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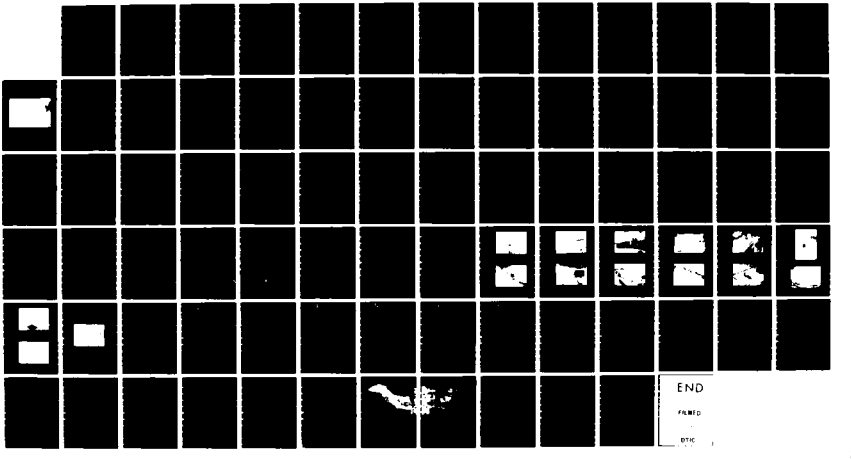

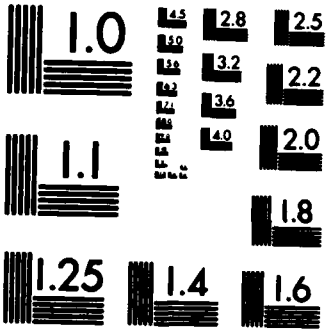

MICROCOPY RESOLUTION TEST CHART
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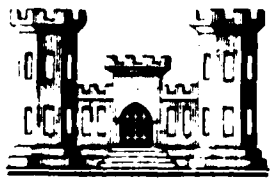
LOWER HOUSATONIC RIVER BASIN
TORRINGTON , CONNECTICUT

CRYSTAL LAKE DAM
CT - 00097

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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

FEBRUARY 1980

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER CT 00097	2. GOVT ACCESSION NO. A142 862	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Lower Housatonic River Basin Torrington, Conn., Crystal Lake 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 February 1980 13. NUMBER OF PAGES 80
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,

Lower Housatonic River Basin
Torrington, Conn
Crystal Lake Dam

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Crystal Lake Dam is an earthen embankment structure with a maximum height of 36 ft and a length of 230 ft. The centrally located stone masonry spillway is 50 ft. wide. The broad crested weir has a series of stone steps which comprise the downstream face. The outlet works consist of an 18 inch diameter conduit which passes through the dam to the left of the spillway structure. Crystal Lake is used for passive recreation. The lake has a maximum storage volume of 63 acre-feet and the size classification is thus small. A breach of the dam could effect several homes and commercial establishments.

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

REPLY TO
ATTENTION OF:
NEDED-E

JUN 19 1980

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

Dear Governor Grasso:

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

The preliminary hydrologic analysis has indicated that the spillway capacity for the Crystal Lake Dam would likely be exceeded by floods greater than 26 percent of the Probable Maximum Flood (PMF), the test flood for spillway adequacy. Our screening criteria specifies that a dam of this class which does not have sufficient spillway capacity to discharge fifty percent of the PMF, should be adjudged as having a seriously inadequate spillway and the dam assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

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

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

NEDED-E
Honorable Ella T. Grasso

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

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. This report has also been furnished to the owner of the project, Torrington Water Company, Torrington, Connecticut.

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

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

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

CRYSTAL LAKE DAM

CT 00097

LOWER HOUSATONIC RIVER BASIN

TORRINGTON, CONNECTICUT

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	CT 00097
Name of Dam:	Crystal Lake Dam
Town:	Torrington
County and State:	Litchfield, Connecticut
Stream:	Nickel Mine Brook
Date of Inspection:	24 October, 1979

BRIEF ASSESSMENT

Crystal Lake Dam is an earthen embankment structure with a maximum height of 36 feet and a length of 230 feet. The centrally located stone masonry spillway is 50 feet wide. The broad crested weir has a series of stone steps which comprise the downstream face. The outlet works consist of an 18 inch diameter conduit which passes through the dam to the left of the spillway structure.

Crystal Lake is used for passive recreation. The lake has a maximum storage volume of 63 acre-feet and the size classification is thus small. A breach of the dam could effect several homes and commercial establishments, along with Connecticut Route 4 and 272 which are in the probable impact area. With the possibility of some loss of life and the probability of excessive economic losses, the dam has been classified as having a high hazard potential.

The dam is judged to be in generally fair condition. The crest of the dam has a slight undulation and is subjected to vehicular traffic. Some erosion of the downstream slope has occurred. No embankment or downstream seepage was noted. Large trees are growing along the downstream slope of the dam. The stone masonry spillway is in good condition.

For the combination of dam size (small) and downstream hazard (high), a range in the magnitude of the spillway test flood of the ½ PMF to PMF is given. A spillway test flood of the ½ PMF was selected for this project. The spillway test flood inflow is 3,820 CFS. The maximum spillway capacity is 1935 CFS at a stage of 5.5 feet (equal to top of dam). The capacity of the spillway is inadequate to pass the one-half PMF test flood outflow (3790 CFS) without overtopping the dam. The test flood would overtop the dam by abour 1.6 feet. The spillway can pass about 51 percent of the test flood outflow without overtopping the dam.

Within one year of receipt of the Phase I Inspection Report, the owner should retain the services of a qualified registered engineer to: 1) evaluate the need for filter layers and riprap on the upstream face and design a protection system, as required; 2) direct removal of trees and stumps on the downstream embankment and toe, to ensure that the root zones are backfilled with carefully selected soils; 3) investigate the erosion at the toe of the slope adjacent to the spillway channel along the left side of the dam and design and construct corrective measures, as required; 4) investigate the erosion adjacent to the spillway wingwall on the upstream and downstream slopes of the embankment and backfill with suitable material; and 5) conduct detailed hydraulics and hydrology studies to determine the need for and methods of increasing the discharge capacity of the project.

The owner should carry out the following operations and maintenance procedures: 1) brush and trees within 25 feet of the downstream toe of the dam should be removed; 2) a regular program of valve operation should be established to ensure continued operation of the blow off; 3) repair displaced masonry blocks in spillway training wall; 4) fill in all animal burrow holes; 5) engage a qualified registered engineer to make a comprehensive technical inspection of the dam once a year; and 6) establish a formal surveillance program for use during and immediately after heavy rainfall and also a flood warning plan to follow in case of floodflow conditions or imminent dam failure.

