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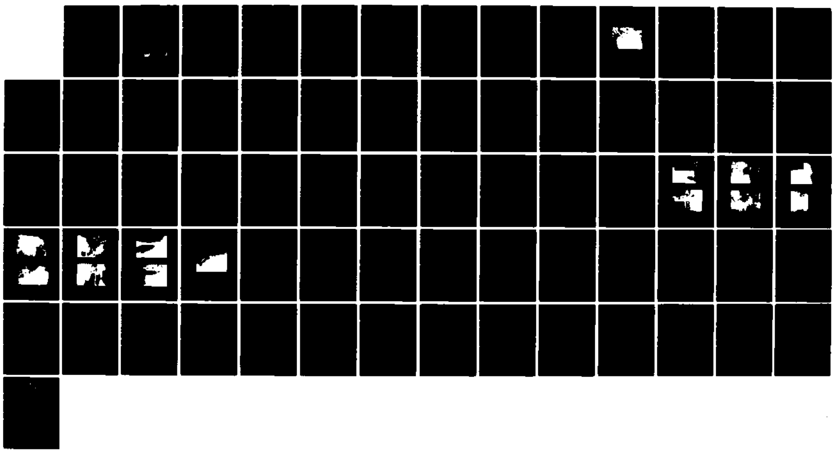

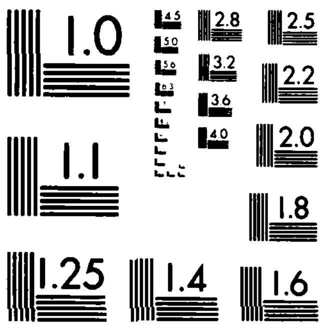

ATLANTIC OCEAN
BELFAST, MAINE

LITTLE RIVER UPPER DAM
ME 00289

STATE NO. 5091

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

NOVEMBER 1979

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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.

DISCLAIMER NOTICE

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 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
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 ¼ to ½ Probable Maximum Flood (PMF). Because the dam's storage capacity is in the upper range of size classification, ½ 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, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
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APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual 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.

TABLE OF CONTENTS

Title	Page
LETTER OF TRANSMITTAL	
BRIEF ASSESSMENT	
REVIEW BOARD PAGE	
PREFACE	iv
TABLE OF CONTENTS	v
OVERVIEW PHOTO	vi
LOCATION MAP	vii

REPORT

SECTION		Page
1	PROJECT INFORMATION	1-1
	1.1 General	1-1
	1.2 Description of Project	1-1
	1.3 Pertinent Data	1-3
2	ENGINEERING DATA	2-1
	2.1 Design	2-1
	2.2 Construction	2-1
	2.3 Operation	2-1
	2.4 Evaluation	2-1
3	VISUAL INSPECTION	3-1
	3.1 Findings	3-1
	3.2 Evaluation	3-3
4	OPERATIONAL PROCEDURES	4-1
	4.1 Procedures	4-1
	4.2 Maintenance of Dam	4-1
	4.3 Maintenance of Operating Facilities	4-1
	4.4 Description of Any Warning System in Effect	4-1
	4.5 Evaluation	4-1
5	HYDROLOGY AND HYDRAULIC ANALYSIS	5-1
	5.1 Evaluation of Features	5-1
6	STRUCTURAL STABILITY	6-1
	6.1 Evaluation of Structural Stability	6-1
7	ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES	7-1
	7.1 Dam Assessment	7-1
	7.2 Recommendations	7-1
	7.3 Remedial Measures	7-2
	7.4 Alternatives	7-2

APPENDICES

	Designation
VISUAL INSPECTION CHECK LISTS	A
ENGINEERING DATA	B
PHOTOGRAPHS	C
HYDROLOGY AND HYDRAULIC COMPUTATIONS	D
INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS	E

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 ($\geq$ 25 to $<$ 40 feet; $\geq$ 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 discharge 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 ¼ to ½ 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 ½ the Probable Maximum Flood (PMF).

Using the ½ 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,[illegible]60 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. 59'msl DN.S. 36.5'msl

PARTY:

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

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrology/Hydraulics	L. Williams/J. Czyzowski	
2.	Structural Stability	S. Gilman	
3.	Soils and Geology	R. Hirschfeld	
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
DAM EMBANKMENT	EMBANKMENT FROM END OF CONCRETE SECTION TO SOUTH ABUTMENT
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	None observed
Pavement Condition	No pavement
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Major erosion next to downstream training wall at south end of concrete section.
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	Trespassing on embankment along upstream and downstream sides of corewall.
Sloughing or Erosion of Slopes or Abutments	See "Condition at Abutment..." above.
Rock Slope Protection - Riprap Failures	No riprap
Unusual Movement or Cracking at or Near Toe	None observed
Unusual Embankment or Downstream Seepage	None observed
Piping or Boils	None observed
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	None observed
Vegetation	Some trees and brush on embankment, some areas bare of vegetation.

PERIODIC INSPECTION CHECKLIST

PROJECT Little River Upper 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, numerous hairline cracks in outside and inside surface. Surface of gate chamber has been faced with gunite.
Condition of Joints	Not visible.
Spalling	Numerous areas of spalling of gunite surfaces.
Visible Reinforcing	None.
Rusting or Staining of Concrete	Yes, at embedded items. Substantial staining at 8"&6" gate chamber outlets.
Any Seepage or Efflorescence	Yes, considerable efflorescence at hairline cracks.
Joint Alignment	Good. No indication of movement.
Unusual Seepage or Leaks in Gate Chamber	Minor leakage into chamber.
Cracks	Numerous hairline cracks.
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Gate Chamber	3 inlet valve operators-reported operable. 2 outlet pipes.
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	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.
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECKLIST

PROJECT Little River Upper Dam, ME DATE Sept. 17, 1979

PROJECT FEATURE Outlet Structure & Channel NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	One drain hole (?) discharging water in concrete abutment (outlet works) section at north end of overflow spillway.
Channel	
Loose Rock or Trees Overhanging Channel	Some trees overhanging channel.
Condition of Discharge Channel	Good.

PERIODIC INSPECTION CHECKLIST

PROJECT Little River Upper Dam, ME DATE Sept. 17, 1979

PROJECT FEATURE Spillway Weir NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	Some trees overhanging channel.
Floor of Approach Channel	Not visible beneath water surface.
b. Weir and Training Walls	
General Condition of Concrete	(Training walls - fair, numerous hairline cracks in surface - surface has been gunited. (Weir - good. Minor surface erosion and spalling of gunite.
Rust or Staining	Only water stain visible
Spalling	Numerous gunited areas are surface spalling
Any Visible Reinforcing	None.
Any Seepage or Efflorescence	Majority of hairline cracks on D/S face Shows efflorescence.
Drain Holes	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	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	Some trees overhanging channel.
Floor of Channel	Bedrock.
Other Obstructions	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 11-9-NE

ocation:

ounty: Waldo

unicipality: Quasi-Municipal Belfast Water District

ame of Dam: Upper Reservoir Dam

ame of Impoundment: Reservoir #2

wnership:

ame of Owner: Belfast Water District

ddress of Owner: 71 Church Street
Belfast, Maine 04915

elephone Number: 338-1200

Name of Agent:
(if different from Owner)

Address:

Telephone Number:

escription of Dam

ype: Arched Concrete

onstruction Material: Concrete
(Concrete, wood, earth)

ear Originally built: 1913

Year last major repair: 1970

eight: 25 ft.

Width: 230 ft.

pillway type: open

Spillway Width: 90 ft.

mpounding Capacity: 58½ acres 157,000,000 gallons (~~Acre-Feet~~)

Drawdown available: 20 ft. (feet)

ish Passage available?: no

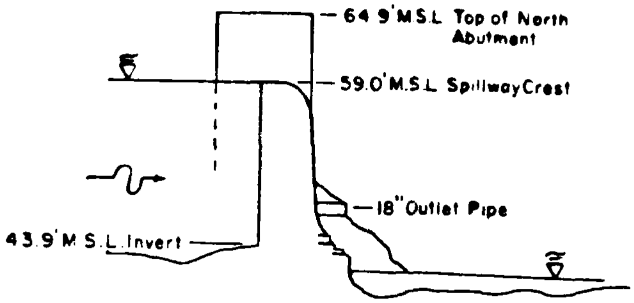
Installed Electrical Generating Cap: --

urposes for which stored water is used: Public drinking supply

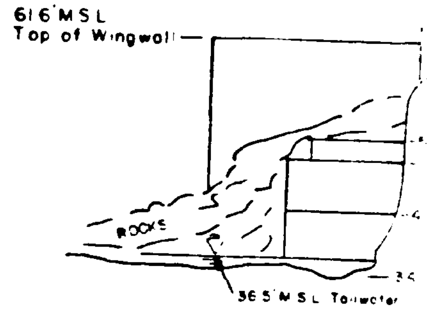
ost recent inspection by Qualified Engineer (Date): August 1972

ame and Address of Engineer: Dale E. Caruthers -(Deceased)
Masonic Building, Gorham, Maine 04038

ther Permits applicable: ------



SECTION A-A



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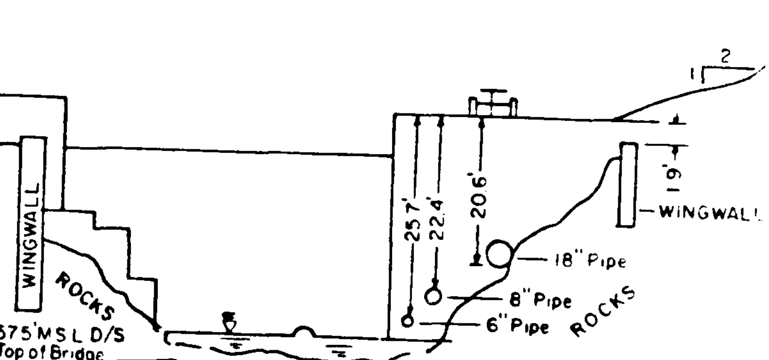
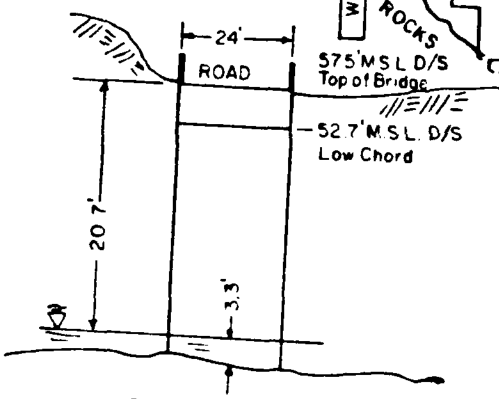


