁰⁰ (SEE FIG. 1)

(U) PEAK CUTOFFS (Q_P & Q'_P)

BECAUSE THE LAKE AREA AND WATERSHED TO THE LAKE AREA OF ARCTIC DAM ARE TWO DIFFERENT AREAS, THE PEAK CUTOFFS IN THE REFLECTIONS OF THE PEAK INFLOW THE PEAK CUTOFFS ARE APPROXIMATELY,

$$Q_P \approx Q'_P = 33000 \text{ cfs} \quad H_3 \approx 16.5'$$

$$Q'_P \approx Q_P = 16500 \text{ cfs} \quad H_3 \approx 10.1'$$

3) SPILLWAY CAPACITY RATIO TO PEAK CUTOFFS

SPILLWAY CAPACITY (cfs)	SLOPE H (FT)	W.S. ELEV. (FT NGVD)	SPILLWAY CAPACITY (cfs)	SPILLWAY CAPACITY AS % OF PEAK CUTOFFS	
				Q_P (33000 cfs)	Q'_P (16500 cfs)
TO F.DAM	11.5	111.3	10000	30.3%	60.6%
TO F.DAM	10.1	106.1	5000	15.1%	30.3%
PAF	16.5	123.3	20000	60.6%	121.2%

REMARKS: ABOVE SPILLWAY ARE NOT THE ONLY SPILLWAYS
 ** THE SPILLWAYS ARE NOT THE ONLY SPILLWAYS
 ** THE SPILLWAYS ARE NOT THE ONLY SPILLWAYS
 ** THE SPILLWAYS ARE NOT THE ONLY SPILLWAYS

Project NON-FEDERAL DAMS INSPECTION

Sheet 2-5 of

Computed By HAI

Checked By SSB

Date 11/1/80

File Book Ref

Other Refs CE #27-785-HB

Revisions

ARCTIC DAM

II) DOWNSTREAM FAILURE HAZARD

1) POTENTIAL IMPACT AREA

TWO LARGE INDUSTRIAL BUILDINGS ARE LOCATED IN THE DOWNSTREAM SIDE OF THE PAWTORET RIVER (1) 2500' AND (2) 3700', RESPECTIVELY, 1/2 MILE FROM THE DAM. TWO OTHER DAMS (RT #17 AND #18) LOCATED NEAR THESE BUILDINGS, DRAINING WATER TO NORMAL LEVELS (1) 5' BELOW THE FIRST FLOORS OF THE BUILDINGS, LOCATED ON THE 1/2 SIDE OF THESE RESERVOIRS. THE BUILDINGS SECTIONS 1/2 FROM THE DAMS, ARE (1) 7' AND (2) 11' RESPECTIVELY, ABOVE THE WATER LEVEL OF RES #140 AND THE RIVER CHANNEL 1/2 FROM THE DAMS. THESE STRUCTURES CONSTITUTE THE POTENTIAL IMPACT AREA IN CASE OF FAILURE OF ARCTIC DAM.

2) FAILURE AT ARCTIC DAM

ASSUME SURCHARGE TO TOP OF DAM, ELEV. 1113' NGVD

a) HEIGHT OF DAM * $H_{max} = 30'$ (TOP OF DAM 1143' NGVD - FOUNDATION ELEV. 1113' NGVD)
ASSUME FLOODING 1/2 FACE (ELEV. 1122' NGVD - HE 1117-32' NGVD) WALL

b) MID HEIGHT LENGTH * $L = 155'$

c) BREACH WIDTH (SEE MED. ACE 1/2 DAM FAILURE SCHEMATIC)

$$W = 0.4 \times 155 = 62' \quad \text{ASSUME } W_b = 62'$$

d) ASSUMED WATER DEPTH AT TIME OF FAILURE. $Y_o = 24.3'$ (TO FIRST 4' OF DAM TIPPING, ELEV. 1113' NGVD)

e) SPILLWAY DISCHARGE AT TIME OF FAILURE:

(1) PREVIOUS TO FAILURE (SEE SCHEMATIC) (FROM P. D-4)

(2) AFTER FAILURE (ASSUMED REMAINING WALL 132' TO 1' ; $H_p = 1800'$)

* FROM CE MEASUREMENTS ON 10/18/80 BY HAI, T. & F.S.