S. Giavara, P.E.
President

Registered CT. 7634

This Phase I Inspection Report on Crystal Lake 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 judgement and practice, and is hereby submitted for approval.

Joseph W. Finnegan

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

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, CHAIRMAN
Chief, Structural Section
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

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

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

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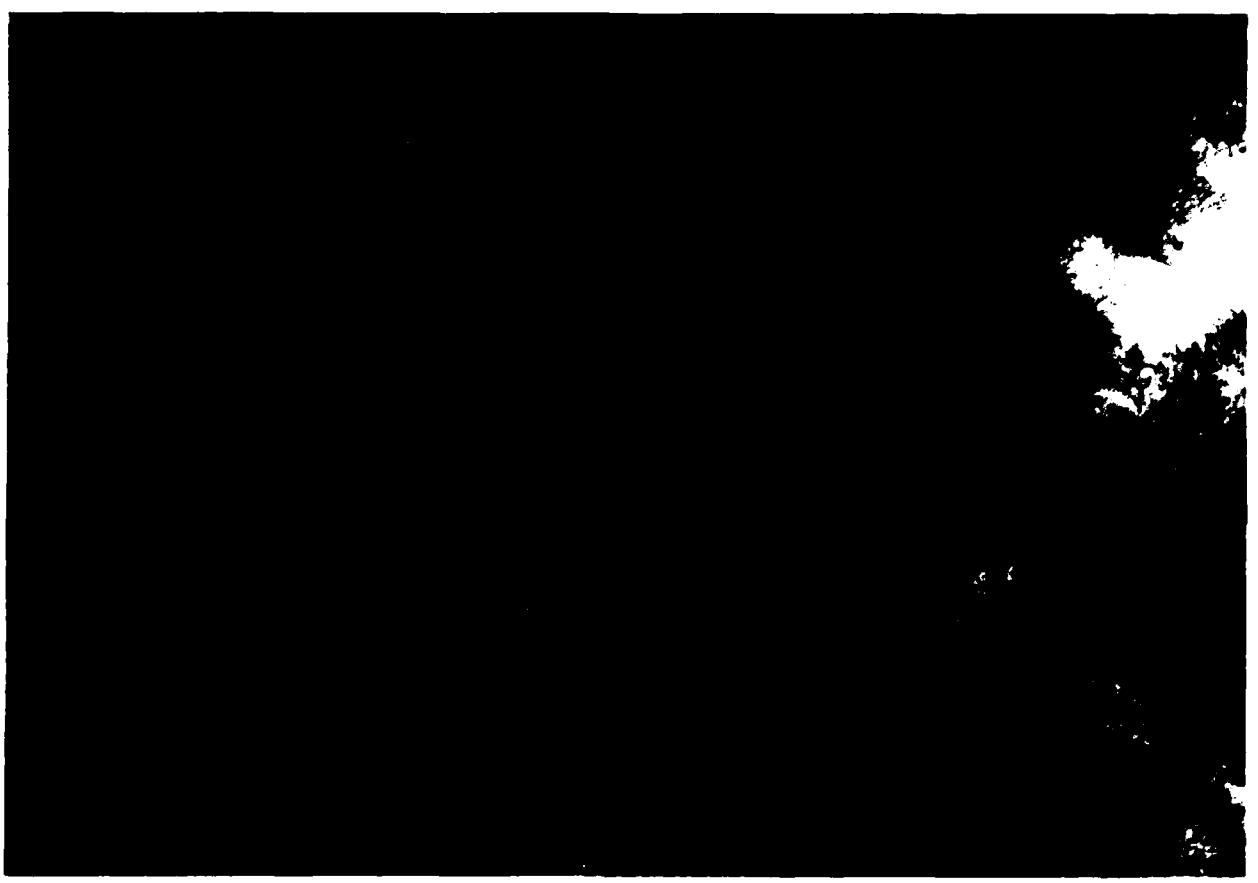
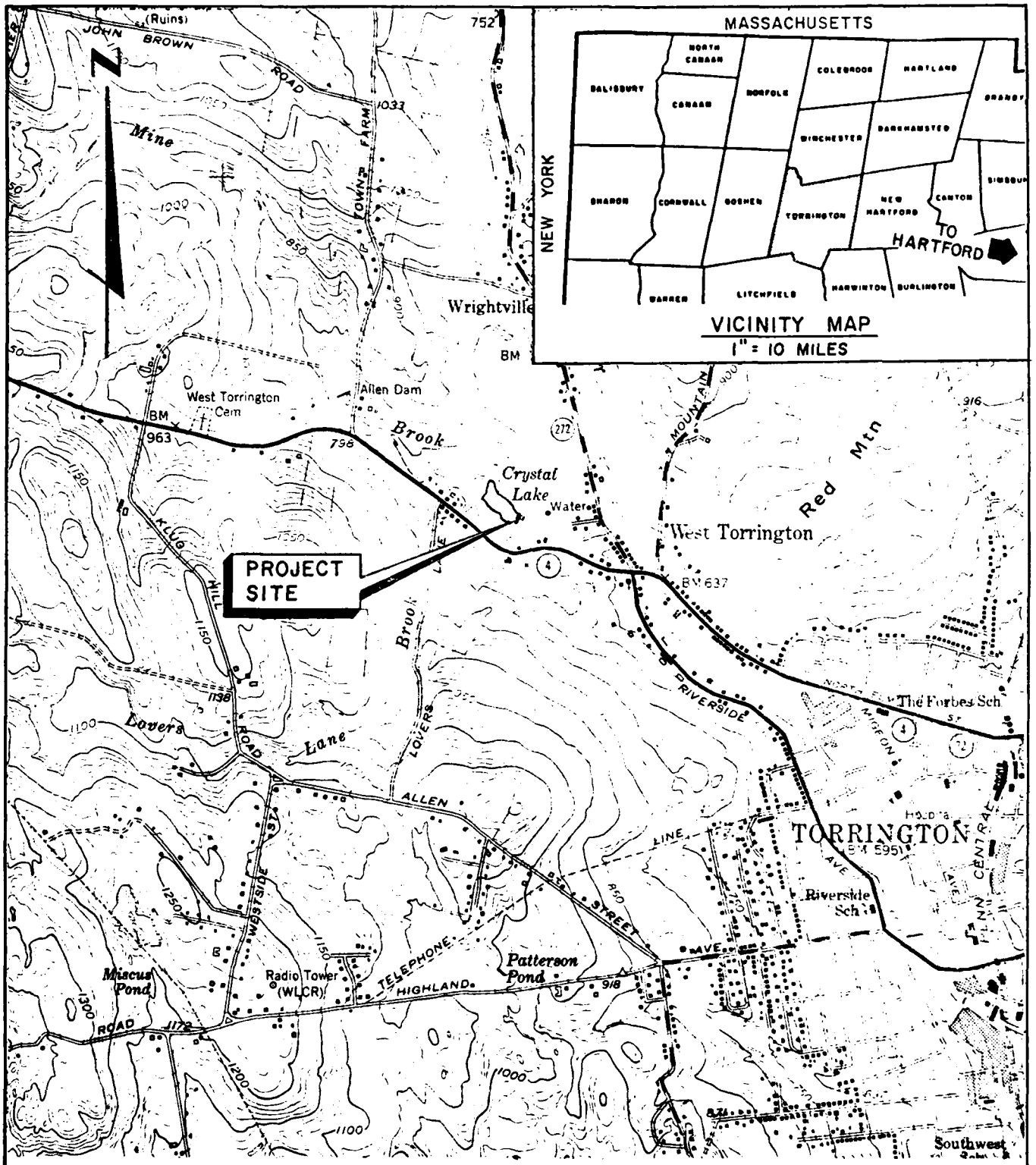
APPENDIXES



