

UPPER AND LOWER LITTLE RIVER DAMS DAM ASSESSMENT REPORT

PREPARED FOR RANSOM CONSULTING, INC.



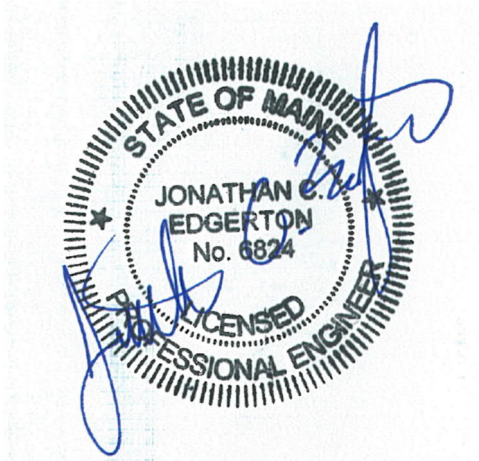
JULY 2018

WRIGHT-PIERCE 
Engineering a Better Environment

UPPER AND LOWER LITTLE RIVER DAMS
DAM ASSESSMENT REPORT

prepared for
RANSOM CONSULTING, INC.

JULY 2018



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**UPPER AND LOWER LITTLE RIVER DAMS
DAM ASSESSMENT REPORT**

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SECTION 1

INTRODUCTION

1.1 PREFACE

The assessment of the general condition of the dams reported herein was based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations were beyond the scope of this report unless reported otherwise.

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

1.2 BACKGROUND AND PURPOSE

The purpose of this investigation was to inspect and evaluate the present condition of the dams and appurtenant structures to provide information that will assist in both prioritizing dam repair needs and planning/conducting maintenance and operation.

The investigation was divided into three parts: 1) obtain and review available reports, investigations, and data previously submitted to the owner pertaining to the dams and appurtenant structures; 2) perform a visual inspection of the sites; and 3) prepare and submit a report presenting the evaluation of the structures, including recommendations and remedial actions.

The discussion has been focused on the desire to understand the risks associated with failure of these two dams. As a part of this effort, we have conducted an assessment into the stability of the Lower Dam. As anticipated, this effort required development of assumptions regarding how the structure is founded (as it does not appear that design drawings for the structure are available) and dewatering the structure to allow for full observation of the structures interface with native conditions was not possible.

Our effort has included a review of past evaluations relative to the hydraulic characteristics of both dams and spillways, and development of new commentary pertinent to the goals of this assessment effort.

1.3 UPPER LITTLE RIVER DAM

The Upper Little River Dam is a 30-foot high, 216-foot long concrete gravity dam. It has historically impounded a reservoir with a surface area of approximately 48 acres and a capacity of about 850 acre-feet. The spillway section of the dam approximately 114 feet in length with a vertical upstream face and slightly battered downstream face. It has been assigned Number 5091 by the Maine Dam Safety office.

A number of inspections conducted since 1979 have identified seepage, scaling, spalling, and surface cracks on the Upper Dam face. A long horizontal crack approximately three feet below the spillway crest apparently is the result of a cold joint between the original concrete dam structure and three feet of additional concrete placed after the 1954 Hurricane Edna flood destroyed the spillway flashboards. The flashboards were not replaced. The top and downstream surfaces of the dam were repaired with sprayed on concrete (called gunitite or shotcrete) in 1991. The deterioration currently visible on the face of the dam is typical for this type of application under the relatively harsh climatic conditions to which it is exposed.

Small trees exist adjacent to the dam abutments and downstream from the dam on both banks of the river. Root growth from trees can compromise the dam foundation, and vegetation can impede water flow in the river during high water events.

Discharge from the dam is controlled by three valves that allow water to enter the control tower and two valves that allow water to exit the control tower through the dam into the Little River. All three of the inlet valves and one of the outlet valves are reportedly operable. There is also an 18-inch drain located in the north abutment (approximately 14.7 feet lower than the spillway and north of the control tower). We were unable to determine the current operational state of this drain.

The top of a 24-inch diameter pipe exists at the downstream toe of the dam. We were unable to discern any gating or valving associated with it, and prior assessments include speculation that it was placed to divert water through the dam structure during the original construction.

Previous efforts included evaluations of the stability and hydraulic capacity of the Upper Dam. The Upper Dam has been inspected a number of times since issuance of the Corps of Engineers report in 1979. There have been persistent questions about its stability which remain as yet unresolved.

1.4 LOWER LITTLE RIVER DAM

The Lower Little River Dam is a 30-foot high, 126-foot long concrete and masonry dam. It has historically impounded a reservoir with a surface area of approximately 37 acres and a capacity of about 600 acre-feet. The spillway section of the dam is an ogee of approximately 91 feet in length with an apron that discharges over a vertical drystone masonry retaining wall. It has been assigned Number 5090 by the Maine Dam Safety office.

Previous inspections, made in 1979 and 1996, indicated the dam was in fair condition. Significant work was undertaken in 1988 to address erosion issues along the south bank of the channel below the dam spillway. Further work was done by the District in 1989 to address erosion issues along the north bank below the dam. Repairs to the concrete surfaces of the dam were completed in 1991.

The gating mechanism for regulating discharge and controlling water level in the reservoir is currently non-functional. This limits the District's ability to lower the level of water behind the dam should it be necessary. Public access to the dam structure is largely uncontrolled.

It was determined that the stability of the Lower Dam should be reviewed in the context of this assessment effort. Section 3 of this report includes discussion regarding the results of the stability analysis.

SECTION 2

UPPER LITTLE RIVER DAM

2.1 Visual Inspection

Upper Little River Dam was inspected on March 15, 2018 and April 10, 2018. At the time of the April inspection, the temperature was near 35° F with partly sunny with a light wind. Photographs to document the current conditions of the dam were taken during both inspections and are included in Appendix C. The level of the impoundment was estimated to be approximately 1-3" inches above the top of spillway/weir crest on both dates. Underwater areas were not inspected.

2.1.1 General Findings

In general, the Upper Little River Dam was found to be in POOR condition with deteriorated concrete. See below for a discussion regarding the factors of safety against sliding and overturning.

2.1.2 Dam

- Abutments

Both abutments appear to be deteriorated and in poor condition.

- Upstream Face - Spillway

The upstream concrete face is believed to be vertical and is cast in place concrete. We were unable to observe the face of the wall as it was underwater.

- Downstream Face - Spillway

The downstream concrete face is offset from the vertical at approximately 1:12. There appear to be significant areas of spalled and cracked concrete. We were limited in our ability to see clearly this portion of the dam due to flows.

- Crest

We were limited in our ability to see clearly this portion of the dam due to flows, but anecdotal reports suggest significant concerns with the condition of the concrete.

- Instrumentation

No instruments were observed at the dam.

- Access Roads and Gates

Both ends of the dam are secured, to some extent, with chain link fencing.

- Drains

No drains were observed during the inspection.

2.1.3 Appurtenant Structures

- Dikes

Not Applicable

- Gates

We were unable to closely observe the gates, but water was discharging from several pipes on the downstream face of the dam (see photos).

2.1.4 Downstream Area

The left and right channel immediately downstream of the dam is comprised largely of rock and stone, transitioning to a bridge opening.

2.1.5 Impoundment Area

No unusual conditions were observed upstream of the dam.

2.2 Assessment Summary

In general, the overall condition of Upper Little River Dam is POOR. Our observations confirmed the presence of significant spalling and delamination of concrete face as well as diagonal and vertical cracks in the abutting gate structure.

Previous inspections and review have identified:

1. Significant concerns relative to the integrity of the concrete comprising the main spillway structure.
2. Likely structural instability, in the form of a low resistance to sliding and overturning of the dam.

2.3 Commentary from Maine Emergency Management Agency

As is customary in our assessment of dams in the State, we contacted Tony Fletcher, the State's Dam Safety Officer. He indicated that, in his opinion, "the upper dam appears to be in an unsatisfactory structural condition, and although it shows no signs of imminent failure, as a precaution I have asked the dam owners to reduce the dams head-pond". He also indicated that "if the dam owners wish to keep the dam, I suggest it be investigated for stability and current material strength before being operated at normal pond".

2.4 Recommendations

Substantial reconstruction is expected to be necessary to address current deficiencies at the dam. Prior to undertaking maintenance, repairs, or remedial measures, the applicability of environmental permits should be determined for activities that may occur within or adjacent to resource areas under the jurisdiction of the local municipal government, the Maine DEP, the Corps of Engineers or other regulatory agencies.

If it is desired to keep the dam, there will be considerable capital cost involved to address the currently identified safety concerns. Development of detailed estimates of the costs associated with such an action is not within the scope of this assessment, although we have provided some information on potential costs, in Section 4 of this report.

Given the condition of the dam, the lack of original as built drawings and the fact that the dam is reaching the end of its useful life, removing the entire dam should be strongly considered. Additional brief discussion is included in Section 4 of this report.

In the interim, the water level of the impoundment should be kept well below the spillway crest to manage the risk of dam breach.

SECTION 4 CONCLUSIONS AND RECOMMENDATIONS

4.1 FUTURE DAM MANAGEMENT

4.1.1 Operation and Maintenance Program

Regardless of any future actions undertaken with respect to the dams, a maintenance program should be put into place any structures to remain.

4.1.2 Monitoring and Surveillance Program

Both the Corps of Engineers and MEMA have recommended that the District prepare Inspection and Monitoring programs for the dams. The operations and maintenance program we have prepared includes routine inspection and monitoring as an integral part.

4.1.3 Emergency Action Plan

The purpose of an emergency action plan is to clearly state what conditions threaten each dam and the steps necessary to protect the public safety. The plan should include the steps the Dam Owner will take to prevent dam failure, for example early release of water in advance of predicted storm events, periodic checking during storm events, etc. It should also include steps the Dam Owner and the community will take to minimize loss of life and downstream damage should either dam breach. The plan, including a notification flowchart and contact information is normally prepared in conjunction with public safety officials.

4.2 UPPER LITTLE RIVER DAM

Given the condition of the Upper Dam, the lack of original as-built drawings and the fact that the dam is reaching the end of its useful life, either partial or complete removal of the dam should be strongly considered. Having said that, the three primary options available include:

4.2.1 Complete Removal of the Upper Dam

This option eliminates the risk associated with future dam breach, as well as the financial burden associated with maintaining a dam at this location. It is worth noting that residents of the community have become accustomed to the impoundment as a scenic and recreational amenity and it is to be expected that there is some contingent (possibly a vocal one) that may actively resist a decision to remove the dam and eliminate the impoundment. Assuming the lower dam is to remain in place, the ecological benefit associated with allowing upstream fish passage at this location is likely limited, and it can probably be argued that the impoundment provides desirable habitat for waterfowl and wading birds.

4.2.2 Partial Removal of the Upper Dam

This option mitigates the risk associated with future dam breach through lowering the effective height of the dam and implementing structural enhancements necessary to provide suitable factors of safety against sliding and overturning. Note that this option perpetuates the financial burden associated with maintaining a dam at this location. The precise elevation of the revised spillway crest would be determined based on a limited bathymetric study, which would support determining a reduced impoundment to remain as a scenic and recreational amenity.

4.2.3 Rehabilitation of the Upper Dam

This option addresses the currently identified deficiencies through implementing structural enhancements necessary to provide suitable factors of safety against sliding and overturning.

Any repairs undertaken at the Upper Dam should be made in accordance to standard design practices, specifications and construction methods associated with concrete gravity dams. Design or analysis of the work should be completed by a qualified professional engineer experienced in the design and rehabilitation of dams.

In the short-term, the water level of the impoundment should be kept well below the spillway crest to manage the risk of dam breach.

4.3 LOWER LITTLE RIVER DAM

Our assessment identified several potential areas for repairs or improvements:

4.3.1 Evaluate and Address Stability Concerns of Left Bank Retaining Wall

Conduct a more detailed review of the stability of the left (westerly) bank downstream retaining wall. Based on our observations, it appears that some of the precast units may have been displaced over time. As noted above, we have contacted the Corps of Engineers to determine whether As-Built drawings are available for the wall in question. In cases like this, it is not uncommon to implement a monitoring system to determine whether the retaining wall is stable in its current configuration, and to define the magnitude of any ongoing or future displacement of the concrete units.

4.3.2 Install Low Level Drain

Install a low-level drain which would facilitate dewatering for the purposes of inspection, maintenance or repairs. This should likely be included in the rehabilitation of the flow chamber/vault area and left bank retaining wall located at the right (easterly) end of the dam, as discussed below.

4.3.3 Rehabilitate / Reconstruct Vault / Flow Chamber

Conduct repairs to the existing concrete and stone masonry at the flow chamber/vault between the dam and Water District building. This effort should be coordinated with the installation of a gated low-level drain.

4.3.4 Reconstruct / Replace Left Bank Retaining Wall

Conduct repairs/replacement to the retaining wall just upstream of the Vault/Flow Chamber on the right (easterly) bank.

4.3.5 Further Evaluate Stability / Factor of Safety Against Sliding

Consider whether further efforts to refine assumptions relative to the stability analysis (sliding – depends on foundation conditions) are warranted. It is difficult to assign a cost to this element as it requires dewatering of the dam (or may be attempted with a diver). The results of

such an effort are uncertain and, hence, it may make sense to further discuss the pros and cons before initiating this task.

Any repairs undertaken at the Lower Dam should be made in accordance to standard design practices, specifications and construction methods associated with concrete gravity dams. Design or analysis of the work should be completed by a qualified professional engineer experienced in the design and rehabilitation of dams.

SECTION 4

CONCLUSIONS AND RECOMMENDATIONS

4.1 FUTURE DAM MANAGEMENT

4.1.1 Operation and Maintenance Program

Regardless of any future actions undertaken with respect to the dams, a maintenance program should be put into place any structures to remain.

4.1.2 Monitoring and Surveillance Program

Both the Corps of Engineers and MEMA have recommended that the District prepare Inspection and Monitoring programs for the dams. The operations and maintenance program we have prepared includes routine inspection and monitoring as an integral part.

4.1.3 Emergency Action Plan

The purpose of an emergency action plan is to clearly state what conditions threaten each dam and the steps necessary to protect the public safety. The plan should include the steps the District will take to prevent dam failure, for example early release of water in advance of predicted storm events, periodic checking during storm events, etc. It should also include steps the Dam Owner and the community will take to minimize loss of life and downstream damage should either dam breach. The plan, including a notification flowchart and contact information is normally prepared in conjunction with public safety officials.

4.2 UPPER LITTLE RIVER DAM

Given the condition of the Upper Dam, the lack of original as built drawings and the fact that the dam is reaching the end of its useful life, either partial or complete removal of the dam should be strongly considered. Having said that, the three primary options available include:

In the short-term, the water level of the impoundment should be kept well below the spillway crest to manage the risk of dam breach.

4.2.1 Complete Removal of the Upper Dam

This option eliminates the risk associated with future dam breach, as well as the financial burden associated with maintaining a dam at this location. It is worth noting that residents of the community have become accustomed to the impoundment as a scenic and recreational amenity and it is to be expected that there is some contingent (possibly a vocal one) that may actively resist a decision to remove the dam and eliminate the impoundment. Assuming the lower dam is to remain in place, the ecological benefit associated with allowing upstream fish passage at this location is likely limited, and it can probably be argued that the impoundment provides desirable habitat for waterfowl and wading birds. We suggest an order-of-magnitude cost associated with full dam removal is likely on the order of \$ [REDACTED].

4.2.2 Partial Removal of the Upper Dam

This option mitigates the risk associated with future dam breach through lowering the effective height of the dam and implementing structural enhancements necessary to provide suitable factors of safety against sliding and overturning. Note that this option perpetuates the financial burden associated with maintaining a dam at this location. The precise elevation of the revised spillway crest would be determined based on a limited bathymetric study, which would support determining a reduced impoundment to remain as a scenic and recreational amenity. We suggest an order-of-magnitude cost associated with partial dam removal is likely on the order of \$ [REDACTED].

4.2.3 Rehabilitation of the Upper Dam

This option addresses the currently identified deficiencies through implementing structural enhancements necessary to provide suitable factors of safety against sliding and overturning. We suggest an order-of-magnitude cost associated with rehabilitation of the upper dam is likely on the order of \$ [REDACTED].

Any repairs undertaken at the Upper Dam should be made in accordance to standard design practices, specifications and construction methods associated with concrete gravity dams.

Design or analysis of the work should be completed by a qualified professional engineer experienced in the design and rehabilitation of dams.

4.3 LOWER LITTLE RIVER DAM

Our assessment identified several potential areas for repairs or improvements:

4.3.1 Evaluate and Address Stability Concerns of Left Bank Retaining Wall

Conduct a more detailed review of the stability of the left (westerly) bank downstream retaining wall. Based on our observations, it appears that some of the precast units may have been displaced over time. As noted above, we have contacted the Corps of Engineers to determine whether As-Built drawings are available for the wall in question. We suggest an order-of-magnitude cost associated with a detailed assessment into the stability of the downstream left bank retaining wall is likely on the order of \$ [REDACTED]. In the event a comprehensive rehabilitation of the wall is in order, we suggest an order-of-magnitude cost for rehabilitation of the wall may be on the order of \$ [REDACTED].

4.3.2 Install Low Level Drain

Install a low-level drain which would facilitate dewatering for the purposes of inspection, maintenance or repairs. This should likely be included in the rehabilitation of the flow chamber/vault area located at the right (easterly) end of the dam, as discussed below. We suggest an order-of-magnitude cost associated with the installation of a low-level drain is likely on the order of \$ [REDACTED]. Note that this should be undertaken in coordination with the rehabilitation of the Vault / Flow Chamber discussed below.

4.3.3 Rehabilitate / Reconstruct Vault / Flow Chamber

Conduct repairs to concrete and stone masonry at the flow chamber/vault between the dam and Water District Building. This effort should be coordinated with the installation of a gated low-level drain. We suggest an order-of-magnitude cost associated with rehabilitation of the flow chamber/vault is likely on the order of \$ [REDACTED].

4.3.4 Reconstruct / Replace Left Bank Retaining Wall

Conduct repairs/replacement to retaining wall just upstream of the Vault/Flow Chamber on the right (easterly) bank. We suggest an order-of-magnitude cost associated with replacement of the upstream left retaining wall is likely on the order of \$ [REDACTED].

4.3.5 Further Evaluate Stability / Factor of Safety Against Sliding

Consider whether further efforts to refine assumptions relative to the stability analysis (sliding – depends on foundation conditions) are warranted. It is difficult to assign a cost to this element as it requires dewatering of the dam (or may be attempted with a diver). The results of such an effort are uncertain and, hence, it may make sense to further discuss the pros and cons before initiating this task.

Any repairs undertaken at the Lower Dam should be made in accordance to standard design practices, specifications and construction methods associated with concrete gravity dams. Design or analysis of the work should be completed by a qualified professional engineer experienced in the design and rehabilitation of dams.

APPENDIX A
Location Map



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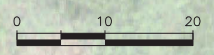
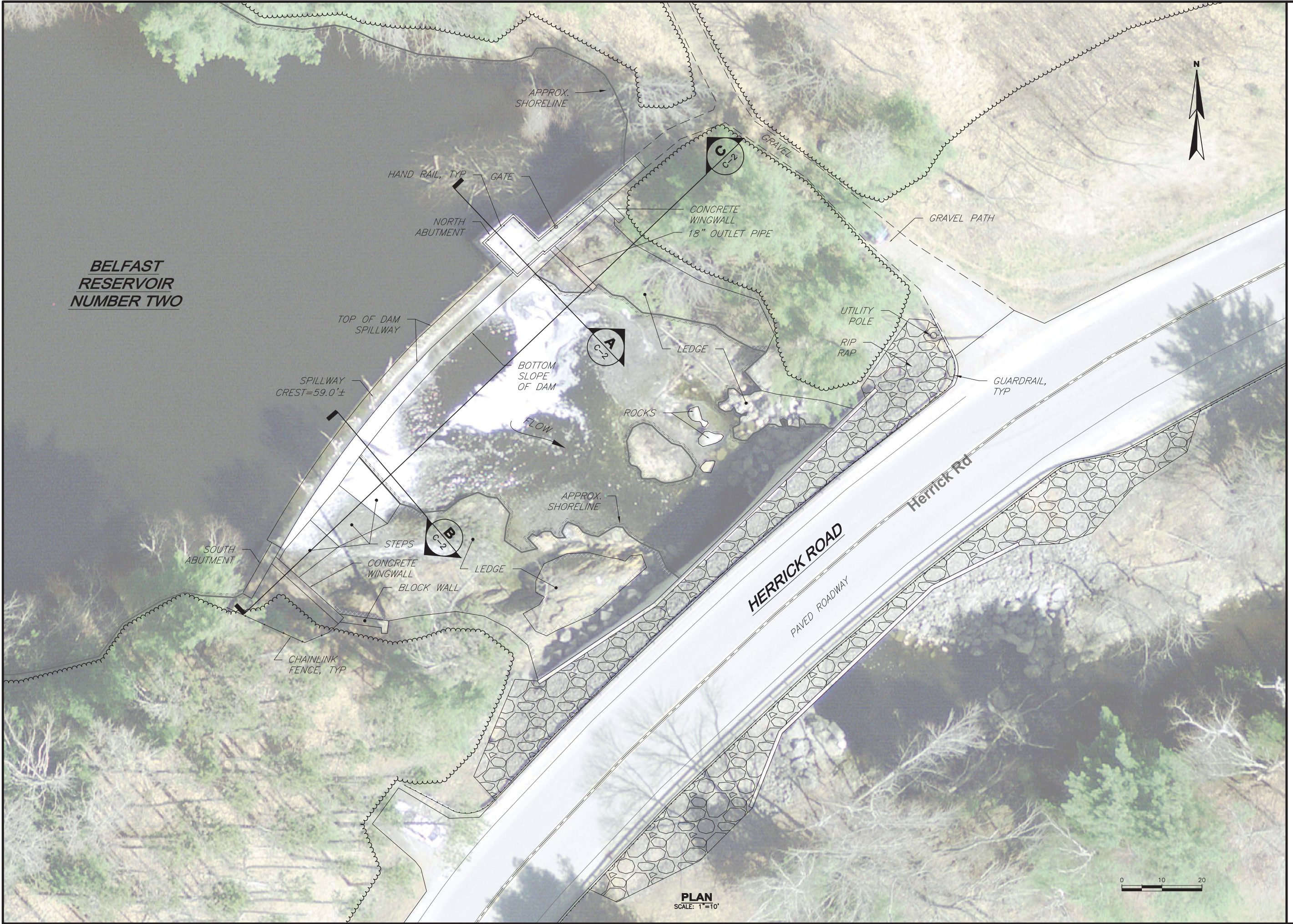
**Upper Little River and
Lower Little River Dams
Belfast, Maine**

PROJ NO:	14037	DATE:	4/19/2018
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WRIGHT-PIERCE Engineering a Better Environment	FIGURE: 1
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Source: Esri, Digital
Data, USDA, USGS,

APPENDIX B
Upper Dam - Plan and Sections



PLAN
SCALE: 1"=10'

SUBMISSIONS/REVISIONS		APP'D	DATE
NO.	DESCRIPTION		
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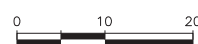
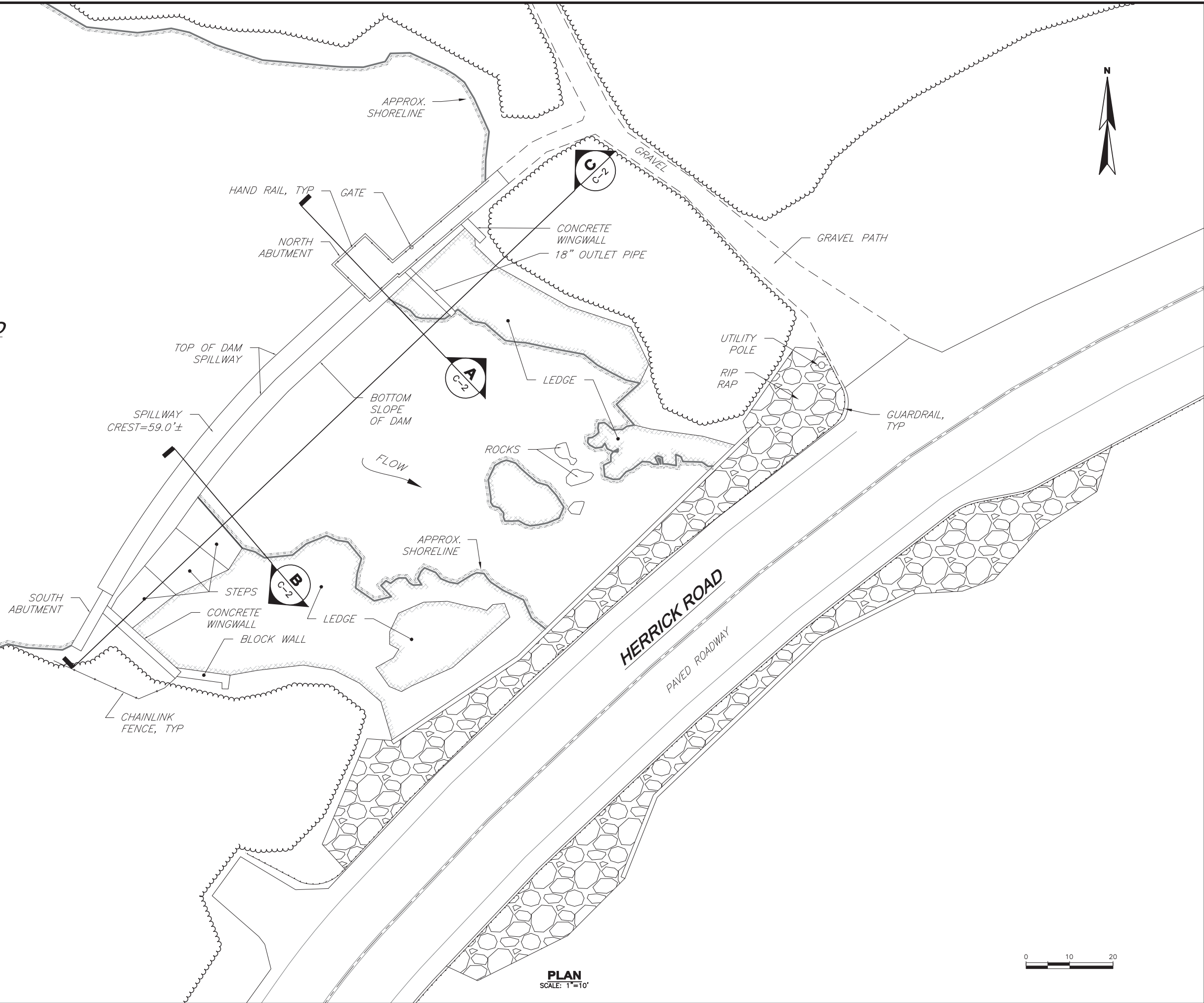
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BELFAST WATER DISTRICT
 UPPER AND LOWER LITTLE RIVER DAMS
 BELFAST, MAINE
 UPPER DAM EXISTING CONDITIONS

DRAWING
 C-1

BELFAST RESERVOIR NUMBER TWO



PLAN
SCALE: 1"=10'

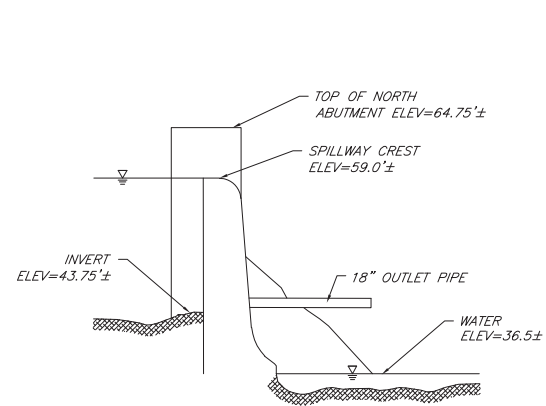
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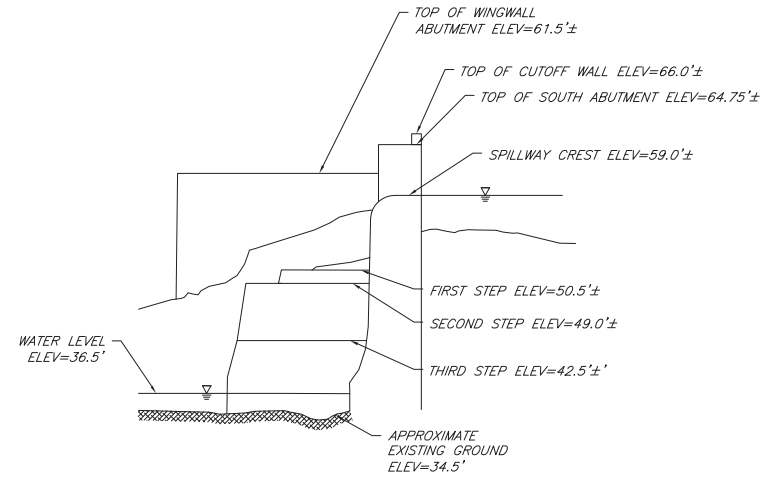
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BELFAST WATER DISTRICT
 UPPER AND LOWER LITTLE RIVER DAMS
 BELFAST, MAINE
 UPPER DAM EXISTING CONDITIONS

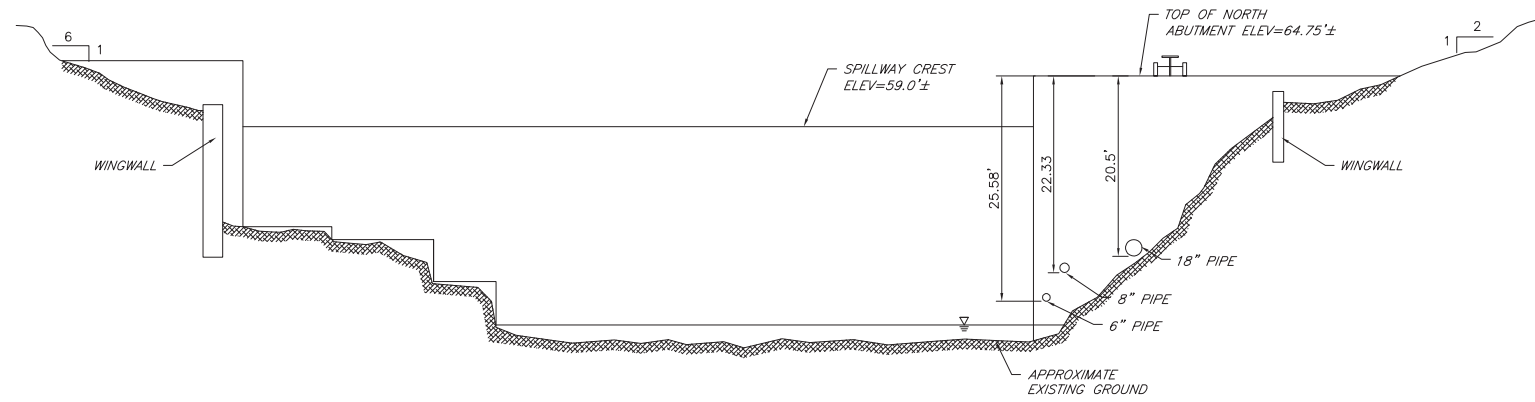
DRAWING
 C-1



SECTION A
SCALE: 1"=10'
C-1



SECTION B
SCALE: 1"=10'
C-1



SECTION C
SCALE: 1"=10'
C-1

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BELFAST WATER DISTRICT
UPPER AND LOWER LITTLE RIVER DAMS
BELFAST, MAINE
UPPER DAM SECTIONS

DRAWING
C-2

APPENDIX C
Upper Dam - Photographs



Little River Dam
Belfast, Maine

Upper Dam



Little River Dam
Belfast, Maine

Upper Dam





Little River Dam
Belfast, Maine

Upper Dam



Little River Dam
Belfast, Maine

Upper Dam

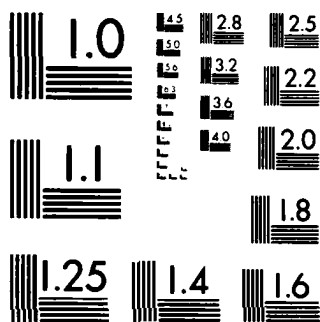








APPENDIX D
Upper Dam - ACOE Phase 1 Report



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

AD-A155 372

(2)

ATLANTIC OCEAN
BELFAST, MAINE

LITTLE RIVER UPPER DAM
ME 00289

STATE NO. 5091

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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JUN 24 1985
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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

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NOVEMBER 1979

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ME 00289	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Little River Upper 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 November 1979
		13. NUMBER OF PAGES 50
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, Atlantic Ocean Belfast Maine Little River		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The dam is a concrete gravity dam with a hydraulic height of 30 ft., and is 216 ft. long. The dam is in fair condition. It is small in size with a hazard potential of significant. A major breach at top of dam could possibly result in the loss of one life and could cause appreciable property damage.		