SECTION C-C



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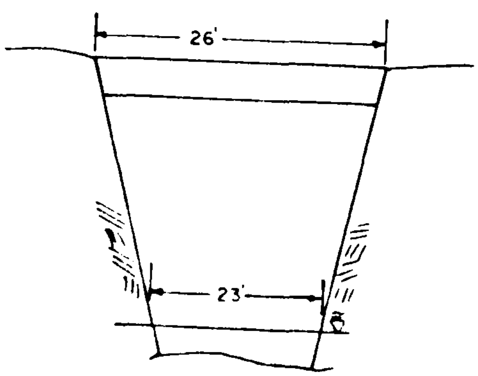

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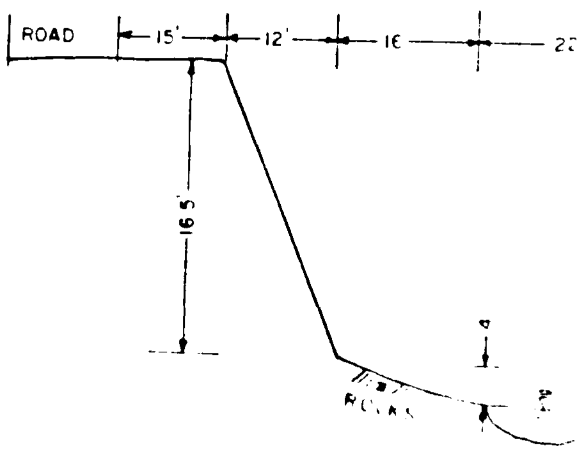
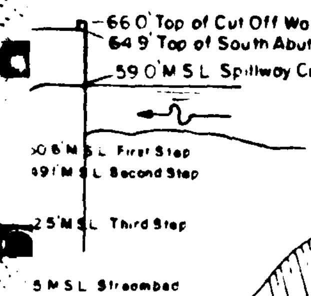
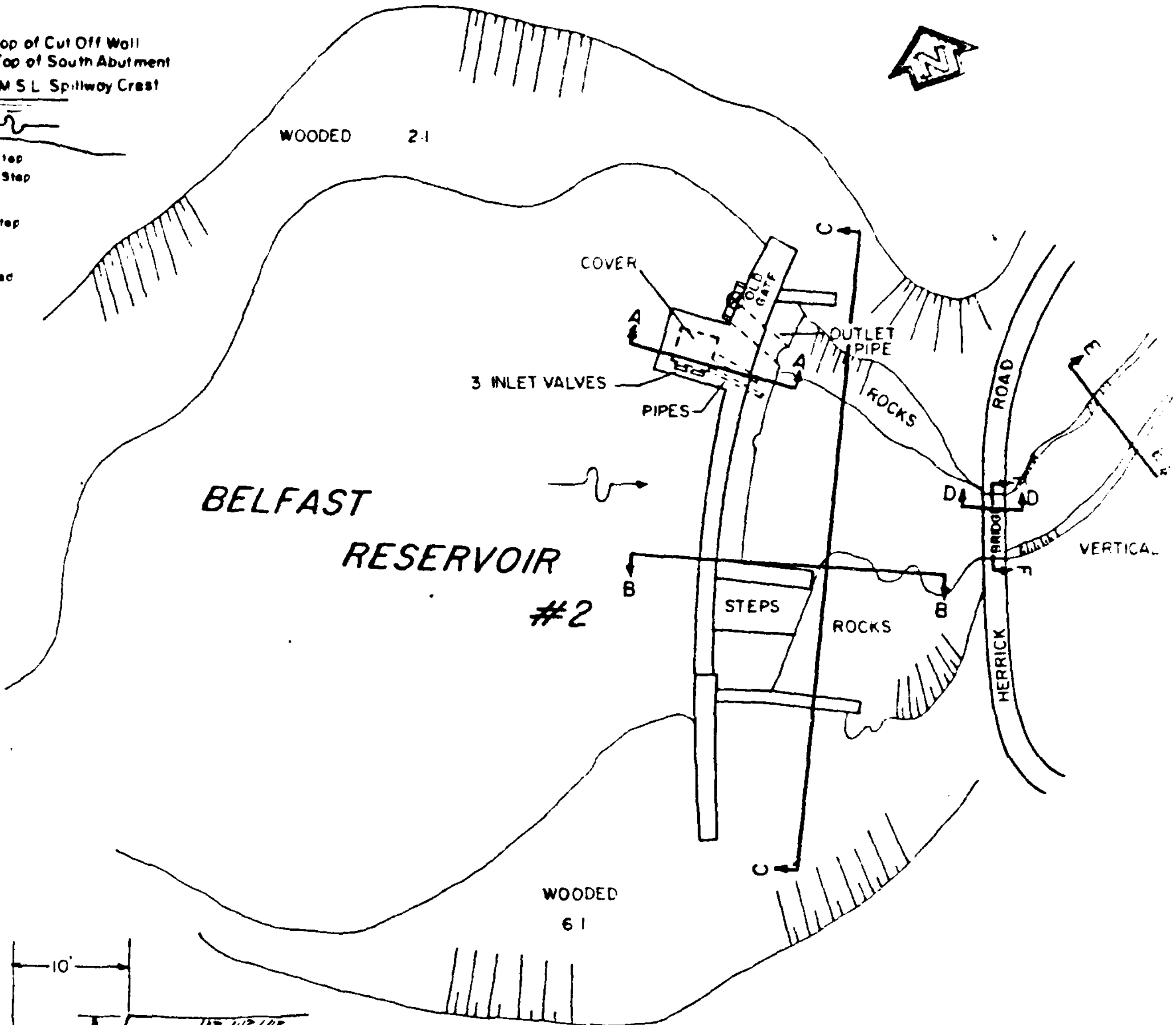
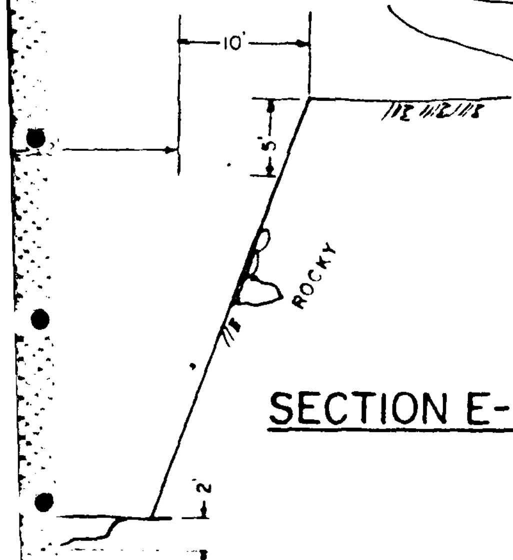




B-B





SECTION E-E

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

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NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