Overview Photo
Crystal Lake Dam



CRYSTAL LAKE DAM
LOCATION MAP
TORRINGTON, CONNECTICUT

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
CRYSTAL LAKE DAM - CT 00097

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 through 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. Flaherty Giavara Associates, P.C. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed was issued to Flaherty Giavara Associates, P.C. under a letter of 19 October 1979 from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0001 has been assigned by the Corps of Engineers for this work.

b. Purpose.

1) 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) Encourage and assist 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. Crystal Lake Dam is located in Torrington, Connecticut on Nickel Mine Brook, a tributary stream to the west branch of the Naugatuck River. The dam is located approximately 1 mile northwest of the center of Torrington. The dam is shown on U.S.G.S. Topographic Map "West Torrington, Connecticut" at a latitude of 41°49'12" and a longitude of 73°09'08". The Location Map on page vi shows the location of this structure.

b. Description of Dam and Appurtenances. Crystal Lake Dam is an earthen embankment structure with a maximum height of 36 feet and a length of 230 feet. A stone masonry spillway about 50 feet in width is located at the central portion of the dam.

The spillway crest is at about elevation 723 NGVD. The upstream face of the earth embankment is grassed and slopes at 2 horizontal to 1 vertical. The top of a concrete core wall was exposed to the left (north) of the spillway on the dam crest. The dam crest elevation is about 728.5.

The spillway is a stone masonry structure about 50 feet in width. This broad crested weir has a series of stone steps which comprise the downstream face. Mortared stone masonry training walls are located on both sides of the spillway.

The outlet works consist of an 18 inch diameter conduit which passes through the dam to the left (north) of the spillway structure. A valve stem and hand wheel are located over the conduit and extend several feet above the crest of the dam.

c. Size Classification. Crystal Lake has a maximum storage volume of 63 acre-feet and a dam height of 36 feet. Storage of less than 1,000 acre-feet and a height of less than 40 feet classifies this structure in the "small" category according to guidelines established by the Corps of Engineers.

d. Hazard Classification. This dam is classified as having a "high" hazard potential. The areas of probable impact include residential dwellings located along Connecticut State Highway Routes 4 and 272 and Riverside Avenue. The number of dwellings in the probable impact area is approximately 8. Additional structures located within the center of Torrington include residential, commercial and industrial properties. In addition, Routes 4 and 272 are located within the probable impact area. Dam failure would result in the potential for the loss of more than a few lives and excessive economic losses and therefore the dam is classified as having a high hazard potential.

e. Ownership. This dam is owned by the Torrington Water Co., 110 Prospect Street, Torrington, Connecticut, telephone: 203-489-4149.

f. Operator. The operator of this dam is William Jones of the Torrington Water Co., telephone: 203-489-4149.

g. Purpose of Dam. The original purpose of the dam was to impound the reservoir for use as a public water supply. The reservoir is currently used for passive recreation.

h. Design and Construction History. The dam is reported to have been constructed in 1878. There was no documented evidence to support this date. There was no design or construction information available for this dam.

i. Normal Operation Procedure. The outlet works and associated conduit are kept closed. The outlet works are

reported to be exercised once every 2 to 3 years. Excess water from the lake discharges over the spillway.

1.3 PERTINENT DATA:

a. Drainage Area. The drainage area of Crystal Lake is 4.02 square miles. The watershed is forested with sparse residential development. There are no significant storage areas within the watershed.

b. Discharge at Dam Site.

1) An 18 inch conduit passing through the dam serves as the outlet. The discharge capacity of the outlet conduit under 15 feet of head is 33 CFS.

2) It is reported that water has been observed at El. 725, equivalent to 127 CFS.

3) The ungated spillway capacity at the top of dam - 1935 CFS @ El. 728.5.

4) The ungated spillway capacity at the test flood elevation - 2840 CFS @ El. 730.1.

5) The gated spillway capacity at normal pool elevation is not applicable at this dam.

6) The gated spillway capacity at test flood elevation is not applicable at this dam.

7) The total spillway capacity at test flood elevation - 2840 CFS @ El. 730.1.

8) The total project discharge at the top of dam - 1935 CFS @ El. 728.5.

9) The total project discharge at test flood elevation - 3790 @ El. 730.1.

c. Elevation. (ft. above National Geodetic Vertical Datum - NGVD)

1) Streambed at toe of dam.....692±

2) Bottom of cut-off.....N/A

3) Maximum tailwater.....N/A

4) Recreation pool.....N/A

5) Full flood control pool.....N/A

6) Spillway crest.....723±

7) Design surcharge (Original design).....Unknown

8) Top of dam.....728.5

9) Test flood design surcharge.....730.1

d. Reservoir. (Length in feet)

1) Normal pool.....700±

2) Flood control pool.....N/A

3) Spillway crest pool.....700±

4) Top of dam.....750±

5) Test flood pool.....750±

e. Storage. (acre-feet)

1) Normal pool.....30

2) Flood control pool.....N/A

3) Spillway crest pool.....30

4) Top of dam.....63

5) Test flood pool.....70

f. Reservoir Surface. (acres)

1) Normal pool.....5.5

2) Flood-control pool.....N/A

3) Spillway crest.....5.5

4) Test flood pool.....6.9

5) Top of dam.....6.6

g. Dam.

1) Type: Earth embankment with stone masonry spillway.

2) Length: 230 feet

3) Height: 36 feet

4)	Top Width:	10 feet
5)	Side Slopes:	Upstream: 2 horizontal to 1 vertical. Downstream: 1.5 horizontal to 1 vertical.
6)	Zoning:	Unknown
7)	Impervious Core:	Concrete
8)	Cut-off:	Unknown
9)	Grout curtain:	Unknown

h. Diversion and Regulating Tunnel.

1)	Type:	Not applicable
2)	Length:	Not applicable
3)	Closure:	Not applicable
4)	Access:	Not applicable
5)	Regulating Facilities:	Not applicable

i. Spillway.