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION
NEDED

JUL 07 1980

Honorable Joseph E. Brennan
Governor of the State of Maine
State Capitol
Augusta, Maine 04330

Dear Governor Brennan.

Inclosed is a copy of the Little River Upper Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Agriculture cooperating agency for the State of Maine. In addition, a copy of the report has also been furnished the owner, Belfast Water District, 71 Church Street, Belfast, Maine 04915.

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

I wish to take this opportunity to thank you and the Department of Agriculture for your cooperation in carrying out this program.

Sincerely,

Max B. Scheider
MAX B. SCHEIDER

Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.: ME00289
Name of Dam: Little River Upper Dam
Town: Belfast
County and State: Waldo, Maine
Stream: Little River
Date of Inspection: September 17, 1979

BRIEF ASSESSMENT

Little River Upper Dam is a concrete gravity dam with a hydraulic height of 30 feet, 216 feet long, 3.0 feet wide at the crest, with a vertical upstream face and a downstream face battered at approximately 1H:12V. The central overflow spillway section of the dam is 114 feet long with a slight curvature. At the south abutment there is a concrete training wall. At the north end of the spillway is a concrete intake structure; beyond this, the dam extends to the north abutment. The dam impounds a reservoir with a maximum storage capacity of about 850 acre-feet. The reservoir is .83 mile long with a surface area of about 48 acres and is used as a regulating reservoir for use in water supply for the Town of Belfast.

The dam is in fair condition. Major concerns are: The large ratio of height to average width of the gravity section of the dam, trespassing and erosion on the embankment sections of the dam, trees and brush growing on the embankment sections at the ends of the dam, cracking and spalling of the exposed concrete surfaces, and flexibility and weathering of the plywood cover over the control tower.

Based on small size and significant hazard classification in accordance with Corps guidelines, the test flood ranges from $\frac{1}{4}$ to $\frac{1}{2}$ Probable Maximum Flood (PMF). Because the dam's storage capacity is in the upper range of size classification, $\frac{1}{2}$ PMF will be used as the test flood. The test flood inflow was determined to be 12,800 cfs. The routed test flood outflow for Little River Upper Dam, having a drainage area of 13.7 square miles was determined to be 12,200 cfs at elevation 68.2' MSL, which would overtop the dam by about 3.3 feet. Spillway capacity at top of dam is 5,390 cfs, which is 44 percent of the test flood discharge. A major breach at top of dam could possibly result in the loss of one life and could cause appreciable property damage. (See Section 5.1 f.)

The owner, Belfast Water District, should implement the results of the recommendations and remedial measures given in Sections 7.2 and 7.3 within one year after receipt of this Phase I Inspection Report.

Warren A. Guinan

Warren A. Guinan
Project Manager
N.H. P.E. 2339

This Phase I Inspection Report on Little River Upper 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.

Aramast Mahtesian

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Richard J. DiBuono

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

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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 inspections. 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 will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway 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.

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October, 1979

Figure 1 - Overview of Little River Upper Dam.

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
LITTLE RIVER UPPER DAM

SECTION 1
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. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols under a letter of August 28, 1979 from William E. Hodgson, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0050, as changed, has been assigned by the Corps of Engineers for this work.

b. Purpose.

- (1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
- (2) To encourage and prepare the States to initiate quickly effective dam safety programs for non-Federal dams.
- (3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Little River Upper Dam, commonly called Upper Dam, is located in the Town of Belfast, Maine; the dam spans Little River approximately 5,600 feet upstream from the river's confluence with the Atlantic Ocean. The dam impounds a pond called Belfast Reservoir Number 2. After discharging at the damsite, Little River flows easterly for a distance of 2,200 feet before it enters Belfast Reservoir Number 1. Little River Upper Dam is shown on the U.S.G.S. Quadrangle Belfast, Maine with coordinates approximately at N 44° 24' 00", W 69° 00' 20", Waldo County, Maine. (See Location Map page vii.)

b. Description of Dam and Appurtenances. Little River Upper Dam is a concrete gravity dam with a hydraulic height of 30 feet, 216 feet long, 3.0 feet wide at the crest, with a vertical upstream face and a downstream face battered at approximately 1H:12V. The central overflow spillway section of the dam is 114 feet long with a slight curvature. At the south end of the overflow spillway section, there is a concrete training wall extending 22.8 feet downstream from the dam. Between this wall and the south abutment earth has been placed. At the south abutment between the training wall and downstream face of the spillway are three concrete steps. Their function is probably to protect the rocky abutment from undermining and also to act as energy dissipators.

Bedrock exposure in the valley downstream of the dam shows that the dam is at least partially founded on bedrock. At the north end of the spillway is a concrete intake structure; beyond this, the dam extends to the north abutment. Earth has been placed against the upstream and downstream faces of the concrete dam near the abutments. A gate, which is not operable and is of unknown size, exists at the north abutment. There are 3 inlet valve operators (unknown type and size) and 2 (6" & 8") outlet pipes from the intake chamber to the downstream channel. There is some evidence of another low-level outlet of an undetermined size and condition approximately 5 feet south of the intake structure under the spillway.

c. Size Classification. Small (hydraulic height - 30 feet; storage - 850 acre-feet) based on height and storage (≥ 25 to < 40 feet; ≥ 50 to < 1000 acre-feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant hazard. A major break would probably result in the loss of one life and could cause appreciable property damage and loss as a regulating reservoir for use in water supply. (See Section 5.1 f.)

e. Ownership. Presently Little River Upper Dam is owned by Belfast Water District. Information about past ownership was not available.

f. Operator. The current owner and operator of the dam is Belfast Water District, 71 Church Street, Belfast, Maine 04915. Telephone: (207) 338-1200.

g. Purpose of Dam. Reservoir Number 2 is used as a regulating reservoir for use in water supply. Water impounded at Little River Upper Dam can be released through valve chambers into the downstream channel to provide sufficient inflow into Reservoir Number 1 during periods of low water.

h. Design and Construction History. No information regarding the original design or construction of the dam was disclosed.

i. Normal Operating Procedures. No written operational procedures exist for Little River Upper Dam. The gate operating mechanism with 18-inch vcp outlet is rusted and is not in operable condition. Three inlet valve operators (that are reported to be operable), a valve chamber, and two outlet pipes are utilized to put discharge into the downstream channel to provide additional inflow into Reservoir Number 1 as required to meet demands.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 13.7 square miles (8,768 acres) of mountainous and partially wooded terrain. The normal pool has a surface area of 48 acres, which constitutes less than 1 percent of the watershed.

b. Discharge at Damsite.

- (1) Outlet works
 - (a) - unknown size gate - not operable
 - (b) - 3 inlet valve operators discharge flow into valve chamber with two outlet pipes:
 - 6-inch diameter at outlet elevation - 38.7' MSL
 - 8-inch diameter at outlet elevation - 35.5' MSL
 - (c) - Low-level outlet of an unknown size

(2) The maximum known discharge at damsite is unknown

(3) Ungated spillway (principal) capacity @ top of dam elevation - 5,390 cfs @ 64.9' MSL

(4) Ungated spillway capacity @ test flood elevation - 10,500 cfs @ 68.2' MSL

(5) Gated spillway capacity @ top of dam elevation - not applicable

(6) Gated spillway capacity @ test flood elevation - not applicable

(7) Total spillway capacity @ test flood elevation - 10,500 cfs @ 68.2' MSL

(8) Total project discharge @ test flood elevation - 12,200 cfs @ 68.2' MSL

c. Elevation. (feet above NGVD of 1929; formerly known as Mean Sea Level (MSL); see (6) below)

(1) Streambed at centerline of dam - 34.5 (at downstream toe)

(2) Maximum tailwater - unknown

(3) Upstream valve chamber invert - unknown

- (4) Recreation Pool - not applicable
 - (5) Full flood control pool - not applicable
 - (6) Spillway crest - 59 (as shown on U.S.G.S. Quadrangle sheet)
 - (7) Design surcharge (original design) - unknown
 - (8) Top of dam - 64.9
 - (9) Test flood pool - 68.2
- d. Reservoir (miles)
- (1) Length of maximum pool - .95
 - (2) Length of spillway crest pool - .83
 - (3) Length of flood control pool - not applicable
- e. Storage. (acre-feet)
- (1) Recreation pool - not applicable
 - (2) Flood control pool - not applicable
 - (3) Spillway crest pool - 480
 - (4) Top of dam - 850
 - (5) Test flood pool - 1045
- f. Reservoir Surface (acres)
- (1) Recreation pool - not applicable
 - (2) Flood control pool - not applicable
 - (3) Spillway crest - 48
 - (4) Test flood pool - 75
 - (5) Top of dam - 70
- g. Dam
- (1) Type - concrete gravity
 - (2) Length - 216'
 - (3) Height - 31.5' structural height
 - (4) Top width - 3'

(5) Side slopes - upstream - vertical
- downstream - 1H:12V

(6) Zoning - not applicable

(7) Impervious core - not applicable

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel. - not applicable.
(See j. below.)

i. Spillway

(1) Type - concrete ogee overflow

(2) Length of weir - 114'

(3) Crest elevation - 59' MSL

(4) Gates - none

(5) U/S Channel - Reservoir Number 2 completely open

(6) D/S Channel - Little River for about 2,200 feet
before it enters Reservoir Number 1, rocky channel,
very well defined. Herrick Road bridge spans
over the river 200' below the Dam.

j. Regulating Outlets. Three inlet valve operators dis-
charge flow into valve chamber with two outlet pipes:

6-inch diameter @ outlet elevation - 38.7' MSL

8-inch diameter @ outlet elevation - 35.5' MSL

SECTION 2
ENGINEERING DATA

2.1 Design

No design data were disclosed for Little River Upper Dam.

2.2 Construction

No construction records were disclosed.

2.3 Operation

No engineering operational data were obtained.

2.4 Evaluation

a. Availability. No engineering data were available for Little River Upper Dam. Direct contact with the Belfast Water District and a search of the files at the Maine Soil and Water Conservation Commission revealed only a limited amount of data.

b. Adequacy. The final assessments and recommendations of this investigation are based on the visual inspection and the hydrologic and hydraulic calculations.

c. Validity. No engineering data were disclosed to validate.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Little River Upper Dam is a low run-of-river dam which impounds a reservoir of small size. The watershed above the reservoir is rolling and partially wooded. The downstream area is rolling and partially wooded.

b. Dam. Little River Upper Dam is a concrete ogee shaped gravity dam 30 feet high (hydraulic), 216 feet long, and 3.0 feet wide at the crest, with a vertical upstream face and a downstream face battered at 1H:12V. (See Appendix C - Figures 2 and 3.) The central overflow spillway section of the dam is 114 feet long with a slight curved alignment. At the south end of the overflow spillway section there is a concrete training wall extending 22.8 feet downstream from the dam. Between this wall and the south abutment earth has been placed against the upstream and downstream faces of the concrete dam. At the north end of the spillway, there is a concrete intake structure, beyond which the dam extends to the north abutment. (See Appendix C - Figure 4.) Earth has been placed against the upstream and downstream faces of the concrete dam near the abutment. The ends of the dam where the concrete wall is flanked by earthfill on both the upstream and downstream sides are referred to as embankment sections in subsequent sections of this report and in the checklist. Bedrock exposures on the south side of the valley downstream of the dam show that that end of the dam is founded on bedrock. (See Appendix C - Figure 5.) Soil cover and brush growing on the north side of the valley make it impossible to determine visually whether that end of the dam is founded on bedrock.

The visible portion of the concrete spillway and training walls show some evidence of surface deterioration and cracking. A substantial portion of the spillway and training walls have been repaired with gunite in the past. Several areas of the gunite patching are cracked and spalled from the original concrete surface. (See Appendix C - Figure 6.) Numerous hairline cracks in the spillway face and training walls exhibit efflorescence. The crest and downstream face of the concrete spillway are water stained. The downstream toe of the concrete spillway has eroded exposing the coarse aggregate.

Trespassing has been considerable on the crest and downstream and upstream slopes of the embankment section at the south end of the dam, to the extent that many patches are bare of vegetation. Major erosion has occurred on the abutment side of the training wall that extends downstream from the south end of the

overflow section of the dam. Brush and small trees are growing on the upstream slope. (See Appendix C - Figures 7 & 8.)

Minor trespassing has occurred on the crest and upstream and downstream slopes of the embankment section at the north end of the dam. Brush and small trees are growing on the crest and upstream and downstream slopes.

c. Appurtenant Structures. At the north end of the overflow spillway there is a 9.7-foot by 8.3-foot concrete control tower (intake structure) constructed integrally with the spillway and north end of the concrete non-overflow section of the dam. (See Appendix C - Figure 9.) The control tower contains 3 inlet valves (unknown size and type) for varied elevations. There are two discharge pipes approximately 30 feet down from the top of the tower to discharge water from the intake chamber to the downstream channel. (See Appendix C - Figure 10.) The Belfast Water Department Assistant Superintendent reported that the 3 inlet valves are in operable condition. Visual inspection revealed that there is only minor seepage into the chamber from the upstream side. There are numerous hairline cracks on the downstream face of the control tower exhibiting efflorescence. (See Appendix C - Figure 6.) Access to the interior of the chamber is through two trap doors on the top of the chamber, one steel and one plywood. (See Appendix C - Figure 4.) The steel door is surface rusted and the plywood door is weathered. The plywood door is unreinforced and is quite flexible. Continued weathering of the plywood will lead to a condition that will no longer support the weight of the operator or other persons and may fail.

Approximately 2 feet to the north of the control tower (intake structure) there is an intermediate level outlet gate operating mechanism. (See Appendix C - Figure 11.) The shaft and steel bearing attached to the upstream face of the dam are coated with gunite. The gate operating mechanism has not been maintained and does not appear operable. The Belfast Water Department Assistant Superintendent reports that the gate has not been operated in many years. An 18-inch clay tile pipe discharges from the downstream face of the dam in line with the gate operating mechanism. (See Appendix C - Figure 6.) Water is discharging from the 18-inch clay tile line at an estimated rate of 15 to 30 gpm.

d. Reservoir Area. The watershed above the reservoir is rolling and partially wooded. (See Appendix C - Figure 12.) No structures were observed on the shore of the reservoir. No evidence of significant sedimentation in the reservoir was observed.

e. Downstream Channel. The channel downstream of the dam appears to be on bedrock. The south bank of the channel is bedrock, but the left bank is soil. Trees and brush overhang the left side of the channel. Herrick Road bridge crosses the channel 200 feet downstream from the dam. (See Appendix C - Figures 13 & 14.)

3.2 Evaluation

Based on the visual inspection, Little River Upper Dam is in fair condition.

Trespassing on the embankment sections at the south and north abutments has caused major erosion on the abutment side of the downstream training wall at the south end of the overflow section of the dam and loss of vegetation elsewhere. Continued trespassing and erosion may endanger the embankment sections and the training wall. Trees and brush are growing on the embankment sections at the ends of the dam. If a tree blows over and pulls out its roots, or if a tree dies and its roots rot, seepage and erosion problems may result.

Trees and brush overhanging the downstream channel between the dam and the highway bridge could contribute to blockage of the channel and the opening under the highway bridge during floodflow.

Hairline cracks and spalled areas of the exposed concrete face could continue to deteriorate and lead to instability of the dam. Frost action in the cracks and rough areas of concrete will speed up at the deterioration process.

The plywood cover over the control tower will pose a dangerous condition to people walking on the cover if left uncorrected.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

No written operational procedures exist for Little River Upper Dam. Three intake valve operators are kept operable to provide sufficient inflow into Reservoir Number 1 during periods of low water.

4.2 Maintenance of Dam

The owner, Belfast Water District, is responsible for the maintenance of dam.

4.3 Maintenance and Operating Facilities

No formal maintenance was disclosed. The intermediate level gate mechanism is inoperable. The three intake valve operating mechanisms are kept in operating condition.

4.4 Description of Any Warning System in Effect

No written warning system exists for the dam.

4.5 Evaluation

Formal operational and maintenance procedures should be developed to ensure that problems that are encountered can be remedied within a reasonable period of time.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. General. Little River Upper Dam is a concrete, ogee shaped gravity dam which impounds a reservoir with a maximum storage capacity of 850 acre-feet. The dam contains runoff from a 13.7-square mile drainage area consisting of mountainous predominately wooded terrain. A gate of unknown size is located at the north abutment. The gate mechanism is rusted and not operable. The gate was designed to control discharge through an 18-inch diameter outlet pipe. There is also a valve chamber control tower at the north abutment. It has three inlet valve operators (size and type unknown) and two outlet pipes (6-inch and 8-inch respectively). The valves are in operating condition. There is evidence of another low-level outlet of an undetermined size and condition approximately 5 feet south of the intake structure, under the spillway. The reservoir level is primarily controlled by the spillway which is located at the center of the dam.

b. Design Data. No hydrologic or hydraulic design data were found.

c. Experience Data. No hydrologic or hydraulic experience data were disclosed.

d. Visual Observations. At the time of the inspection, no visual evidence was noted of damage to the structure caused by overtopping.

e. Test Flood Analysis. Little River Upper Dam is classified as being small in size having a hydraulic height of 30 feet and a maximum storage capacity of 850 acre-feet. The dam was determined to have a significant hazard classification. Using the Recommended Guidelines for Safety Inspection of Dams, test flood range is $\frac{1}{4}$ to $\frac{1}{2}$ the Probable Maximum Flood (PMF).

Because the dam maximum storage capacity is in the upper range of small size classification, the test flood was determined to be $\frac{1}{2}$ the Probable Maximum Flood (PMF).

Using the $\frac{1}{2}$ PMF, the test flood inflow for Little River Upper Dam, having a drainage area of 13.7 square miles, was determined to be 12,800 cfs. After reservoir routing, the test flood discharge was determined to be 12,200 cfs. This value was obtained using the COE guide curves with the 'mountainous' characteristics. The test flood analysis indicates that the dam embankment would be overtopped by approximately 3.3 feet during the test flood conditions. The water depth discharging through the principal spillway would be 9.2 feet and would amount to 10,500 cfs. Spillway capacity at top of dam (64.9' MSL) is 5,390 cfs, which is 44 percent of test flood discharge. Flow through two outlet pipes (6" and 8" in diameter) from the valve chamber is insignificant. Because the gate is

inoperable, the overtopping analysis was calculated assuming no discharge through the 18" outlet pipe or through the larger low-level outlet under the spillway.

f. Dam Failure Analysis. The impact of failure of the dam at the top of dam was assessed using the Guidance for Estimating Downstream Dam Failure hydrographs issued by the Corps of Engineers. The analysis covered the reach extending from the dam to Reservoir Number 1, a distance of 2,200 feet along Little River. A major breach of Little River Upper Dam would result in a breach discharge of about 20,160 cfs. The discharge immediately prior to a breach would be 5,300 cfs or maximum spillway capacity. This antecedent discharge would pass low flow through the Herrick Road bridge with a depth of about 12 feet. A breach would raise the water surface about 16.6 feet causing overtopping of the road and possible structural damage. The antecedent discharge from the Upper Dam, would cause the Lower Dam to have a depth of about 7 feet over the spillway, without considering any storage effects of the reservoir. A breach wave would cause an increase of almost 7 feet which could cause damage to the dam and the water facilities for the Town of Belfast. There could possibly be a loss of life to the dam tender at the Lower Dam. The breach could also cause loss of a regulating reservoir for use in water supply and could cause appreciable property damage. Therefore, Little River Upper Dam was classified Significant Hazard.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The most significant visual observation about the concrete section of this dam is that the ratio of its height to average width appears to be larger than the values commonly associated with gravity dams having conventional factors of safety. (Because the reservoir was filled with water, it was not practical to measure the width at various elevations during the inspection.)

Trespassing on the embankment sections at the south and north abutments has caused major erosion on the abutment side of the downstream training wall at the south end of the overflow section of the dam and loss of vegetation elsewhere. Continued trespassing and erosion may endanger the embankment sections and the training walls.

Hairline cracks and spalled areas of the exposed concrete surface could continue to deteriorate and lead to instability of the dam. Frost action in the cracks and rough areas of the concrete will speed up the process.

The plywood cover over the control tower will pose a dangerous condition to people walking on the cover if left uncorrected.

Trees and brush are growing on the embankment sections at the ends of the dam. If a tree blows over and pulls out its roots, or if a tree dies and its roots rot, seepage and erosion problems may result.

b. Design and Construction Data. No design and construction data are available for this dam.

c. Operating Records. No engineering operational records were obtained.

d. Post-Construction Changes. No information regarding post-construction changes were disclosed.

e. Seismic Stability. This dam is located in Seismic Zone 2 and, in accordance with the Phase I guidelines, does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection indicates that Little River Upper Dam is in fair condition. The major concerns with respect to the integrity of the dam, if left uncorrected, are:

- (1) Large ratio of height to average width of the gravity section of the dam.
- (2) Trespassing and erosion on the embankment sections of the dam.
- (3) Trees and brush growing on the embankment sections at the ends of the dam.
- (4) Cracking and spalling of the exposed concrete surfaces.
- (5) Flexibility and weathering of the plywood cover over the control tower.

b. Adequacy of Information. The information available is such that the assessment of this dam must be based primarily on the results of the visual inspection. There is not enough information about the geometry of the cross section and the foundation conditions to assess the stability of the gravity section of the dam against overturning or sliding.

c. Urgency. The recommendations made in 7.2 and 7.3 should be implemented by the owner within one year after receipt of this Phase I inspection report.

d. Need for Additional Investigation. Additional investigation is needed to assess the stability of the gravity section of the dam against sliding or overturning.

7.2 Recommendations

The owner should engage a Registered Professional Engineer to:

- (1) Evaluate the stability of the dam against sliding and overturning and to design remedial measures, if needed.
- (2) Design procedures for and inspect the clearing of trees and brush from the embankment sections of the dam.

- (3) Design repairs for the erosion that has occurred on the embankment sections of the dam.
- (4) Design repairs to the cracked and spalled areas of the concrete surfaces.
- (5) Repair or replace plywood cover to the control tower.
- (6) Repair or replace 18" clay tile pipe.

The owner should carry out the recommendations made by the Engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

- (1) Prevent trespassing on the embankment section of the dam.
- (2) Repair or replace plywood cover.
- (3) Clear trees and brush for a distance of 25 feet on either side of the downstream channel between the dam and the highway bridge.
- (4) Visually inspect the dam and appurtenant structures once a month.
- (5) Engage a Registered Professional Engineer to make a comprehensive technical inspection of the dam once every year.
- (6) Establish a surveillance program for use during and immediately after heavy rainfall, and also a downstream warning program to follow in case of emergency conditions.

7.4 Alternatives

None.

APPENDIX A
VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Little River Upper Dam, ME

DATE Sept. 17, 1979

TIME 1500

WEATHER Sunny, cool

W.S. ELEV U.S. DN.S.
 59' msl 36.5' msl

PARTY:

- | | |
|----------------------------------|-----------------------------------|
| 1. <u>Warren Guinan (ANCo)</u> | 6. <u>Janusz Czyzowski (ANCo)</u> |
| 2. <u>Stephen Gilman (ANCo)</u> | 7. <u>Ronald Hirschfeld (GEI)</u> |
| 3. <u>Leslie Williams (ANCo)</u> | 8. _____ |
| 4. <u>John Regan (ANCo)</u> | 9. _____ |
| 5. <u>Terry Sapp (ANCo)</u> | 10. _____ |

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>Hydrology/Hydraulics</u>	<u>L. Williams/J. Czyzowski</u>	_____
2. <u>Structural Stability</u>	<u>S. Gilman</u>	_____
3. <u>Soils and Geology</u>	<u>R. Hirschfeld</u>	_____
4. _____	_____	_____
5. _____	_____	_____
6. _____	_____	_____
7. _____	_____	_____
8. _____	_____	_____
9. _____	_____	_____
10. _____	_____	_____

PERIODIC INSPECTION CHECKLIST

PROJECT Little River Upper Dam, ME DATE Sept. 17, 1979
 PROJECT FEATURE Dam Embankment NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<p><u>DAM EMBANKMENT</u></p> <p>Crest Elevation</p> <p>Current Pool Elevation</p> <p>Maximum Impoundment to Date</p> <p>Surface Cracks</p> <p>Pavement Condition</p> <p>Movement or Settlement of Crest</p> <p>Lateral Movement</p> <p>Vertical Alignment</p> <p>Horizontal Alignment</p> <p>Condition at Abutment and at Concrete Structures</p> <p>Indications of Movement of Structural Items on Slopes</p> <p>Trespassing on Slopes</p> <p>Sloughing or Erosion of Slopes or Abutments</p> <p>Rock Slope Protection - Riprap Failures</p> <p>Unusual Movement or Cracking at or Near Toe</p> <p>Unusual Embankment or Downstream Seepage</p> <p>Piping or Boils</p> <p>Foundation Drainage Features</p> <p>Toe Drains</p> <p>Instrumentation System</p> <p>Vegetation</p>	<p><u>EMBANKMENT FROM END OF CONCRETE SECTION TO SOUTH ABUTMENT</u></p> <p>None observed</p> <p>No pavement</p> <p>None observed</p> <p>None observed</p> <p>Good</p> <p>Good</p> <p>Major erosion next to downstream training wall at south end of concrete section.</p> <p>None observed</p> <p>Trespassing on embankment along upstream and downstream sides of corewall. See "Condition at Abutment..." above.</p> <p>No riprap</p> <p>None observed</p> <p>None observed</p> <p>None observed</p> <p>None observed</p> <p>None observed</p> <p>None observed</p> <p>None observed</p> <p>Some trees and brush on embankment, some areas bare of vegetation.</p>

PERIODIC INSPECTION CHECKLIST

PROJECT Little River Upper Dam, ME DATE September 17, 1979
 PROJECT FEATURE Control Tower NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<p><u>OUTLET WORKS - CONTROL TOWER</u></p> <p>a. Concrete and Structural</p> <p>General Condition</p> <p>Condition of Joints</p> <p>Spalling</p> <p>Visible Reinforcing</p> <p>Rusting or Staining of Concrete</p> <p>Any Seepage or Efflorescence</p> <p>Joint Alignment</p> <p>Unusual Seepage or Leaks in Gate Chamber</p> <p>Cracks</p> <p>Rusting or Corrosion of Steel</p> <p>b. Mechanical and Electrical</p> <p>Gate Chamber</p> <p>Float Wells</p> <p>Crane Hoist</p> <p>Elevator</p> <p>Hydraulic System</p> <p>Service Gates</p> <p>Emergency Gates</p> <p>Lightning Protection System</p> <p>Emergency Power System</p> <p>Wiring and Lighting System</p>	<p>Fair, numerous hairline cracks in outside and inside surface. Surface of gate chamber has been faced with gunite.</p> <p>Not visible.</p> <p>Numerous areas of spalling of gunite surfaces.</p> <p>None.</p> <p>Yes, at embedded items. Substantial staining at 8" & 6" gate chamber outlets.</p> <p>Yes, considerable efflorescence at hairline cracks.</p> <p>Good. No indication of movement.</p> <p>Minor leakage into chamber.</p> <p>Numerous hairline cracks.</p> <p>3 inlet valve operators-reported operable.</p> <p>2 outlet pipes.</p> <p>Lower level 18" clay tile pipe (VCP) - gate operating mechanism poor condition seeping ± GPD. No lubrication, rusted, no indication of recent operation. Ass't Supt. indicated no operation that he could remember.</p>

PERIODIC INSPECTION CHECKLIST

PROJECT Little River Upper Dam, ME DATE Sept. 17, 1979
 PROJECT FEATURE Outlet Structure & Channel NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<p><u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u></p> <p>General Condition of Concrete</p> <p>Rust or Staining</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>Drain holes</p> <p>Channel</p> <p>Loose Rock or Trees Overhanging Channel</p> <p>Condition of Discharge Channel</p>	<p>One drain hole (?) discharging water in concrete abutment (outlet works) section at north end of overflow spillway.</p> <p>Some trees overhanging channel.</p> <p>Good.</p>

PERIODIC INSPECTION CHECKLIST

PROJECT Little River Upper Dam, ME DATE Sept. 17, 1979
 PROJECT FEATURE Spillway Weir NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel General Condition Loose Rock Overhanging Channel Trees Overhanging Channel Floor of Approach Channel	Good. None. Some trees overhanging channel. Not visible beneath water surface.
b. Weir and Training Walls General Condition of Concrete Rust or Staining Spalling Any Visible Reinforcing Any Seepage or Efflorescence Drain Holes	(Training walls - fair, numerous hairline cracks in surface - surface has been gunited. (Weir - good. Minor surface erosion and spalling of gunite. Only water stain visible Numerous gunited areas are surface spalling None. Majority of hairline cracks on D/S face Shows efflorescence. One drain hole (1"-3") discharging water from training wall downstream of right end of spillway section. (Only dripping seep)
c. Discharge Channel General Condition Loose Rock Overhanging Channel Trees Overhanging Channel Floor of Channel Other Obstructions	Good. None. Some trees overhanging channel. Bedrock. Highway bridge immediately downstream of dam.

PROJECT Little River Upper Dam, Me.

DATE Sept. 17, 1979

PROJECT FEATURE Reservoir

NAME J. Czyzowski

AREA EVALUATED	REMARKS
Stability of Shoreline	Good
Sedimentation	No evidence
Changes in Watershed Runoff Potential	None
Upstream Hazards	None
Downstream Hazards	Herrick Road Bridge; Reservoir Number 1
Alert Facilities	None
Hydrometeorological Gages	None
Operational & Maintenance Regulations	No written recommendations were found.