2) BREACH (OFFENSE) (USE VERB-ACT MODEL: VERB)

$$L = \frac{S}{2\pi} \ln \frac{V_2}{V_1} \approx 16500 \text{ cm}$$

2) FEAR FAILURE NOT IN TO CRASH PROXY ENCL.

$$Q_p = Q_1 + Q_2 = \underline{\underline{18500 \text{ m}^3}}$$

3) FLOOD DEPTH * IMMEDIATE: 4' PAULI DAM

$$Y_2 = 0.45\% \cdot \underline{12.9'}$$

* (FROM RETREATING WAVE THEORY APPLIED TO DAM FAILURE)

A) ESTIMATE 4 D% FAILURE CONDITIONS AT POTENTIAL IMPACT AREA.

DATE NED-ICE SUPERIMPOSED ON ESTIMATING OF FAVORABLE HYDROGRAPH.

[illegible]

1) REPERCUSSIA POSITIVA DO IMU E FINANÇAS

Schizothorax *schizothorax*

[illegible]

Project 100% FEDERAL DAM INSPECTION Sheet D-7 of 10
 Computed By HR Checked By CHP Date 7/15/72
 and book Ref _____ Other Refs. SE #27-755-10 Revisions _____

3) APPROXIMATE STAGE AT POTENTIAL LAKE AREA AFTER FAILURE

(a) 1st REACH 1/3 FROM R.I. DAM #147

R.I. # OVERFLOW APPROX. EQUAL TO PRESENT AND $C_F = 3.2$

ASSUME AGE LAKE AREA ($\bar{A}$) WITHIN THE EXPECTED LAKE LENGTH (513', 3400')

$$TO: \bar{A} = 140 \times 2500 = 350000 \text{ SF} \approx 8 \text{ AC}$$

THE TOTAL OVERFLOW FROM R.I. DAM #147 IS APPROXIMATED BY

$$Q_{(147)} = 384 H^{3/2}$$

AND, APPROXIMATE ROUTING (USE NED-ICE GUIDELINES) OF THE PEAK FAILURE OUTFLOW GIVES:

$$(S_P)_1 = Q_P \left(1 - \frac{1}{3}\right) = \underline{12000 \text{ CFS}}; (H_3)_1 = 9.7' \text{ (1/3 R.I. DAM #147)}$$

(b) 2nd REACH 1/3 FROM R.I. DAM #146

ASSUME $C_F = 3.2$ AND $C_F = 2.8$ FOR THE SPILLWAY FLOW AND ADJACENT TERRAIN OVERFLOW.

ASSUME AGE LAKE AREA ($\bar{A}$) WITHIN THE EXPECTED LAKE LENGTH

$$\bar{A} = 150 \times 1400 = 210000 \text{ SF} \approx 4.8 \text{ AC}$$

THE TOTAL OVERFLOW FROM R.I. DAM #146 IS APPROXIMATED BY

$$Q_{(146)} = 320 H^{3/2} + 724 (H-5)^{3/2}$$

APPROXIMATE ROUTING OF THE PEAK OUTFLOW ($(S_P)_1 = 12000 \text{ CFS}$) GIVES:

$$(Q_P)_2 = \underline{1800 \text{ CFS}}; (H_3)_2 = \underline{5.7'} \text{ (1/3 R.I. DAM #146)}$$

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U.S. FEDERAL DAM REPAIRATION
Designed By RL Checked By RL Date 11/15/72
Book Ref 1 Other Refs CE # 77-105-12 Revisions _____

D) APPROXIMATE STAGE BEFORE FAILURE OF THE DAM

a) 1ST REACH $(H_1)_0 = 3.2'$ ($Q_1 = 2200 \text{ CFS}$, SEE P. 140)

at 2ND REACH $(H_2)_0 = 3.2'$ (SAME AS 1ST REACH - $Q_2 = 2200 \text{ CFS}$)