1)	Type:	Broad crested stone masonry
2)	Length of weir:	50 feet
3)	Crest elevation:	723 feet
4)	Gates:	None
5)	U/S Channel:	Reservoir
6)	D/S Channel:	Stream: Boulders, cobbles, gravel.

j. Regulating Outlets.

1)	Invert:	Unknown
2)	Size:	18" diameter
3)	Description:	Asbestos cement pipe (visible material at outlet).
4)	Control Mechanism:	Valve stem and manual hand wheel.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

No engineering data has been found to provide any information about the design of Crystal Lake Dam.

2.2 CONSTRUCTION:

There are no available records of the construction or any subsequent repairs to this dam.

2.3 OPERATION:

Operation of the dam is by the Torrington Water Company. No formal records of operation are maintained for this facility.

2.4 EVALUATION:

a. Availability. No engineering information is available for this dam. Therefore, an assessment of the structural stability of the embankment cannot be made.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgement.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

a. General. Based on visual inspection, history and general appearance, the Crystal Lake Dam and its appurtenances are judged to be in fair condition. The dam is an earthen embankment, with a 50 foot long central stone masonry spillway section. A slight undulation at the crest of the dam near the left (north) abutment was noted. A vehicular access road is also located in this vicinity on the crest of the dam. Some erosion of the downstream slope to the right of the spillway section was observed and erosion has occurred adjacent to the spillway training walls. No unusual embankment or downstream seepage was noted. Large trees are growing along the downstream slope of the dam. The stone masonry spillway is in generally fair condition; however, several of the stone blocks have been displaced.

b. Dam.

1) Upstream Face - The upstream face of the dam is covered with grass, brush, and several trees (see Photo No. 1). There are many tree stumps on the upstream face. The stump shown in Photo No. 13 appears to have been cut by beavers. Due to the extensive vegetation, it was difficult to examine the upstream face of the dam. No riprap was present on the upstream face.

2) Crest - The crest is covered with vegetation, as indicated in Photo No. 3 and Photo No. 5. A portion of the concrete core wall was exposed on the left (north) side of the dam (see Photo No. 11). An area on the crest has been worn bare as a result of trespassing and vehicular traffic, as indicated in Photo No. 3.

3) Downstream Face - The downstream face is comprised of an earthen embankment on both sides of the central spillway.

The downstream slope on the left (north) side of the dam is covered by grass and patches of brush, as indicated in Photo No. 7 and Photo No. 8. Some erosion and slumping of the surface has taken place on a portion of the slope. Several animal holes were observed on the downstream slope near the toe of the dam. One of these animal holes is approximately 7.5 in. diam. and 7 in. deep.

Several large trees are growing at or near the toe of the slope in the vicinity of the left (north) abutment, as evidenced in Photo No. 12.

Downstream of the left side of the dam is an asphalt walkway which borders the spillway channel, as indicated in Photo No. 6. At this location the spillway walls are comprised of cut stone masonry blocks with open joints. It appears several of the stones have fallen into the channel.

The downstream face of the right side of the dam is sparsely covered with vegetation, as indicated in Photo No. 2. Some erosion of the embankment has occurred adjacent to the right spillway training wall.

4) Spillway - The visible portions of the stone spillway are in good condition (Photo No. 4) with no significant faults. The left (north) side of the spillway's face was not visible due to the discharge over it. The stone and mortar spillway training walls are in good condition, as indicated in Photo No. 6 and Photo No. 9.

The approach to the spillway is directly from the reservoir, and was clear and free of debris.

c. Appurtenant Structures. There is an 18 inch diameter conduit under the north side of the dam. The valve stem was observed at the top of the dam (see Photo No. 5) north of the spillway. The conduit's outlet is through a stone wall on the downstream side of the dam. Some deterioration of the pipe was noted. The blow off is reported to be opened and exercised about once every two to three years.

d. Reservoir. The perimeter of the reservoir has moderate slopes that are well wooded and stable. There is no evidence of slides or sloughing (Photo No. 15). The upstream end of the reservoir has significant sediment deposits that are projecting above the water level. The exposed sediments support a reed and shrub vegetation. The size of the reservoir appears to be smaller than indicated on the U.S.G.S. quadrangle map.

e. Downstream Channel. The channel has a typical width of 15 feet and normal flow depth of 1 to 2 feet. It is a natural channel with wooded banks. The stream bed is composed of cobbles and boulders, with some exposed bedrock (Photo No. 14). The channel is neither aggrading or degrading.

f. Footbridge. The metal truss footbridge over the channel just downstream of the dam has a wood deck and is in good condition, as indicated in Photo No. 10.

3.2 EVALUATION:

On the basis of the results of the visual inspection, Crystal Lake Dam is considered to be in fair condition.

Trees growing on the upstream slope, on the downstream slope near the left abutment, and in the area downstream of the toe of the dam may cause serious seepage or erosion problems if they blow over and pull out their roots, or if they die or are cut and their roots rot. An animal burrow in the dam could become a focus for seepage and erosion which would endanger the dam if not controlled. The erosion adjacent to the spillway retaining walls could lead to breaching of the dam if remedial action is not taken.

The lack of riprap on the upstream slope could result in wave erosion of the upstream face.

The displaced stone masonry wall in the left side of the spillway channel just downstream from the toe of the dam could lead to long-term erosion problems if remedial action is not taken.

SECTION 4 - OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 OPERATIONAL PROCEDURES:

a. General. The water level in Crystal Lake can be controlled by an 18 inch low level outlet.

b. Description of any Warning System in Effect. There is no warning system of any kind in effect at the dam. There are no formal emergency operation plans in effect for lowering the water level in anticipation of severe storms.

4.2 MAINTENANCE PROCEDURES:

a. General. Maintenance of the dam appears to be generally lacking.

b. Operating Facilities. There are no formal maintenance procedures followed for the operating facilities.

4.3 EVALUATION:

Regular operational maintenance for this dam and its appurtenances have not been developed or implemented.

An emergency action plan should be prepared to prevent or minimize the impact of failure. This plan should list the expedient action to be taken and authorities to be contacted.

SECTION 5 - EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 GENERAL:

The Crystal Lake Dam is an earth embankment with a centrally located 50 foot wide stone masonry spillway. The spillway acts as a broad crested weir, and has a sloping approach face with a 4' wide, flat crest. The maximum spillway capacity is 1935 CFS at a stage of 5.5 feet. At stages above 5.5 feet the dam would be overtopped. The blow off consists of an 18" diameter conduit under the east side of the dam.

The watershed area is 4.02 square miles, and is characterized by rolling upland terrain that is well wooded. The land use within the watershed is mixed rural residential and forest land. The central business area of the City of Torrington is located about 2 miles downstream of the dam. The watershed upstream of this dam does not include any significant impoundments or natural water storage areas.