APPENDIX B
ENGINEERING DATA

APPLICATION FOR DAM REGISTRATION

Dam Registration Number 5091
Date Received DEC 15 1975
Fee Enclosed 10.00 P82
Quad Sheet Name Belfast
Quad Sheet Number M-9-NE

Location:

County: Waldo
Municipality: Quasi-Municipal Belfast Water District
Name of Dam: Upper Reservoir Dam
Name of Impoundment: Reservoir #2

Ownership:

Name of Owner: Belfast Water District
Address of Owner: 71 Church Street
Belfast, Maine 04915
Telephone Number: 338-1200

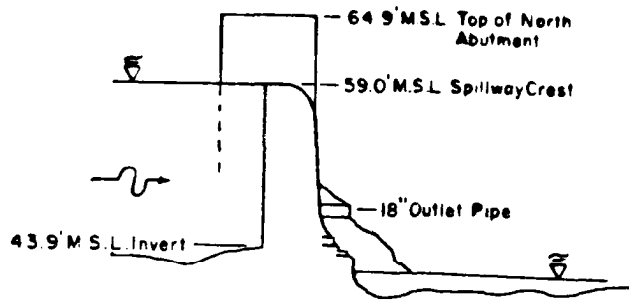
Name of Agent: _____
(if different from Owner)
Address: _____
Telephone Number: _____

Description of Dam

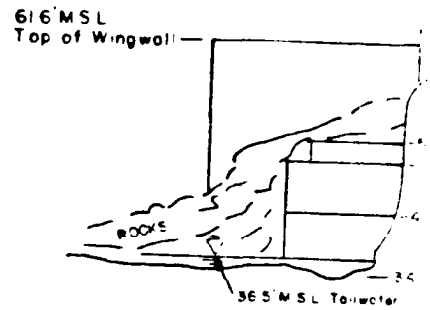
Type: Arched Concrete
Construction Material: Concrete
(Concrete, wood, earth)
Year Originally built: 1913 Year last major repair: 1970
Height: 25 ft. Width: 230 ft.
Spillway type: open Spillway Width: 90 ft.
Impounding Capacity: 157,000,000 gallons
(Acres-feet) Drawdown available: 20 ft.
(feet)
Fish Passage available?: no Installed Electrical Generating Cap: --
Purposes for which stored water is used: Public drinking supply

Most recent inspection by Qualified Engineer (Date): August 1972
Name and Address of Engineer: Dale E. Caruthers - (Deceased)
Masonic Building, Gorham, Maine 04038

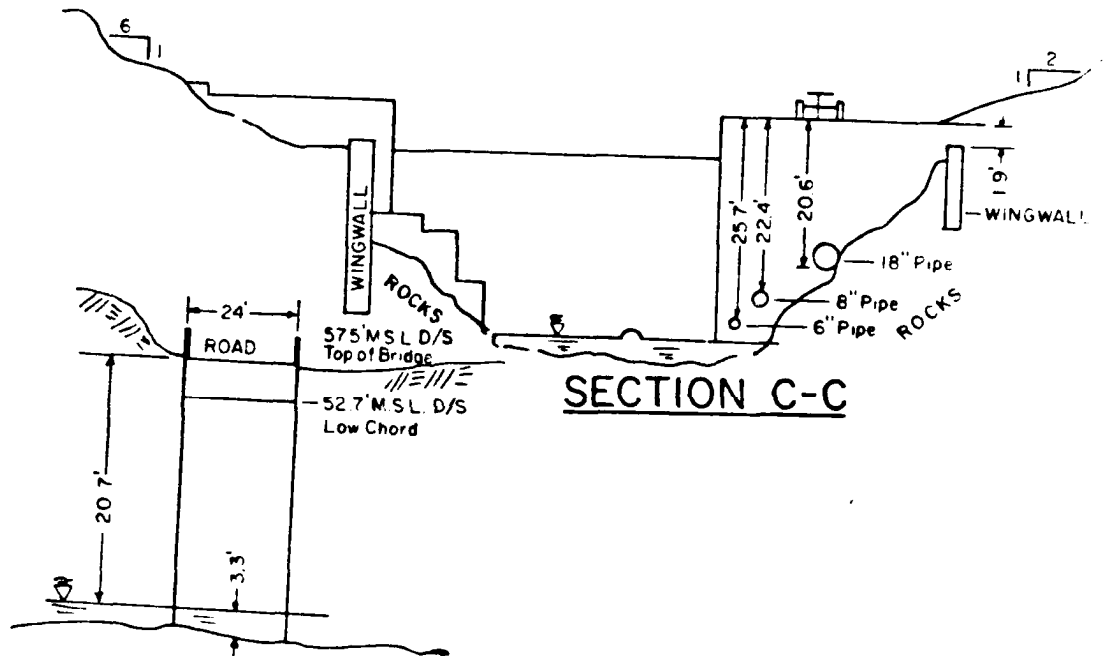
Other Permits applicable: -----



SECTION A-A

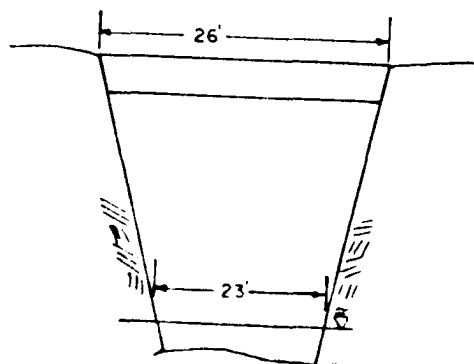


SECTION E-E

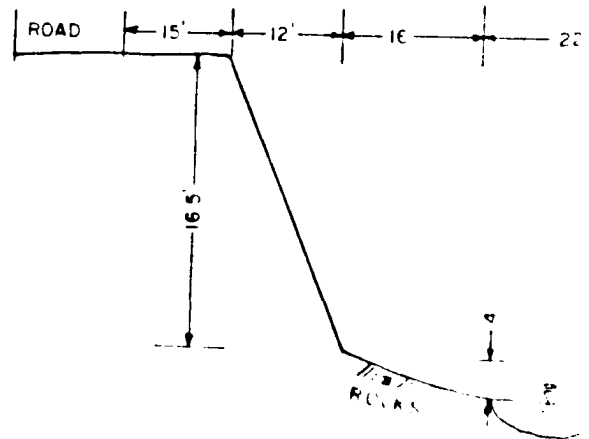


SECTION C-C

SECTION D-D

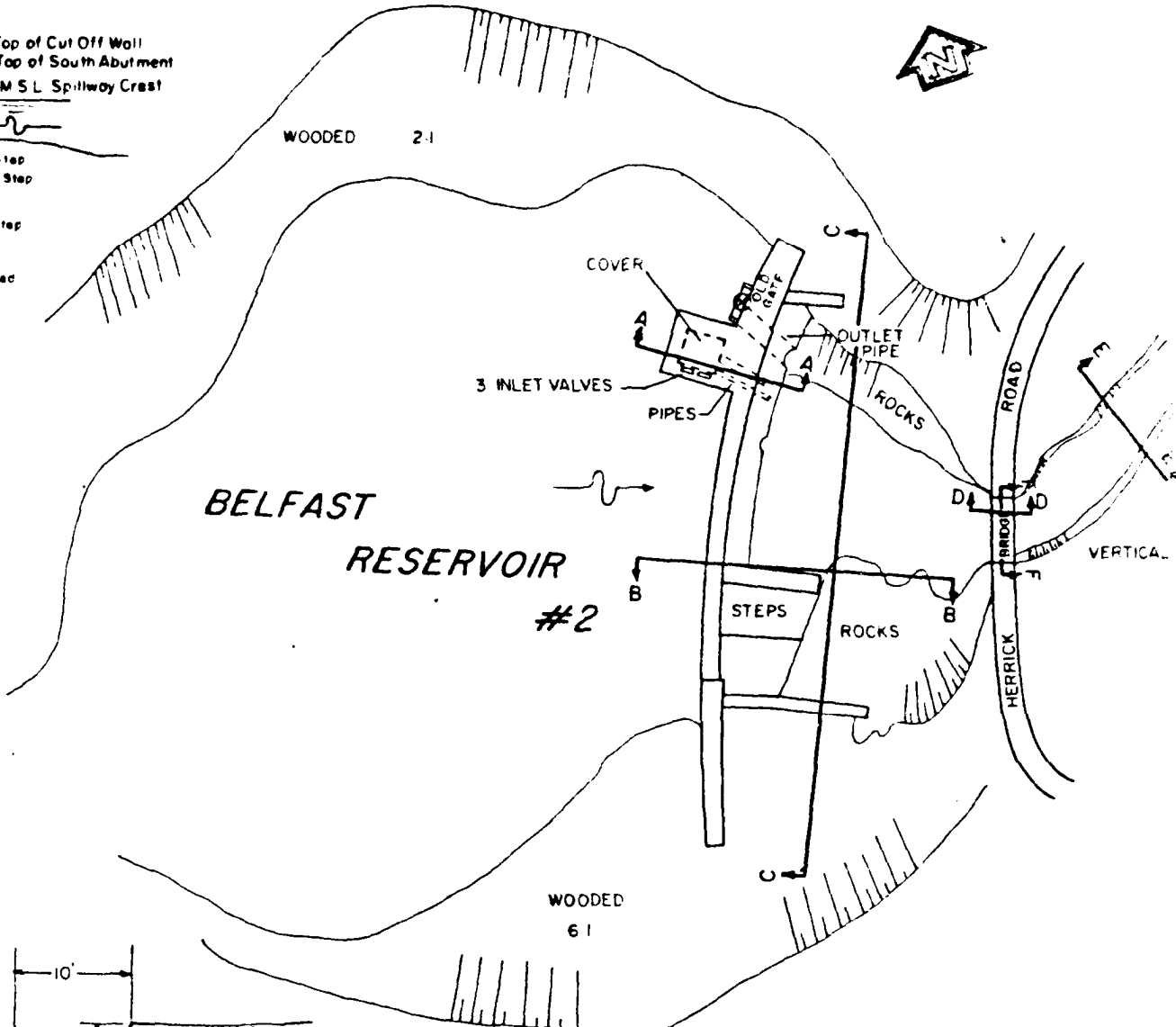


SECTION F-F

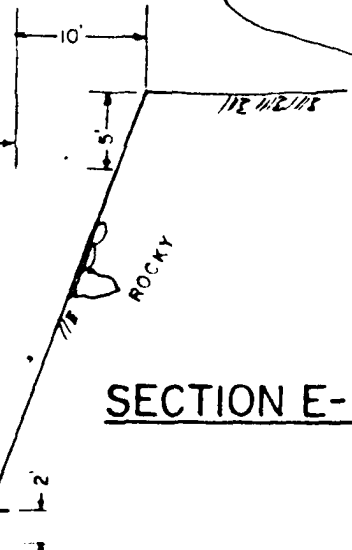


66.0' Top of Cut Off Wall
 64.9' Top of South Abutment
 59.0' M.S.L. Spillway Crest
 50.6' M.S.L. First Step
 49.1' M.S.L. Second Step
 2.5' M.S.L. Third Step
 5' M.S.L. Streambed

3-B



**BELFAST
 RESERVOIR
 #2**

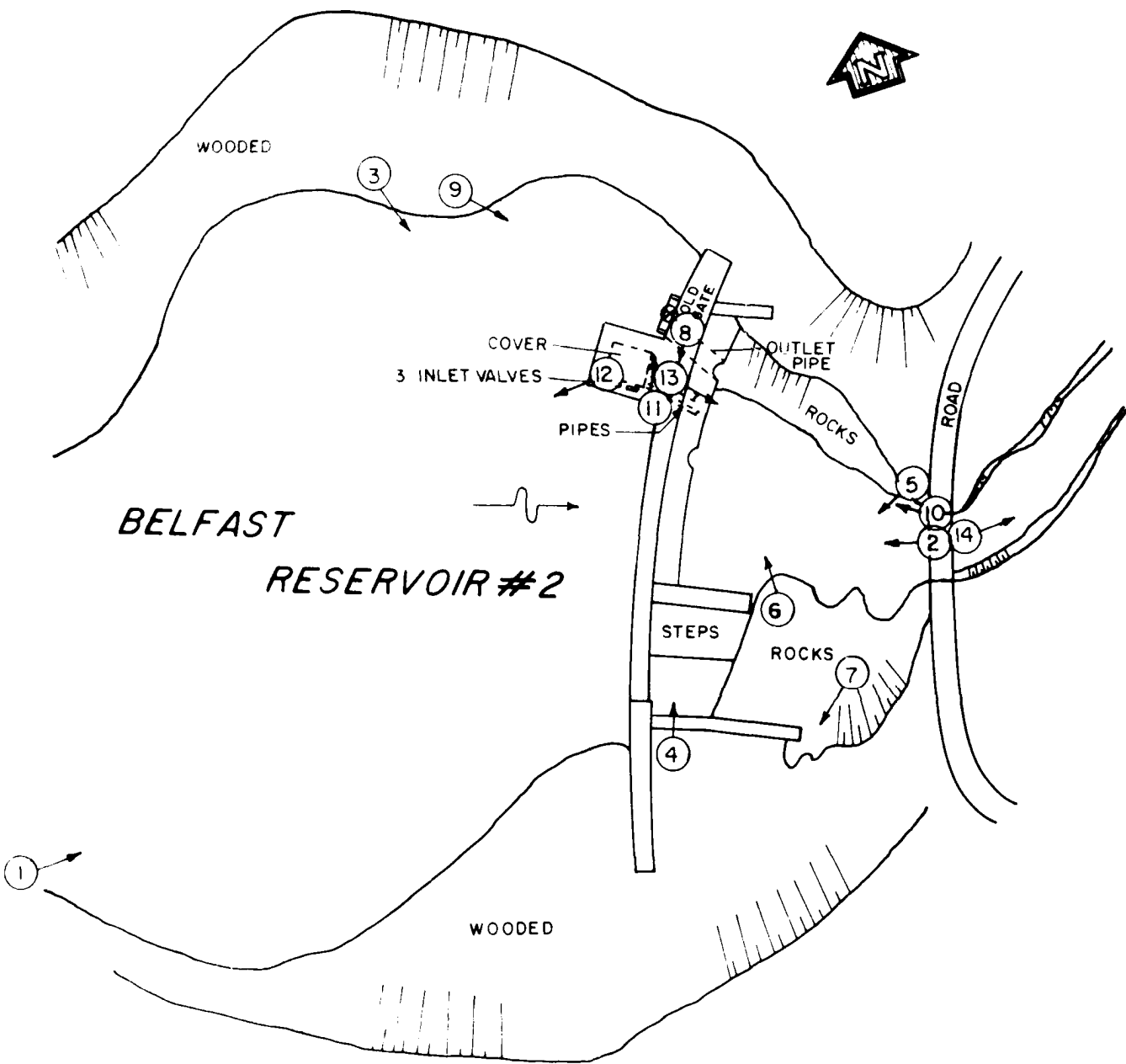


SECTION E-E

NOTE: ALL ELEVATIONS ARE BASED ON SPILLWAY CREST ASSUMED ELEVATION OF 59' M.S.L. DATUM (NGVD)

Anderson-Nichols & Co, Inc		U.S. ARMY ENGINEER DIV NEW ENGLAND	
CONCORD		CORPS OF ENGINEERS	
NEW HAMPSHIRE		WALTHAM, MA	
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS			
LITTLE RIVER UPPER DAM			
LITTLE RIVER		MAINE	
		SCALE NOT TO SCALE	
		DATE NOVEMBER 1979	

APPENDIX C
PHOTOGRAPHS



Anderson-Nichols & Co., Inc.		U.S. ARMY ENGINEER DIV. NEW ENGLAND	
CONCORD		CORPS OF ENGINEERS	
NEW HAMPSHIRE		WALTHAM, MA	
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS			
PHOTO INDEX			
LITTLE RIVER		MAINE	
		SCALE NOT TO SCALE	
		DATE NOVEMBER 1979	



September 17, 1979
Figure 2 - Looking at downstream face of Little
River Upper Dam.



September 17, 1979
Figure 3 - View of upstream face of Little River
Upper Dam.



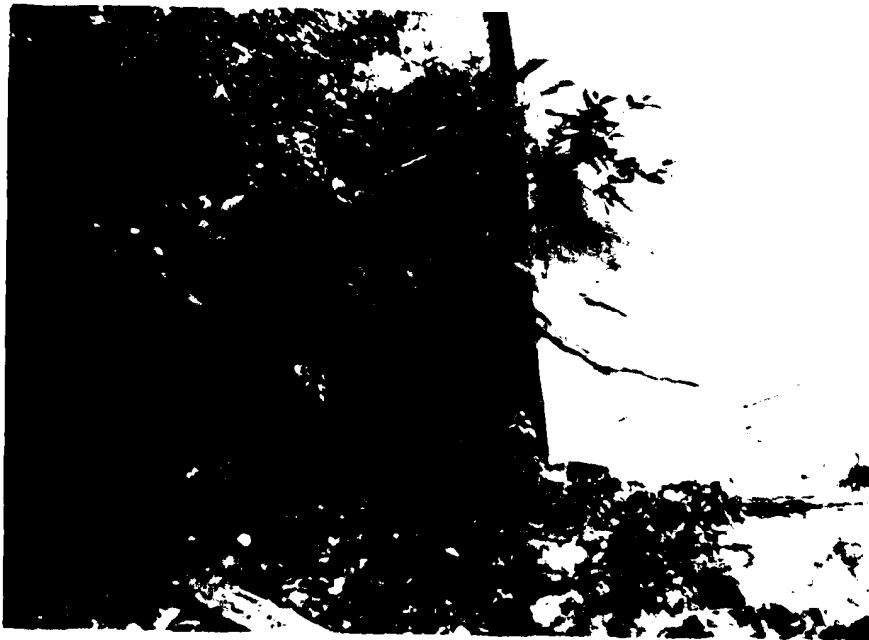
September 17, 1979
Figure 4 - Looking at north abutment of dam.



September 17, 1979
Figure 5 - Downstream face of south abutment.



September 17, 1979
Figure 6 - Looking at 18-inch outlet pipe at
north abutment of the dam.



September 17, 1979
Figure 7 - View of major erosion on south end of
training wall at south abutment.



September 17, 1979

Figure 8 - Looking across crest from north abutment
of the dam.



September 17, 1979

Figure 9 - Upstream face of the north abutment. View
of control tower and gate mechanism.



September 17, 1979
Figure 10 - View of two discharge pipes from the
intake structure.



September 17, 1979
Figure 11 - View of gate mechanism at the north
abutment.



September 17, 1979
Figure 12 - Looking upstream at the reservoir from the
top of the north abutment.



September 17, 1979
Figure 13 - Herrick Road Bridge 200' downstream of
the dam.



September 17, 1979
Figure 14 - Looking at the downstream channel from
the top of Herrick Road Bridge.

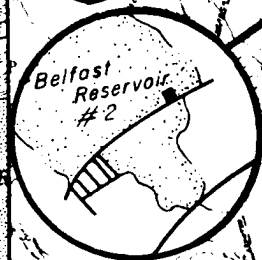
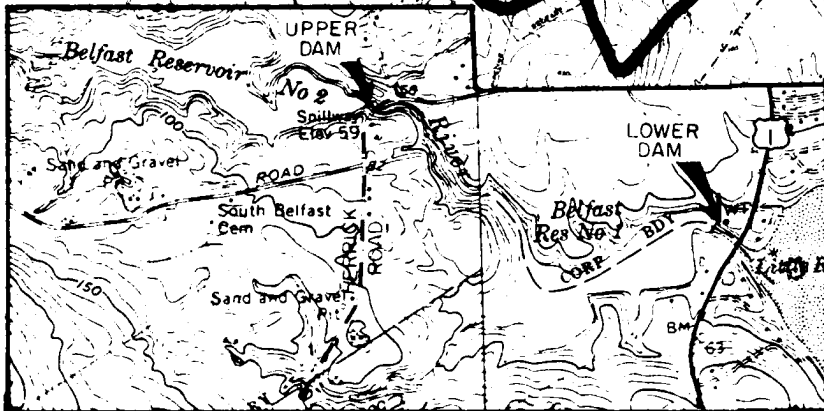
APPENDIX D
HYDROLOGIC AND HYDRAULIC COMPUTATIONS

UPSTREAM DRAINAGE AREA



DOWNSTREAM HAZARD AREA
(SEE DETAIL LOWER LEFT)

DAM LOCATION



**NATIONAL PROGRAM OF INSPECTION
OF NON-FED. DAMS**

LITTLE RIVER UPPER DAM
BELFAST, MAINE

REGIONAL VICINITY MAP

NOVEMBER 1979

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

SCALE IN MILES



MAP BASED ON U.S.G.S. 7.5MINUTE QUADRANGLE
SHEETS. BELFAST, ME, 1960. REVISED 1973.
SEARSPORT, ME., 1973. LINCOLNVILLE, ME., 1960,
REVISED 1973. ISLESBORO, ME., 1973.

ANTHONY-NICHOLS & CO., INC.

CONCORD, NH

JOB NO. 3273-16 LITTLE RIVER - UPPER DAMJARES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
IN. SCALEBREACH ANALYSIS

DETERMINE EFFECTS OF BREACH AT TOP OF DAM
TO CLASSIFY DOWNSTREAM HAZARD CONDITIONS.

$$Q_F = \frac{8}{27} W L \sqrt{g} Y_0^{3/2}$$

NB = BREACH WIDTH

$$g = 32.2 \text{ FT/SEC}^2$$

$$Y_0 = \text{POOL ELEV.} - \frac{1}{3} \text{ RIVER BED}$$

$$NB = 216 \times .4 = 86$$

ASSUME BREACH OCCURS

$$Y_0 = 64.9 - 39.2 = 25.7$$

AT TOP OF THE DAM - 64.9 FTMSL

$$Q = 18,839 \text{ CFS}$$

Q THROUGH SPILLWAY OTHER THAN WHERE IT IS BREACH.

$$L = 114 - 86 = 28 \text{ FT}$$

$$H = 64.9 - 59 = 5.9$$

$$C = 3.2$$

$$Q = C \cdot L \cdot H^{3/2} = 1,324 \text{ CFS}$$

$$\underline{\underline{\text{TOTAL BREACH } Q = 20,160 \text{ CFS}}}$$

ANTECEDENT DISCHARGE (SPILLWAY CAPACITY AT TOP OF
DAM)

$$Q = 3.2 \times 114 \times 5.9^{3/2} = \underline{\underline{5290 \text{ CFS}}}$$

D-2

JOB NO. 3273-16

JARES IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

LITTLE RIVER - UPPER DAM

BREACH ANALYSIS - CONT'D

REACH # 1

USE A TYPICAL CROSS SECTION ALONG THE DOWNSTREAM
REACH FROM THE DAM TO THE HERRICK ROAD BRIDGE FOR A
DISTANCE OF 200 FEET

DEVELOP A RATING CURVE FOR THIS SECTION BY
USE OF MANNING'S EQUATION: $Q = \frac{1.49}{n} \cdot A \cdot R^{2/3} \cdot S^{1/2}$ *

$$n = .05 \quad S = .005$$

DEPTH [FT]	AREA	WPER	Q [CFS]
0	0	0	0
4	154.5	49.1	694
8	378.2	68.1	2469
12	670.8	87.1	5439
16	1030.8	105.6	9770
20	1468.	130.7	15265
24	2008.	158.	22658
28	2652.	185.2	32369

- * 'n' - ROUGHNESS COEFFICIENT
A - AREA OF SECTION IN SQUARE FEET
R - ^A/WETTED PERIMETER
S - SLOPE OF REACH

ANDERSON + NICHOLS - CICO
DATE: 07-26-71
COMPILED BY: J. G.
CHECKED BY: W. G.

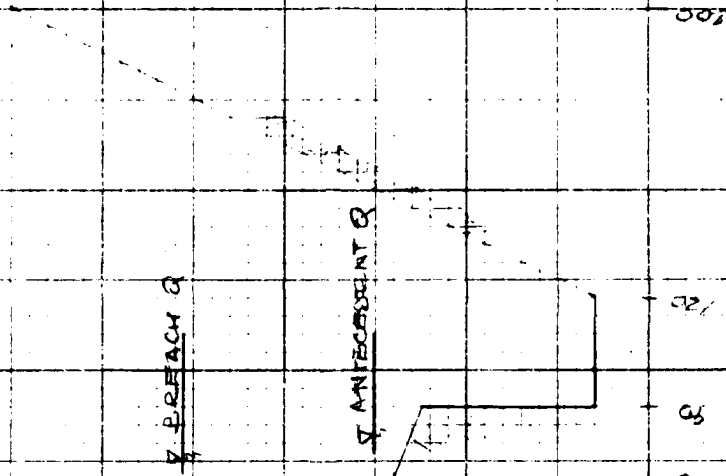
JOB # BR 72 + 16

LITTLE RIVER UPPER DAM

REACH # 1

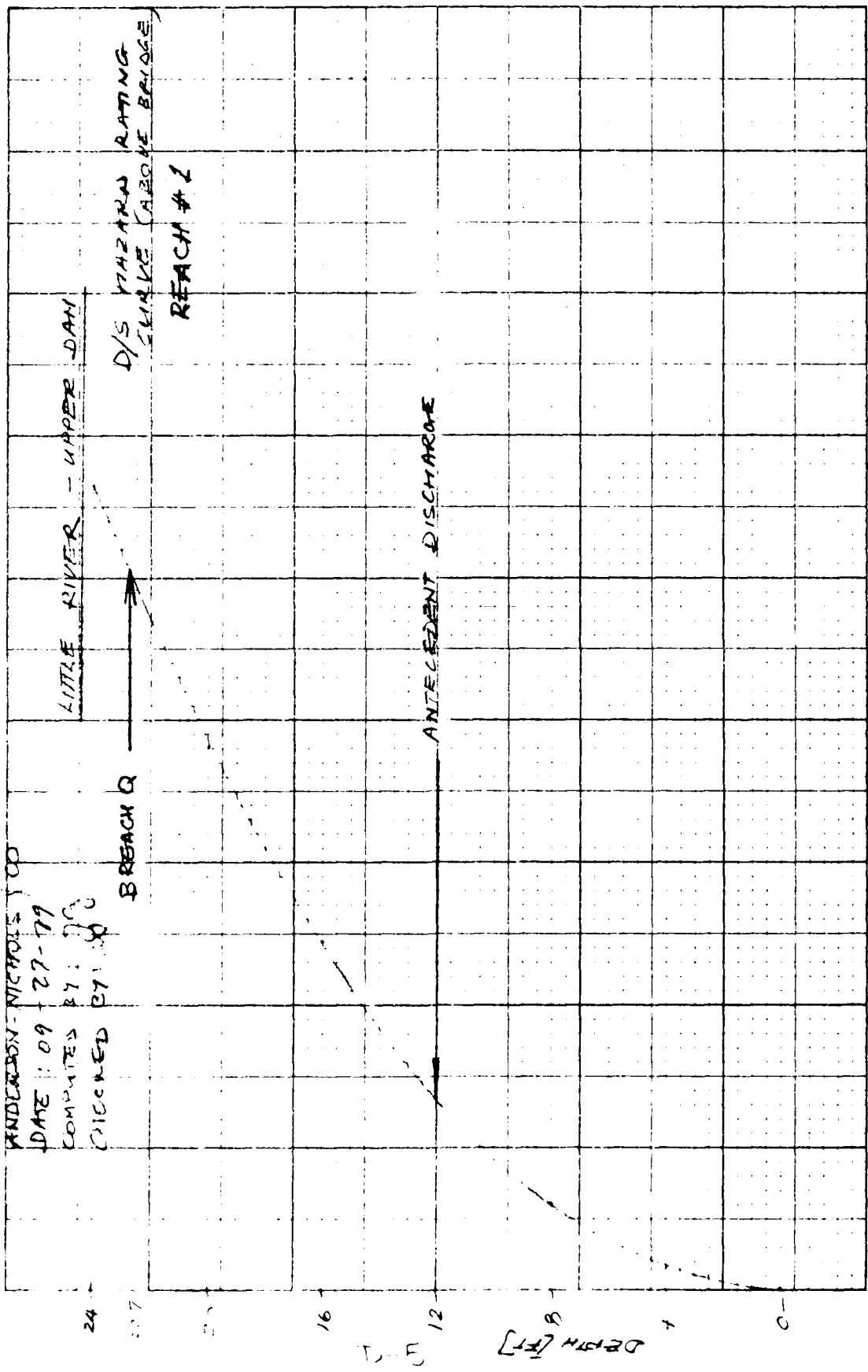
X-SECTION OF DOWNSTREAM CHANNEL (EITHER IN BRIDGE RAIL DAM)

25 +
24 +
23 +
16 +
12 +
8 +
4 +
0 +
(FT) HEIGHT



DISTANCE [FT]

KENDERSON - NICHOLS FOOD
 DATE: 09 - 27 - 77
 COMPUTED BY: JCS
 CHECKED BY: JCS



LITTLE RIVER - UPPER DAM

D/S YAZAWA RATING
 SLUICE (ABOVE BRIDGE)
 REACH #1

BREACH Q

ANTECEDENT DISCHARGE

4000 8000 12000 16000 20000 24000
 DISCHARGE (CFS)

24

20

16

12

DEPTH [FT]

8

4

0

JOB NO. 3273-16

INCHES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
 IN. SCALE

LITTLE RIVER - UPPER DAM

BREACH ANALYSIS - CONT'D

DEVELOP A RATING CURVE FOR THE X-SECTION ALONG HERRICK ROAD BRIDGE 200' DOWNSTREAM THE DAM.

ROUGHNESS COEFF.	LOW FLOW -	CALCULATED	USING	MANVING'S EQUATION	
		ELEV.	AREA	WPER	Q [CFS]
		33.5	0	0	0
		36.7	74.4	29.4	696
CONCR WALL .015		39.9	150.4	35.8	2055
BOTTOM .035		43.1	228.	42.2	3795
		46.5	307.2	48.7	5807
$\epsilon = .0125$		49.5	388	55.	8034
		52.7	470.4	61.5	10440

PRESSURE WEIR FLOW

C VALUE CALCULATION FOR PRESSURE FLOW:

$$k_f = \frac{29.1 \times h^2 \times L}{R^{4/3}}$$

$$k_f = \frac{29.1 \times .02^2 \times 24}{5.27^{4/3}} = .067$$

$$1.10 + .067 = 1.167$$

$$k = \frac{1}{C^2} = 1.167 \quad \underline{\underline{C = .93}}$$

L = LENGTH OF BRIDGE
 = 24'

n = for CONCRETE BRIDGE
 WITH GRASS BOTTOM - 0.03

R - HYDRAULIC RADIUS

INTAKE AND EXIT LOSSES =
 = 1.10

JOB NO. 3273 - 16

JARES IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

LITTLE RIVER - UPPER DAM

BREACH ANALYSIS - CONT'D

PRESSURE FLOW - AREA - 470. SQFT C - .93

ELEV.	H.	$Q = AC \sqrt{2gH^3}$	[CFS]
57.5	14.4	13,331	
60.0	16.9	14,424	
65.0	21.9	16,435	
70.0	26.9	18,183	

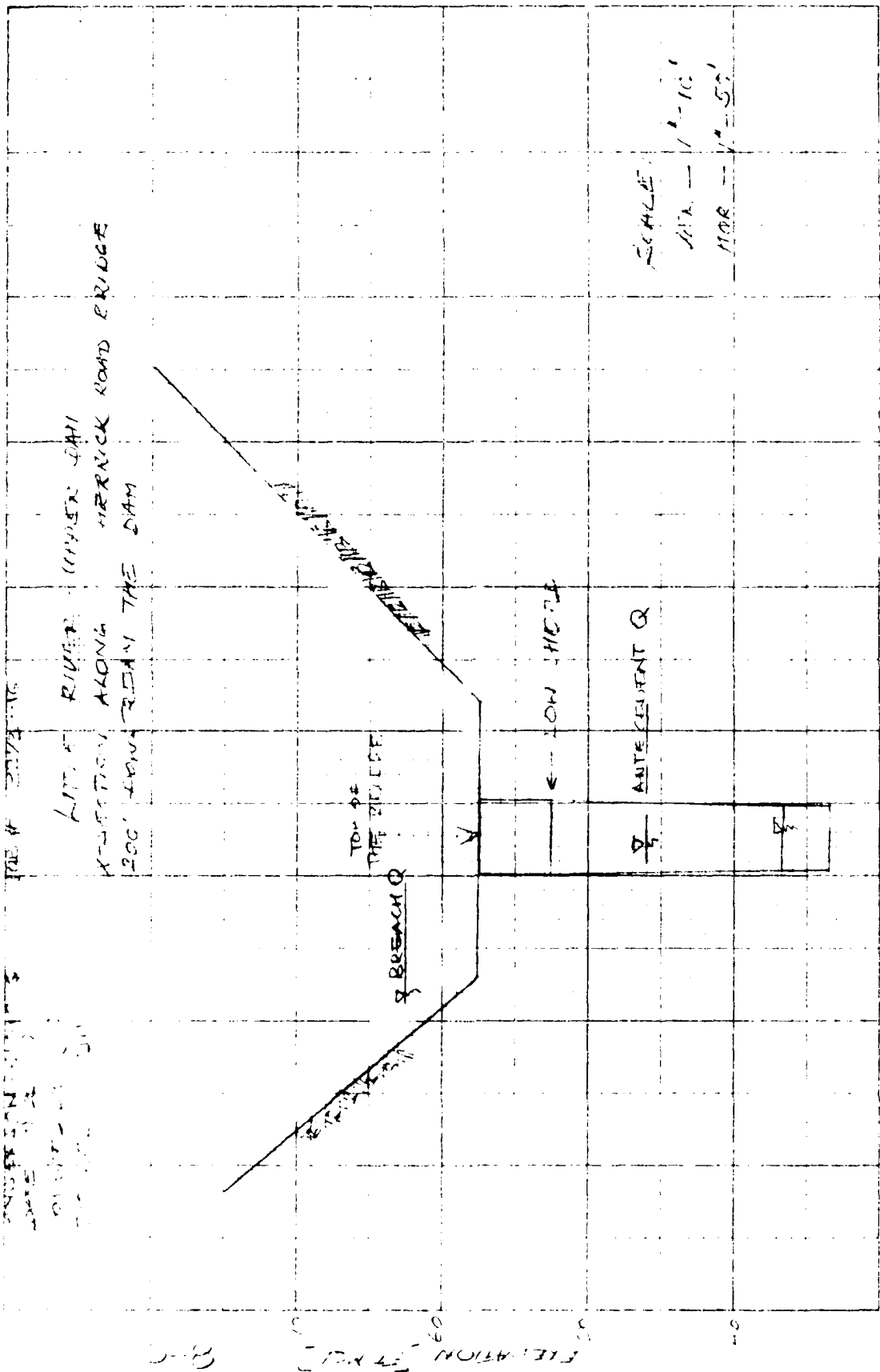
WEIR FLOW - C = 2.8

[FT MSL] ELEV.	[FT] L	[FT] H	$Q = CLH^{3/2}$	[CFS]
57.5		0		
60.0	110	2.5	1217	
65.0	130	7.5	7476	
70.0	170	12.5	21036	

SUMMARY -

ELEV. [FT MSL]	Q [CFS]
33.5	0
36.7	696
39.9	2055
43.1	3795
46.5	5807
49.5	8034
52.7	10410
57.5	13,331
60.0	15,641
65.0	23,911
70.0	39,219

D-7



LITTLE RIVER UPPER DAM
 SECTION ALONG HERRICK ROAD BRIDGE
 200' DOWN REAR THE DAM

SCALE:
 H/A - 1" = 10'
 H/B - 1" = 50'

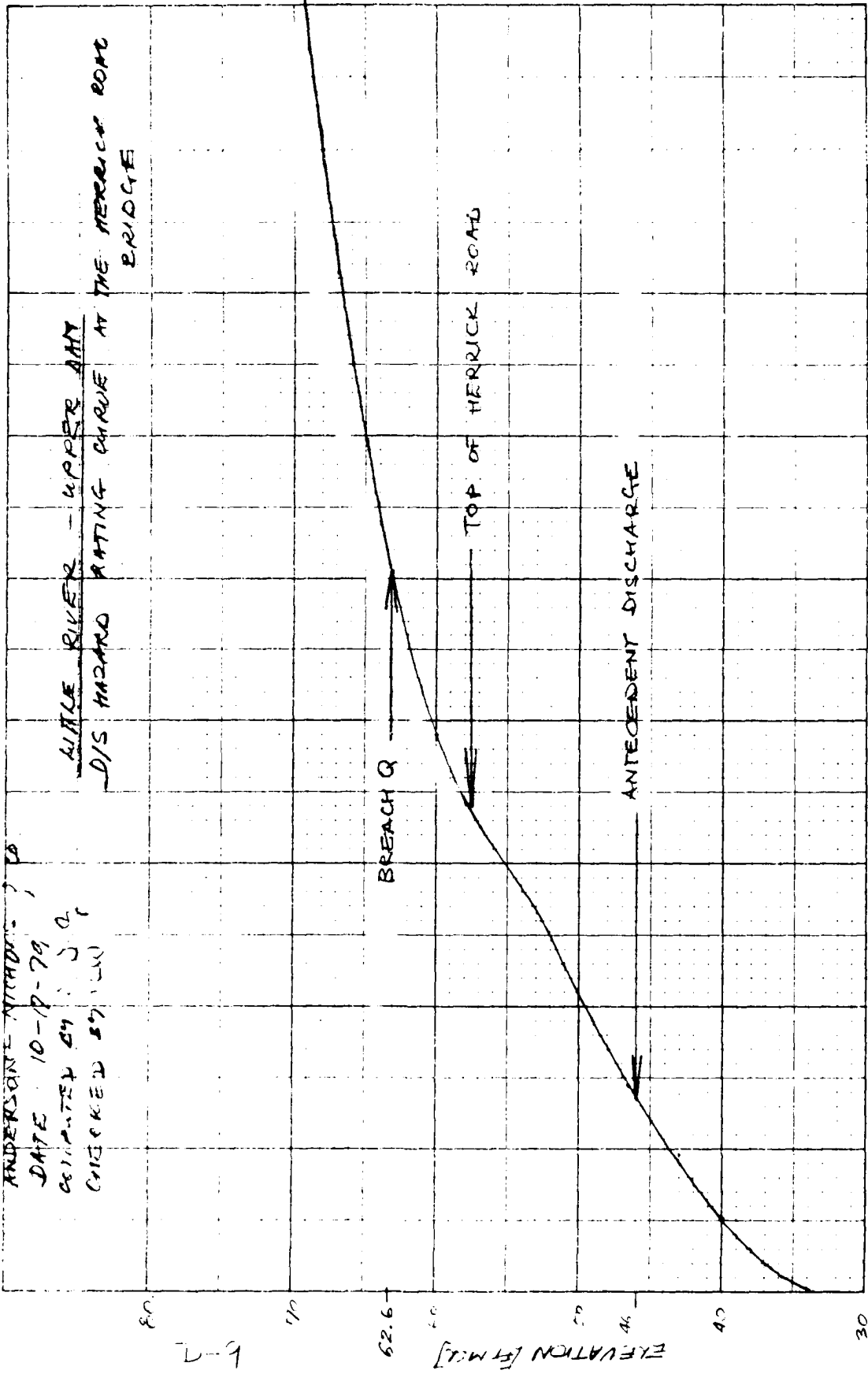
SECTION ALONG
 HERRICK ROAD
 BRIDGE

ELEVATION [FT.]