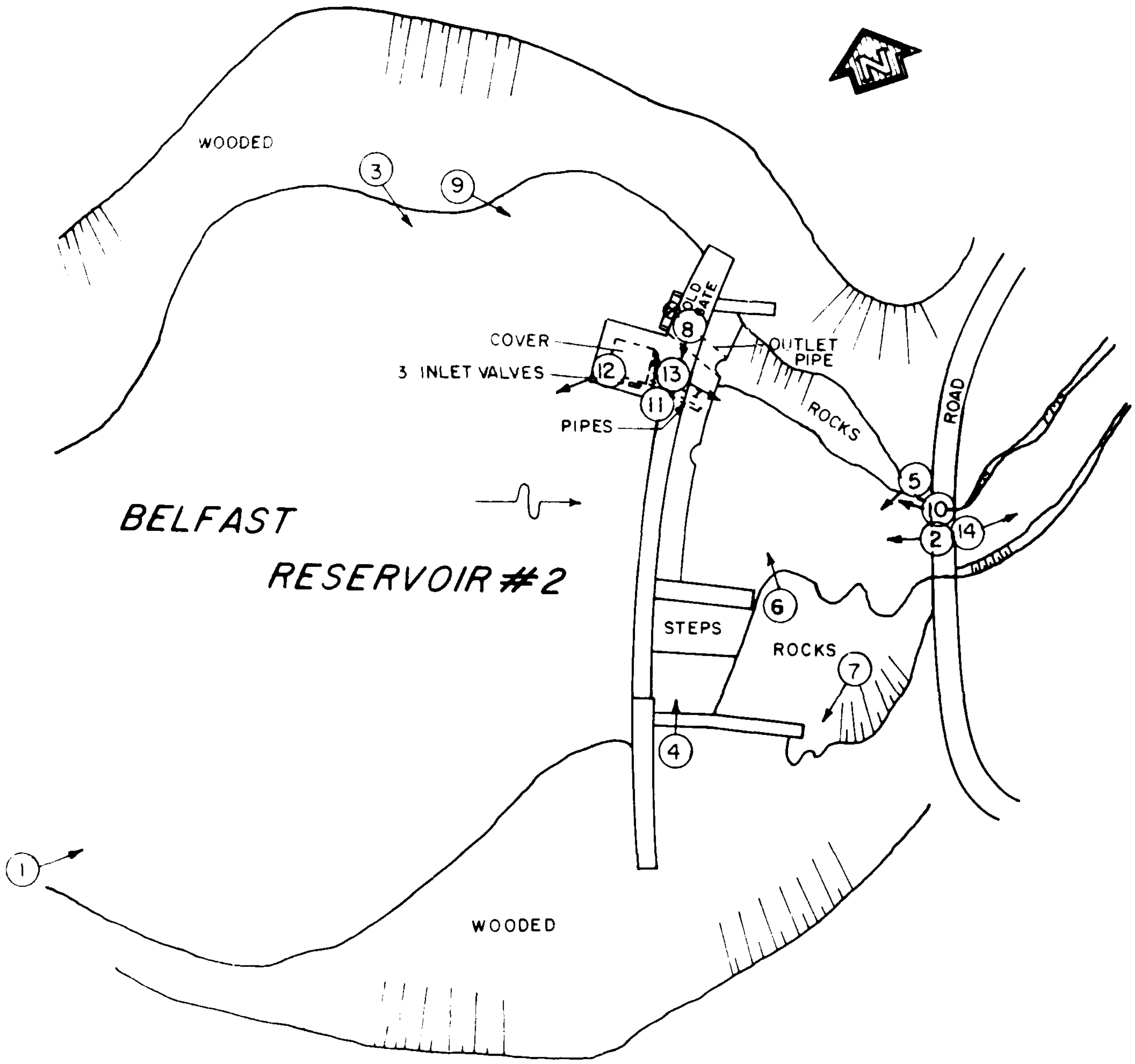
LITTLE RIVER UPPER DAM

LITTLE RIVER MAINE

			SCALE: NOT TO SCALE
			DATE: NOVEMBER 1979

APPENDIX C

PHOTOGRAPHS



Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS 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.

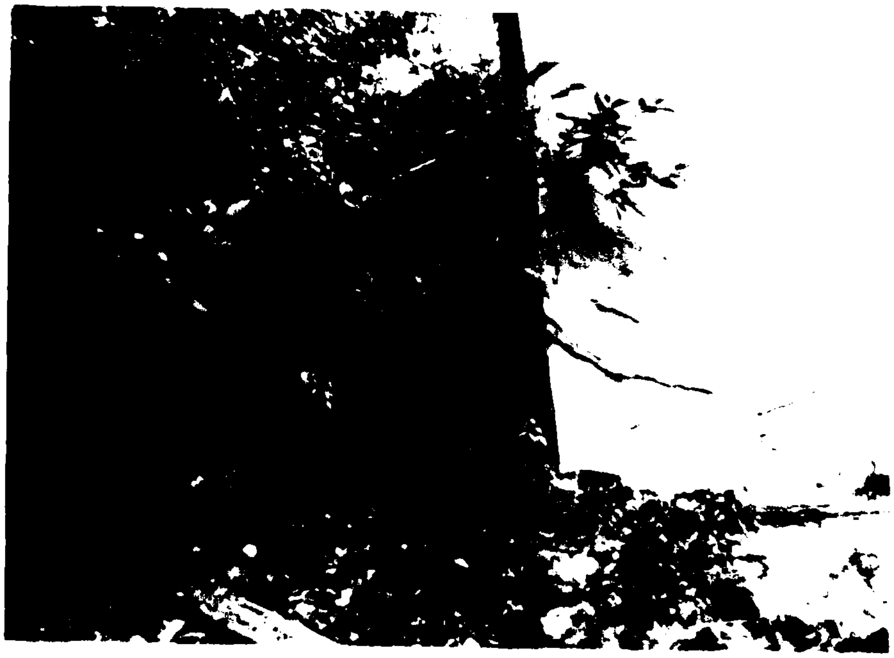
September 17, 1979

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.

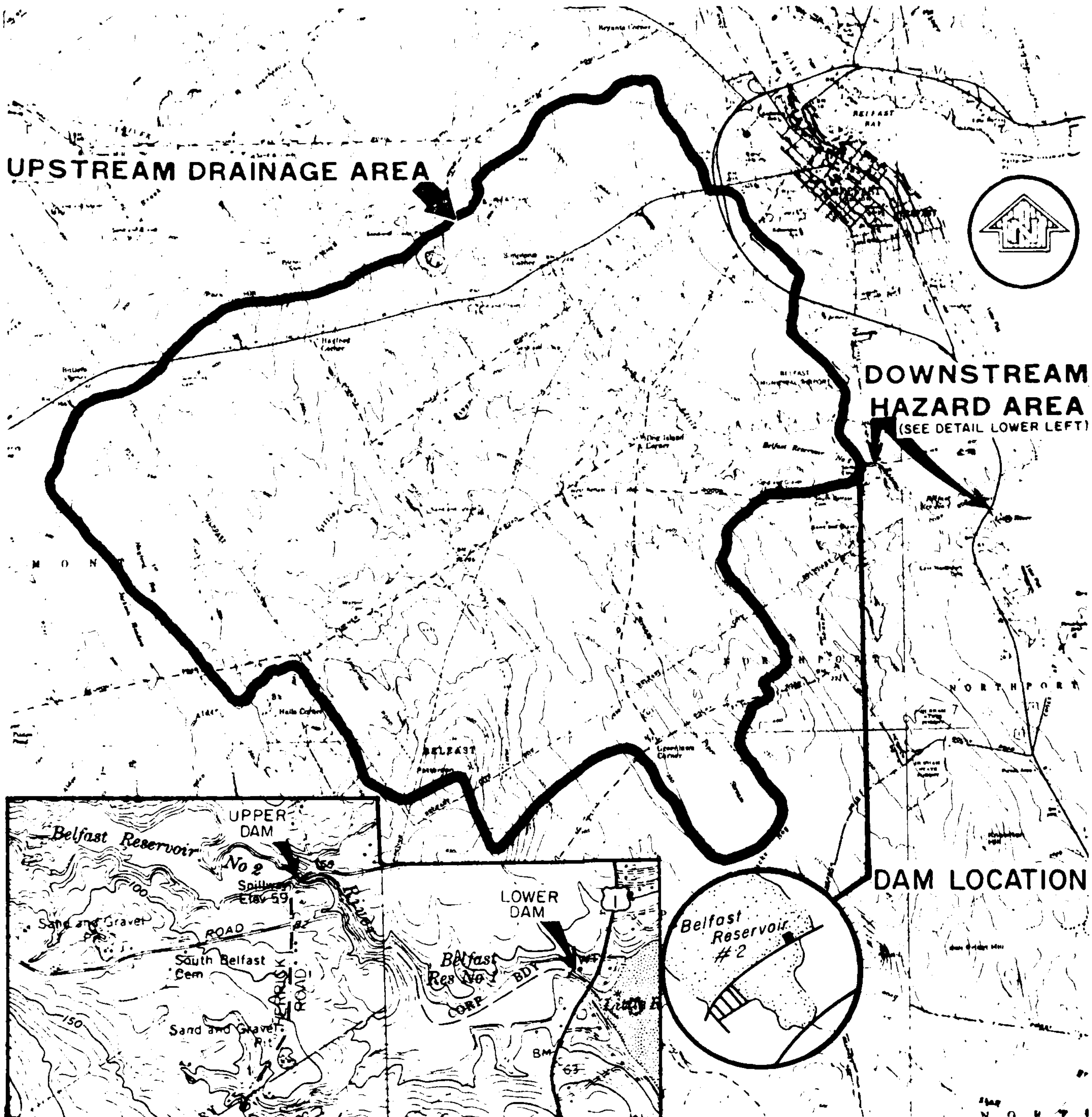
September 17, 1979
Figure 12 - Looking upstream at the reservoir from the top of the north abutment.

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



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

ANDERSON-NICHOLS & CO., INC. CONCORD, N.H.

SCALE IN MILES

0 1 2

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.

BREACH ANALYSIS

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

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

W_b = BREACH WIDTH
g = 32.2 FT/SEC²
Y_0 = POOL ELEV. - U/S RIVER BED

$W_b = 216 \times .4 = 86$ ASSUME BREACH OCCURS
$Y_0 = 64.9 - 39.2 = 25.7$ AT TOP OF THE DAM - 64.9 FT MSL
Q = 18,839 CFS

Q THROUGH SPILLWAY OTHER THAN WHERE IT IS BREACH.

L = 114 - 86 = 28 FT
H = 64.9 - 59 = 5.9
C = 3.2
$Q = C \cdot L \cdot H^{3/2}$ = 1,324 CFS

TOTAL BREACH Q = 20,160 CFS

ANTECEDENT DISCHARGE (SPILLWAY CAPACITY AT TOP OF DAM)

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

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Subject: H & H.

Sheet No. 2 of

Date 10-12-79

Computed J.G.