5.2 DESIGN DATA:

There is no known data available on the original design of the dam.

5.3 EXPERIENCE DATA:

The only information available on past flood experience and flood stages at the dam is that the maximum known spillway flow depth was about 2.0 feet, based on interview with operating personnel.

5.4 TEST FLOOD ANALYSIS:

The test flood for determining the spillway adequacy is based upon COE guidelines. The size classification of the dam is "small," based upon a height of 36 feet and storage volume of 63 acre-feet. The hazard potential is "high," due to intense land use downstream of the dam. The spillway test flood required by COE guidelines for this size dam and hazard potential can range from the ½ probable maximum flood to the probable maximum flood.

The spillway test flood selected for this project is the ½ PMF, due to the small volume of water stored in the impoundment.

The magnitude of the PMF (and thence the ½ PMF spillway test flood) is based upon "Preliminary Guidance for Estimating PMF Discharges" by the New England Division, Corps of Engineers, dated December, 1977. The watershed is rolling, and has no significant floodwater storage areas in impoundments. The ½ PMF, Spillway Test flood inflow is 3,820 CFS.

The spillway test flood inflow was formed into a triangular hydrograph with a peak of 3,820 CFS and a duration of 12.0 hours. The duration was selected so that the triangular hydrograph would contain the same volume of water as the estimated storm runoff.

The hydrograph was routed through the reservoir using a computer program based on stage-storage and stage-discharge data. The initial water level was assumed to be at El. 723.0 (spillway crest). The discharge flows are based upon a spillway coefficient of 3.0 and a length of 50 feet.

The results of the Flood Routing Procedure indicate that the spillway test flood inflow of 3,820 CFS would produce a spillway test flood outflow rate of 3,790 CFS. The small reservoir only has a minor flood storage capacity and does not significantly alter the peak spillway outflow rate.

The maximum flood stage at the spillway is at elevation 730.1 which is 1.6 feet above the crest of the earth embankment. The crest of the earth embankment would be overtopped for a period of about six hours, and the possibility exists that the embankment could be eroded and destroyed during the spillway test flood. The spillway can pass 51 percent of the spillway test flood outflow without overtopping.

5.5 DAM FAILURE ANALYSIS:

The downstream impact of a dam failure was analyzed using the COE "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs" dated April 1978.

Based upon an assumed breach width equal to 40% of the dam's width at mid-height, the peak flood flow leaving the dam would be 16,452 CFS, with an initial depth of 8.6 feet downstream of the dam. The flood flow rate diminishes as the flow moves downstream, due to an increasingly broad valley and the low storage volume in the reservoir.

The areas of probable impact include Connecticut State Highway Routes 4 and 272, plus urban and residential properties near Nickel Mine Brook. The number of dwellings in the probable initial impact area is about 9, with additional structures

farther downstream (over one mile) in the City of Torrington. The depth of flooding is estimated to be about 5 feet ½ mile downstream of the dam. This represents an increase in stage of 4.5 feet over prefailure conditions.

High value industrial and commercial properties are located approximately two miles downstream of the dam, in an area where the flood wave will be unsteady due to numerous cross road bridges, embankments, and a small dam on the West Branch of the Naugatuck River. Dam failure would result in the potential for the loss of more than a few lives and excessive economic losses and therefore the dam is classified as having a high hazard potential.

SECTION 6 - EVALUATION OF STRUCTURAL STABILITY

6.1 VISUAL OBSERVATIONS:

The visual observations did not disclose any immediate stability problems. However, several problems were observed, which, if allowed to continue, could lead to instability of the dam in the future. These are:

a. Erosion of the upstream and downstream slopes adjacent to the spillway wingwalls.

b. Erosion of the downstream toe of slope along the left side of the dam adjacent to the spillway channel.

6.2 DESIGN AND CONSTRUCTION DATA:

No design and construction data are available for this dam. Thus the assessment of stability is based only on the visual inspection.

6.3 POST-CONSTRUCTION CHANGES:

No information is available on post-construction changes insofar as they are pertinent to the embankment or foundations.

6.4 SEISMIC STABILITY

Crystal Lake Dam is located in Seismic Zone 1 and, in accordance with the recommended Phase I guidelines, does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

a. Condition. On the basis of the visual inspection, the dam is judged to be in fair condition and functioning adequately. Features that can affect the long-term performance of the dam are the lack of riprap on the upstream face of the dam, erosion adjacent to the spillway wing wall, and deterioration of the spillway training walls downstream from the toe of the dam.

The capacity of the spillway is inadequate to pass the ½ PMF test flood outflow of 3,790 CFS without overtopping the dam. The test flood would overtop the dam by about 1.6 ft. The spillway can pass 51 percent of the test flood outflow without overtopping the dam.

b. Adequacy of Information. The information available was very limited, and thus the assessment of the condition of the dam is based primarily on the visual inspection, past operational performance of the structure and sound engineering judgement.

c. Urgency. The recommendations presented in Sections 7.2 and 7.3 should be carried out within one year of receipt of this Phase I inspection report by the owner.

7.2 RECOMMENDATIONS:

The following recommendations should be carried out under the directions of a qualified registered engineer:

a. The need for filter layers and riprap on the upstream face of the embankment should be evaluated and a protection system designed and installed, as required.

b. The trees and stumps on the embankment and at the toe of the slope should be removed and root zones should be back-filled with carefully selected soils.

c. The erosion at the toe of the slope adjacent to the spillway channel along the left side of the dam should be investigated and corrective measures should be designed and constructed, as required.

d. The erosion adjacent to the spillway wingwall on the upstream and downstream slopes of the embankment should be investigated and backfilled with suitable material.

e. Conduct detailed hydraulics and hydrology studies to determine the need for and methods of increasing the discharge capacity of the project.

7.3 REMEDIAL MEASURES:

a. Operation and Maintenance Procedures.

1) Brush and trees within 25 ft. of the downstream toe of the dam should be removed.

2) A regular program of valve operation should be established to ensure continued operation of the blow off.

3) Repair displaced masonry blocks in spillway training wall.

4) Fill in all animal burrows with suitable backfill.

5) Engage a qualified registered engineer to make a comprehensive inspection of the dam once a year.

6) Establish a formal surveillance program for use during and immediately after heavy rainfall and also a flood warning plan to follow in case of floodflow conditions or imminent dam failure.

7.4 ALTERNATIVES:

There are no practical alternatives to the recommendations contained in Sections 7.2 and 7.3.