DISTANCE [FT.]

ANDERSON'S MICHIGAN
 DATE 10-18-79
 COMPUTED BY J. Q.
 CHECKED BY J. Q.

LAKE RIVER - UPPER ARM
 DISCHARGE CURVE AT THE HERRICK ROAD
 BRIDGE



4,000 8,000 12,000 16,000 20,000 24,000 28,000 32,000 36,000
 DISCHARGE [CFS]

6-9

ELEVATION [FT.M.]

JOB NO. 3273-16

JARES IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

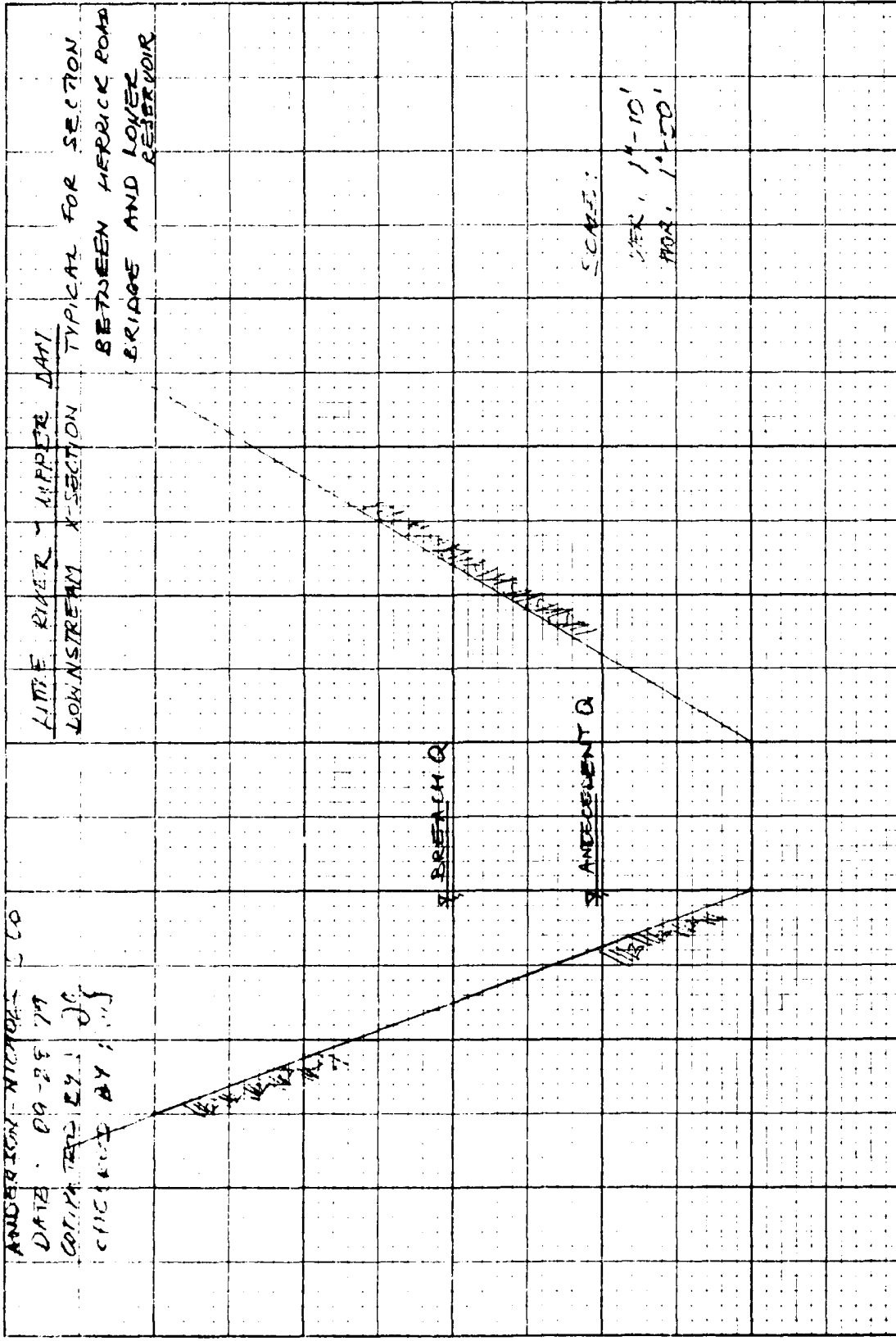
LITTLE RIVER - UPPER DAM

BREACH ANALYSIS - CONT'D

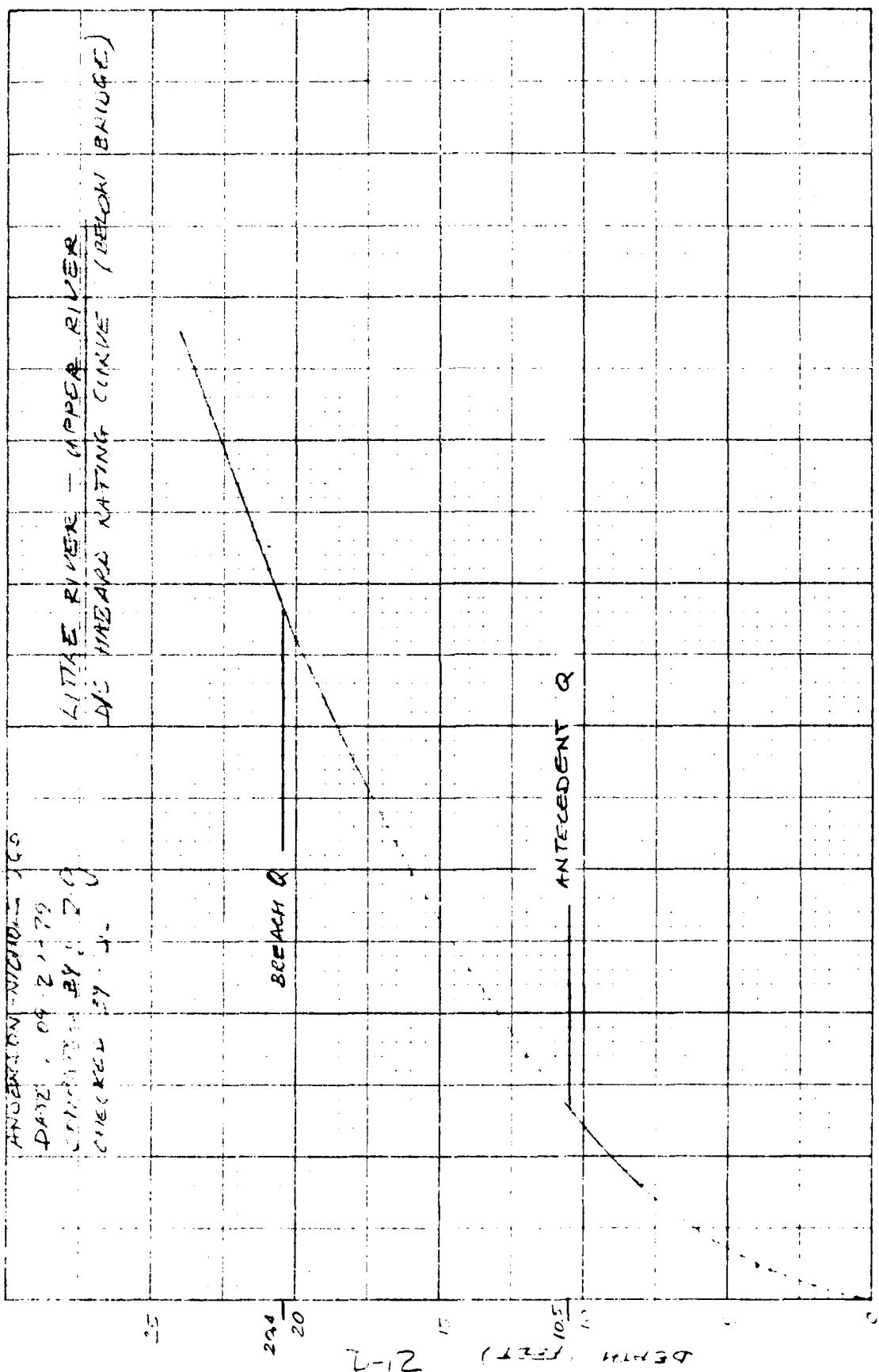
USE A TYPICAL CROSS SECTION ALONG THE DOWNSTREAM REACH FROM THE HERRICK ROAD BRIDGE (200' BELOW THE DAM) TO CONFLUENCE WITH RESERVOIR OF LOWER DAM AT A DISTANCE OF 1700 FT. DEVELOP A RATING CURVE FOR THIS SECTION BY USE OF MANNING'S EQUATION: $Q = \frac{1.49}{n} \cdot A \cdot R^{2/3} \cdot S^{1/2}$

$n = 0.06$ $S = 0.005$

DEPTH [FT]	AREA	W PER	Q [CFS]
0	0	0	0
4	239	71	933
8	576	92	3193
12	951	113	6794
16	1424	125	11862
20	1975	156	18542
24	2604	177	26976



11-D



DEPTH (FEET) 21-2

DISCHARGE (CFS)

100
 200
 300
 400
 500
 600
 700
 800
 900
 1000
 1100
 1200
 1300
 1400
 1500
 1600
 1700
 1800
 1900
 2000
 2100
 2200
 2300
 2400
 2500
 2600
 2700
 2800
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 3000
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 8400
 8500
 8600
 8700
 8800
 8900
 9000
 9100
 9200
 9300
 9400
 9500
 9600
 9700
 9800
 9900
 10000

JARES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
N. SCALE

BREACH ANALYSIS CONT'D

TO DETERMINE MAXIMUM RISE OF LOWER RESERVOIR DUE TO BREACH OF UPPER RESERVOIR THE TOTAL BREACH Q WILL BE APPLIED TO THE RATING CURVE FOR THE LOWER DAM. THIS RESULTS IN AN ELEVATION OF 38.6 FT MSL

CONCLUSIONS: A BREACH OF LITTLE RIVER UPPER DAM COULD CAUSE OVERTOPPING AND POSSIBLE DAMAGE TO THE HERRICK ROAD BRIDGE AND COULD ALSO CAUSE OVERTOPPING OF LOWER RESERVOIR DAM. THE BREACH COULD ALSO CAUSE LOSS OF A REGULATING RESERVOIR FOR USE IN WATER SUPPLY AND THEREFORE POSSES A HAZARD TO A PUBLIC UTILITY. THERE WOULD PROBABLY BE NO LOSS OF LIFE BUT IT COULD CAUSE APPRECIABLE PROPERTY DAMAGE. THEREFORE, LITTLE RIVER UPPER DAM HAS BEEN CLASSIFIED AS SIGNIFICANT HAZARD

JOB NO. 3273-16

JARES IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

LITTLE RIVER UPPER DAM

DRAINAGE AREA - 13.7 SQ MILE

SIZE CLASSIFICATION - SMALL

HAZARD CLASSIFICATION - SIGNIFICANT

TEST FLOOD RANGE $1/4$ PMF - $1/2$ PMF, CHOSEN $1/2$ PMF
BECAUSE THE SIZE OF DAM IS IN UPPER RANGE OF SIZE CLASSIFICATION.STEP # 1 CALCULATE PMF USING "PRELIMINARY GUIDANCE
FOR ESTIMATING MAXIMUM PROBABLE DISCHARGES IN
PHASE I DAM SAFETY INVESTIGATIONS, MARCH 1978"SLOPE OF WATERSHED IS 125 FT/M, THEREFORE THE
MOUNTAINOUS CURVE WILL BE USED.

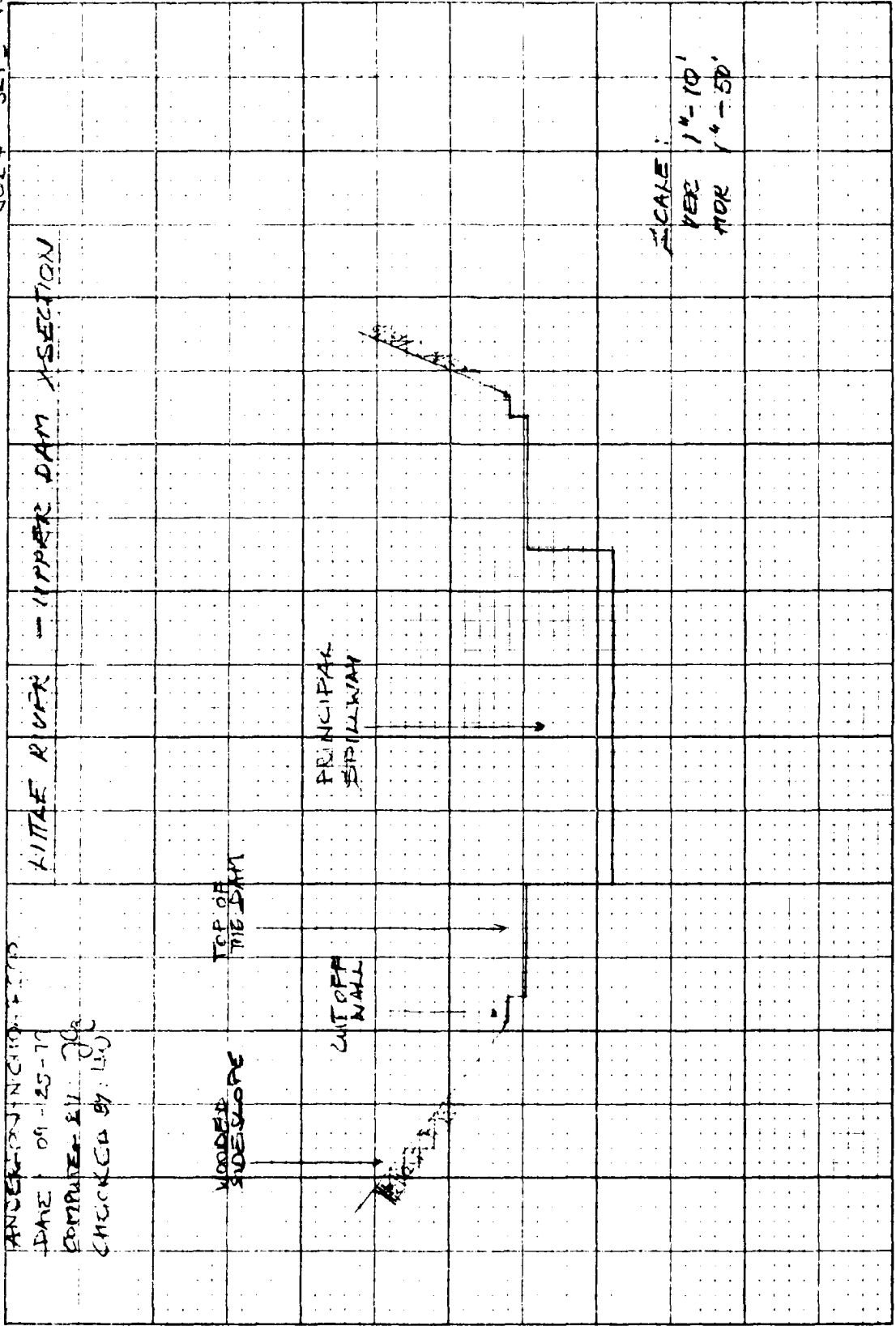
USE A CFM VALUE OF 1870

$$13.7 \text{ SQ MILE} \times 1870 \text{ CFM} = 25600 \text{ CFS}$$

$$\text{TEST FLOOD } (1/2 \text{ PMF}) = 12,800 \text{ CFS } (Q_{PI})$$

STEP # 2A DETERMINE SURCHARGE HEIGHT TO PASS
 Q_{PI} OF 12,800 CFS. TO OBTAIN THIS, A DISCHARGE
RATING CURVE MUST BE CALCULATED FOR UPPER
RESERVOIR DAM. OUTFLOW WOULD OCCUR FIRST OVER
THE PRINCIPAL SPILLWAY. HIGHER FLOOD WATERS WILL
FLOW OVER THE DAM EMBANKMENTS AND SIDE SLOPES,
NOW THROUGH TWO OUTLET PIPES (6" AND 8" DIAMETER)
FROM VALVE CHAMBER IS INCONSIDERABLE. SIZE OF
EMERGENCY GATE IS UNKNOWN, GATE OPERATING MECHANISM
IS RUINED AND IN POOR CONDITION. THERE IS NO INDICATION
OF RECENT OPERATION. 18" TOP OUTLET PIPE FROM THE
BASE IS LEAKING ABOUT 30 GPM. BECAUSE OF ITS
CONDITION POSSIBLE FLOOD THROUGH EMERGENCY GATE
WILL NOT BE CALCULATED.

JOB # 3272-16



2-15

ELEVATION (FEET)

JOB NO. 272-16

STATION IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

FLOW OVER THE SPURWAY AT TOP OF DAM - RATING CURVE CALCULATION

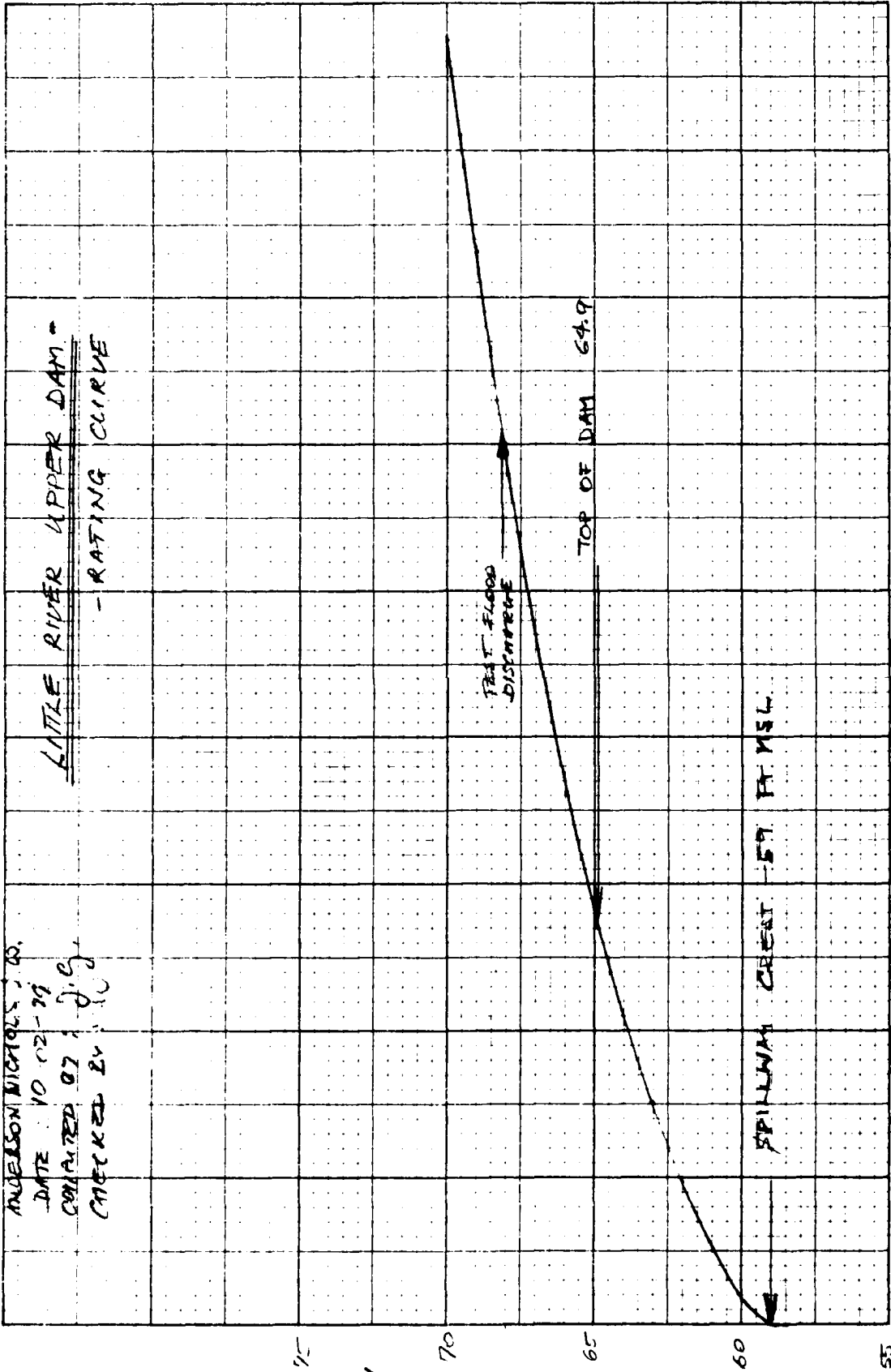
ELEV. (NSL)	FLOW OVER THE SPURWAY AT TOP OF DAM				FLOW OVER THE SIDE SLOPES				TOTAL
	C. VALUE	H (FEET)	A (FEET)	Q (CFS)	C. VALUE	H (FEET)	A (FEET)	Q (CFS)	
59	6.2	114	0	0					0
60			1	275					275
61			2	1285					1285
62			3	1955					1955
63			4	3000					3000
64			5	3800					3800
65			5.7	4290					4290
66			7	6160	20	1.5	14	9410	9410
67			8	8270	30	2	29	11906	11906
68			9	10000	40	3	75	14517	14517
69			10	11500	50	4	250	17500	17500
70			12	15000	60	5	570	20118	20118

TOT. DAM 649

D-16

ANDERSON MICHAELS & CO.
DATE 10 02-79
COMPUTED BY J.C.
CHECKED BY J.C.

LITTLE RIVER UPPER DAM
- RATING CURVE



ELEVATION FEET M.S.L.

DISCHARGE [CFS]

JOB NO. 2272 - 1.5

AREAS IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

WISSE RIVER - UPPER DAM

STORAGE - ELEVATION CURVE CALCULATIONS

NORMAL STORAGE (SPILLWAY CHEST - 59 FT MSL) - 480 AC-FT

NOTE: 480 AC-FT WAS OBTAINED BY ESTIMATING AVERAGE DEPTH OF RESERVOIR - 10 FT AND PLANIMETERED SURFACE OF RESERVOIR FROM QUAD SHEET - 48 AC. 15' 000 000 GAL RISERL AC IMPOUNDING CAPACITY IN APPLICATION FOR DAM REGISTRATION (SEE PAGE) AGREES WITH THIS CALCULATION.

USING 'FRUSTUM OF PYRAMID EQUATION' AND PLANIMETERED SURFACE AREAS, DEVELOP POINTS FOR A STORAGE - ELEVATION CURVE

$$V = \frac{1}{3} h (b_1 + b_2 + \sqrt{b_1 b_2})$$

h - STEN. ABOVE NORMAL POOL SURFACE
 b₁ - NORMAL POOL SURFACE
 b₂ - ENLARGE POOL SURFACE

ELEV. 70. FT MSL

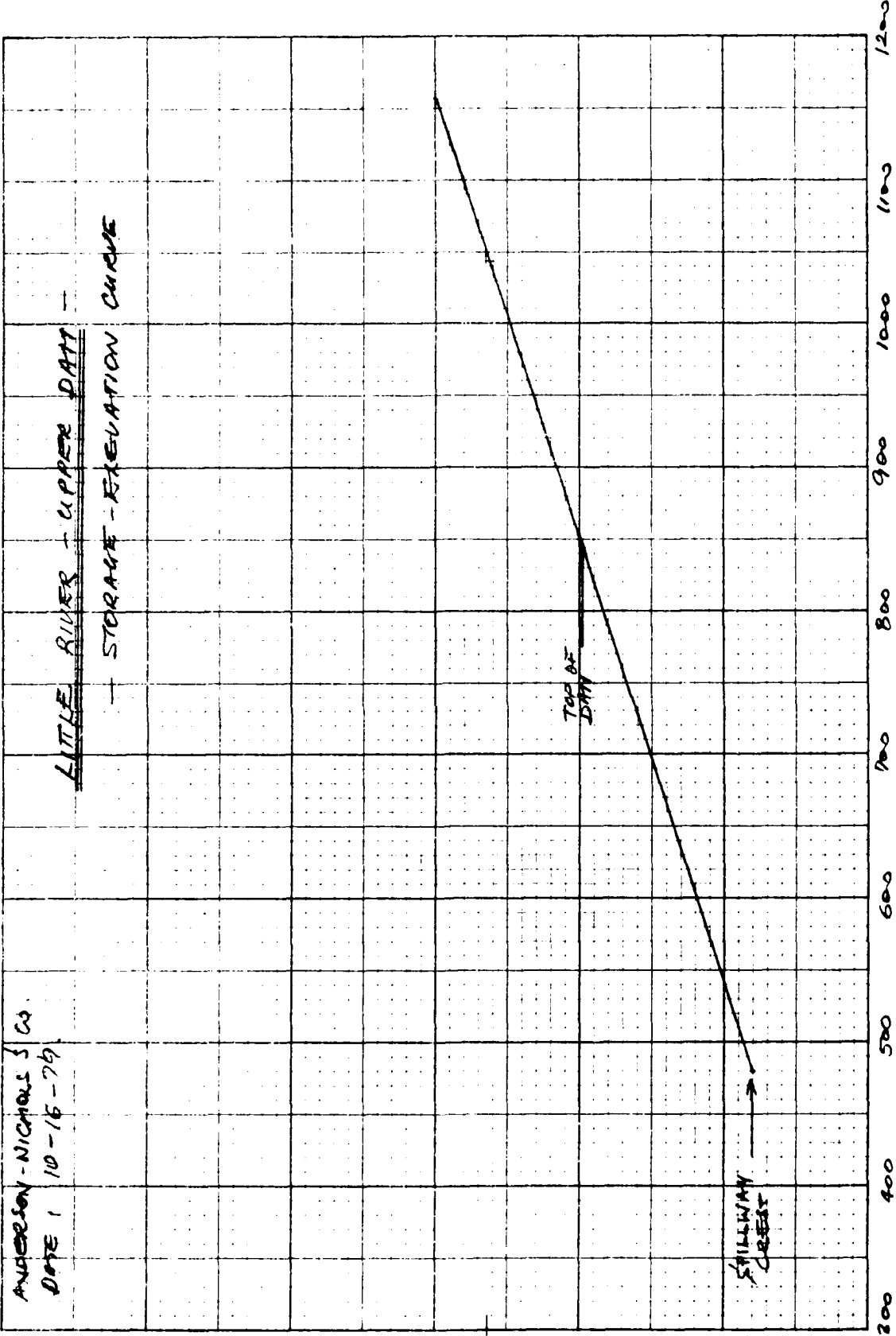
SURFACE AREA - 76 AC

$$V = \frac{1}{3} h (48 + 76 + \sqrt{48 \cdot 76}) = 676 \text{ AC-FT}$$

TOTAL STORAGE - 1156 AC-FT

ANDERSON-NICHOLS & CO.
DATE 1 10-15-79

LITTLE RIVER - UPPER DAM
- STORAGE - ELEVATION CURVE



6-1-C

ELEVATION FT MSL
60
59

55

STORAGE [AC - FT]

JOB NO. 3212 16

STATION 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

LITTLE RIVER - UPPER DAMSTEP # 1 (CONT)

$$\text{GROSS FLOOD (1/2 PMF)} = 12,800 \text{ CFS}$$

$$\text{ELEV (@ 12,800 CFS) } \Rightarrow 68.4 \text{ FT MSL}$$

STEP # 2a

DETERMINE VOLUME OF SURCHARGE IN INCHES
OF RUNOFF

$$Q_{p1} = 12,800 \text{ CFS } \Rightarrow \text{ELEV. } 68.4 \text{ FT MSL}$$

$$\text{STORAGE AT } 68.4 \text{ FT MSL } \Rightarrow 1,050 \text{ AC-FT}$$

$$\text{STORAGE AT } 59.0 \text{ FT (1/2 PMF) (MILLWYAM CREST) } \Rightarrow 480 \text{ AC-FT}$$

$$570 \text{ AC-FT} \times \frac{1}{3.7 \text{ MI}^2} \times \frac{1 \text{ MI}^2}{640 \text{ AC}} \times 12 \frac{\text{IN}}{\text{FT}} = .78 \text{ " RUNOFF}$$

(STOR. 1)

STEP # 2c

$$Q_{p2} = Q_{p1} \times \left(1 - \frac{\text{STOR. 1}}{9.5 \text{ "}}\right)$$

$$Q_{p2} = 12,800 \text{ CFS} \times \left(1 - \frac{.78 \text{ "}}{9.5 \text{ "}}\right) = 11,750 \text{ CFS}$$

STEP # 3a

DETERMINE SURCHARGE HEIGHT TO PASS Q_{p2}

$$Q_{p2} = 11,750 \text{ CFS } \Rightarrow 68. \text{ FT MSL } \Rightarrow 1,035 \text{ AC-FT}$$

$$555 \text{ AC-FT} \times \frac{1}{3.7 \text{ MI}^2} \times \frac{1 \text{ MI}^2}{640 \text{ AC}} \times 12 \frac{\text{IN}}{\text{FT}} = .76 \text{ " RUNOFF}$$

7.520

JOB NO. 2272 - 16INCHES
IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29LITTLE RIVER - UPPER DAMSTEP # 36AVERAGE STOR 1 & STOR 2

$$\frac{.78 + .76}{2} = .77 \text{ " RUNOFF}$$

$$.77 \times \frac{13.7 \text{ MI}^2}{1} \times \frac{640 \text{ AC}}{\text{MI}^2} \times \frac{\text{FT}}{12 \text{ IN}} = 563 \text{ AC-FT}$$

$$\underline{563 \text{ AC-FT} + 480 \text{ AC-FT} = 1043 \text{ AC-FT} \Rightarrow 68.2 \text{ FT-MSL}}$$

TEST FLOOD - $\frac{1}{2}$ PMF

TEST FLOOD DISCHARGE - 12,200 CFS

TEST FLOOD ELEVATION - 68.2 FT-MSL

TOP OF DAM - 64.9 FT MSL THEREFORE DAM EMBANKMENT
WOULD BE OVERTOPPED BY ABOUT 3.3 FT DURING
TEST FLOOD CONDITIONS.