Checked LW

JOB NO. 3273-16

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 MANNINGS EQUATION: $Q = \frac{1.49}{n} \cdot A \cdot R^{2/3} \cdot S^{1/2}$ *

$n = .05$ $S = .005$

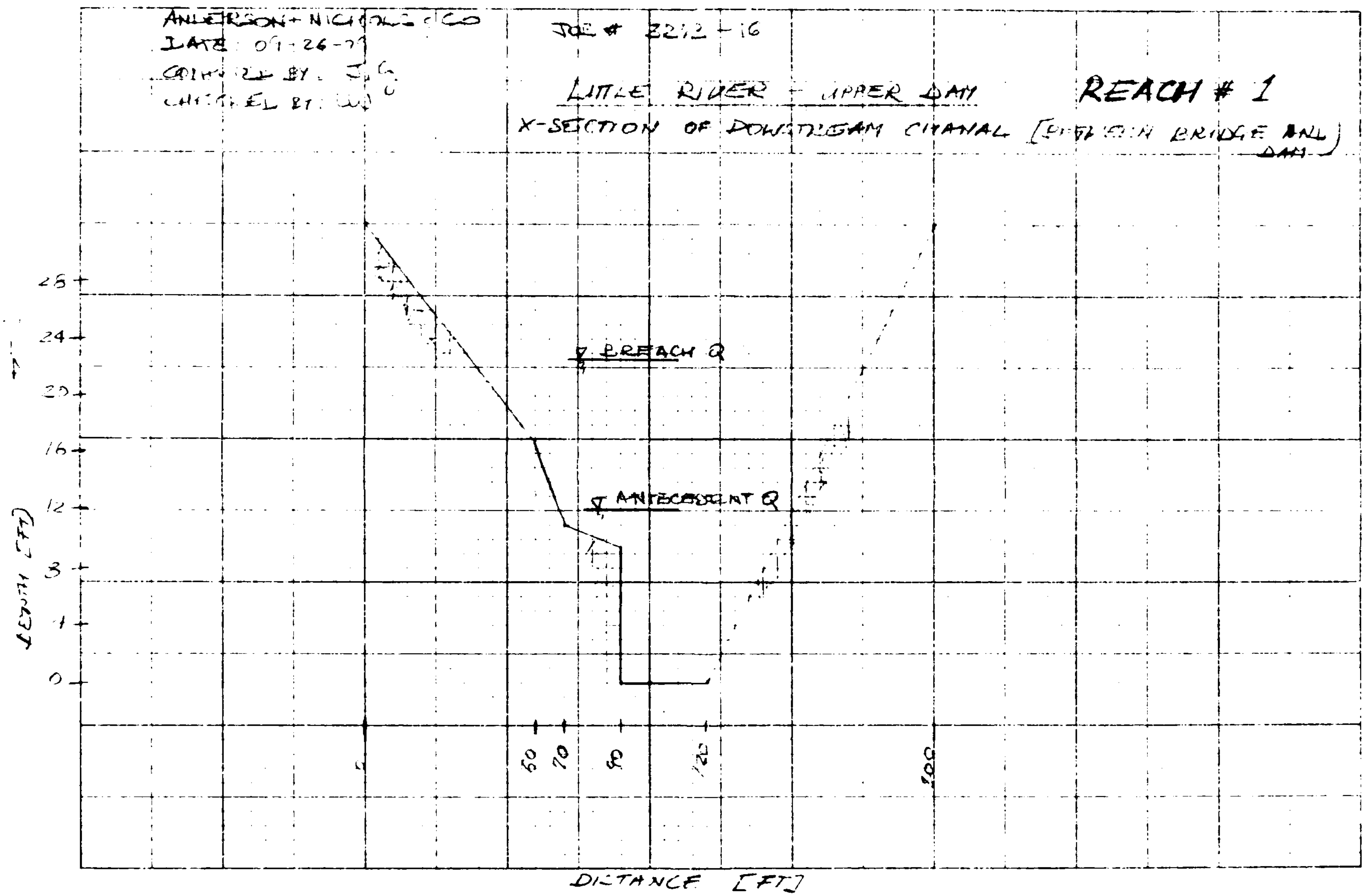
DEPTH [FT]	AREA	W PER	Q [CFS]
0	0	0	0
4	154.5	49.1	694
8	378.2	68.1	2469
12	670.8	87.1	5439
16	1030.8	105.6	9770
20	1468.	130.7	15265
24	2008.	158.	22658
28	2652.	185.2	32369

* 'n' - ROUGHNESS COEFFICIENT

A - AREA OF XSECTION IN SQUARE FEET

R - A/WETTED PERIMETER

S - SLOPE OF REACH



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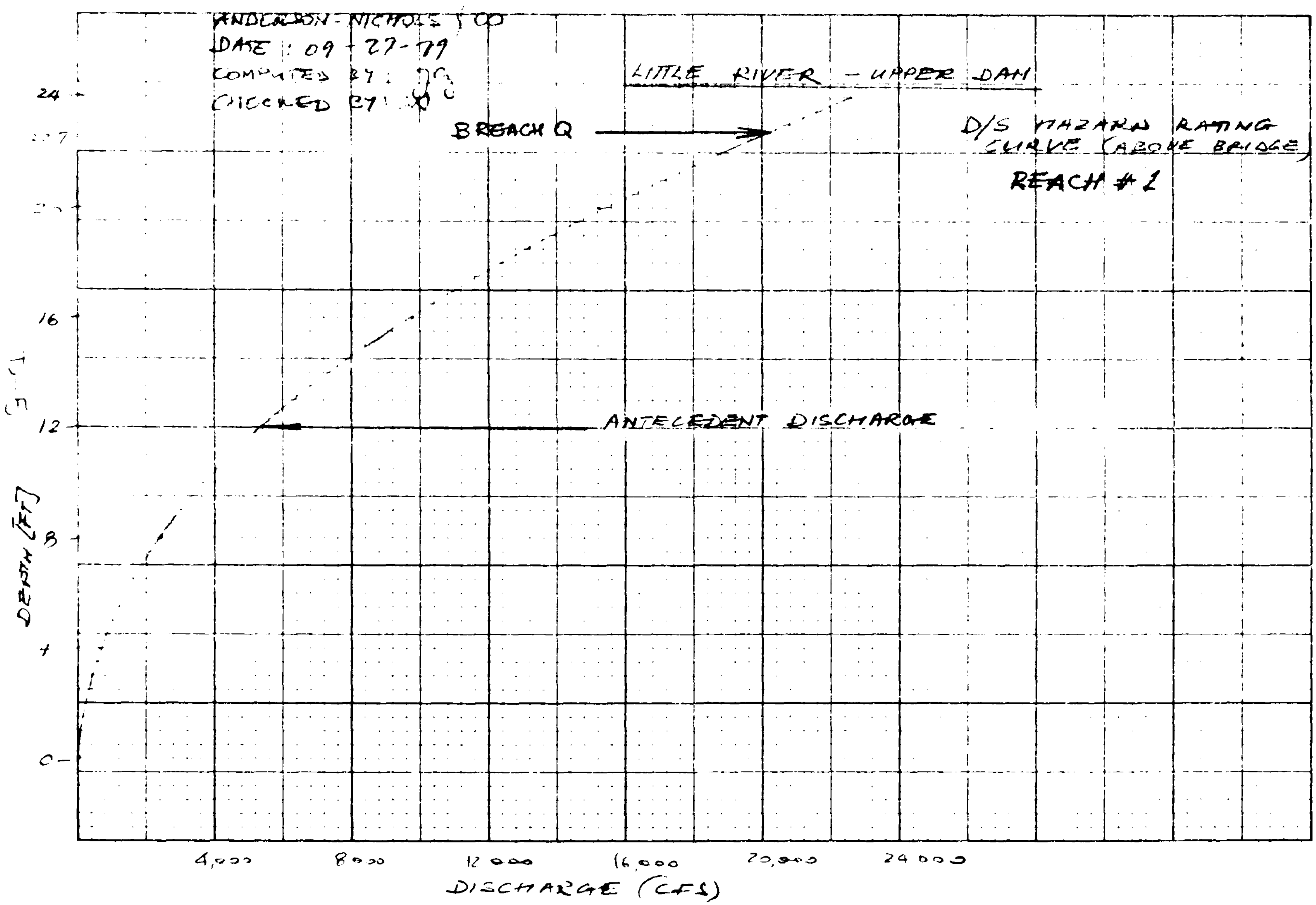
DATE: 09-26-79
COMPUTED BY: J.G.
CHECKED BY:
JOB # 3212-16
LITTLE RIVER - UPPER DAM
REACH # 1
X-SECTION OF DOWNSTREAM CHANNEL
BREACH Q
ANTECEDENT Q
DEPTH [FT]
DISTANCE [FT]
28
24
20
16
12
8
4
0
60
70
80
120


ANDERSON-NICHOLS & CO
DATE : 09-27-79
COMPUTED BY:
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LITTLE RIVER - UPPER DAM
D/S HAZARD RATING CURVE (ABOVE BRIDGE)
REACH #1
BREACH Q
ANTECEDENT DISCHARGE
24
16
12
8
4
0
DEPTH [FT]
4,000
8000
12 000
16,000
20,000
24000
DISCHARGE (CFS)

LITTLE RIVER - UPPER DAM

BREACH ANALYSIS - CONT'D

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

LOW FLOW - CALCULATED USING MANNINGS EQUATION

	ELEV.	AREA	WPER	Q [CFS]
	33.5	0	0	0
ROUGHNESS COEFF.:	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
S = .0125	49.5	388	55.	8034
	52.7	470.4	61.5	10440

PRESSURE & WEIR FLOW

C VALUE CALCULATION FOR PRESSURE FLOW:

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

L = LENGTH OF BRIDGE = 24'

n - for CONCRETE BRIDGE WITH EARTH BOTTOM - 0.03

R - HYDRAULIC RADIUS

$$k_f = \frac{29.1 \times .03^2 \times 24}{5.27^{4/3}} = .067$$

INTAKE AND EXIT LOSSES = 1.10

$$1.10 + .067 = 1.167$$

$$k = \frac{1}{C^2} = 1.167 \qquad C = .92$$

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Subject H & H

Sheet No. 2 of

Date 10/17/79

Computed

Checked

JOB NO. 3273 - 16

LITTLE RIVER - UPPER DAM

BREACH ANALYSIS - CONT'D

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

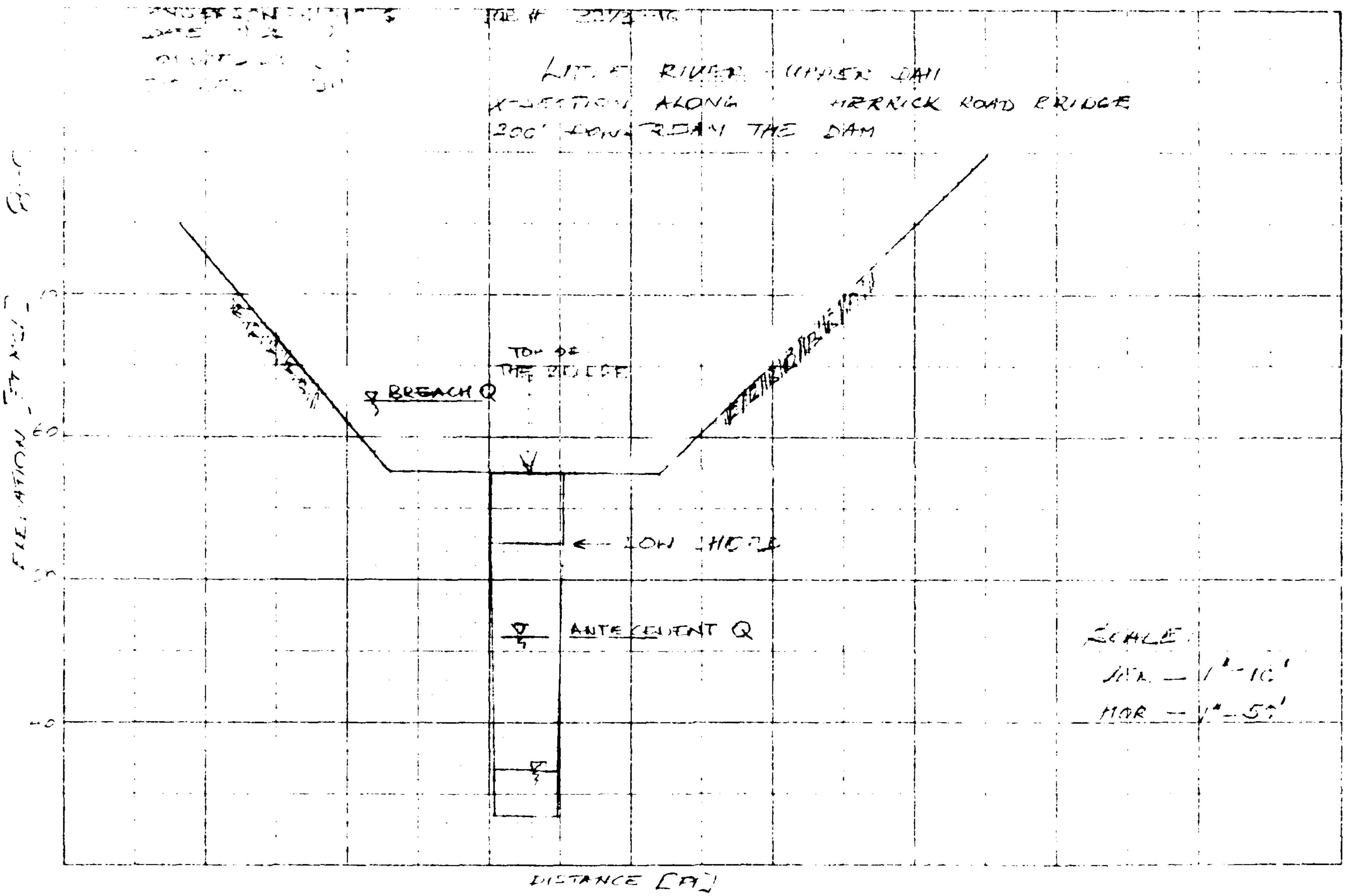
ELEV.	H.	$Q = AC\sqrt{2gH}$ [CFS]
57.5	14.4	13,331
60.0	16.9	14,424
65.0	21.9	16,435
70.0	26.9	18,183

WEIR FLOW — C = 2.8

ELEV. [FT MSL]	L [FT]	H [FT]	$Q = CLH^{3/2}$ [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
46.3	5807
49.5	8034
52.7	10410
57.5	13,331
60.0	15,641
65.0	23,911
70.0	39,219


LITTLE RIVER UPPER DAM
X-SECTION ALONG HERRICK ROAD BRIDGE
TOP OF THE BRIDGE
BREACH Q
LOW CHORD
ANTECEDENT Q
SCALE:
HOR — 1" = 50'
60
40
ELEVATION [FT MSL]
DISTANCE [FT]

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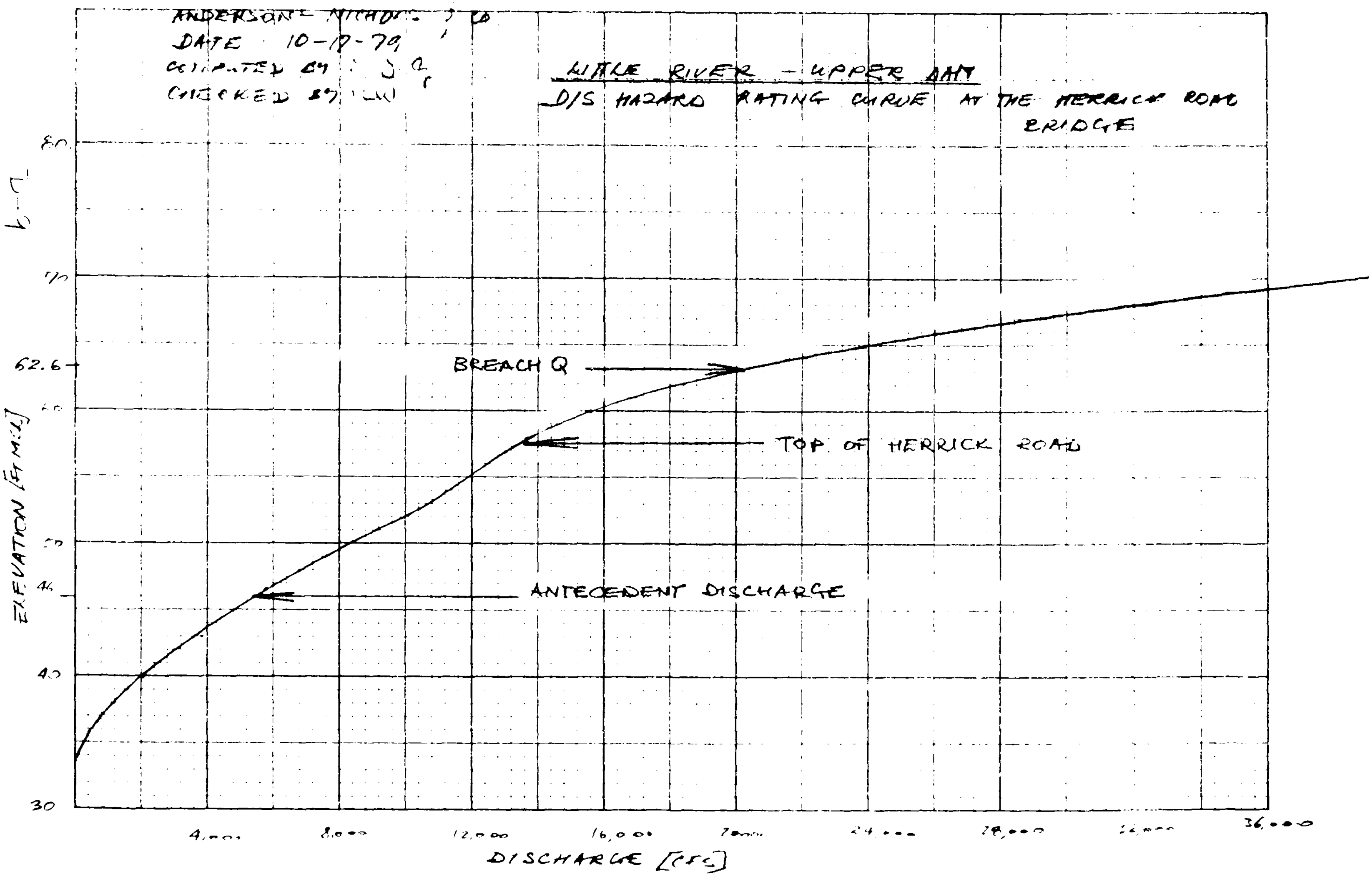
DATE 10-17-79
COMPUTED BY
CHECKED BY