E) STAGE IN STAGE $\frac{1}{2}$ FROM DAM

a) 1ST REACH $(\Delta H)_1 = 6.7'$ (1ST REACH - SEE P. 140)

b) 2ND REACH: $(\Delta H)_2 = 5.1'$ ($\frac{1}{2}$ FROM W 2ND REACH #140)

of NOX-FEDERAL DAMS INSPECTION Sheet D-1 of 10
 Drawn By RL Checked By SKG Date 11.1.80
 Book Ref. _____ Other Refs. CE #27-785-HB Revisions _____

ARCTIC DAM

III) SELECTION OF TEST FLOOD

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

a) SIZE: * STORAGE (MAX) $\approx 230^{1000}$ AC-FT ($50 < S < 1000^{1000}$ AC-FT)
 * HEIGHT $\approx 33'$ ($25 < H < 40'$)

* STORAGE SEE P. D-3; HEIGHT: SEE P. D-5

SIZE CLASSIFICATION: SMALL

b) HAZARD POTENTIAL: AS A RESULT OF THE $\frac{1}{2}$ FAILURE ANALYSIS AND
 IN VIEW OF THE IMPACT THAT FAILURE OF ARCTIC DAM MAY
 HAVE ON THE POTENTIAL IMPACT AREA (P. D-5), THE DAM IS
 CLASSIFIED AS HAVING:

HAZARD CLASSIFICATION: HIGH

2) TEST FLOOD: $\frac{1}{2}$ PMF = 16500 CFS

THIS SELECTION IS BASED ON THE RESULTS OF THE FAILURE
 ANALYSIS AND CLASSIFICATION

Project: FEARLESS DAM IN ARIZONA Date: 10/1/54
 By: JU Checked by: WAB Date: 10/1/54
 Ref: _____ Other Refs: CE # 27-785-HA Revision: _____

ARCTIC DAM

II) SUMMARY

1) TEST FLOOD: $\frac{1}{2}$ PMF = 16500 CFS

(ALL FLOOD CONDITIONS AND TRANSFORMATIONS FOR PMF AND $\frac{1}{2}$ PMF ARE ALSO SUMMARIZED BELOW)

2) PERFORMANCE AT PEAK FLOOD CONDITIONS:

- a) PEAK INFLOWS: $Q_p = PMF = 33000$ CFS $Q_p = \frac{1}{2} PMF = 16500$ CFS
- b) PEAK OUTFLOWS: $Q_3 = Q_p = 33000$ CFS $Q_3 = Q_p = 16500$ CFS
- c) FILLWAY CAPACITY (SEE TABLE P. 2-4)
- d) PERFORMANCE:

- (i) AT TEST FLOOD: OVERTOPPED (2) 7.6' (N.S. ELEV. 118.1' M.S.L.)
- (ii) AT PMF: OVERTOPPED (2) 13.5' (N.S. ELEV. 124.3' M.S.L.)

3) DOWNSTREAM FAILURE CONDITIONS:

- a) PEAK FAILURE OUTFLOW: $Q_p = 18500$ CFS
- b) FLOOD DEPTH IMMEDIATELY FROM DAM: $H_2 = 12.7'$
- c) CONDITIONS $\frac{1}{2}$ FROM THE DAM:
 - (i) STAGE BEFORE FAILURE: $H_2 = 3.6'$ ABOVE NORMAL POOL (Q = 7200 CFS)
 - (ii) STAGE AFTER FAILURE: $H_2 = 7.1'$ ABOVE NORMAL POOL (Q = 18500 CFS)
 - (iii) RISE IN STAGE AFTER FAILURE: $\Delta H = 3.5'$
- d) CONDITIONS $\frac{1}{2}$ FROM P.I. DAM #146:
 - (i) STAGE BEFORE FAILURE: $H_2 = 3.6'$ ABOVE NORMAL POOL (Q = 7200 CFS)
 - (ii) STAGE AFTER FAILURE: $H_2 = 8.7'$ ABOVE NORMAL POOL (Q = 18500 CFS)
 - (iii) RISE IN STAGE AFTER FAILURE: $\Delta H = 5.1'$