APPENDIX A

INSPECTION CHECK LIST

INSPECTION CHECK LIST

PARTY ORGANIZATION

PROJECT Crystal Lake Dam **DATE** Oct. 24, 1979

TIME 1400

WEATHER Clear 50° F

W.S. ELEV. ____ **U.S.** ____ **DN.S.**

PARTY:

1. R. Smith, FGA, Project Manager
2. J. MacBroom, FGA, Hydraulics/Hydrology
3. R. Murdock, GEI, Geotechnical
4.
5.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Crystal Lake Dam DATE: Oct. 24, 1979

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	None
Pavement Condition	Worn path, slight undulation of surface near the left abutment.
Movement or Settlement of Crest	None Observed
Lateral Movement	None Observed
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Erosion adjacent to spillway wingwall, vehicular road adjacent to left abutment.
Indications of Movement of Structural Items on Slopes	None
Trespassing on Slopes	Vehicular road near left abutment
Sloughing or Erosion of Slopes or Abutments	Some erosion of downstream slopes along right side of dam.
Rock Slope Protection - Riprap Failures	No riprap
Unusual Movement or Cracking at or near Toes	None
Unusual Embankment or Downstream Seepage	None
Piping or Boils	No
Foundation Drainage Features	None
Toe Drains	None
Instrumentation System	None
Vegetation	Large trees and stumps along the upstream face of the dam.

PERIODIC INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Crystal Lake Dam DATE: Oct. 24, 1979

AREA EVALUATED	CONDITIONS
DIKE EMBANKMENT	Not applicable
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	
Vegetation	

PERIODIC INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Crystal Lake Dam DATE: Oct. 24, 1979

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	Not applicable
a. Approach Channel	
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Crystal Lake Dam DATE: Oct. 24, 1979

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	Not applicable
a. Concrete and Structural	
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System in Gate Chamber	

PERIODIC INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Crystal Lake Dam DATE: Oct. 24, 1979

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	Not applicable
General Condition of Concrete	
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Crystal Lake Dam DATE: Oct. 24, 1979

AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	Not applicable
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain Holes	
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	

PERIODIC INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Crystal Lake Dam **DATE:** Oct. 24, 1979

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	Underwater
General Condition	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Approach Channel	
b. Weir and Training Walls	
General Condition of Concrete	
Rust or Staining	
Spalling	
Any Visible Reinforcing	
Any Seepage or Efflorescence	
Drain Holes	None
c. Discharge Channel	
General Condition	Fair condition
Loose Rock Overhanging Channel	Large boulder on right side of channel
Trees Overhanging Channel	Large trees on both sides of the channel
Floor of Channel	Bedrock and boulders
Other Obstructions	

PERIODIC INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Crystal Lake Dam DATE: Oct. 24, 1979

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE	
a. Superstructure	Steel truss, wooden deck in generally good condition
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	Good condition
Expansion Joints	Good condition, minor rusting
Paint	
b. Abutment & Piers	
General Condition of Concrete	Dry stone masonry, in fair condition
Alignment of Abutment	
Approach to Bridge	
Condition of Seat and Backwall	

APPENDIX B

ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Crystal Lake Dam

I.D. NO. CT-00097

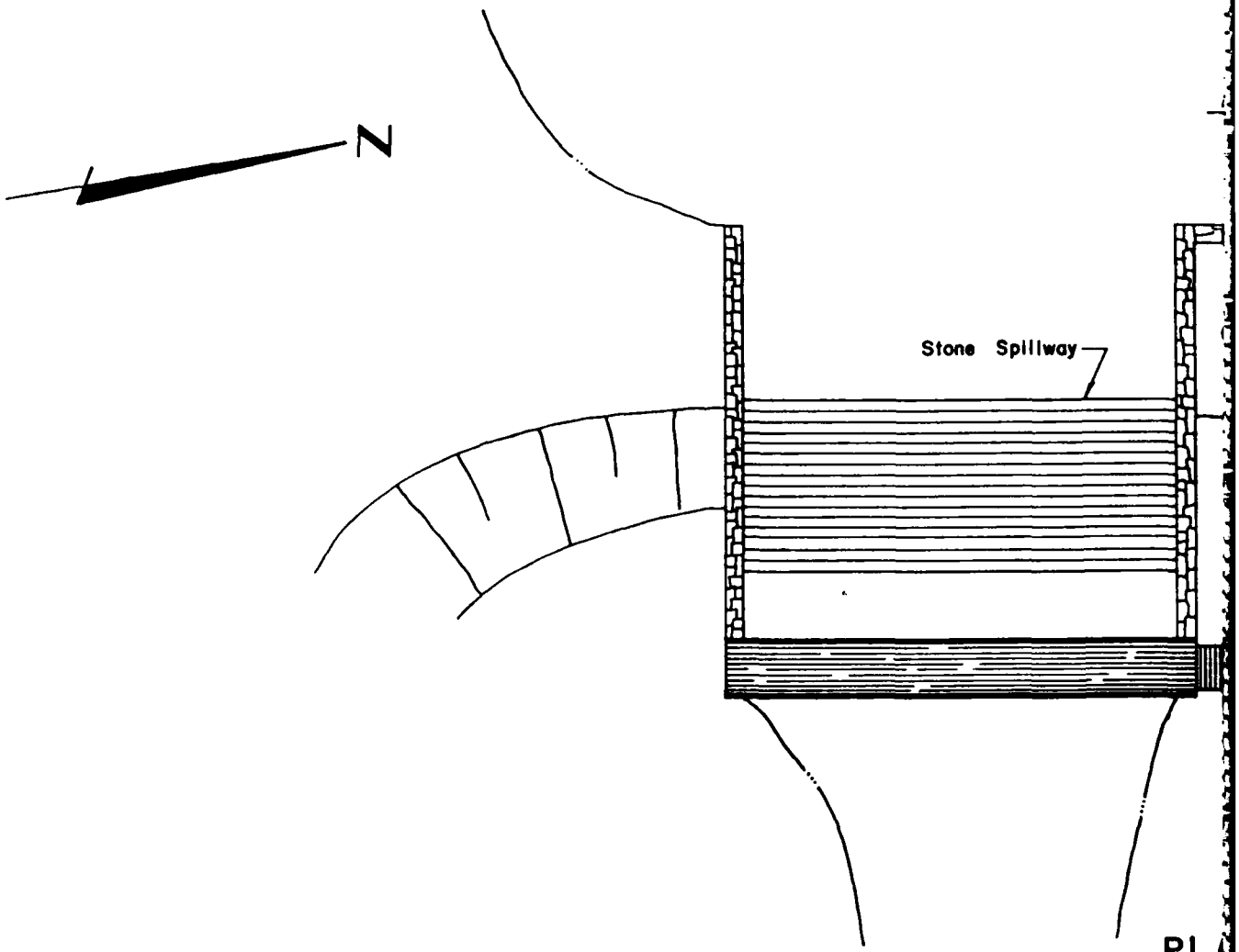
ITEM	REMARKS
AS-BUILT DRAWINGS	None available
REGIONAL VICINITY MAP	Available from U.S.G.S.
CONSTRUCTION HISTORY	None available
TYPICAL SECTIONS OF DAM	Field measurements
OUTLETS - Plan	Not available
- Details	Not available
- Constraints	Unknown
- Discharge Ratings	None available
RAINFALL/RESERVOIR RECORDS	Unavailable
DESIGN REPORTS	None
GEOLOGY REPORTS	None
DESIGN COMPUTATIONS	
HYDROLOGY & HYDRAULICS	None
DAM STABILITY	None
SEEPAGE STUDIES	None
MATERIALS INVESTIGATIONS	
BORINGS RECORDS	None
LABORATORY	None
FIELD	None