TOP OF DAM - 64.9 FT MSL \Rightarrow STORAGE 850 AC-FT

SPILLWAY CAPACITY @ TOP OF DAM IS 5390 CFS
WHICH IS 44 PERCENT OF THE TEST FLOOD DISCHARGE.

D-21

APPENDIX E
INFORMATION AS
CONTAINED IN THE NATIONAL
INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

OFFICE OF THE SECRETARY OF THE ARMY
 WASHINGTON, D. C. 20315
 DATE: MAY 1968
 PROJECT NUMBER: 55-00079

DAM NAME: LITTLE RIVER UPPER DAM
 PROJECT NUMBER: 55-00079
 COUNTY: WASHINGTON COUNTY, MISSISSIPPI
 STATE: MISSISSIPPI
 COORDINATE: 33° 10' N, 90° 10' W
 DAM TYPE: CONCRETE GRAVITY
 YEAR COMPLETED: 1910
 HEIGHT: 110 FEET
 LENGTH: 530 FEET
 OWNER: MISSISSIPPI POWER AND LIGHT CO.
 PURPOSES: FLOOD CONTROL, HYDROELECTRICITY, RECREATION
 STATUS: OPERATIONAL

REMARKS

1. DAM IS IN GOOD CONDITION. RECENT INSPECTION BY MISSISSIPPI POWER AND LIGHT CO. REPORTS NO MAJOR DEFICIENCIES.
 2. DAM IS 110 FEET HIGH AND 530 FEET LONG. IT WAS DESIGNED BY THE U.S. ARMY CORPS OF ENGINEERS.
 3. THE DAM IS A GRAVITY DAM AND IS SUBJECT TO SLIDING AND OVERTURNING. THE FOUNDATION IS ON SAND AND GRAVEL.
 4. THE DAM HAS TWO MAIN GATES AND A BYPASS CHANNEL. THE BYPASS CHANNEL IS USED FOR FLOOD CONTROL.
 5. THE DAM IS USED FOR RECREATION AND FISHING. THERE IS A FISH PASSAGE UNDER THE DAM.
 6. THE DAM IS A CONCRETE GRAVITY DAM AND IS SUBJECT TO SLIDING AND OVERTURNING. THE FOUNDATION IS ON SAND AND GRAVEL.
 7. THE DAM HAS TWO MAIN GATES AND A BYPASS CHANNEL. THE BYPASS CHANNEL IS USED FOR FLOOD CONTROL.
 8. THE DAM IS USED FOR RECREATION AND FISHING. THERE IS A FISH PASSAGE UNDER THE DAM.
 9. THE DAM IS A CONCRETE GRAVITY DAM AND IS SUBJECT TO SLIDING AND OVERTURNING. THE FOUNDATION IS ON SAND AND GRAVEL.
 10. THE DAM HAS TWO MAIN GATES AND A BYPASS CHANNEL. THE BYPASS CHANNEL IS USED FOR FLOOD CONTROL.
 11. THE DAM IS USED FOR RECREATION AND FISHING. THERE IS A FISH PASSAGE UNDER THE DAM.
 12. THE DAM IS A CONCRETE GRAVITY DAM AND IS SUBJECT TO SLIDING AND OVERTURNING. THE FOUNDATION IS ON SAND AND GRAVEL.
 13. THE DAM HAS TWO MAIN GATES AND A BYPASS CHANNEL. THE BYPASS CHANNEL IS USED FOR FLOOD CONTROL.
 14. THE DAM IS USED FOR RECREATION AND FISHING. THERE IS A FISH PASSAGE UNDER THE DAM.
 15. THE DAM IS A CONCRETE GRAVITY DAM AND IS SUBJECT TO SLIDING AND OVERTURNING. THE FOUNDATION IS ON SAND AND GRAVEL.
 16. THE DAM HAS TWO MAIN GATES AND A BYPASS CHANNEL. THE BYPASS CHANNEL IS USED FOR FLOOD CONTROL.
 17. THE DAM IS USED FOR RECREATION AND FISHING. THERE IS A FISH PASSAGE UNDER THE DAM.
 18. THE DAM IS A CONCRETE GRAVITY DAM AND IS SUBJECT TO SLIDING AND OVERTURNING. THE FOUNDATION IS ON SAND AND GRAVEL.
 19. THE DAM HAS TWO MAIN GATES AND A BYPASS CHANNEL. THE BYPASS CHANNEL IS USED FOR FLOOD CONTROL.
 20. THE DAM IS USED FOR RECREATION AND FISHING. THERE IS A FISH PASSAGE UNDER THE DAM.

REFERENCES

1. MISSISSIPPI POWER AND LIGHT CO. REPORT, 1967.
 2. U.S. ARMY CORPS OF ENGINEERS, DESIGN REPORT, 1910.
 3. MISSISSIPPI POWER AND LIGHT CO. REPORT, 1968.
 4. U.S. ARMY CORPS OF ENGINEERS, DESIGN REPORT, 1910.
 5. MISSISSIPPI POWER AND LIGHT CO. REPORT, 1967.
 6. U.S. ARMY CORPS OF ENGINEERS, DESIGN REPORT, 1910.
 7. MISSISSIPPI POWER AND LIGHT CO. REPORT, 1968.
 8. U.S. ARMY CORPS OF ENGINEERS, DESIGN REPORT, 1910.
 9. MISSISSIPPI POWER AND LIGHT CO. REPORT, 1967.
 10. U.S. ARMY CORPS OF ENGINEERS, DESIGN REPORT, 1910.
 11. MISSISSIPPI POWER AND LIGHT CO. REPORT, 1968.
 12. U.S. ARMY CORPS OF ENGINEERS, DESIGN REPORT, 1910.
 13. MISSISSIPPI POWER AND LIGHT CO. REPORT, 1967.
 14. U.S. ARMY CORPS OF ENGINEERS, DESIGN REPORT, 1910.
 15. MISSISSIPPI POWER AND LIGHT CO. REPORT, 1968.
 16. U.S. ARMY CORPS OF ENGINEERS, DESIGN REPORT, 1910.
 17. MISSISSIPPI POWER AND LIGHT CO. REPORT, 1967.
 18. U.S. ARMY CORPS OF ENGINEERS, DESIGN REPORT, 1910.
 19. MISSISSIPPI POWER AND LIGHT CO. REPORT, 1968.
 20. U.S. ARMY CORPS OF ENGINEERS, DESIGN REPORT, 1910.

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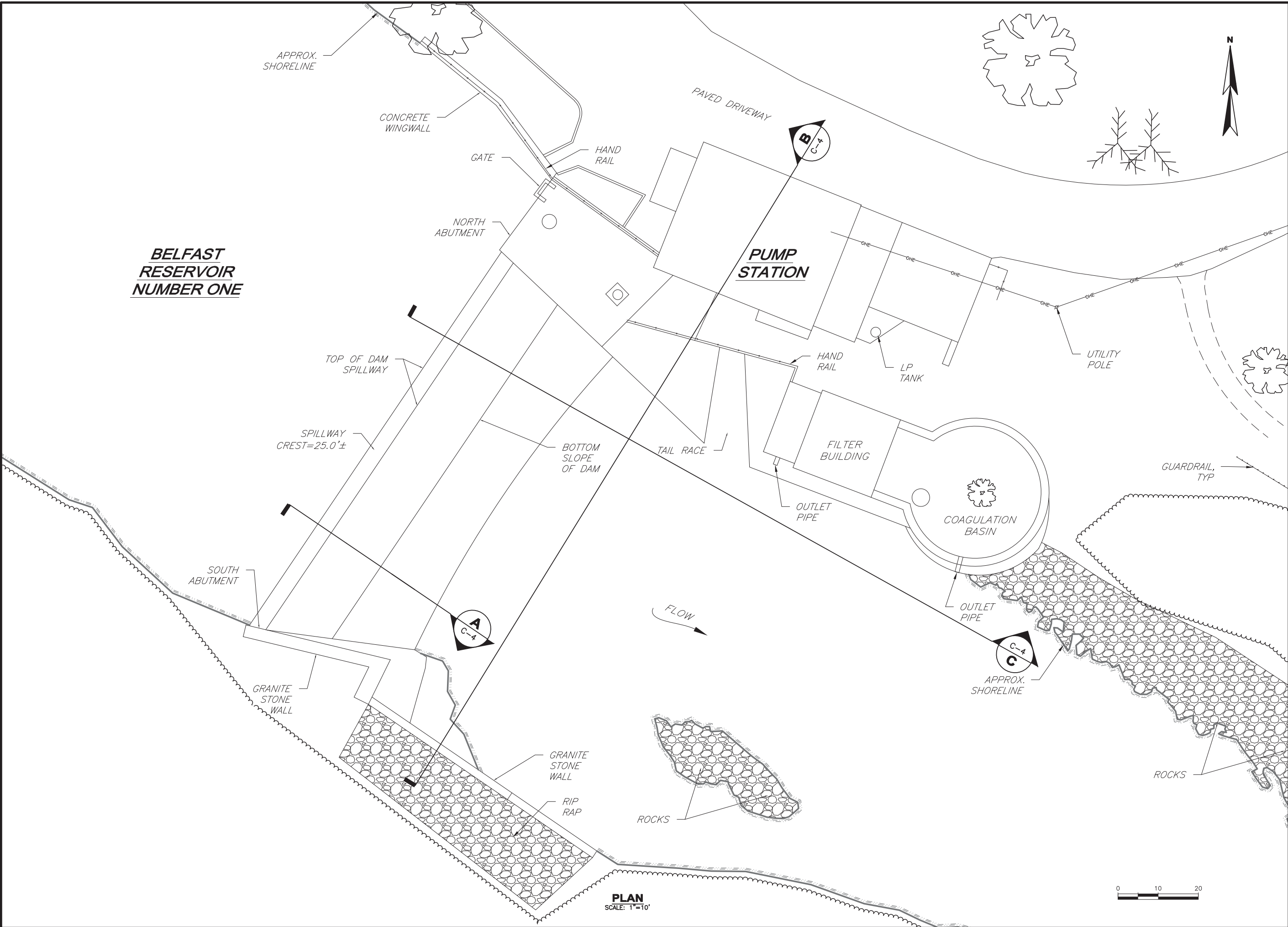
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APPENDIX E
Lower Dam – Plan and Sections



**BELFAST
RESERVOIR
NUMBER ONE**

DESIGNED BY: ###		APP'D:	DATE:
CAD CONTOUR: ###			
CHECKED BY: ###			
DATE: ###			
APPROVED BY: ###			
DATE: ###			
PROJECT NO: ###			
SUBMISSIONS/REVISIONS			
NO.	DATE		
1			
2			
3			
4			
<p>WRIGHT-PIERCE Engineering a Better Environment 888.621.8156 www.wright-pierce.com</p>			
BELFAST WATER DISTRICT UPPER AND LOWER LITTLE RIVER DAMS BELFAST, MAINE		LOWER DAM EXISTING CONDITIONS	
DRAWING C-3			



NO.	DATE	DESCRIPTION

DESIGNED BY: ###
 CAD: ###
 CHECKED BY: ###
 DATE: ###

APPROVED BY: ###
 DATE: ###

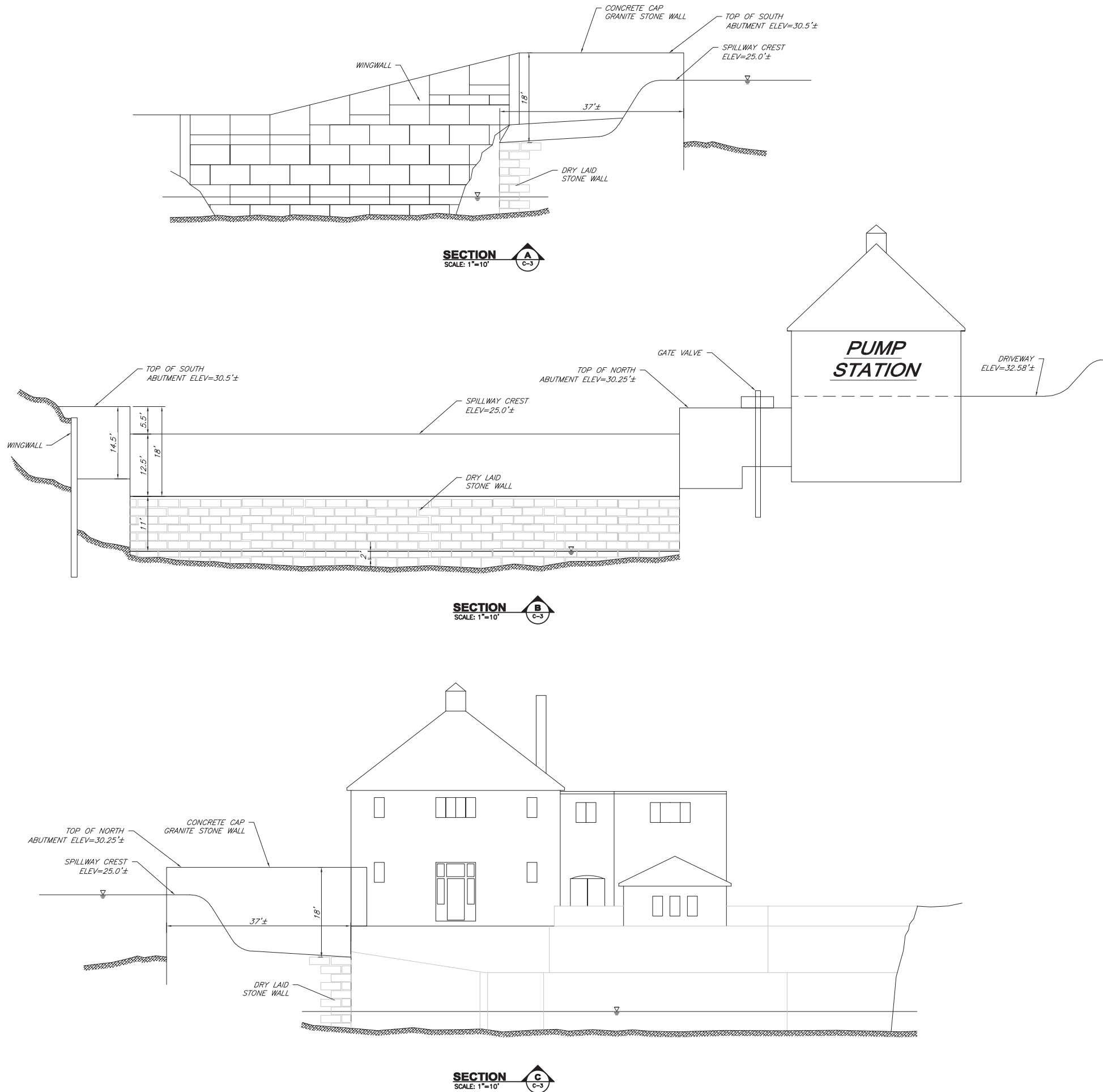
PROJECT NO: ###

WRIGHT-PIERCE
 Engineering a Better Environment
 888.621.8156 | www.wright-pierce.com

BELFAST WATER DISTRICT
 UPPER AND LOWER LITTLE RIVER DAMS
 BELFAST, MAINE

LOWER DAM EXISTING CONDITIONS

DRAWING
 C-3



DESIGNED BY: ###		NO.	DATE
CAD CORRECTED BY: ###		NO.	DATE
CHECKED BY: ###		NO.	DATE
DATE: ###/###/###		NO.	DATE
APPROVED BY: ###		NO.	DATE
DATE: ###/###/###		NO.	DATE
PROJECT NO: ###		NO.	DATE
SUBMISSIONS/REVISIONS			
NO.	DATE	DESCRIPTION	BY
WRIGHT-PIERCE Engineering a Better Environment 888.621.8156 www.wright-pierce.com			
BELFAST WATER DISTRICT UPPER AND LOWER LITTLE RIVER DAMS BELFAST, MAINE		LOWER DAM CROSS SECTIONS	
DRAWING C-4			

APPENDIX F
Lower Dam - Photographs

Little River Dam
Belfast, Maine

Lower Dam



Little River Dam
Belfast, Maine

Lower Dam



Little River Dam
Belfast, Maine

Lower Dam



Little River Dam
Belfast, Maine

Lower Dam



Little River Dam
Belfast, Maine

Lower Dam



Little River Dam
Belfast, Maine

Lower Dam



Little River Dam
Belfast, Maine

Lower Dam



Little River Dam
Belfast, Maine

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Little River Dam
Belfast, Maine

Lower Dam





Little River Dam
Belfast, Maine

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Little River Dam
Belfast, Maine

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Little River Dam
Belfast, Maine

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Little River Dam
Belfast, Maine

Lower Dam

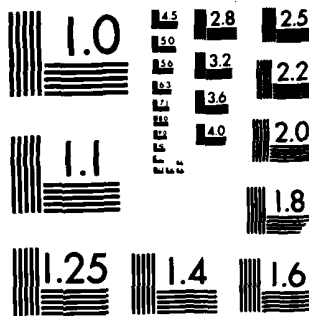


Little River Dam
Belfast, Maine

Lower Dam



APPENDIX G
Lower Dam - ACOE Phase 1 Report



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

①

AD-A155 797

ATLANTIC OCEAN
BELFAST, MAINE

LITTLE RIVER LOWER DAM
ME 00288

STATE NO. 5090

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DTIC
SELECT
JUN 28 1985
S G

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

NOVEMBER 1979

STATEMENT A
Approved for public release
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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM	
1. REPORT NUMBER ME 00288	2. GOVT ACCESSION NO. A155 797	3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) Little River Lower 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 November 1979	
		13. NUMBER OF PAGES 55	
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, Atlantic Ocean Belfast Maine Little River			
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The dam is a concrete and dry stone masonry dam with a hydraulic height of 30 ft. and is 126 ft. long. The dam is in fair condition. It is small in size with a hazard potential of significant. A major breach with pool at top of dam would probably result in the loss of no lives, but could cause appreciable damage to property.			

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.: ME00288
Name of Dam: Little River Lower Dam
Town: Belfast
County and State: Waldo, Maine
Stream: Little River
Date of Inspection: September 17, 1979

BRIEF ASSESSMENT

Little River Lower Dam is a concrete and dry-stone-masonry dam, with a hydraulic height of 30 feet, 126 feet long, with a 91-foot long concrete ogee spillway section which makes a smooth transition into a slightly sloping spillway apron. At its downstream end the spillway apron discharges over a vertical dry-stone-masonry wall about 11 feet high. At the south end of the dam there is a concrete retaining wall. At the north end of the dam there is a massive intake structure which appears to be dry-stone-masonry encased in concrete. A pump station building and a filter house for a water supply system is located integrally with the north abutment. The gate mechanism on the north abutment is in poor condition and hasn't been operational for over 24 years. The dam impounds a reservoir with a maximum storage capacity of about 615 acre-feet. The reservoir is .51 mile long with a surface area of about 37 acres and is used for water supply for the Town of Belfast.

The dam is in fair condition. Major concerns are: Erosion on the upstream and downstream sides of the south concrete abutment, and deterioration of the dry-stone-masonry walls at the downstream edge of the spillway apron, on the north bank of the upstream channel and on the north bank of the downstream channel.

Based on small size and significant hazard classification in accordance with Corps guidelines, the test flood ranges from $\frac{1}{4}$ to $\frac{1}{2}$ the Probable Maximum Flood (PMF). Because the storage capacity of this reservoir is in the upper range of the size classification, $\frac{1}{2}$ PMF was selected as the test flood. Using the COE guide curves with 'mountainous' terrain, and the $\frac{1}{2}$ PMF routed outflow from the Little River Upper Dam, the test flood inflow was determined to be 15,920 cfs. After routing, the test flood discharge was determined to be 15,000 cfs at elevation 36.7' NGVD. The test flood analysis indicates the dam would be overtopped by 6.4 feet. Spillway capacity at top of dam is 3,665 cfs, which is 24 percent of the routed test flood discharge. A major breach with pool at top of dam would probably result in the loss of no lives, but could cause appreciable property damage. (For details see Section 5.1 f.)

The owner, Belfast Water District, should implement the results of the recommendations and remedial measures given in Sections 7.2 and 7.3 within one year after receipt of this Phase I Inspection Report.

Warren A. Guinan
Warren A. Guinan
Project Manager
N.H. P.E. 2339



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

JUL 07 1980

Honorable Joseph E. Brennan
Governor of the State of Maine
State Capitol
Augusta, Maine 04330

Dear Governor Brennan:

Inclosed is a copy of the Little River Lower Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Agriculture cooperating agency for the State of Maine. In addition, a copy of the report has also been furnished the owner, Belfast Water District, 71 Church Street, Belfast, Maine 04915.

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

I wish to take this opportunity to thank you and the Department of Agriculture for your cooperation in carrying out this program.

Sincerely,


MAX B. SCHEIDER

Colonel, Corps of Engineers
Division Engineer

Incl
As stated

This Phase I Inspection Report on Little River Lower 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.

Aramast Mahtesian

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Richard J. DiBuono

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

Accession For	
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DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/	
Availability Codes	
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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 inspections. 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 will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway 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.

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REPORT

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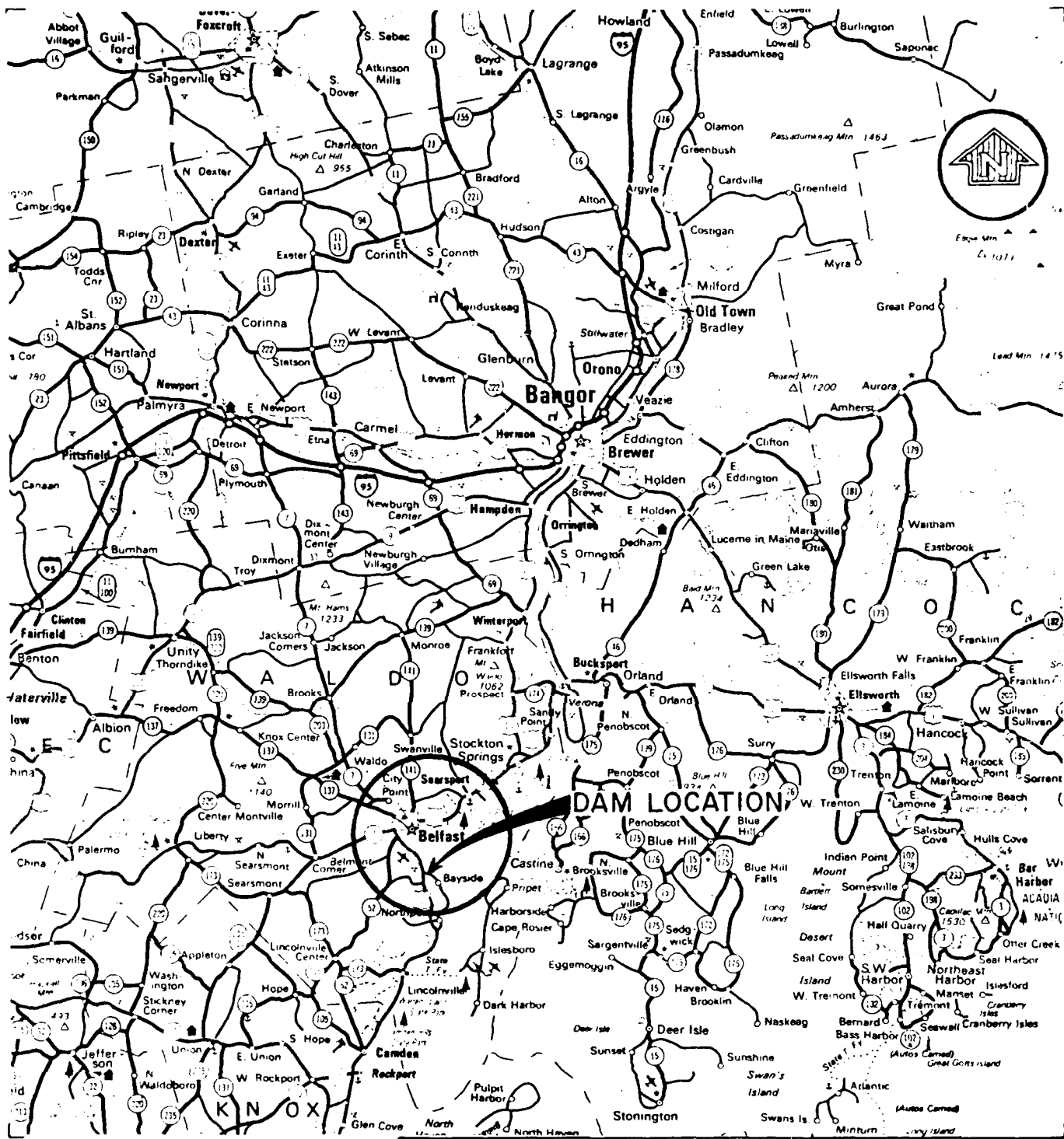
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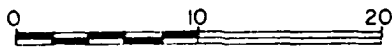
October, 1979

Figure 1 - Overview of Little River Lower Dam.



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SCALE IN MILES



MAP BASED ON 1979-1980 OFFICIAL TRANSPORTATION MAP, STATE OF MAINE

Anderson-Nichols & Co., Inc		U S ARMY ENGINEER DIV NEW ENGLAND	
CONCORD		CORPS OF ENGINEERS	
NEW HAMPSHIRE		WALTHAM, MA	
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS			
LITTLE RIVER LOWER DAM			
LOCATION MAP			
LITTLE RIVER		MAINE	
		SCALE SEE BAR SCALE	
		DATE NOVEMBER 1979	

NATIONAL DAM INSPECTION PROGRAM
PHASE 1 INSPECTION REPORT
LITTLE RIVER LOWER DAM

SECTION 1
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. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols under a letter of August 28, 1979 from William E. Hodgson, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0050, as changed, has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Little River Lower Dam, commonly called Lower Dam, is located on the boundary of the Town of Belfast and the Town of Northport, Maine; the dam spans Little River approximately 700 feet upstream from the river's confluence with the Atlantic Ocean. The dam impounds a pond called Belfast Reservoir Number 1. After discharging at the damsite, Little River flows easterly into Penobscot Bay in the Atlantic Ocean. Little River Lower Dam is shown on the U.S.G.S. Quadrangle, Searsport, Maine with coordinates approximately at N 44° 23' 42", W 68° 59' 24", Waldo County, Maine. (See Location Map page vii.)

b. Description of Dam and Appurtenances. Little River Lower Dam is a low, run-of-river dam which impounds a reservoir

of small size. It is a concrete and dry-stone-masonry dam, about 30 feet high (hydraulic) and 126 feet long, with a 91-foot long ogee spillway section which makes a smooth transition into a slightly sloping spillway apron. At its downstream end, the spillway apron discharges over a vertical dry-stone-masonry wall about 11 feet high.