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Subject: H & H

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Date: 10-17-79

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JOB NO. 3273-16

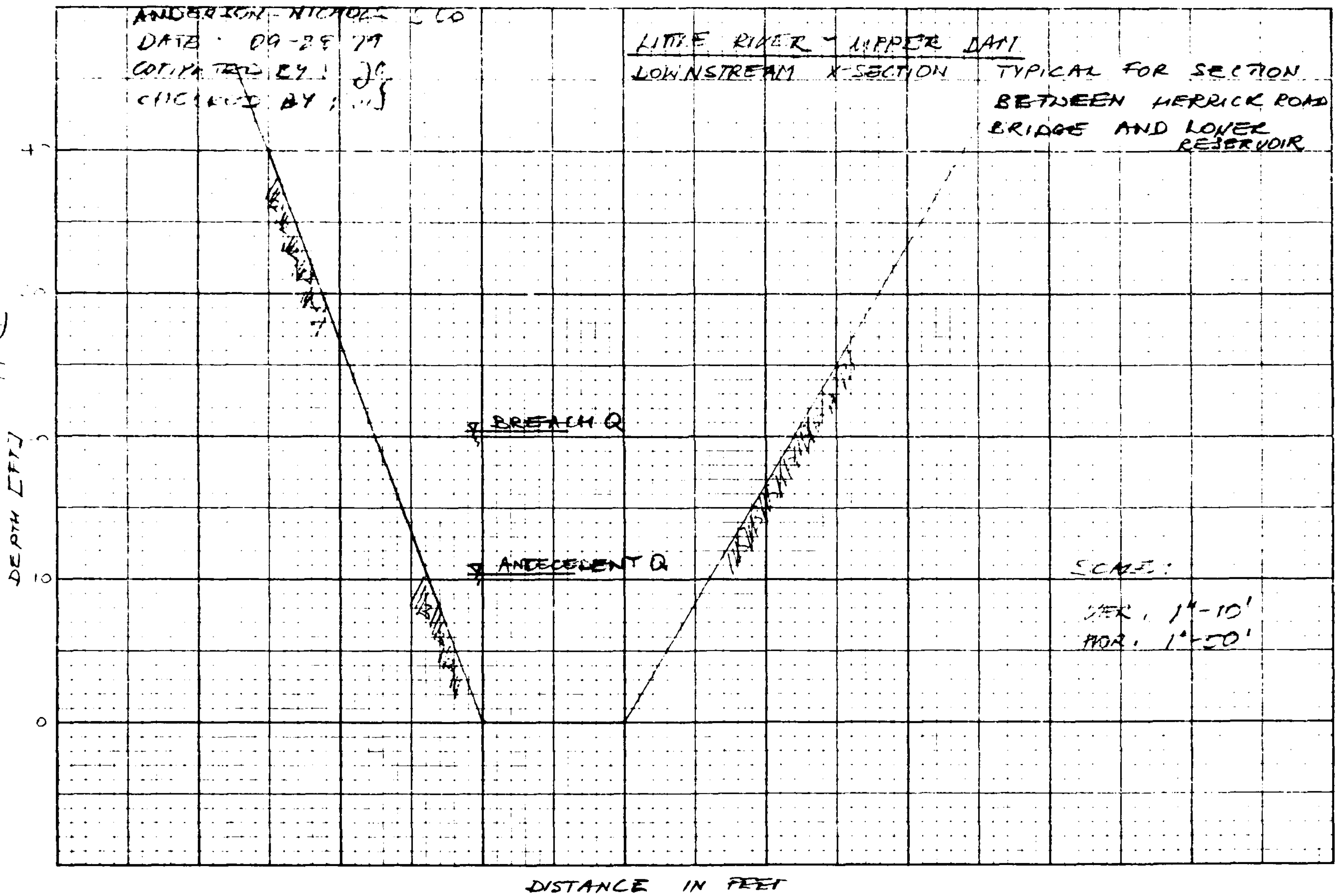
LITTLE RIVER - UPPER DAM

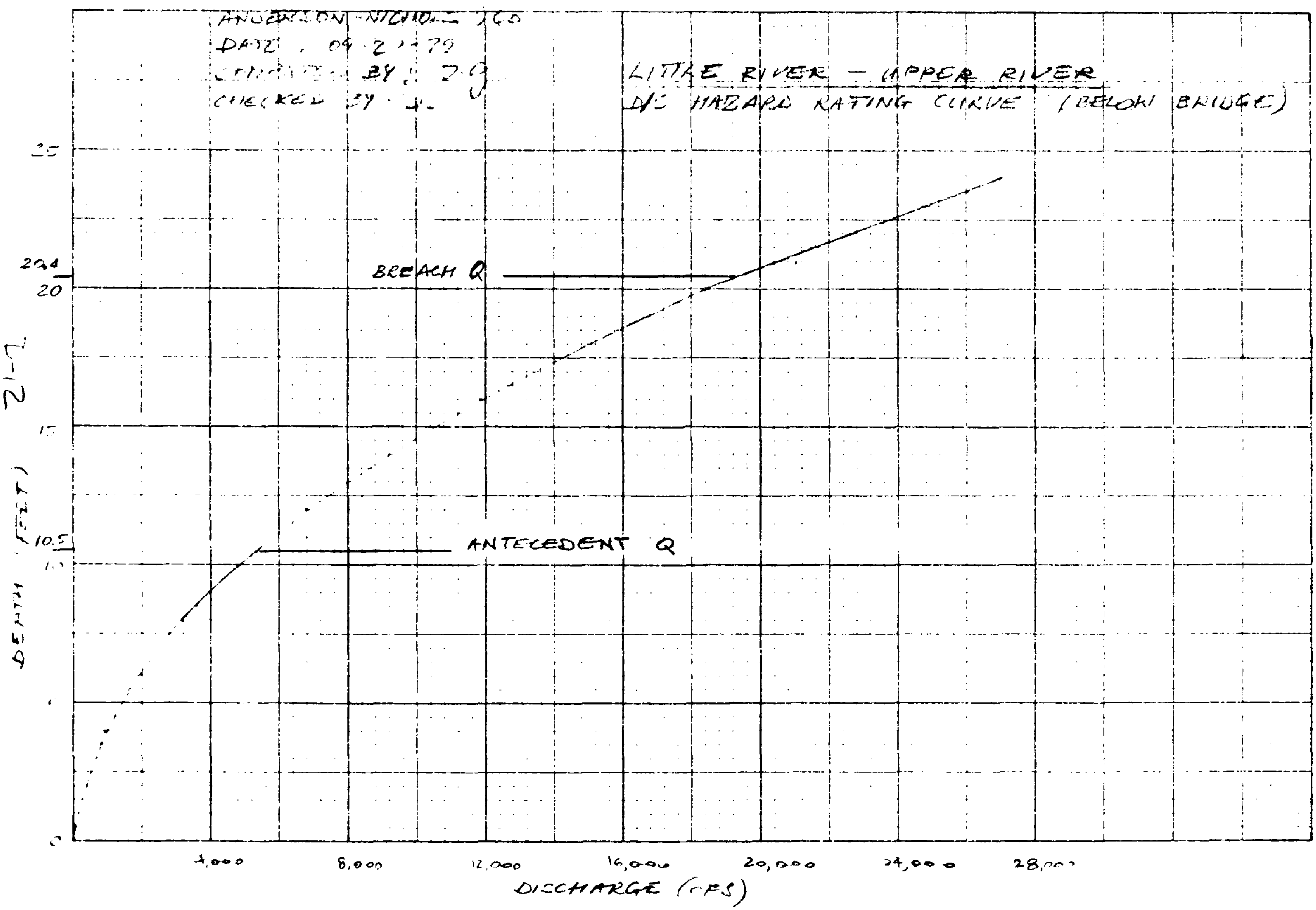
BREACH ANALYSIS - CONT'D

USE A TYPICAL CROSS SECTION ALONG THE DOWNSTREAM REACH FROM THE MERRICK ROAD BRIDGE (200' BELOW THE DAM) TO CONFLUENCE WITH RESERVOIR OF LOWER DAM FOR 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	135	11 862
20	1975	156	18 542
24	2604	177	26 976


ANDERSON-NICHOLS & CO
DATE: 09-28-79
COMPUTED BY: JC
CHECKED BY:
LITTLE RIVER - UPPER DAM
DOWNSTREAM X-SECTION
TYPICAL FOR SECTION BETWEEN HERRICK ROAD BRIDGE AND LOWER RESERVOIR
BREACH Q
ANTECEDENT Q
SCALE:
VER. 1"-10'
HOR. 1"-20'
DEPTH [FT]
10
0
DISTANCE IN FEET



ANDERSON-NICHOLS & CO
DATE . 09-2 -79
BY
CHECKED BY
LITTLE RIVER - UPPER RIVER
D/S HAZARD RATING CURVE (BELOW BRIDGE)
BREACH Q
ANTECEDENT Q
22.4
20
15
10.5
10
0
4,000
8,000
12,000
16,000
20,000
24,000
28,000
DISCHARGE (CFS)
DEPTH (FEET)

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Subject: HGH

Sheet No. 12 of

Date 10-17-77

Computed

Checked LW

JOB NO. 3272 – 16 LITTLE RIVER - UPPER DAM

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 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 UPPER DAM HAS BEEN CLASSIFIED AS SIGNIFICANT HAZARD

SQUARES 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.