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Crystal Lake Dam

I.D. NO. CT - 00097

ITEM	REMARKS
POST-CONSTRUCTION SURVEYS OF DAM	None
BORROW SOURCES	Unknown
MONITORING SYSTEMS	None
MODIFICATIONS	Unknown
HIGH POOL RECORDS	None available
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION	Unknown
REPORTS	None
MAINTENANCE OPERATION RECORDS	None
SPILLWAY PLAN	
SECTIONS	Field Measurements
DETAILS	None
OPERATING EQUIPMENT PLANS & DETAILS	Unknown



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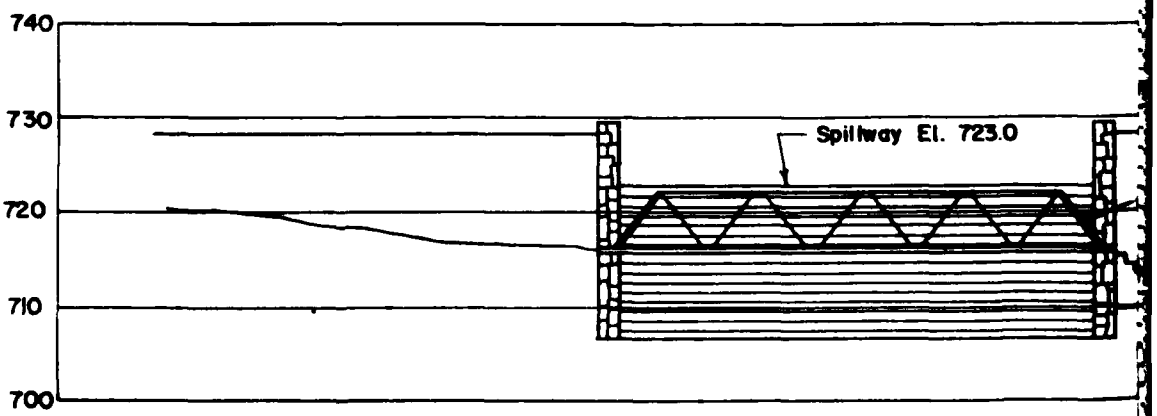
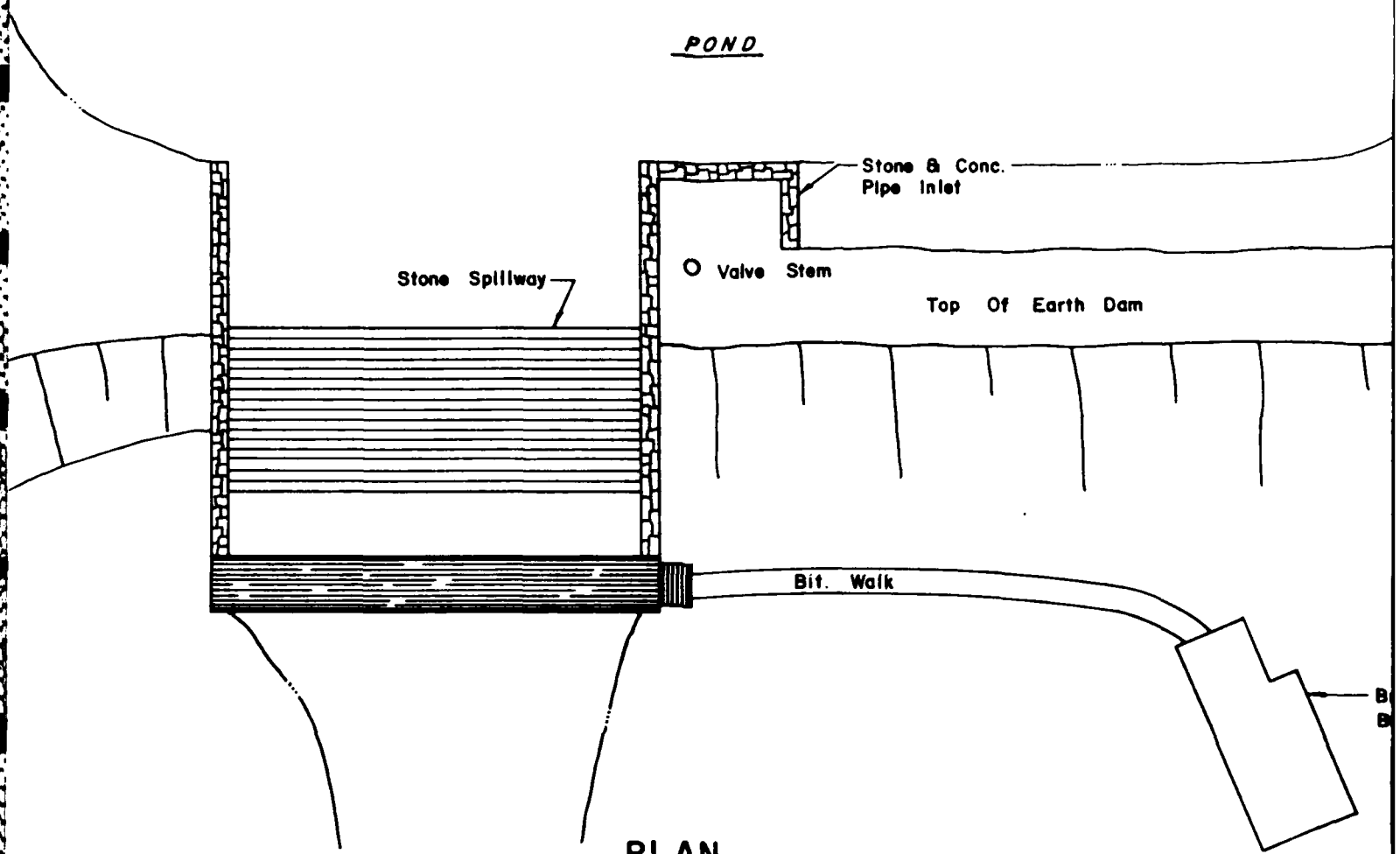
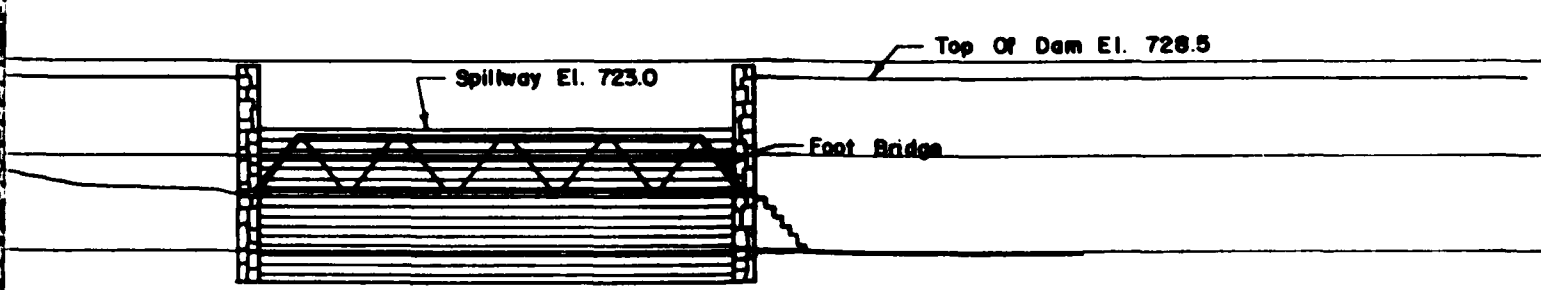