At the south end of the dam there is a concrete retaining wall. The wall extends downstream 36 feet (width of the spillway and apron) then bends at right angle towards south abutment for a distance of 12 feet and then again continues downstream for the next 14 feet. At the downstream side of the concrete retaining wall it can be observed that the wall is founded on bedrock. Soil lies against the upstream and landward sides of the retaining wall. At the north end of the dam there is a massive intake structure which appears to be dry-stone-masonry encased in concrete on the top, upstream face, and river side face. A stone masonry training wall, partially faced with concrete supports the north bank of the upstream approach channel. The training wall extends for 24 feet perpendicular to the spillway and then bends slightly toward the center of the upstream channel to the next 24 feet. On the north bank of the downstream channel there is a concrete-faced dry-stone-masonry wall which, in the lower section, is not faced with concrete. Located in the lower section of the downstream retaining wall is an outlet channel for the intake structure. This outlet is plugged with sand and gravel to about one-third of its height. A pump station building and a filter house for a water supply system is located immediately downstream of the north abutment. A concrete wall which exists on the river side of these buildings is an extension to the downstream retaining wall. The gate operating mechanism on the north abutment is inoperable; the gate size and type is unknown. Its outlet is a 5-foot diameter steel pipe that exits at the bottom of the training wall on the north bank of the downstream channel. The average daily intake through the water supply pump is about 275 gpm.

c. Size Classification. Small (hydraulic height - 30 feet; storage - 615 acre-feet) based on height and storage (height \geq 25 to $<$ 40 feet and storage \geq 50 to $<$ 1000 acre-feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant hazard. A major breach would probably not result in the loss of lives, but could cause appreciable property damage and loss of the reservoir and water supply of the Town of Belfast. (See Section 5.1 f.)

e. Ownership. Little River Lower Dam is owned by Belfast Water District.

f. Operator. The current owner and operator of the dam is Belfast Water District, 71 Church Street, Belfast, Maine. Telephone: (207) 338-1200.

g. Purpose of Dam. Water impounded at Little River Lower Dam is used as a water supply reservoir.

h. Design and Construction History. The original stone masonry dam was built in 1887 and was breached in 1941. In 1943 a new dam was built about 15 feet downstream of the old dam crest. Some parts of the original dam were used to build the new dam. Gunitite patchwork was done on the dam face about two years ago. This historical information was obtained orally from the Belfast Water District Superintendent, Mr. Milford Rhodes, during the visual inspection. No other information regarding the original design or construction of the dam was disclosed.

i. Normal Operating Procedures. No written operational procedures exist for Little River Lower Dam. Operating procedures are restricted to water supply operation. There are two 8-inch pipes leading to a wet well which has one 10-inch supply line. The average daily supply amounts to 275 gpm.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 16.8 square miles (10,752 acres) of rolling and partially wooded terrain. 3.1 square miles is intermediate drainage area and 13.7 square miles is drainage for Little River Upper Dam, which is located about 4,900 feet upstream. The normal pool has a surface area of 37 acres which constitutes less than 1 percent of the watershed.

b. Discharge at Damsite

- (1) Outlet works (a) - unknown gate size - gate is not now operable
(b) - two 8-inch diameter intake pipes for water supply
- (2) The maximum known discharge for this dam was in the 1950's when high water flowed over the abutments and filter house. No elevation for this incident was available.
- (3) Ungated spillway capacity @ top of dam elevation - 3,665 cfs @ 30.3' MSL
- (4) Ungated spillway capacity @ test flood elevation - 12,018 cfs @ 36.7' MSL
- (5) Gated spillway capacity @ top of dam elevation - not applicable
- (6) Gated spillway capacity @ test flood elevation - not applicable
- (7) Total spillway capacity @ test flood elevation - 12,018 cfs @ 36.7' MSL

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Little River Lower Dam, Me. DATE Sept. 17, 1979

TIME 1300

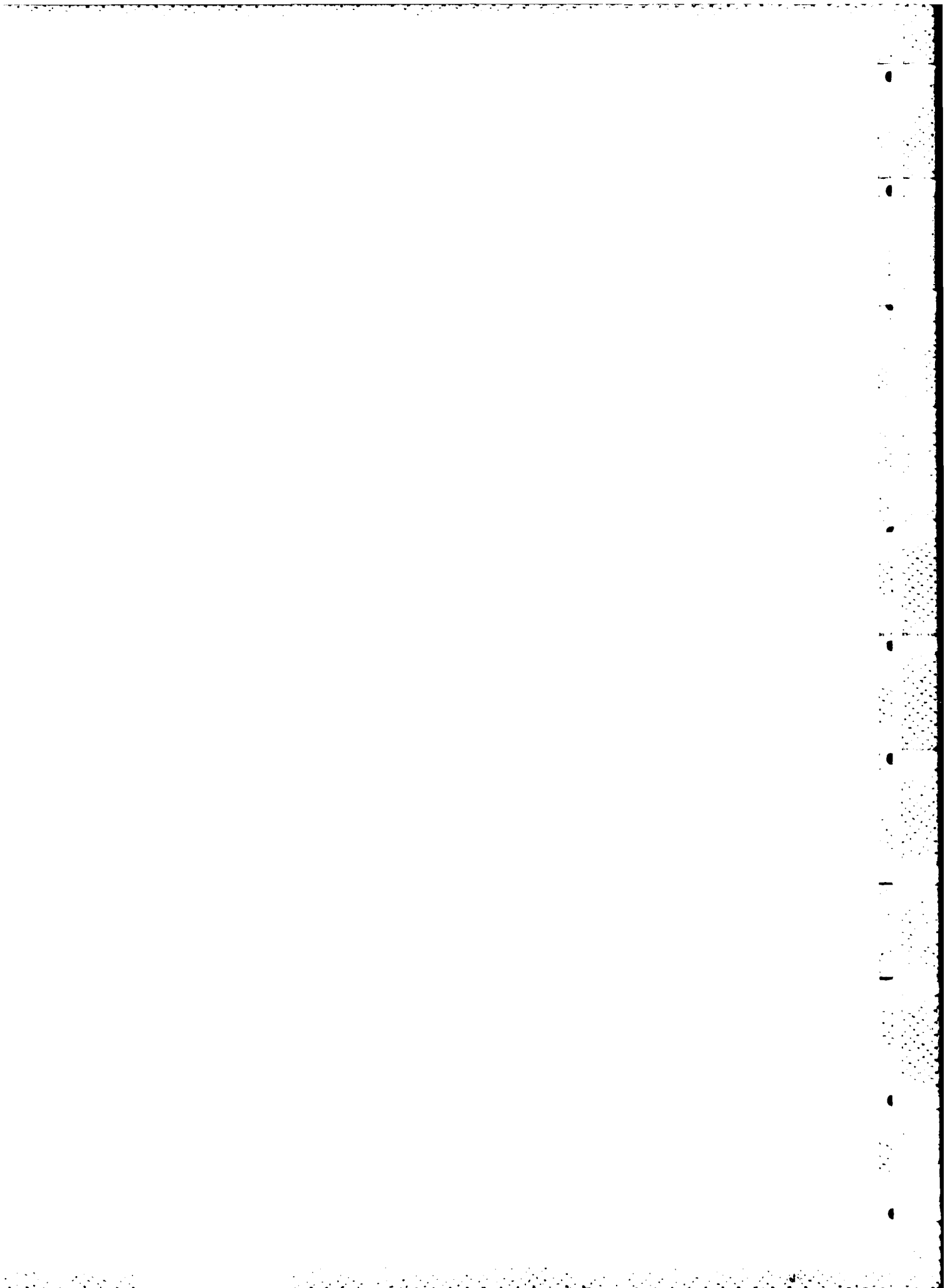
WEATHER Sunny, hot

W.S. ELEV. U.S. DN.S.
25' MSL 1.3' MSL

PARTY:

- | | |
|----------------------------------|--|
| 1. <u>Warren Guinan (ANCo)</u> | 6. <u>Janusz Czyzowski (ANCo)</u> |
| 2. <u>Stephen Gilman (ANCo)</u> | 7. <u>Ronald Hirschfeld (GEI)</u> |
| 3. <u>Leslie Williams (ANCo)</u> | 8. <u>Milford Rhodes (Bel. Water Dist)</u> |
| 4. <u>John Regan (ANCo)</u> | 9. _____ |
| 5. <u>Teresa Sapp (ANCo)</u> | 10. _____ |

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>Hydrology/Hydraulics</u>	<u>L. Williams/J. Czyzowski</u>	
2. <u>Structural Stability</u>	<u>S. Gilman</u>	
3. <u>Soils and Geology</u>	<u>R. Hirschfeld</u>	
4. _____		
5. _____		
6. _____		
7. _____		
8. _____		
9. _____		
10. _____		



APPENDIX A
VISUAL INSPECTION CHECKLIST

- (2) Clear the sand and gravel that partially block the discharge end of the low-level outlet pipe.
- (3) Inspect visually the dam and appurtenant structures once a month.
- (4) Engage a Registered Professional Engineer to make a comprehensive technical inspection of the dam once a year.
- (5) Establish a surveillance program for use during and immediately after heavy rainfall and also a warning program to follow in case of emergency conditions.

7.4 Alternatives

None.

SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination indicates that Little River Lower Dam is in fair condition. The major concerns with respect to the integrity of the dam, if left uncorrected, are:

- (1) Erosion on the upstream and downstream sides of the south concrete abutment block.
- (2) Deterioration of the dry-stone-masonry walls at the downstream edge of the spillway apron, on the north bank of the upstream channel, and on the north bank of the downstream channel.

b. Adequacy of Information. The information available is such that the assessment of this dam must be based primarily on the results of the visual inspection.

c. Urgency. The recommendations made in 7.2 and 7.3 should be implemented by the owner within one year after receipt of this Phase I report.

d. Need for Additional Investigation. No additional investigation for the purposes of this Phase I investigation is needed.

7.2 Recommendations

The owner should engage a Registered Professional Engineer to:

- (1) Design and implement repairs for the dry-stone-masonry walls at the downstream edge of the spillway apron, on the north bank of the upstream channel, and on the north bank of the downstream channel.
- (2) Design and implement repairs for the erosion on the upstream and downstream sides of the right concrete abutment block.
- (3) Design repairs to the low-level outlet gate, operating mechanism, and outlet pipe as required.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

- (1) Remove trees and brush from the right bank of the downstream channel between the dam and the highway bridge.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. Erosion on the upstream and downstream sides of the south concrete abutment shell, if not corrected, could have an adverse effect on the stability of the abutment.

Deterioration of the dry-stone-masonry walls at the downstream edge of the spillway apron, on the north bank of the downstream channel, and on the north bank of the upstream channel, if not corrected, could result in erosion and undermining of the dam and the north abutment.

b. Design and Construction Data. No design and construction data are available.

c. Operating Records. No written operational procedures exist for Little River Lower Dam. Operating procedures are restricted to water supply operation.

d. Post-Construction Changes. See Section 1.2 h.

e. Seismic Stability. This dam is located in Seismic Zone 2 and, in accordance with the Phase I guidelines, does not warrant seismic analysis.

cfs at elevation 36.7' NGVD. The test flood analysis indicates that the dam embankment would be overtopped by approximately 6.4 feet during the test flood conditions. The spillway capacity at top of dam is 3,665 cfs which is 24 percent of the routed test flood discharge. Flow through the water supply pump which averages daily about 275 gpm is insignificant for this study. Because of the inoperable gate condition, overtopping analyses were calculated assuming gate closed.

f. Dam Failure Analysis. The impact of failure of the dam at the top of dam was assessed using the Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers. The analysis covered the reach extending from the dam to the Atlantic Ocean, a distance of 700 feet along Little River. A major breach of Little River Lower Dam would discharge about 14,780 cfs. The discharge from the dam just prior to failure would be 3,665 cfs or maximum spillway capacity. A breach would cause an increase in stage of 6.3 feet in addition to the 8.2-foot antecedent stage from the dam to the U.S. Route 1 bridge. This increase could cause damage to the water treatment facilities. The U.S. Route 1 bridge would pass the breach discharge without overtopping but this discharge could possibly cause structural damage to the bridge. In the reach from the bridge to the Atlantic Ocean, a distance of 300 feet, an increase in stage of 9 feet in addition to the 10-foot antecedent stage would probably occur. An historic home which also houses a doctor's and optician's office is located on the north bank of the channel just downstream of the U.S. Route 1 bridge. The sill of this home is about 19 feet above channel bottom. Possible damage may occur to this home and the parking lot beside it. The breach could also cause loss of reservoir for use in water supply and therefore poses a hazard to a public utility. There would probably be no loss of life, but it could cause appreciable property damage. Therefore, Little River Lower Dam was classified Significant Hazard.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. General. Little River Lower Dam is a concrete and dry-stone-masonry dam with an ogee spillway section which makes a smooth transition into a slightly sloping spillway apron. Discharge is over the vertical dry-stone-masonry wall at its downstream end. The dam impounds a reservoir of small size (maximum storage capacity 615 acre-feet) which is used for water supply. The drainage area at the dam consists of 16.8 square miles of mountainous terrain. Reservoir Number 2, impounded by the Upper Dam, is located 0.42 miles upstream. A gate of unknown size is located at the north abutment. The gate mechanism is rusted and not operable. The gate was designed to control discharge through an outlet channel which is plugged with sand and gravel to about one-third of its height. Also at the north abutment, there are two 8-inch intake pipes for the water supply pump. Intake through the water supply pump averages daily about 275 gpm. The reservoir level is controlled by the spillway which is located at the center of the dam.

b. Design Data. No hydrologic or hydraulic experience data were found.

c. Experience Data. No hydrologic or hydraulic experience data were disclosed. Only oral information from the retired Superintendent of the Belfast Water District was available. He described the discharge in the 1950's when high water flowed over the abutments and filter house. No elevation of this incident was available.

d. Visual Observations. At the time of the inspection, no visual evidence was noted of damage to the structure caused by overtopping.

e. Test Flood Analysis. Little River Lower Dam is classified as being small size having a hydraulic height of 30 feet and a maximum storage capacity of 615 acre-feet. The dam was determined to have a significant hazard classification. Using the Recommended Guidelines for Safety Inspection of Dams, the test flood ranged from $\frac{1}{2}$ to $\frac{1}{2}$ the Probable Maximum Flood (PMF). Because the dam's storage capacity is in the upper end of the size classification, the $\frac{1}{2}$ PMF was chosen as the test flood.

Using the $\frac{1}{2}$ PMF, the test flood inflow for Little River Lower Dam was determined to be 15,920 cfs. The total drainage area is 16.8 square miles, but only 3.1 square miles is intermediate drainage for Little River Lower Dam. Therefore, inflow to Little River Lower Dam is the sum of the routed outflow from Little River Upper Dam and inflow from the intermediate drainage area using the 'mountainous' COE guide curve. The routed outflow value from the Upper Dam was taken from the Little River Upper Dam Phase I inspection report. After routing, the test flood discharge was determined to be 15,000

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

No written operational procedures exist for Little River Lower Dam. Operating procedures are restricted to water supply operation. There are two 8-inch pipes leading to a wet well which has one 10-inch supply line. The normal daily usage is 275 gpm.

4.2 Maintenance of Dam

The owner, Belfast Water District, is responsible for the maintenance of the dam.

4.3 Maintenance of Operating Facilities

No formal maintenance procedure was disclosed. The Superintendent of the Belfast Water District reported that the low-level gate mechanism is inoperable and has not been operated for over 24 years. Maintenance facilities apply to the water supply station. Someone from the Belfast Water District is on duty at the dam site in the daytime during the weekdays.

4.4 Description of Any Warning System in Effect

No written warning system exists for the dam.

4.5 Evaluation

Formal operational and maintenance procedures should be developed to ensure that problems that are encountered can be remedied within a reasonable period of time.

the approximately 8-inch thick concrete cap which is severely cracked. (See Appendix C - Figure 9.)

A 5-foot-diameter steel pipe exits at the bottom of the training wall on the north bank of the downstream channel. The outlet of the pipe is plugged with sand and gravel to about one-third of its height. (See Appendix C - Figure 9.) The gate mechanism on the north abutment is inoperable; the gate size is unknown. (See Appendix C - Figure 4.) The mechanism is in poor condition with no indication of maintenance. A pump station building and a filter house for a water supply system is located integrally with the north abutment. A concrete wall which exists on the river side of these buildings is an extension to the downstream retaining wall. (See Appendix C - Figure 10.)

d. Reservoir Area. The watershed above the reservoir is rolling and partially wooded. (See Appendix C - Figure 11.) No structures were observed on the shore of the reservoir. No evidence of significant sedimentation in the reservoir was observed.

e. Downstream Channel. The downstream channel is bedrock. Trees overhang the south side of the channel. About 400 feet downstream of the dam is the U.S. Route 1 bridge that crosses the channel. (See Appendix C - Figure 12.) Little River discharges into Penobscot Bay through a channel lined with well-placed derrick stone. (See Appendix C - Figure 13.)

3.2 Evaluation

Based on the visual inspection, Little River Lower Dam is in fair condition. Erosion on the upstream and downstream sides of the south concrete abutment shell, if not corrected, could have an adverse effect on the stability of the abutment.

Deterioration of the dry-stone-masonry walls at the downstream edge of the spillway apron, on the north bank of the downstream channel, and on the north bank of the upstream channel, if not corrected, could result in erosion and undermining of the dam and the north abutment. Also, cracked concrete cap on the lower part of north abutment poses a dangerous condition to people walking on the top of the wall.

The inoperable gate and low-level outlet provides no means of draining the reservoir.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Little River Lower Dam is a low, run-of-river dam which impounds a reservoir of small size. The watershed above the reservoir is rolling and partially wooded. Little River discharges into Penobscot Bay about 700 feet downstream of the dam.

b. Dam. Little River Lower Dam is a concrete and dry-stone-masonry dam, about 30 feet high (hydraulic) and 126 feet long, with a 91-foot long ogee spillway section which makes a smooth transition into a slightly sloping spillway apron. At its downstream end, the spillway apron discharges over a vertical dry-stone-masonry wall about 11 feet high. (See Appendix C - Figure 2.) This vertical dry-stone-masonry wall has two openings, but it cannot be determined from the visual inspection whether these openings are built into the original wall or whether they are the result of blocks of rock having fallen out.

At the north end of the dam there is a massive intake structure which appears to be dry-stone-masonry encased in concrete on the top, upstream face, and river-side face. (See Appendix C - Figures 3 & 4.) The downstream face is dry-stone-masonry. (See sketch plan, Appendix B.)

At the south end of the dam there is a concrete abutment shell. (See Appendix C - Figure 5.) Bedrock is exposed at the downstream side of the concrete abutment. (See Appendix C - Figure 6.) Soil rests against both the upstream and landward sides of the concrete abutment shell. (See Appendix C - Figure 7.) Minor erosion is occurring in the soil immediately adjacent to the upstream side of the concrete abutment shell. Major erosion and sloughing of the soil cover, down to bedrock, is occurring immediately adjacent to the downstream side of the shell. (See Appendix C - Figure 6.) A weephole is located on the downstream face of this shell and it was discharging a small amount of water at the time of the inspection.

c. Appurtenant Structures. A stone masonry training wall, partially faced with concrete which is in poor condition, supports the north bank of the upstream approach channel. (See Appendix C - Figure 8.)

On the north bank of the downstream channel there is a concrete-faced dry-stone-masonry wall. The lower, dry-stone-masonry section of the wall is in poor condition and several blocks of rock are missing from the wall. This causes lack of support to

SECTION 2
ENGINEERING DATA

2.1 Design

No design data were disclosed for Little River Lower Dam.

2.2 Construction

No construction records were disclosed.

2.3 Operation

No engineering operational data were obtained.

2.4 Evaluation

a. Availability. No engineering data were available for Little River Lower Dam. Direct contact with the Belfast Water District and a search of the files at the Maine Soil and Water Conservation Commission revealed only a limited amount of information.

b. Adequacy. The final assessments and recommendations of this investigation are based on the visual inspection and the hydrologic and hydraulic calculations.

c. Validity. No engineering data were disclosed to validate.

g. Dam

- (1) Type - concrete gravity
- (2) Length - 126' (dam embankment)
- (3) Height - 31' (structural height)
- (4) Top width - 35'
- (5) Side slopes - upstream - vertical
- downstream - vertical
(ogee spillway section makes transition into a slightly sloping spillway apron which drops vertically about 11 feet at downstream toe of the dam)
- (6) Zoning - not applicable
- (7) Impervious core - not applicable
- (8) Cutoff - unknown
- (9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - not applicable.

i. Spillway

- (1) Type - concrete ogee overflow
- (2) Length of weir - 91'
- (3) Crest elevation - 25' MSL
- (4) Gates - none
- (5) U/S Channel - Reservoir Number 1; completely open
- (6) D/S Channel - Little River for about 700 feet before its confluence with the Atlantic Ocean, rock channel well defined. U.S. Route Number 1 spans the river 400' below the dam.

j. Regulating Outlets - unknown size gate (not operable) with 60-inch diameter steel pipe outlet pipe and channel which is plugged with sand and gravel to about one-third of its height. This outlet exits at the bottom of the retaining wall on the north bank of the downstream channel.

(8) Total project discharge @ test flood elevation -
15,000 cfs @ 36.7' MSL

c. Elevation (feet above MSL; see (6) below)

- (1) Streambed at centerline of dam - 0.3 (at downstream toe, 1.0 foot deep pool)
- (2) Maximum tailwater - unknown
- (3) Upstream valve chamber invert - unknown
- (4) Recreation pool - not applicable
- (5) Full flood control pool - not applicable
- (6) Spillway crest - 25 (estimated from U.S.G.S. Quadrangle sheet)
- (7) Design surcharge (original design) - unknown
- (8) Top of dam - 30.3
- (9) Test flood pool - 36.7

d. Reservoir (miles)

- (1) Length of maximum pool - 0.66
- (2) Length of spillway crest pool - 0.51
- (3) Length of flood control pool - not applicable

e. Storage (acre-feet)

- (1) Recreation pool - not applicable
- (2) Flood control pool - not applicable
- (3) Spillway crest pool - 370
- (4) Top of dam - 615
- (5) Test flood pool - 910

f. Reservoir Surface (acres)

- (1) Recreation pool - not applicable
- (2) Flood control pool - not applicable
- (3) Spillway crest - 37
- (4) Test flood pool - 52
- (5) Top of Dam - 46

PERIODIC INSPECTION CHECKLIST

PROJECT Little River Lower Dam, Me. DATE September 17, 1979
 PROJECT FEATURE Intake Channel and Structure NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<p><u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u></p> <p>a. Approach Channel</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</p> <p>Drains or Weep Holes</p> <p>b. Intake Structure</p> <p>Condition of Concrete</p> <p>Stop Logs and Slots</p>	<p>Good</p> <p>Not visible beneath lake surface</p> <p>None</p> <p>None</p> <p>None</p> <p>Not visible beneath lake surface</p> <p>None observed</p> <p>Not visible beneath lake surface</p> <p>None</p>

PERIODIC INSPECTION CHECKLIST

PROJECT Little River Lower Dam, ME DATE September 17, 1979

PROJECT FEATURE Control Tower NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED

CONDITION

OUTLET WORKS - CONTROL TOWER

a. Concrete and Structural

General Condition

Fair

Condition of Joints

No indication of movement

Spalling

Numerous surface spalls

Visible Reinforcing

None

Rusting or Staining of
Concrete

Only at embedded items

Any Seepage or Efflorescence

None visible

Joint Alignment

Good - no indication of movement

Unusual Seepage or Leaks in
Gate Chamber

None visible

Cracks

Numerous minor surface cracks

Rusting or Corrosion of
Steel

Only at embedded steel items

b. Mechanical and Electrical

Air Vents

Gate operating mechanism is in poor condition-no indication of maintenance, lubrication or operation. Belfast Water District Superintendent indicated that gate hasn't been operated in 24 years.

Float Wells

Crane Hoist

Elevator

Hydraulic System

None

Service Gates

Not visible-reported to be steel

Emergency Gates

None

Lightning Protection System

None

Emergency Power System

None

Wiring and Lighting System

Not applicable

PERIODIC INSPECTION CHECKLIST

PROJECT Little River Lower Dam, Me. DATE September 17, 1979

PROJECT FEATURE Outlet Structure and Channel NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<p><u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u></p> <p>General Condition of Stone Masonry</p> <p>Rust or Staining</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>Drain holes</p> <p>Channel</p> <p>Loose Rock or Trees Overhanging Channel</p> <p>Condition of Discharge Channel</p>	<p>North stone masonry wall has several large stones missing from wall.</p> <p>Downstream wall above tailrace is badly spalled and cracked.</p> <p>None</p> <p>None</p> <p>Considerable movement where wall is cracked.</p> <p>One weep hole discharging water in concrete block south abutment.</p> <p>Brush and a few trees overhanging channel immediately upstream.</p> <p>Good</p>

PERIODIC INSPECTION CHECKLIST

PROJECT Little River Lower Dam, Me. DATE September 17, 1979

PROJECT FEATURE Spillway Weir NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<p><u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u></p> <p>a. Approach Channel</p> <p> General Condition</p> <p> Loose Rock Overhanging Channel</p> <p> Trees Overhanging Channel</p> <p> Floor of Approach Channel</p> <p>b. Weir and Training Walls</p> <p> General Condition of Concrete</p> <p> Rust or Staining</p> <p> Spalling</p> <p> Any Visible Reinforcing</p> <p> Any Seepage or Efflorescence</p> <p> Drain Holes</p> <p>c. Discharge Channel</p> <p> General Condition</p> <p> Loose Rock Overhanging Channel</p> <p> Trees Overhanging Channel</p> <p> Floor of Channel</p> <p> Other Obstructions</p>	<p>Good</p> <p>None</p> <p>A few trees</p> <p>Not visible beneath lake surface.</p> <p>Weir-good-only surface erosion of face some erosion of construction joints Training walls-poor-considerable erosion and spalling on faces, south wall cracked with 1/2" movement. Some on face of weir and retaining walls.</p> <p>None</p> <p>None visible</p> <p>One weep hole discharging water from concrete south-abutment block.</p> <p>Good</p> <p>None, but soil on top of bedrock is eroding immediately downstream of right abutment. Some trees overhanging right side of channel. Bedrock (phyllite) and chips of decomposed phyllite. Bridge carrying Route 1 across downstream channel.</p>

PROJECT Little River Lower Dam, Me.

DATE September 17, 1979

PROJECT FEATURE Reservoir

NAME

AREA EVALUATED	REMARKS
Stability of Shoreline	Upstream-good
Sedimentation	Downstream-phyllite and fines by south abutment eroded. A large field would wash much of the lower south side away.
Changes in Watershed Runoff Potential	Not much ground cover. Not visible below water source.
Upstream Hazards	None
Downstream Hazards	Filter house-bridge-home past bridge
Alert Facilities	None
Hydrometeorological Gages	Staff gage
Operational & Maintenance Regulations	None posted

APPENDIX B
ENGINEERING DATA

APPLICATION FOR DAM REGISTRATION

Dam Registration Number 5090
Date Received DEC 15 1975 *pg 2*
Fee Enclosed 10.00
Quad Sheet Name Cashier
Quad Sheet Number M 10
+-----+

Location:
County: Waldo
Municipality: Quasi-Municipal Belfast Water District
Name of Dam: Lower Reservoir Dam
Name of Impoundment: Reservoir #1

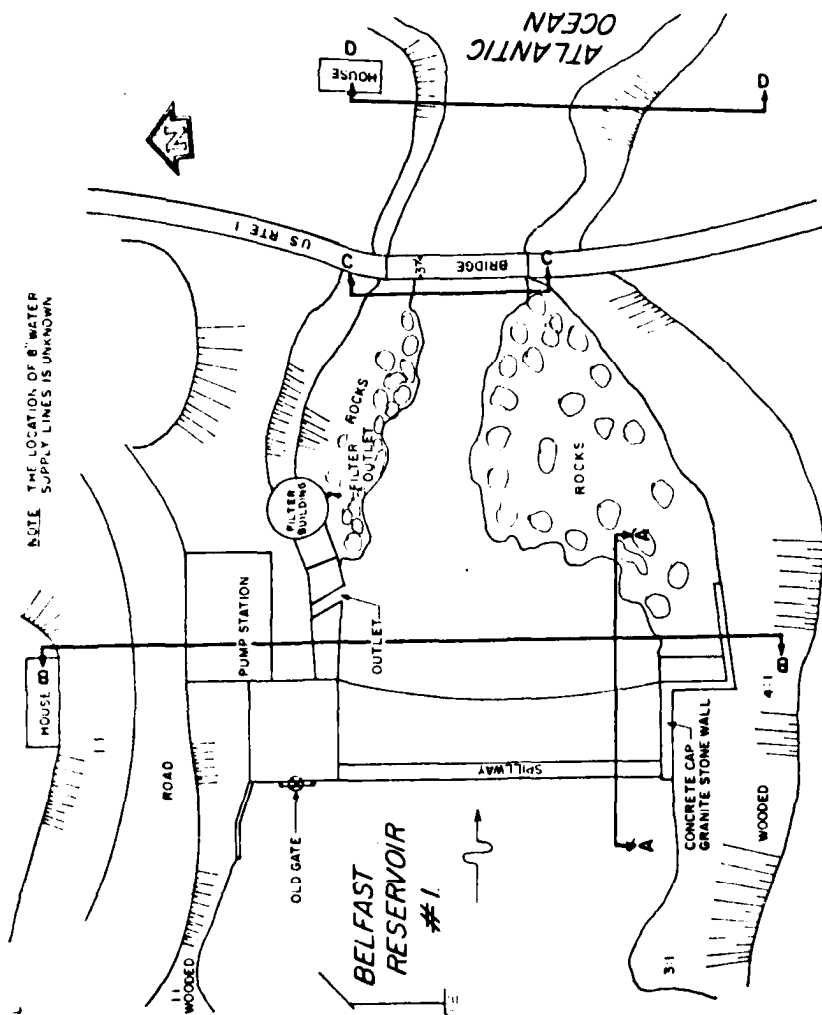
Ownership:
Name of Owner: Belfast Water District
Address of Owner: 71 Church Street
Belfast, Maine 04915
Telephone Number: 338-1200

Name of Agent: _____
(if different from Owner)
Address: _____
Telephone Number: _____

Description of Dam
Type: Arched Concrete
Construction Material: Concrete
(Concrete, wood, earth)
Year Originally built: 1944 Year last major repair: 1968
Height: 25 ft. Width: 175 ft.
Spillway type: open Spillway Width: 70 ft.
Impounding Capacity: 57,000,000 gallons Drawdown available: 10
(Acres-Feet) (feet)
Fish Passage available?: no Installed Electrical Generating Cap: ---
Purposes for which stored water is used: Public drinking supply

Most recent inspection by Qualified Engineer (Date): August 1972
Name and Address of Engineer: Dale E. Caruthers - (Deceased)
Masonic Building, Gorham, Maine 04038

Other Permits applicable: ----

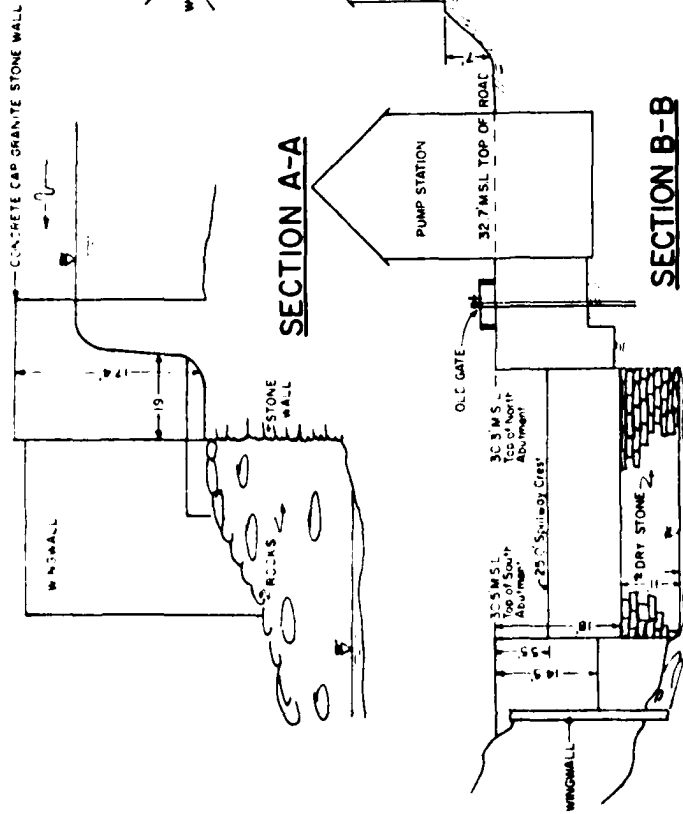


NOTE: THE LOCATION OF B WATER SUPPLY LINES IS UNKNOWN

PLAN

NOTE: ELEVATIONS ARE BASED ON SPILLWAY CREST ASSUMED
ELEVATION OF 25 M.S.L. DATUM (M.G.V.C.)