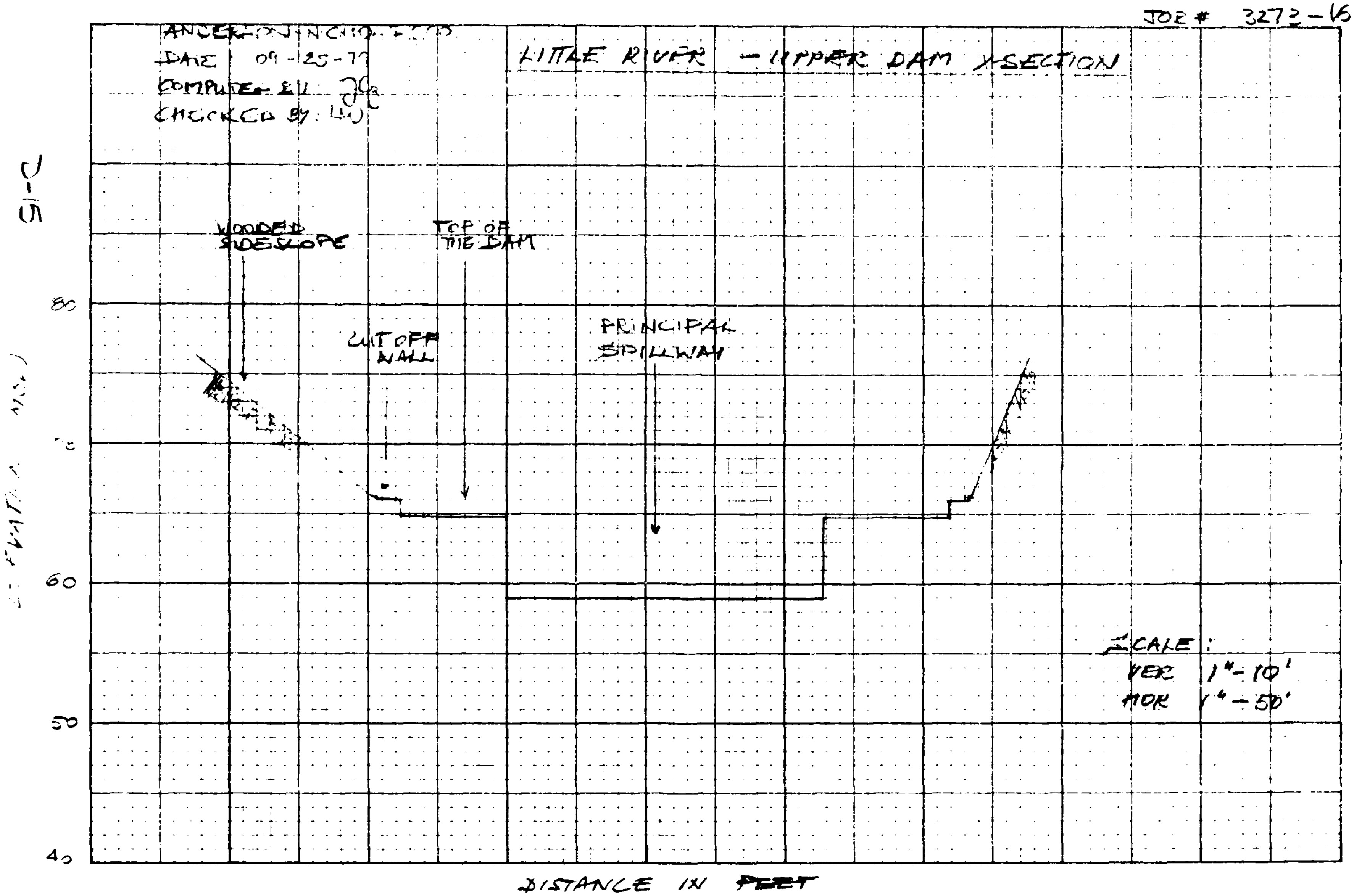
STEP #1 CALCULATE PMF USING "PRELIMINARY GUIDANCE FOR ESTIMATING MAXIMUM PROBABLE DISCHARGES IN PHASE I DAM SAFETY INVESTIGATIONS, MARCH 1978"

SLOPE OF WATERSHED IS 125 FT/MI, THEREFORE THE MOUNTAINOUS CURVE WILL BE USED.
USE A CSM VALUE OF 1870

13.7 SQ MILE × 1870 CSM = 25600 CFS

TEST FLOOD (1/2 PMF) = 12,800 CFS (Q_{P1})

STEP #2A DETERMINE SURCHARGE HEIGHT TO PASS Q_{P1} 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. FLOW THROUGH TWO OUTLET PIPES (6" AND 8" IN DIAMETER) FROM VALVE CHAMBER IS INSIGNIFICANT. SIZE OF EMERGENCY GATE IS UNKNOWN, GATE OPERATING MECHANISM IS RUSTED AND IN POOR CONDITION. THERE IS NO INDICATION OF RECENT OPERATION. 18" CIP OUTLET PIPE FROM THE GATE IS SEEPING ABOUT 30 GPM. BECAUSE OF ITS CONDITION POSSIBLE FLOW THROUGH EMERGENCY GATE WILL NOT BE CALCULATED.


JOB # 3272-16
ANDERSON-NICHOLS & CO.
DATE 09-25-77
COMPUTED BY JCR
CHECKED BY: LJ
LITTLE RIVER - UPPER DAM X-SECTION
WOODED SIDESLOPE
TOP OF THE DAM
CUTOFF WALL
PRINCIPAL SPILLWAY
80
60
50
40
SCALE:
VER 1" - 10'
HOR 1" - 50'
DISTANCE IN FEET

Anderson-Nichols & Company, Inc.

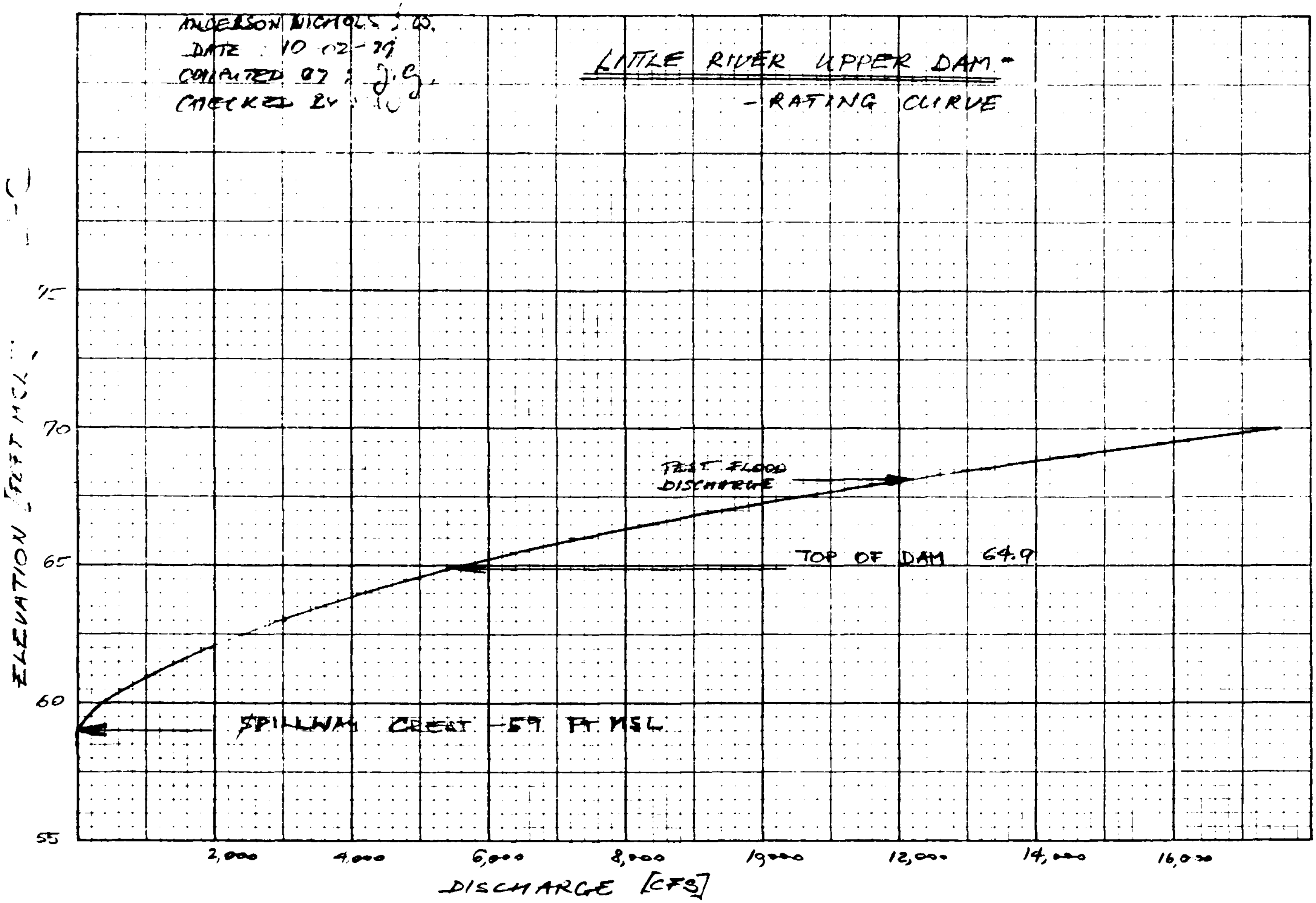
Subject: H-1

JOB NO. 3242 - 16

Sheet No. 15 of
Date
Computed
Checked

[illegible] OVER UPPER DAM — RATING CURVE CALCULATION

FLOW OVER THE SPILLWAY					FLOW OVER THE TOP OF DAM				FLOW OVER THE SIDE SLOPES				TOTAL
ELEV. (FEET MSL)	'C' VALUE	L (FEET)	H (FEET)	Q (CFS)	'C' VALUE	L (FEET)	H FEET	Q (CFS)	'C' VALUE	L (FEET)	H FEET	Q CFS	Q CFS
59	3.3	114	0	0									0
60	.	.	1	375									375
61		.	2	1065									1065
[illegible]	.		3	1955									1955
[illegible]		.	4	[illegible]									3010
[illegible]	.	.	5	[illegible]									4205
TOP OF DAM 64.9	.		5.9	5290									5290
[illegible]		.	7	6764?	2.0	[illegible]	82	195?					7265
[illegible]			8	[illegible]		[illegible]	[illegible]	686?	2.5	5	1	14	9410
[illegible]	.		9	[illegible]		[illegible]	102	1610?	.	10	2	79	[illegible]706
[illegible]	.		10	[illegible]		[illegible]	102	[illegible]	.	15?	[illegible]	165?	1465?
[illegible]			11	[illegible]		[illegible]	92	2534		15	4	25?	1755?
[illegible]			12	150[illegible]		[illegible]	102	4610	.	15	5	170	20512?