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

New England Division
Corps of Engineers

March 1978

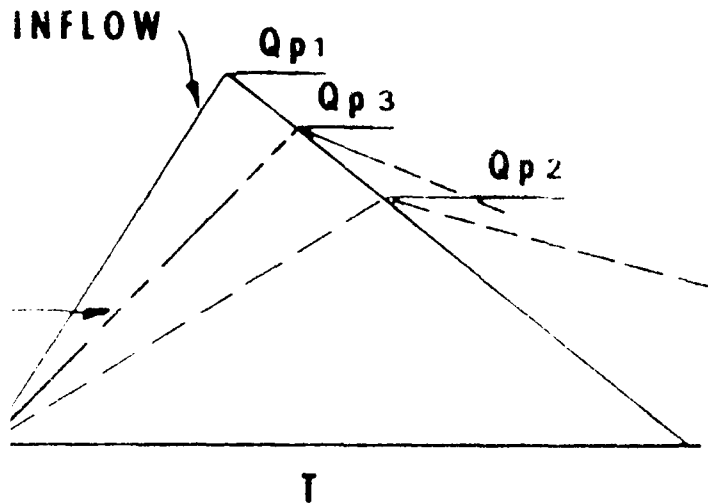
MAXIMUM PROBABLE FLOOD INFLOWS
NED RESERVOIRS

<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

TIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES



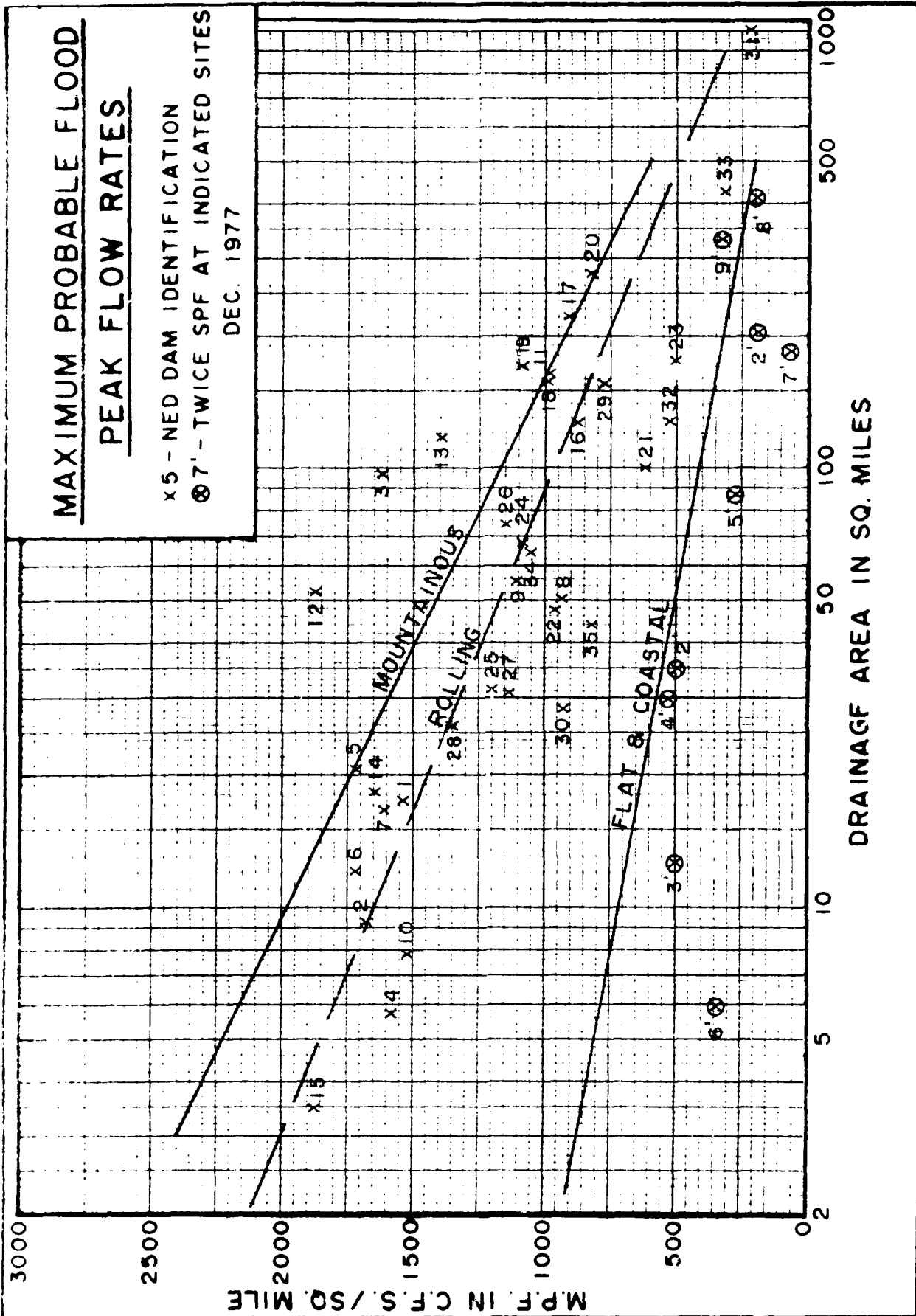
- 1: Determine Peak Inflow (Q_{p1}) from Guide Curves.
- 2: a. Determine Surcharge Height To Pass " Q_{p1} ".
b. Determine Volume of Surcharge ($STOR_1$) In Inches of Runoff.
c. Maximum Probable Flood Runoff In New England equals Approx. 19", Therefore:

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

- 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



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

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

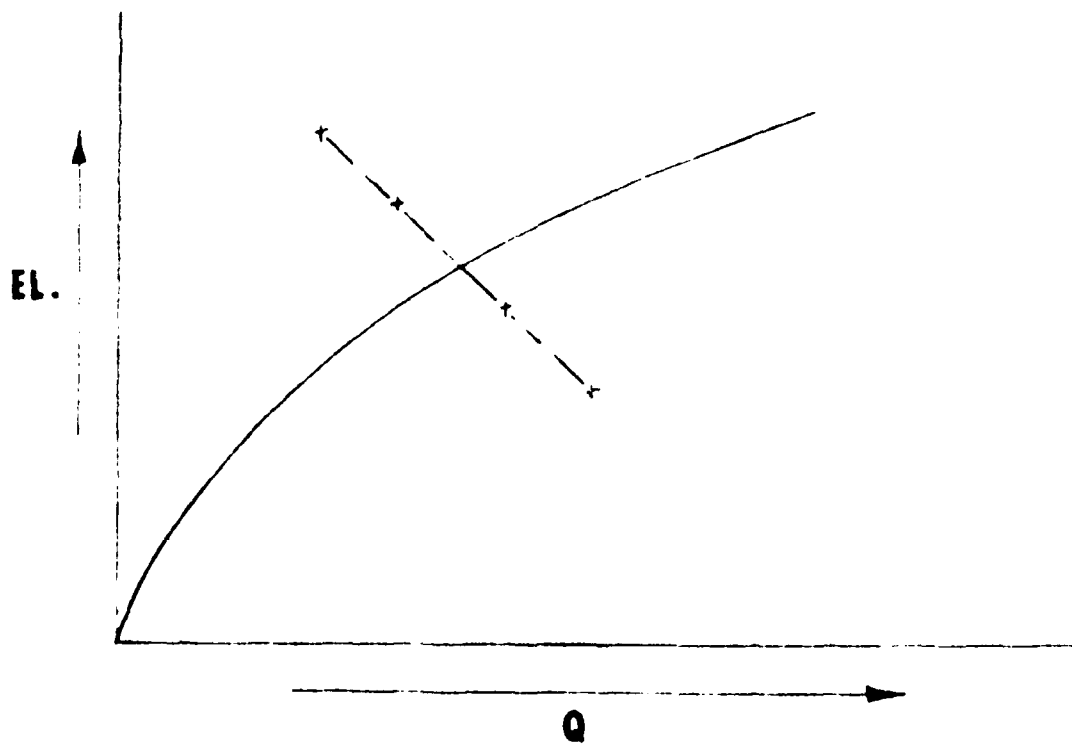
$$Q_{p2} = Q_{p1} - Q_{p1} \left(\frac{\text{STOR}}{19} \right)$$