CONTRACT:	NEW HAMPSHIRE	U.S. ARMY ENGINEER DIVISION NEW ENGLAND
ENGINEER:	ANDERSON-NICHOLS & CO., INC.	CORPS OF ENGINEERS
	MALDEN, MASS.	
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS		
LITTLE RIVER LOWER DAM		
LITTLE RIVER	SCALE: NOT TO SCALE	MAINE
	DATE: NOVEMBER 1979	FIGURE B-1

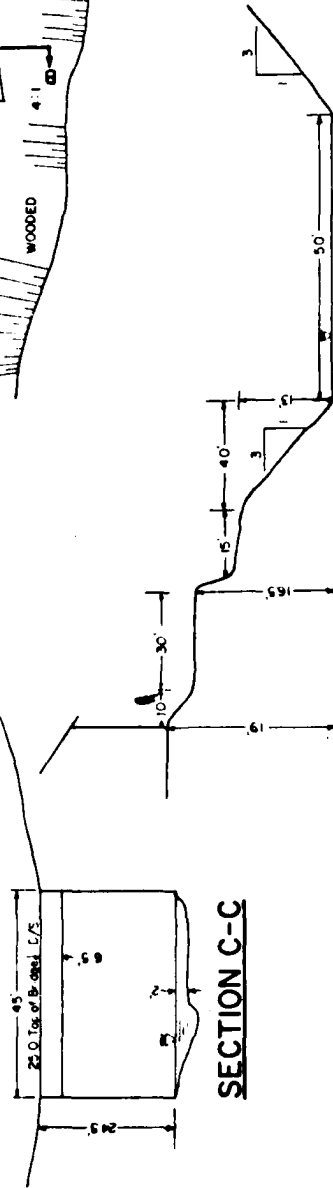


SECTION A-A

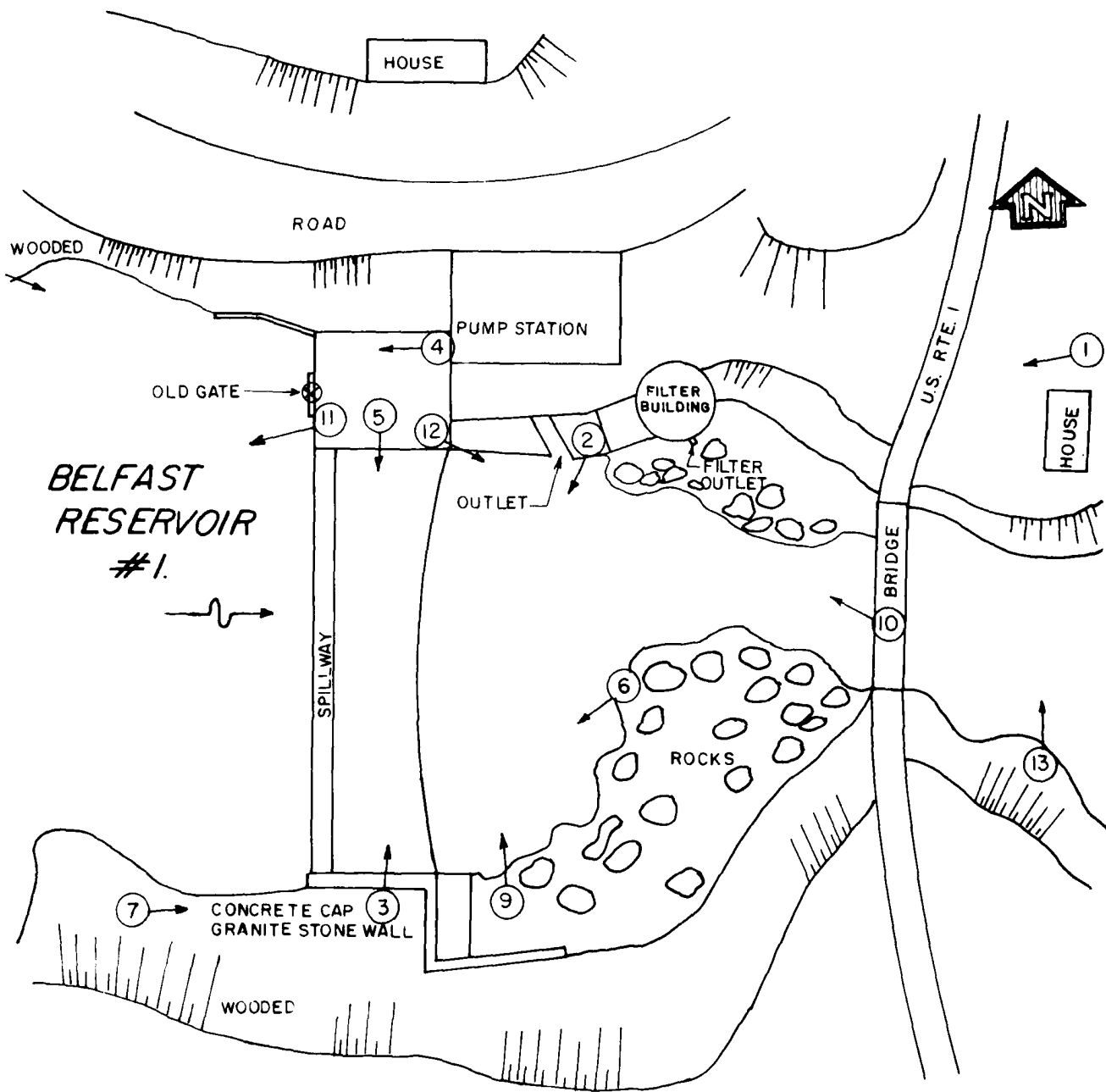
SECTION B-B

SECTION C-C

SECTION D-D



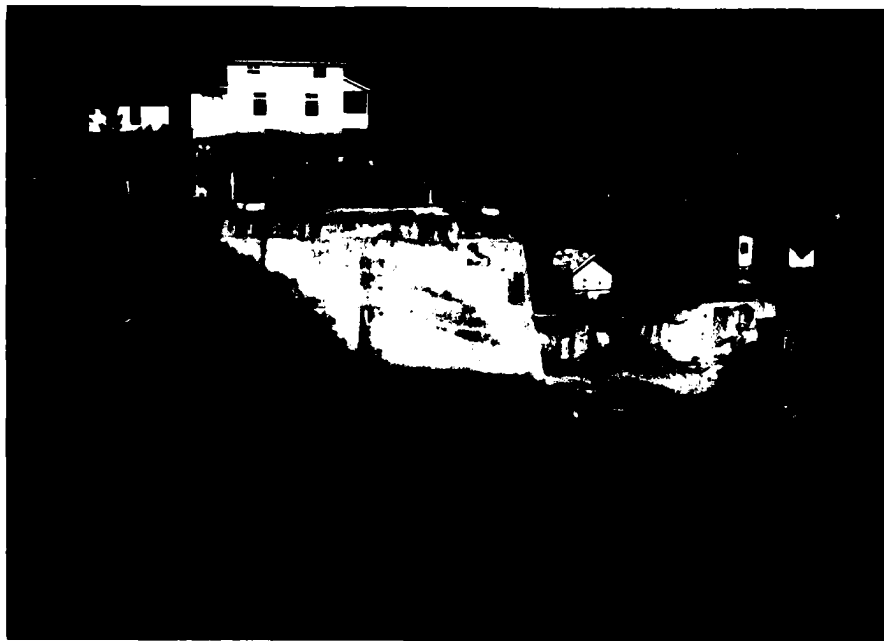
APPENDIX C
PHOTOGRAPHS



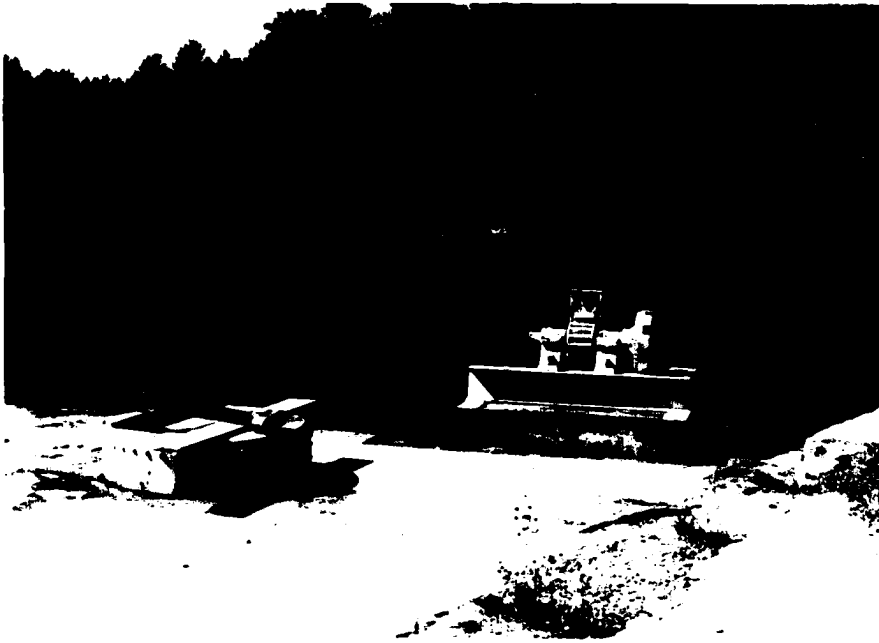
Anderson-Nichols & Co., Inc		U.S. ARMY ENGINEER DIV. NEW ENGLAND	
CONCORD		CORPS OF ENGINEERS	
NEW HAMPSHIRE		WALTHAM, MA.	
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS			
PHOTO INDEX			
LITTLE RIVER		MAINE	
		SCALE: NOT TO SCALE	
		DATE: NOVEMBER 1979	



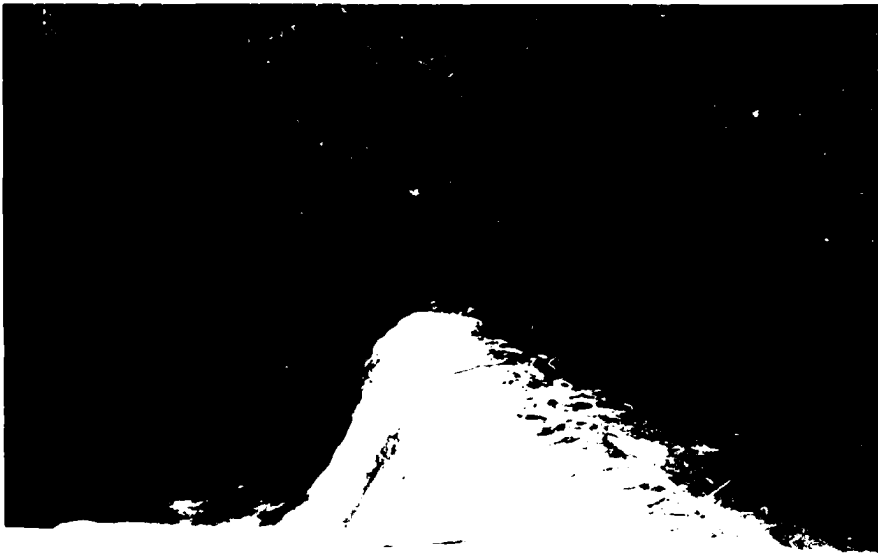
September 17, 1979
Figure 2 - Downstream face of the dam.



September 17, 1979
Figure 3 - Looking across the crest at north
abutment.



September 17, 1979
Figure 4 - Gate mechanism at the north abutment.



September 17, 1979
Figure 5 - Looking across the spillway crest at
south abutment.



September 17, 1979

Figure 6 - Downstream face of south abutment of the dam. Note bedrock.



September 17, 1979

Figure 7 - View of the adjacent earth to the upstream side of south abutment.



September 17, 1979
Figure 8 - View of upstream side of the north abutment.

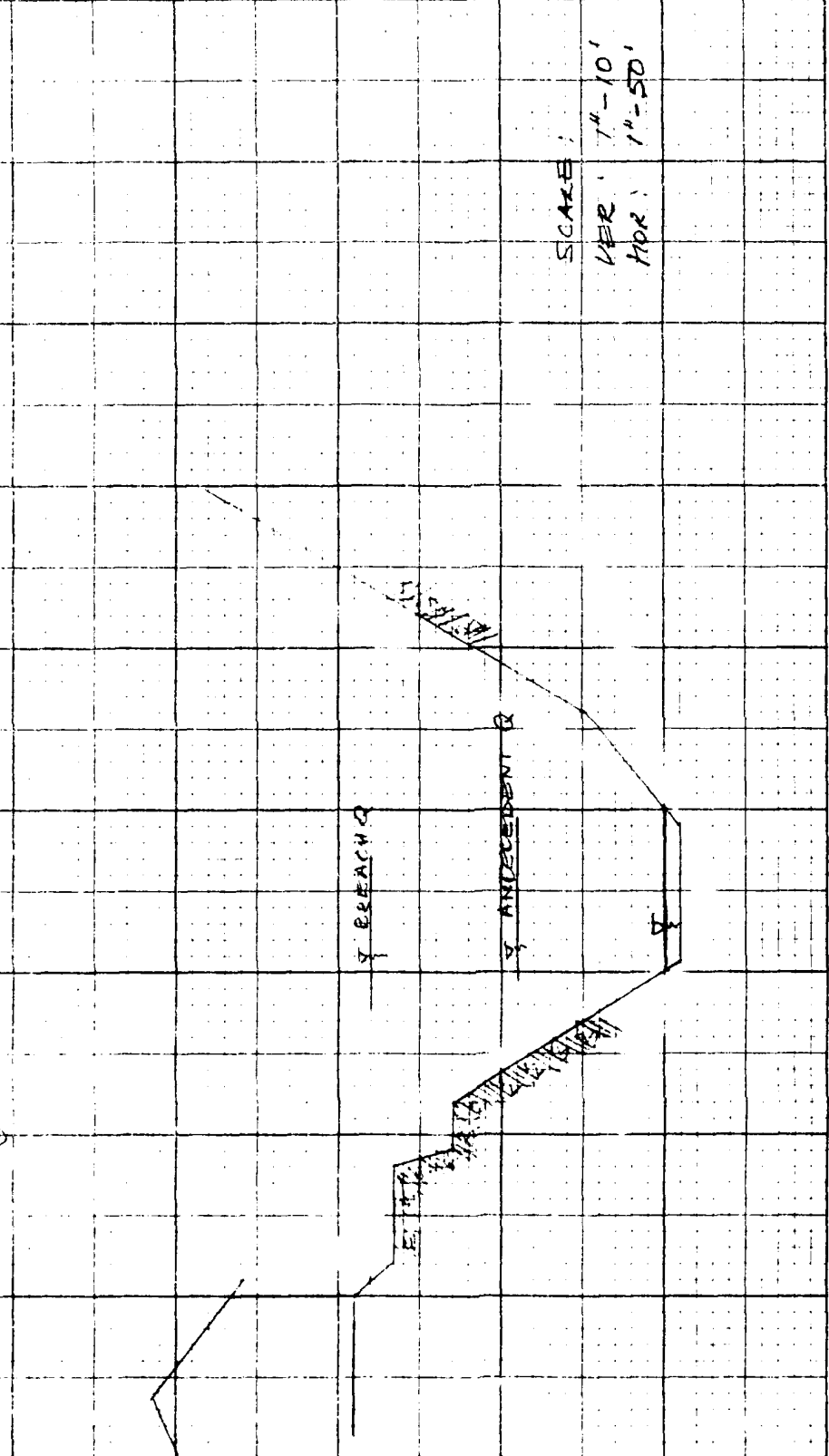


September 17, 1979
Figure 9 - Dry-stone-masonry wall at north bank of the downstream channel.

ANDERSON MICHAEL S
 JOB # 2272-15
 DATE: 29-07-79
 FORMED BY: JG
 CHECKED BY: (signature)

LITTLE RIVER - LOWER DAM
 V-SECTION DOWNSTREAM
 BRIDGE CROSSING

REACH # 2



SCALE:
 VER: 1"=10'
 HOR: 1"=50'

DISTANCE (FT)

1-1

D. 1312-15

2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

LITTLE RIVER - LOWER DAM

BREACH ANALYSIS - CONT'D

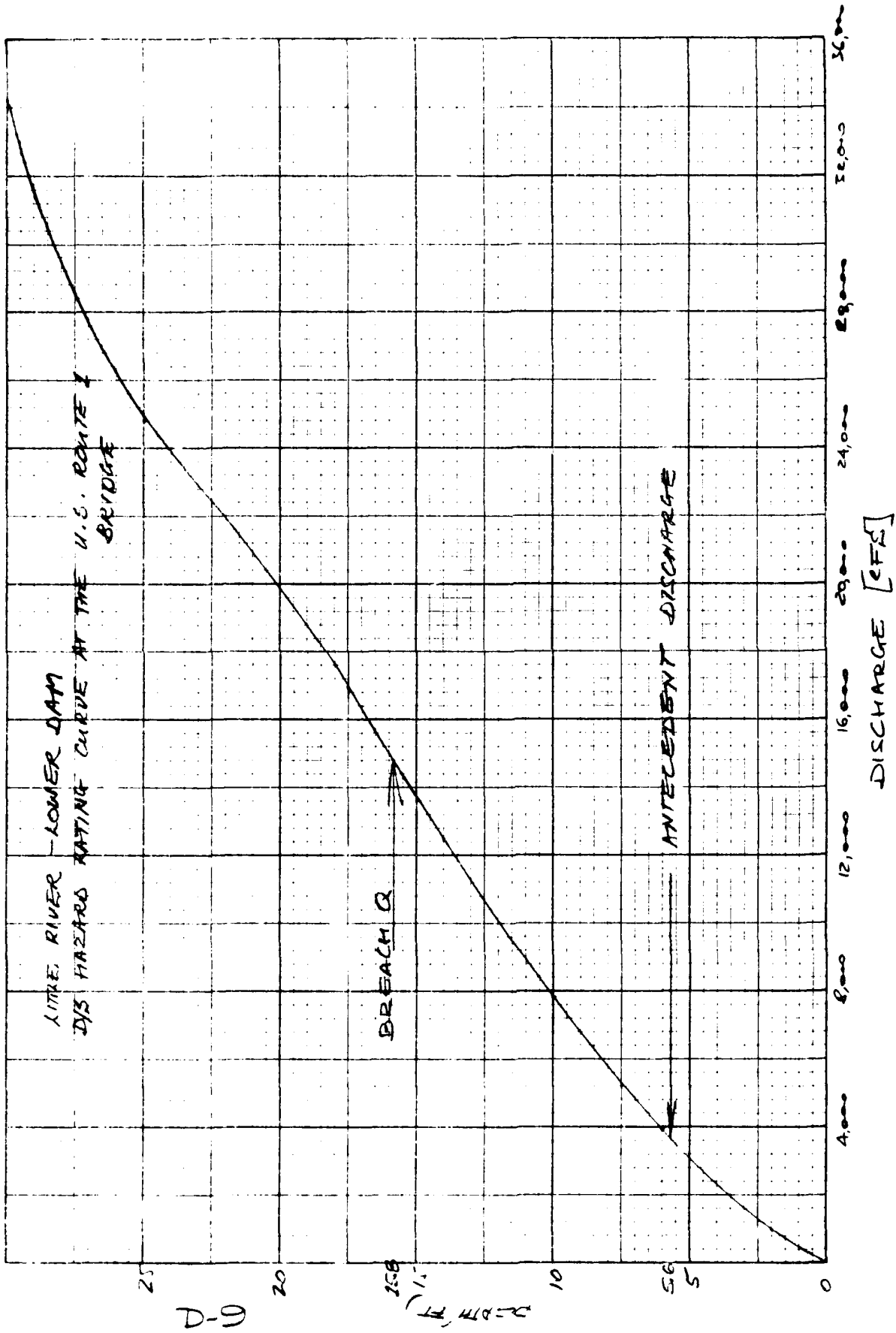
REACH # 2

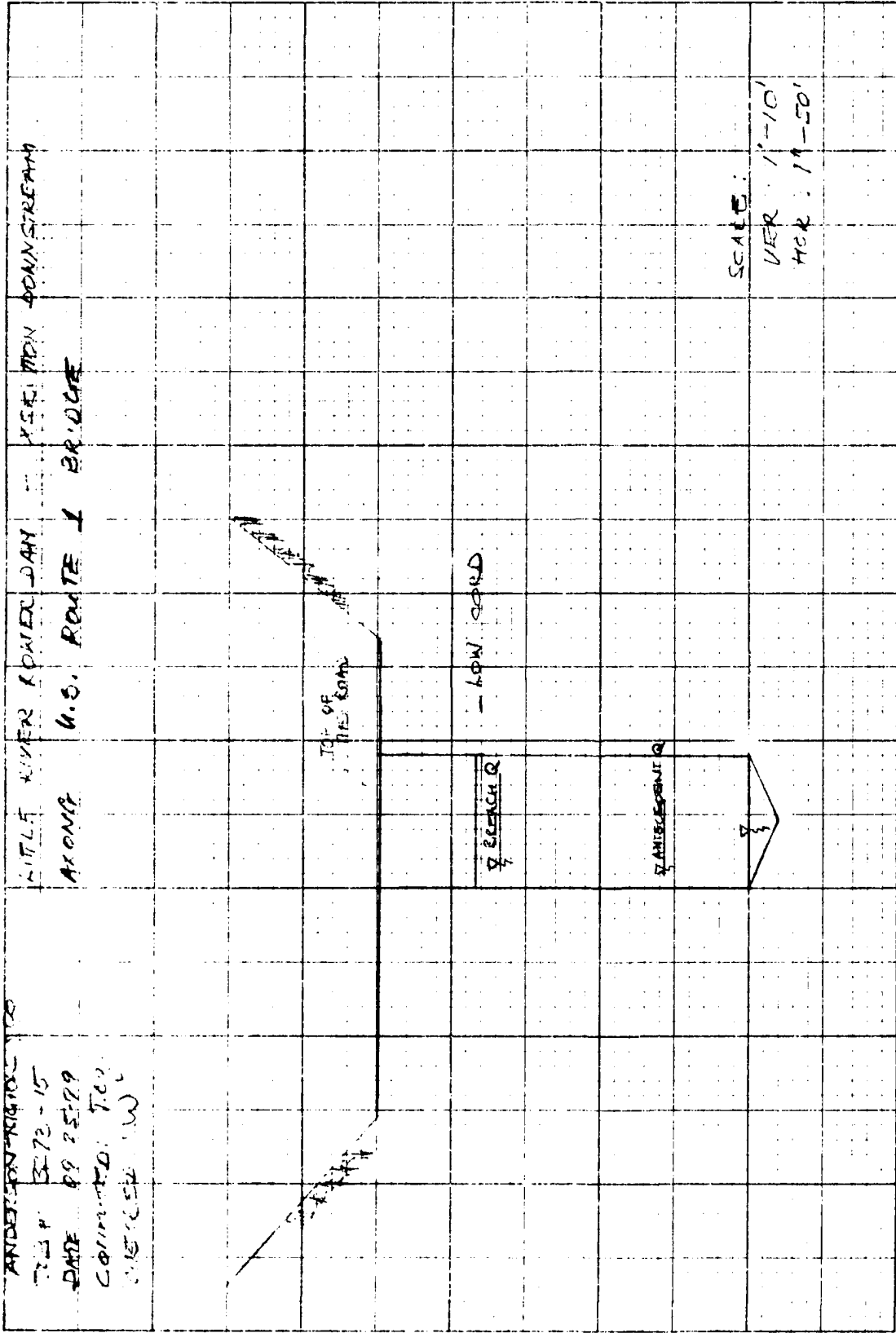
USE A TYPICAL CROSS SECTION ALONG THE DOWN-
-STREAM REACH FROM THE BRIDGE (US 1) TO
CONTINUE ICE WITH ATLANTIC OCEAN FOR A DISTANCE
OF 300 FEET.

DEVELOP A RATING CURVE FOR THIS SECTION
BY USE OF MANNING'S EQUATION: $Q = \frac{1.49}{n} \times A \times R^{2/3} \times S^{1/2}$

n = .05 S = .0025

DEPTH [FT]	AREA	WPER	Q [CFS]
0	0	0	0
4	242	82	736
8	626	111	2932
12	1113	137	6618
16	1720	174	11648
20	2490	226	18105





ANDERSON BRIDGE
 TRIP 3-72-15
 DATE 09 25 79
 COMPILED: J.C.
 CHECKED: W.

LITTLE RIVER LOWER DAM
 ALONG U.S. ROUTE 1 BRIDGE
 U.S. ROAD DOWNSTREAM

2-8

ELEVATION FEET

DISTANCE IN FEET

JOB NO. 3273-16

SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

LITTLE RIVER - LOWER DAM

BREACH ANALYSIS - CONT'D

PRESSURE FLOW - AREA - 855 SQFT C - .92

ELEV. [FTMSL]	H. [FT]	$Q = AC \sqrt{2gh}$ [CFS]
25.	15.5	24,852
27.	17.5	26,407
30.	20.5	28,580
35.	35.5	37,610

WEIR FLOW - C = 2.8

ELEV. [FTMSL]	L [FT]	H [FT]	$Q = C \cdot L \cdot H^{3/2}$ [CFS]
25.	0	0	0
27.	170	2	1346.
30.	180	5	5635.
35.	200	10	17709.

SUMMARY - ELEV. [FTMSL]	Q [CFS]
2	1,022
6	3,929
10	7,869
14	12,505
18	17,647
25	24,852
27	27,753
30	34,215
35	55,319

JOB NO. 3273-16

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

LITTLE RIVER LOWHEAD DAM

BREACH ANALYSIS - CONT'D

DEVELOP A RATING CURVE FOR THE X-SECTION ALONG
 THE U.S. ROUTE 1 BRIDGE 400 FEET DOWNSTREAM THE DAM

LOW FLOW —

"C" VALUES .925 FOR CONC. WALL
 .835 FOR BOTTOM
 SLOPE 1.008

ELEV. (FT. MSL)	AREA	V	Q
2	134.7	49.1	1022
6	314.5	57.1	3929
10	494.5	65.1	7,869
14	674.6	73.1	12,505
18	854.9	81.1	17,647

PRESSURE & WEIR FLOW

C-VALUE CALCULATION FOR PRESSURE FLOW:

$$K_f = \frac{0.11 + 0.2^2 + 1}{2 \times 4/3}$$

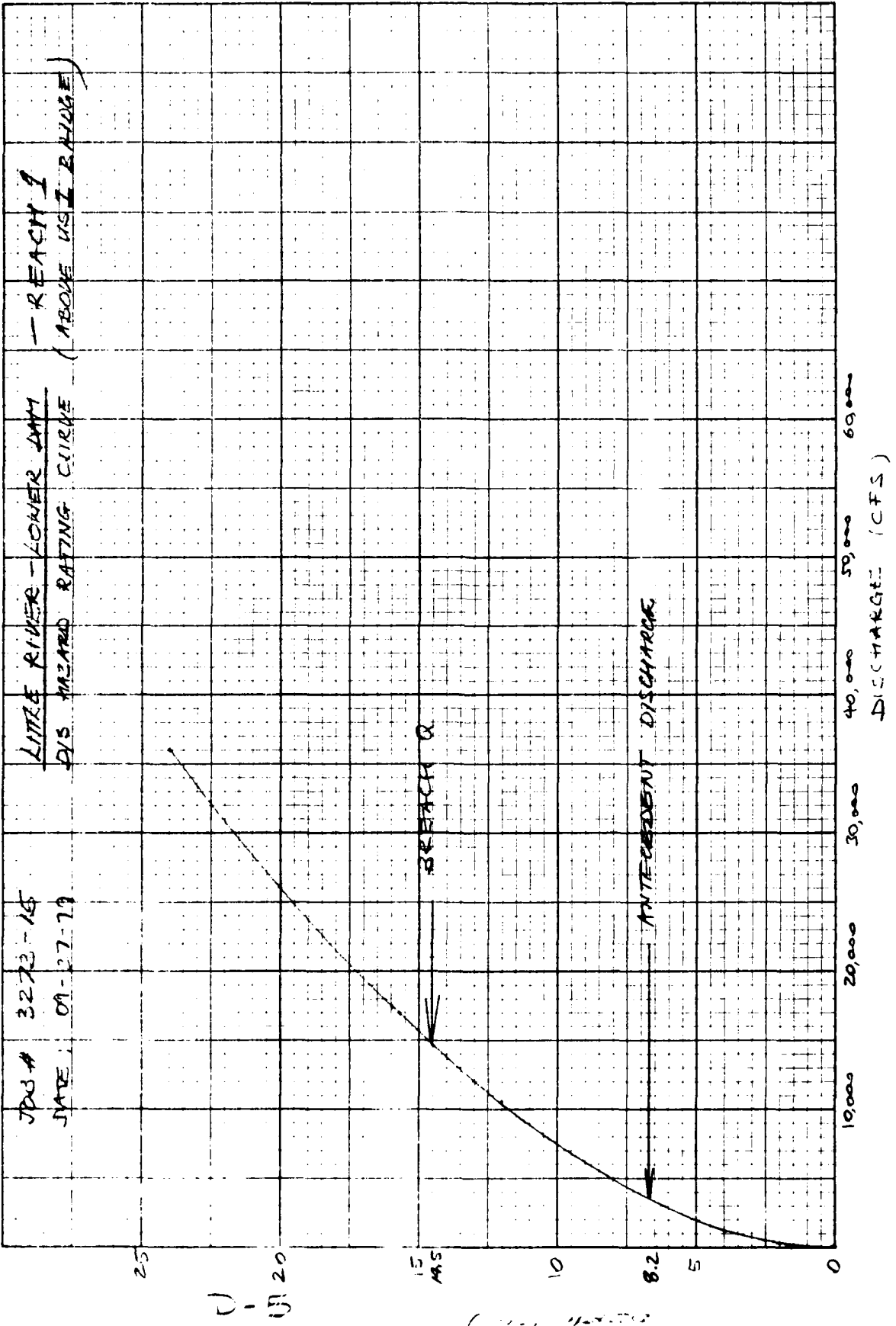
$$K_f = \frac{0.11 + 0.04 + 1}{8/3} = .08$$

$$1.10 + .08 = 1.18$$

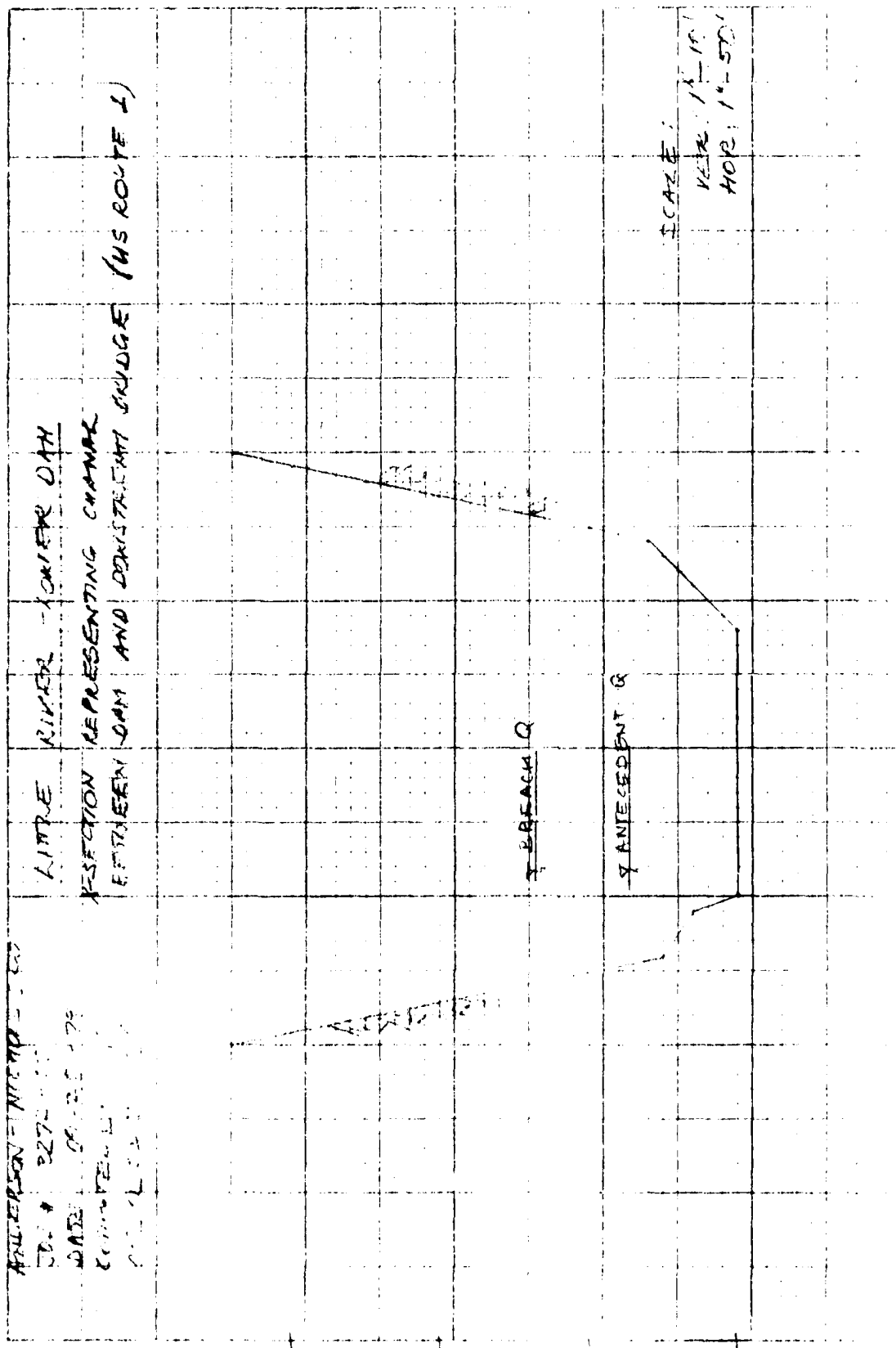
$$K = \frac{1}{0.85} = 1.18$$

$$C = .92$$

1. REVISION OF EQUATION 17'
 2. FOR CONCRETE BRIDGE WITH
 BIRTH BOTTOM = 0.00
 3. HYDRAULIC ATTACK
 INTAKE AND EXIT POINTS =
 = 1.10



MILLERSON - MICHIGAN - 1929
 DATE OF REVISION
 COMPILED BY
 1929



DISTANCE

10 20 30 40
 0 20 40
 10 20 30 40
 0 20 40

JOB NO. 3273-16

JARES IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

LITTLE RIVER - LOWER DAM

BREACH ANALYSIS - CONT'D

REACH #1

USE A TYPICAL CROSS SECTION ALONG THE DOWNSTREAM REACH FROM THE DAM TO THE U.S. ROUTE 1 BRIDGE FOR A DISTANCE OF 400 FEET

DEVELOP A RATING CURVE FOR THIS SECTION BY USE OF MANNING'S EQUATION $Q = \frac{1.49}{n} \cdot A \cdot R^{2/3} \cdot S^{1/2}$ *

$$n = .05 \quad S = .0025$$

DEPTH [FT]	AREA	WPER	Q [CFS]
4	416	124	1,380
8	969	149	4,974
12	1567	160	10,509
16	2199	172	17,605
20	2864	184	26,150
24	3563	195	36,085
28	4295	207	47,378
32	5062	218	60,016

*

n' - ROUGHNESS COEFFICIENT

A - AREA OF X-SECTION IN SQUARE FEET

R - WETTED PERIMETER

S - SLOPE OF REACH

D-3

JOB NO. 3273-15 LITTLE RIVER - LOWER DAM

INCHES IN SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

BREACH ANALYSIS

DETERMINE EFFECTS OF BREACH AT TOP OF DAM
TO CLASSIFY DOWNSTREAM HAZARD CONDITIONS.