ANDERSON NICHOLS & CO.
DATE 10-02-79
COMPUTED BY J.G.
CHECKED BY
LITTLE RIVER UPPER DAM -
- RATING CURVE
TEST FLOOD DISCHARGE
TOP OF DAM 64.9
SPILLWAY CREST 59 FT MSL
ELEVATION [FEET MSL]
75
70
65
60
55
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
DISCHARGE [CFS]

Anderson-Nichols & Company, Inc.

Subject D-1

Sheet No. ___ of ___
Date 12-09-77
Computed ___
Checked ___

JOB NO. 2272-15

NITRE RIVER - UPPER DAM

STORAGE - ELEVATION CURVE CALCULATIONS

NORMAL STORAGE (SPILLWAY CREST - 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. 157 000 000 GAL LISTED AS IMPOUNDING CAPACITY IN APPLICATION FOR DAM REGISTRATION (SEE PAGE) AGREES WITH THIS CALCULATION.

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

$$V = \tfrac{1}{3} h \left(L_1 + L_2 + \sqrt{L_1 L_2} \right)$$

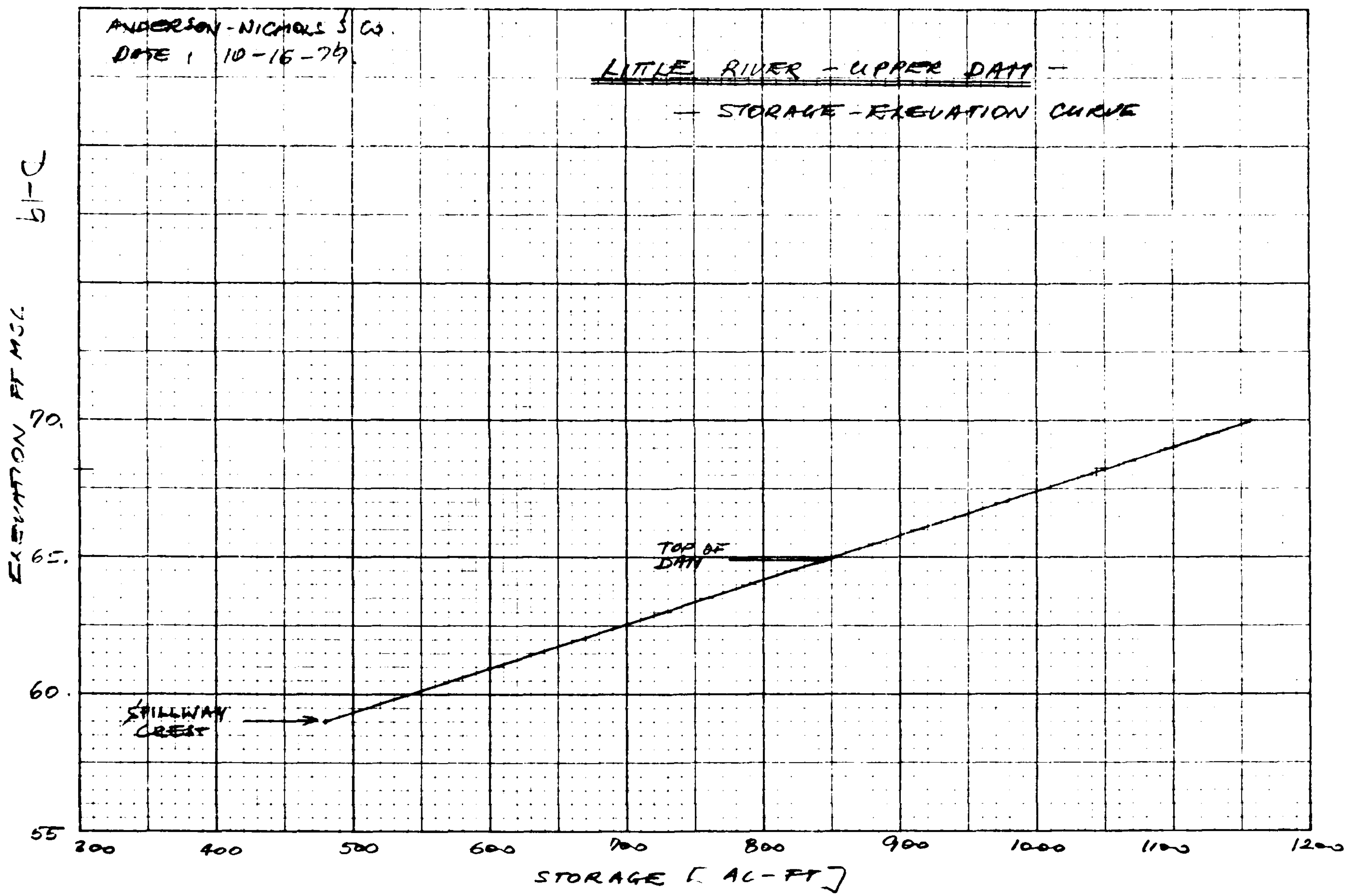
h - ELEV. ABOVE NORMAL POOL
L_1 - NORMAL POOL SURFACE
L_2 - ENLARGE POOL SURFACE

ELEV. 70. FT MSL

SURFACE AREA - 76 AC

$V = \tfrac{1}{3}\, 11 \left(48 + 76 + \sqrt{48 \times 76} \right) = 676$ AC-FT

TOTAL STORAGE - 1156 AC-FT



ANDERSON-NICHOLS & CO.
DATE : 10-16-79
LITTLE RIVER - UPPER DAM -
- STORAGE - ELEVATION CURVE
TOP OF DAM
SPILLWAY CREST
ELEVATION FT MSL
55
60
65
70
200
400
500
600
700
800
900
1000
1100
1200
STORAGE [AC-FT]

LITTLE RIVER - UPPER DAM

STEP 2A (CONT)
TEST FLOOD (1/2 PMF) = 12,800 CFS
ELEV @ 12,800 CFS ⇒ 68.4 FT MSL

STEP #2B
DETERMINE VOLUME OF SURCHARGE IN INCHES OF RUNOFF

Q_{P1} = 12,800 CFS → ELEV. 68.4 FT MSL

STORAGE AT 68.4 FT MSL ⟶ 1,050 AC-FT
STORAGE AT 59.0 FT MSL (SPILLWAY CREST) ⟶ 480 AC-FT

570 AC-FT × 1/(? MI²) × (1 MI²)/(640 AC) × 12 IN/FT = .78" RUNOFF
(STOR 1)

STEP #2C

$Q_{P2} = Q_{P1} \times \left(1 - \frac{STOR 1}{9.5''}\right)$

$Q_{P2} = 12,800 \text{ CFS} \times \left(1 - \frac{.78''}{9.5''}\right) = 11,750 \text{ CFS}$

STEP #2D
DETERMINE SURCHARGE HEIGHT TO PASS Q_{P2}

Q_{P2} = 11,750 CFS ⟶ 68. FT MSL ⟶ 1,035 AC-FT

555 AC-FT × 1/(? MI²) × (1 MI²)/(640 AC) × 12 IN/FT = .76" RUNOFF

LITTLE RIVER - UPPER DAM

STEP # 36

AVERAGE STOR 1 & STOR 2

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

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

563 AC-FT + 480 AC-FT = 1043 AC-FT ⟹ 68.2 FT-MSL

TEST FLOOD — 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 ⟹ STORAGE 850 AC-FT

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

APPENDIX E

INFORMATION AS
CONTAINED IN THE NATIONAL
INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

NAME: LITTLE RIVER UPPER DAM

LATITUDE (NORTH) / LONGITUDE (WEST) / REPORT DATE (DAY MO YR): 25NOV79

POPULAR NAME

NAME OF IMPOUNDMENT: BELFAST RESERVOIR NUMBER 2

RIVER OR STREAM: LITTLE RIVER

NEAREST DOWNSTREAM CITY-TOWN-VILLAGE: NORTHPORT

DIST FROM DAM (MI): 2

POPULATION: 1,000

TYPE OF DAM / YEAR COMPLETED / PURPOSES / IMPOUNDING CAPACITIES

VER/DATE

1910

REMARKS

SPILLWAY

POWER CAPACITY

NAVIGATION LOCKS

OWNER: BELFAST WATER DISTRICT

ENGINEERING BY

CONSTRUCTION BY

REGULATORY AGENCY

CONSTRUCTION

OPERATION

MAINTENANCE

INSPECTION BY: ANDERSON-NICHOLS & COMPANY INC

AUTHORITY FOR INSPECTION