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

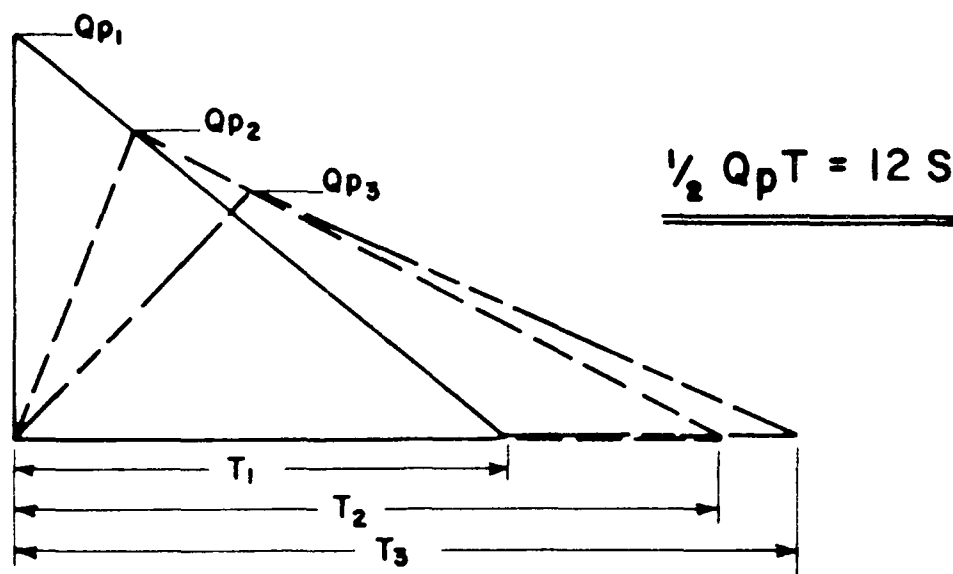
Q_{p2}
=====

STOR
=====

EL.
=====



"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

H

STATE	IDENTITY NUMBER	CONSON	STATE	CONSON	STATE	CONSON	STATE	CONSON	STATE	CONSON	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE	
		DAY		DAY		DAY		DAY		DAY				MO	YR
01	3802	25	01	03	02						ARCTIC DAM	4142.4	7131.3	05	FEB 68

POPULAR NAME	NAME OF IMPOUNDMENT
FACILITY STREET DAM	PANTUCKET RIVER-SOUTH BRANCH

(5)	(6)	(7)	(8)	(9)	(10)
REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY--TOWN--VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	09	PAATINET RIVER--SOUTH BRANCH	WEST HAWAII	0	24323

(A)	(B)	(C)	(D)	(E)	(F)	(G)
TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCT. HEIGHT (FEET)	HYDRAUL. HEIGHT	IMPOUNDING CAPACITIES	
					MAXIMUM (ACRE-FT.)	NORMAL (ACRE-FT.)
OT	1985	U	30	30	210	175

REMARKS
21 MASONRY AND EARTHFILL 23 INDUSTRIAL WATER

[illegible]

OWNER	ENGINEERING BY	CONSTRUCTION BY
ARCTIC DEVELOPMENT CORP.	UNKNOWN	UNKNOWN

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	RI DEM	RI DEM

INSPECTION BY	INSPECTION DATE	AUTHORITY FOR INSPECTION
CANN ENGINEERS INC	DAY MO YR	PL 92-367

REMARKS	

END

FILMED

8-85

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