$$Q_p = \frac{8}{121} W_b P q' Y_o^{3/2}$$

W_b - BREACH WIDTH

$$q = 32.2 \text{ FT/SEC}^2$$

Y_o - POOL ELEV. - Y_o RIVER BED

$$W_b = 126 \times 4 = 504$$

ASSUME BREACH OCCURS
AT TOP OF THE DAM - 30.5'

$$Y_o = 30.3 - 1.3 = 29$$

$$Q = 13,129 \text{ CFS}$$

Q THROUGH SPILLWAY OTHER THAN WHERE IT IS DESIGNED

$$L = 91 - 50 = 41 \text{ FT}$$

$$H = 30.3 - 25 = 5.3 \text{ FT}$$

$$C = 3.3$$

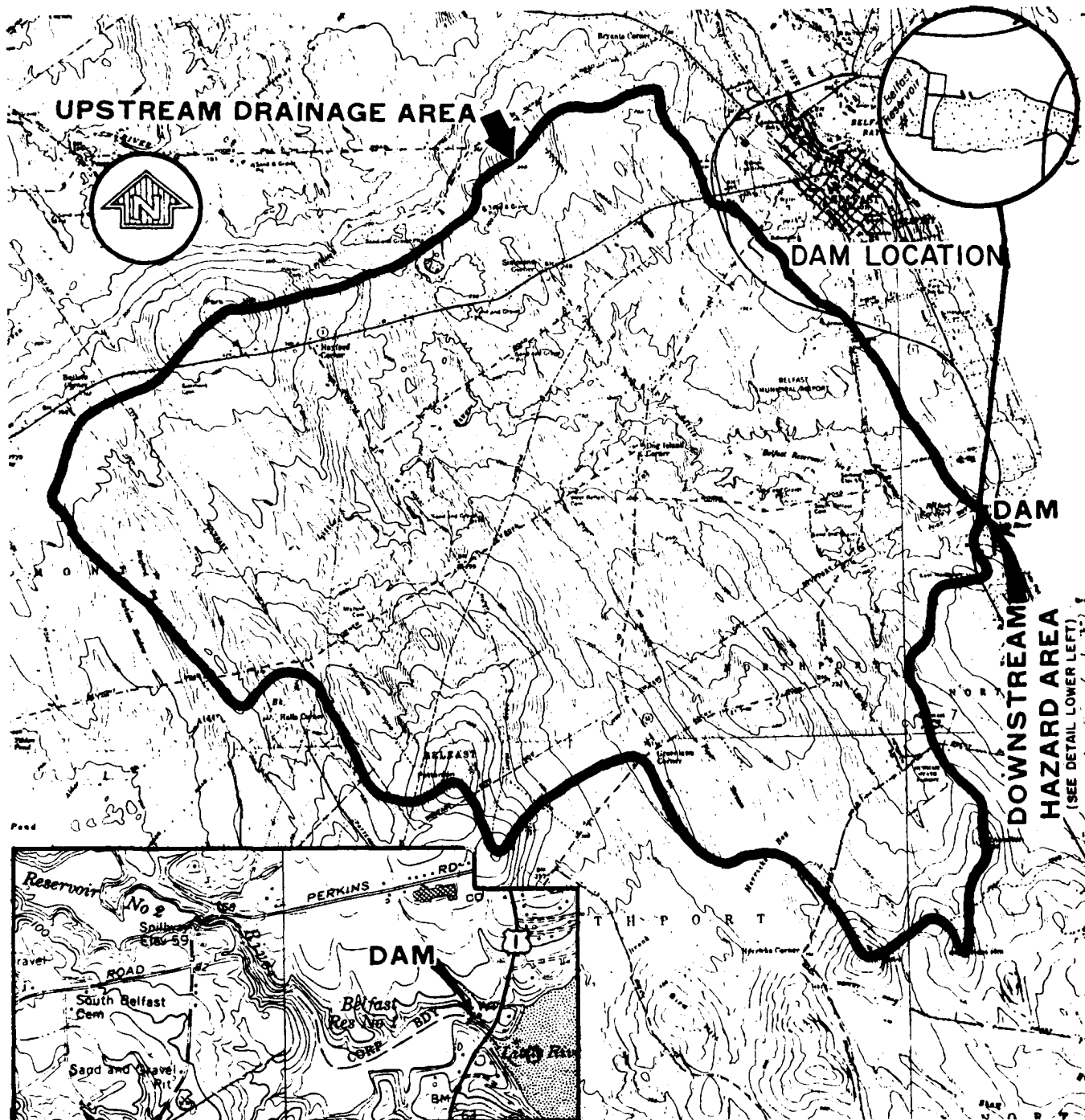
$$Q = C \cdot L \cdot H^{3/2} = 1800 \text{ CFS}$$

$$\text{TOTAL BREACH } Q = \underline{14,980 \text{ CFS}}$$

PRECEDENT DISCHARGE (SPILLWAY CAPACITY AT TOP OF
DAM)

$$Q = 3.3 \cdot 91 \cdot 5.3^{3/2} = \underline{3665 \text{ CFS}}$$

D-2

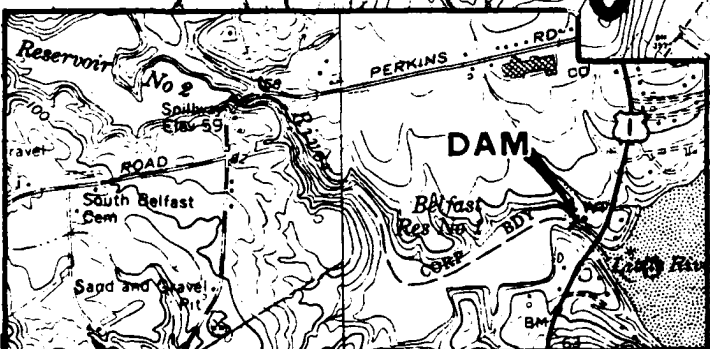


UPSTREAM DRAINAGE AREA

DAM LOCATION

DAM

DOWNSTREAM HAZARD AREA
(SEE DETAIL LOWER LEFT)



**NATIONAL PROGRAM OF INSPECTION
OF NON-FED. DAMS**

**LITTLE RIVER LOWER DAM
BELFAST, MAINE**

REGIONAL VICINITY MAP

NOVEMBER 1979

**DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS**

ANDERSON-NICHOLS & CO., INC

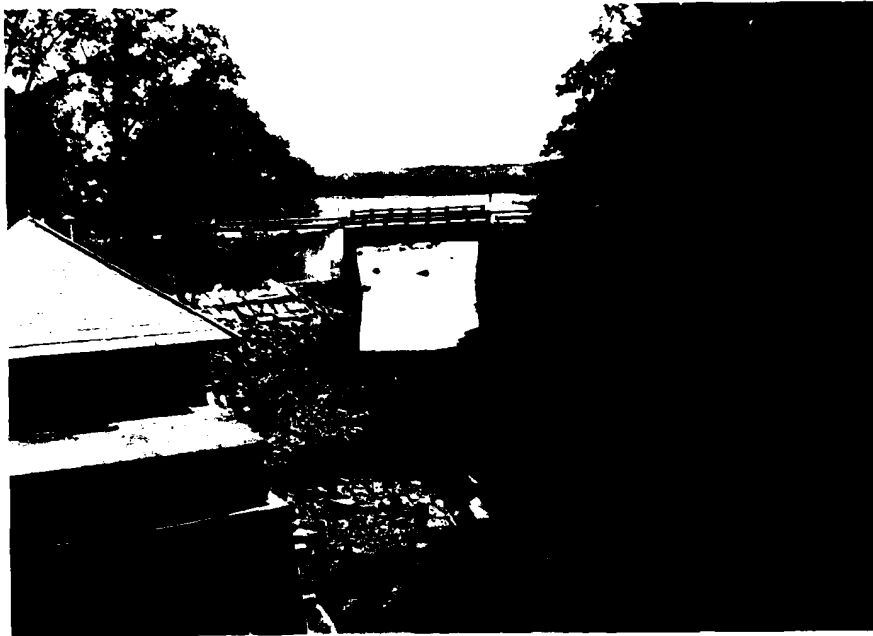
CONCORD, N.H.

SCALE IN MILES



**MAP BASED ON U.S.G.S. 7.5 MINUTE QUADRANGLE
SHEETS. BELFAST, ME., 1960. REVISED 1973.
SEARSPORT, ME., 1973. LINCOLNVILLE, ME., 1960,
REVISED 1973. ISLESBORO, ME., 1973.**

APPENDIX D
HYDROLOGIC AND HYDRAULIC COMPUTATIONS



September 17, 1979
Figure 12 - Looking downstream at U.S. Route 1 bridge
from the north abutment of the dam.



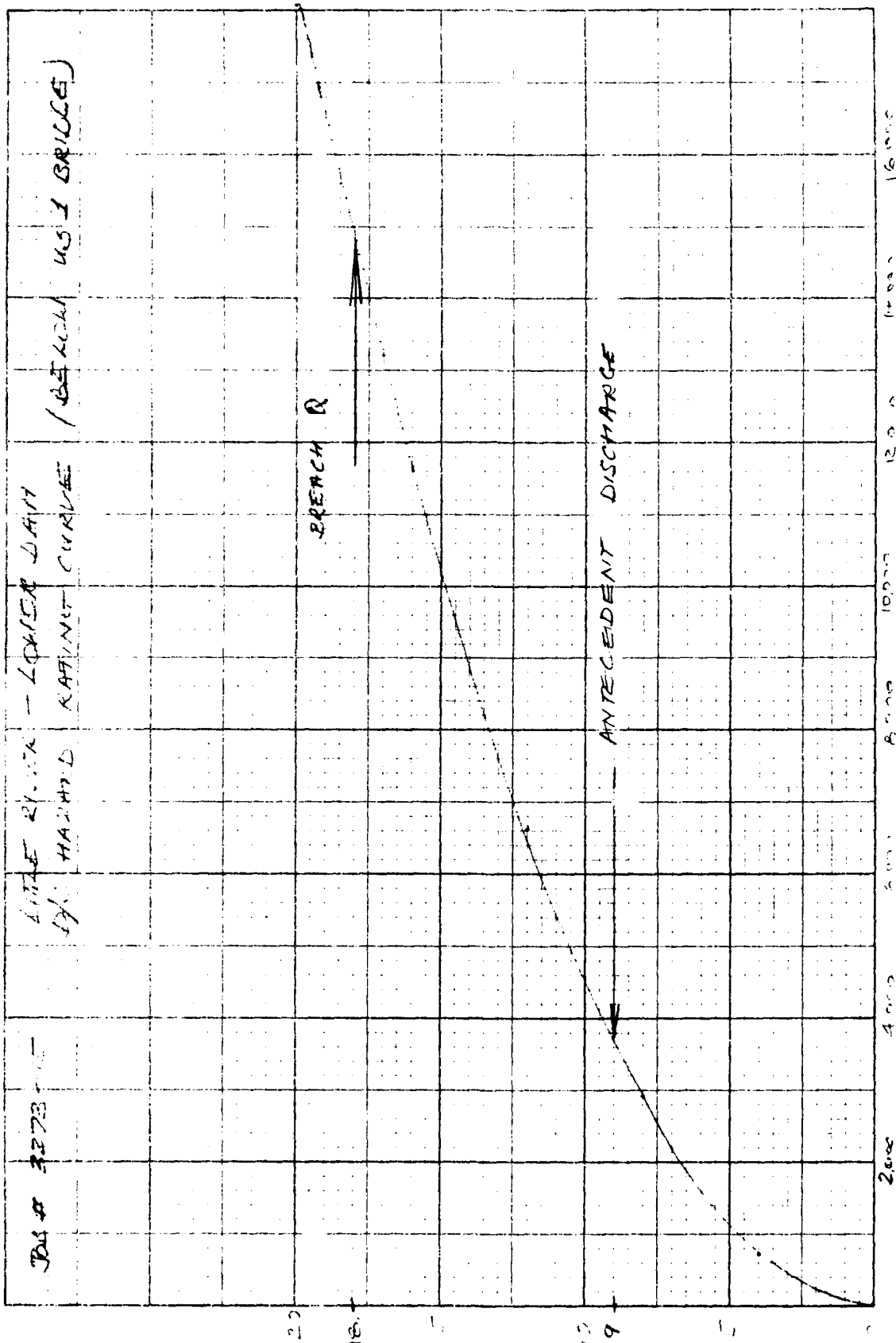
September 17, 1979
Figure 13 - Looking north at downstream channel below
the U.S. Route 1 bridge just before
confluence with the Atlantic Ocean.



September 17, 1979
Figure 10 - View of the north bank of the downstream
channel from the U.S. Route 1 bridge.



September 17, 1979
Figure 11 - Looking upstream at the reservoir from
the north abutment.



LITTLE RIVER - LOWISEN DAM
 HAYWARD KAYAKING CURVE
 BEKOH US 1 BRIDGE

BREACH R

ANTECEDENT DISCHARGE

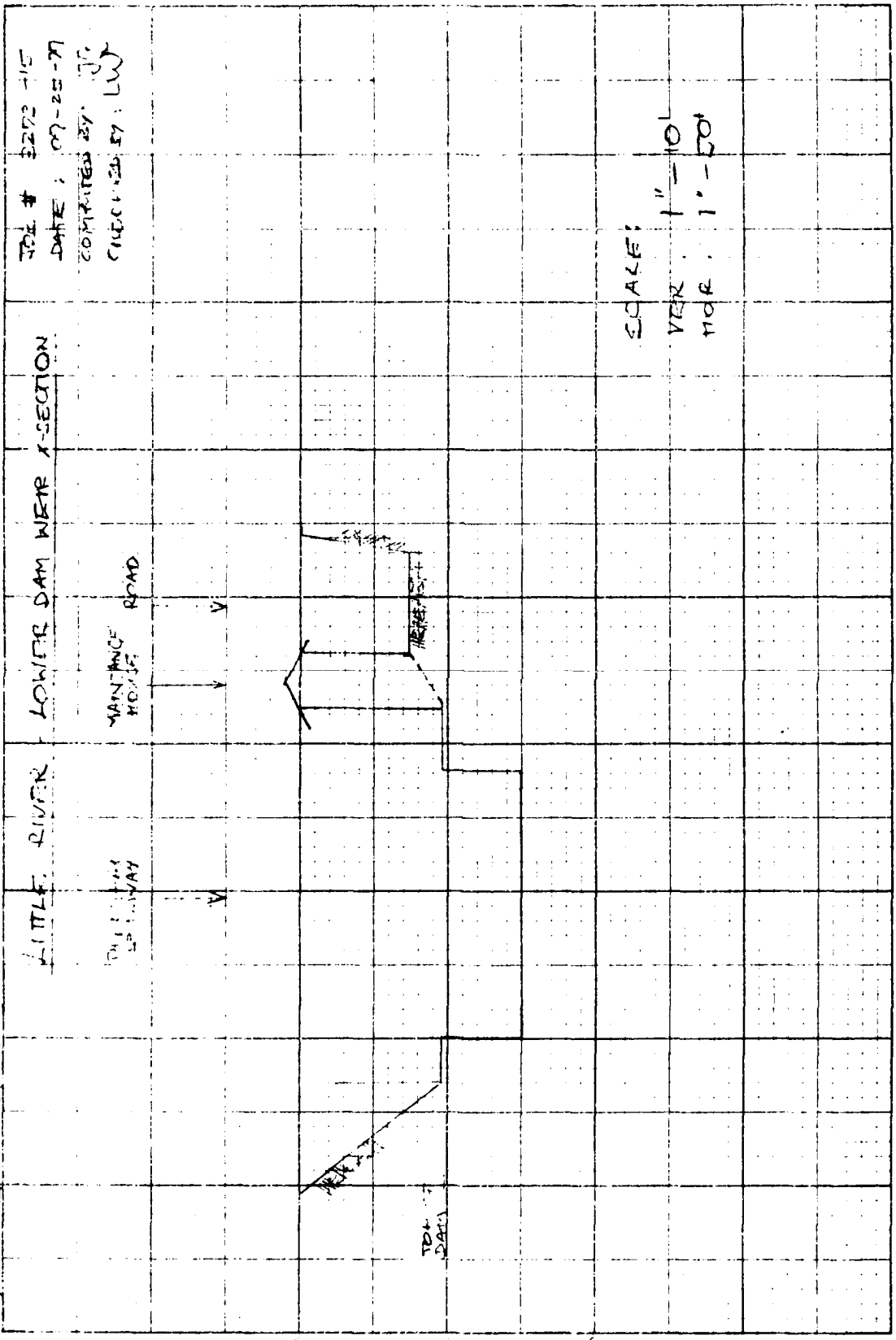
DA # 3273

21-2

ELEVATION IN FEET

2000 4000 6000 8000 10000 12000 14000 16000
 DISTANCE IN FEET

ANNE ARUNDEL COUNTY



JOB # 2272-15
 DATE: 07-25-71
 COMPUTED BY: J.C.
 CHECKED BY: L.W.

SCALE:
 VER. 1" = 10'
 HOR. 1" = 50'

JOB NO. 2272-15

RES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

LITTLE RIVER LOWER DAM - RATING CURVE
CALCULATION

ELEVATION FEET	FROM CURVE THE SPILLWAY		FROM CURVE THE SIDE SLOPER		TOTAL Q
	Q CFS	H FEET	Q CFS	H FEET	
25	91	0			0
26	91	1			300
27	91	2			850
28	91	3			1580
29	91	4			2400
30	91	5			3665
31	91	6			4480
32	91	7	2.8	1.9	5930
33	91	8	5	2.4	7350
34	91	9	40	1.3	9080
35	91	10	50	2.2	11200
36	91	11	55	3.2	13410
37	91	12	60	4.3	15930
38	91	13	65	5.2	18670
39	91	14	70	6.2	21716

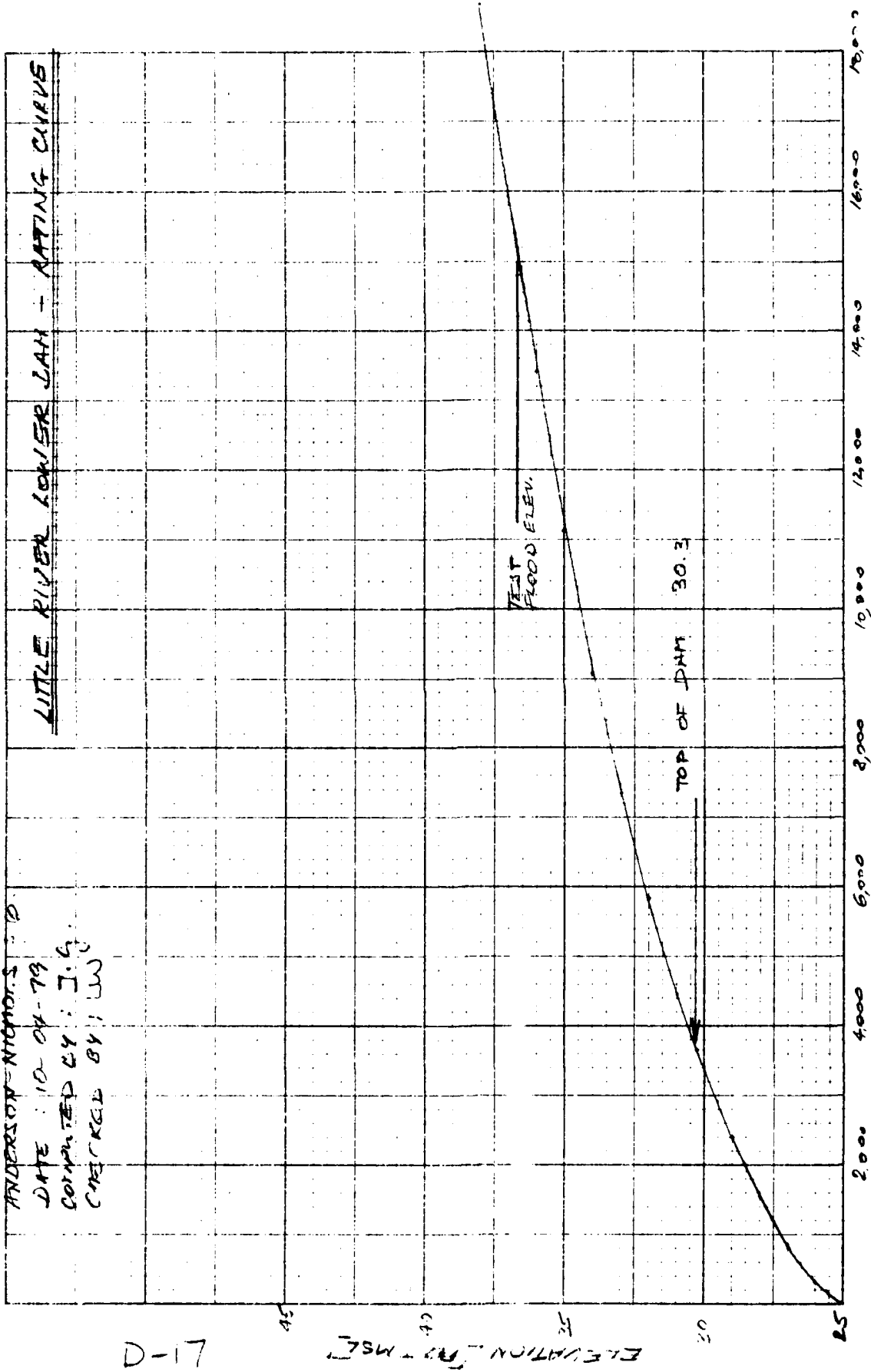
TRAP OF
LAW 303

L-16

Q = CLH^{3/2}

ANDERSON-NICHOLS
DATE: 10-04-79
COMPUTED BY: J.G.
CHECKED BY: J.W.

LITTLE RIVER LOWER DAM - RATING CURVE



D-17

ELEVATION (ft - MSL)

DISCHARGE [cfs]

JOB NO. 1273-15

S 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
 SCALE

LITTLE CREEK LOWER DAM

STORAGE - ELEVATION CURVE CALCULATION

NORMAL STORAGE (SPRING CREEK - 20. FT HIGH) - 370 AC.-FT.
 NOTE: 370 AC.-FT WAS OBTAINED BY ESTIMATING AVERAGE DEPTH
 OF RESERVOIR - 10 FEET AND PLANNING THE SURFACE OF
 RESERVOIR FROM QUADS SHEET BY AC. 175 AC.-FT (SPRING CREEK)
 LISTED AS IMPROVING CAPACITY IN APPLICATION FOR
 DAM REGISTRATION (SEE APPENDIX B) IS NOT REASONABLE.

USING 'FRUSTRUM OF CYLINDER' EQUATION AND PARAMETERS
 SURFACE AREAS, ELEVATION POINTS FOR A STORAGE -
 ELEVATION CURVE.

$$T = \frac{1}{3} (b_1 + b_2 + \sqrt{b_1 b_2})$$

- b₁ - ELEV. ABOVE NORMAL POOL
- b₂ - NORMAL POOL SURFACE
- b₃ - ENLARGED POOL SURFACE

1. SURFACE AREA - 46 AC

2. SURFACE AREA - 46 AC

3. SURFACE AREA (27 + 46 + 27) = 100 AC.-FT

TOTAL STORAGE - 370 AC.-FT

2. SURFACE AREA - 55 AC

3. SURFACE AREA - 55 AC

4. SURFACE AREA (46 + 55 + 55) = 156 AC.-FT

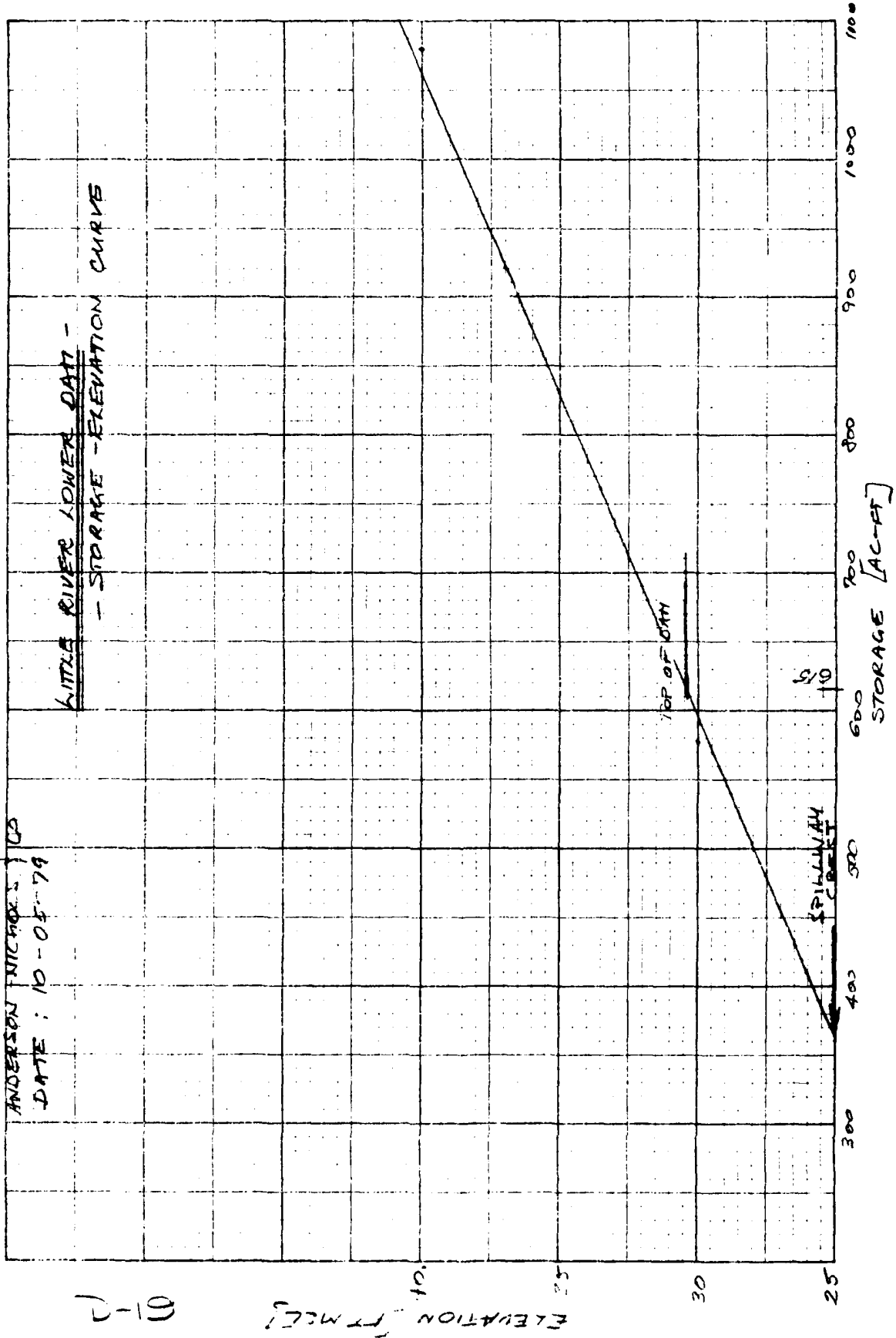
TOTAL STORAGE - 1081 AC.-FT

D-13

ANDERSON NICHOLS / CS

DATE: 10-05-79

LITTLE RIVER LOWER DAM -
- STORAGE - ELEVATION CURVE



01-10

JOB NO. 3273-16

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

LITTLE RIVER - LOWER DAM

STEP # 2a

DETERMINE SURCHARGE HEIGHT TO PASS Q_{pi} of 15,920. TO OBTAIN THIS, A DISCHARGE RATING CURVE MUST BE CALCULATED FOR LOWER RESERVOIR DAM. OUTFLOW WOULD OCCUR FIRST OVER THE PRINCIPAL SPILLWAY. HIGHER FLOOD WIMERS WILL FLOW OVER THE DAM EMBANKMENTS AND SIDE SLOPES. SIZE OF EMERGENCY GATE IS UNKNOWN AND HAS NOT BEEN OPENED FOR 20 YEARS. THEREFORE FLOW THROUGH GATE WILL NOT BE INCLUDED IN CALCULATIONS. OUTFLOW THROUGH WATER SUPPLY PUMP WHICH AVERAGES DAILY 275 GPM IS INSIGNIFICANT TO STUDY.

$Q_{pi} = 15,920 \text{ CFS} \implies 37.0 \text{ FT MSL}$

STEP # 2b

DETERMINE VOLUME OF SURCHARGE IN INCHES OF RUNOFF

$Q_{pi} = 15,920 \text{ CFS} \implies 37.0 \text{ FT MSL}$

STORAGE AT 37.0 FT MSL $\implies 920 \text{ AC-FT}$
 STORAGE AT 25.0 FT MSL (SPILLWAY CREST) $\implies 370 \text{ AC-FT}$

$550 \text{ AC-FT} \times \frac{1}{16.5 \text{ MI}^2} \times \frac{1 \text{ MI}^2}{640 \text{ AC}} \times 12 \frac{\text{IN}}{\text{FT}} = .61" \text{ RUNOFF (STOR 1)}$

STEP # 2c

$Q_{p2} = Q_{pi} \times (1 - \frac{\text{STOR 1}}{9.5'})$
 $Q_{p2} = 5,920 \text{ CFS} \times (1 - \frac{.61'}{9.5'}) = 14,900 \text{ CFS}$
1-10

JOB NO. 2273-16RES
V. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29LITTLE RIVER - LOWER DAMSTEP # 3aDETERMINE SURCHARGE HEIGHT TO PASS Q_{p2}

$$Q_{p2} = 14,900 \text{ CFS} \rightarrow 36.6 \text{ FT MSL} \rightarrow 900 \text{ AC-FT}$$

$$530 \text{ AC-FT} \times \frac{1}{16.8 \text{ MI}^2} \times \frac{1 \text{ MI}^2}{640 \text{ AC}} \times 12 \frac{\text{IN}}{\text{FT}} = .59'' \text{ RUNOFF} \\ (\text{STOR 2})$$

STEP # 3b

AVERAGE STOR 1 & STOR 2

$$\frac{.61'' + .59''}{2} = .60'' \text{ RUNOFF}$$

$$.60'' \times \frac{16.8 \text{ MI}^2}{1} \times \frac{640 \text{ AC}}{1} \times \frac{1}{12} \frac{\text{FT}}{\text{IN}} = 538 \text{ AC-FT}$$

$$538 \text{ AC-FT} + 370 = 908 \text{ AC-FT}$$

$$\underline{908 \text{ AC-FT} \rightarrow 36.7 \text{ FT MSL} \Rightarrow 15,000 \text{ CFS}}$$

TEST FLOOD - $\frac{1}{2}$ PMF

TEST FLOOD DISCHARGE - 15,000 CFS (@ 36.7' MSL)

TOP OF DAM - 30.2 (FT MSL) THEREFORE DAM EMBANKMENT
WOULD BE OVERTOPPED BY ABOUT 6.4 FT DURING TEST
FLOOD CONDITIONS.

TOP OF DAM - 30.2 FT MSL - STORAGE 615 AC-FT.

SPILLWAY CAPACITY @ TOP OF DAM IS 3665 CFS
WHICH IS EQUIVALENT TO 24 PERCENT OF THE
TEST FLOOD.

D-21

APPENDIX E
INFORMATION AS
CONTAINED IN THE NATIONAL
INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

COUNTY: EMERSON STATE: VT COUNTY DIST: CLARENCE DISTRICT: 1
 NAME: LITTLE RIVER LOWER DAM REPORT DATE: 05 NOV 79
 COUNTY: VT COUNTY DIST: CLARENCE DISTRICT: 1

POPULAR NAME: LITTLE RIVER NAME OF IMPOUNDMENT: NORTHPORT
 RIVER OR STREAM: LITTLE RIVER NEAREST DOWNSTREAM CITY-TOWN-VILLAGE: NORTHPORT
 TYPE OF DAM: CONCRETE YEAR COMPLETED: 1943 PURPOSES: S

DIST: VT COUNTY: CLARENCE DISTRICT: 1 DIST: VT COUNTY: CLARENCE DISTRICT: 1
 TYPE OF DAM: CONCRETE YEAR COMPLETED: 1943 PURPOSES: S

TYPE OF DAM: CONCRETE YEAR COMPLETED: 1943 PURPOSES: S
 TYPE OF DAM: CONCRETE YEAR COMPLETED: 1943 PURPOSES: S

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TYPE OF DAM: CONCRETE YEAR COMPLETED: 1943 PURPOSES: S
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END

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