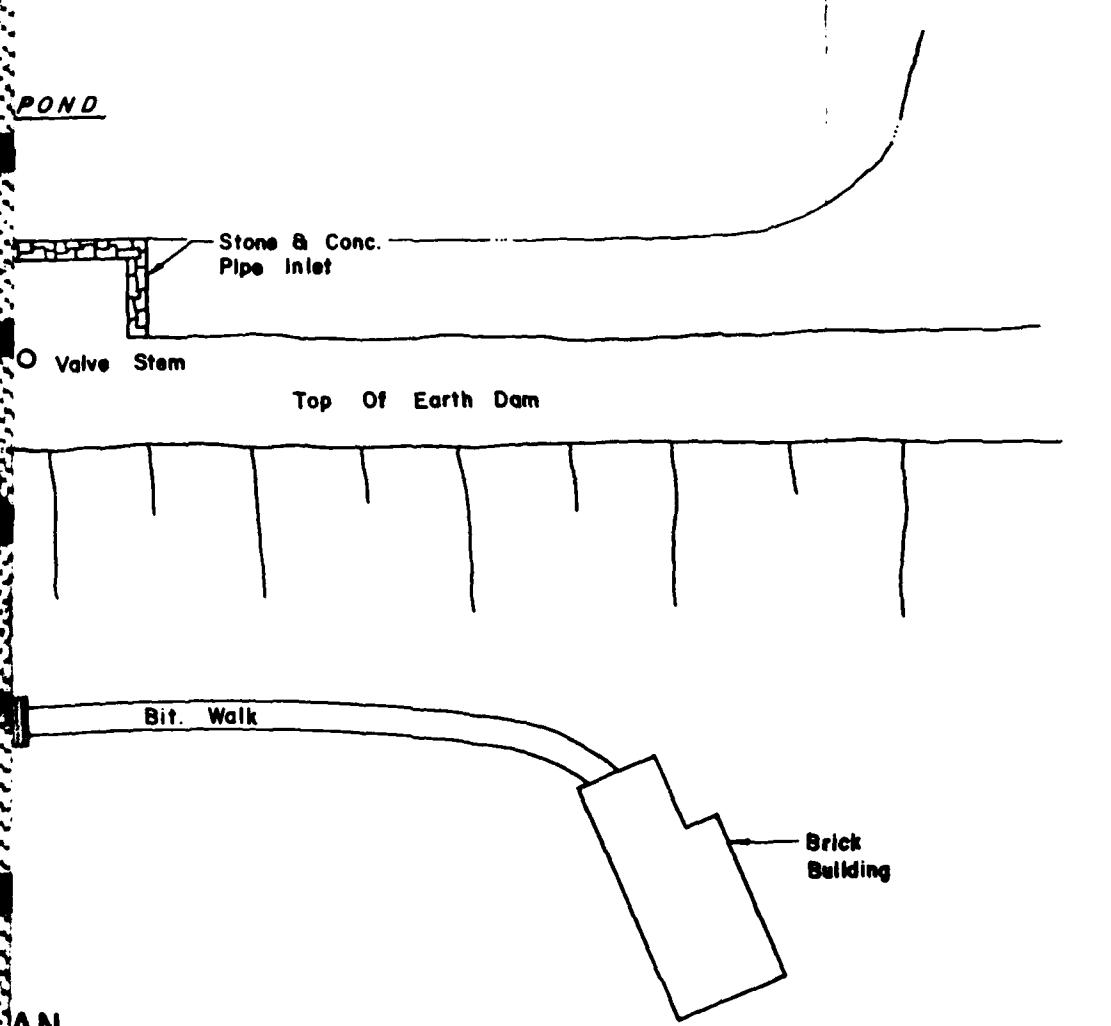
PROFIL
NTS



PLAN
NTS



PROFILE
NTS



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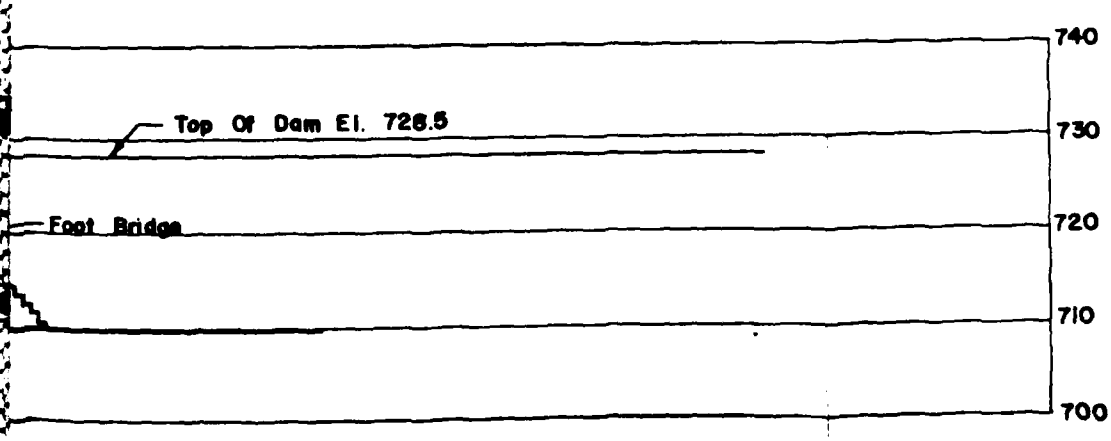


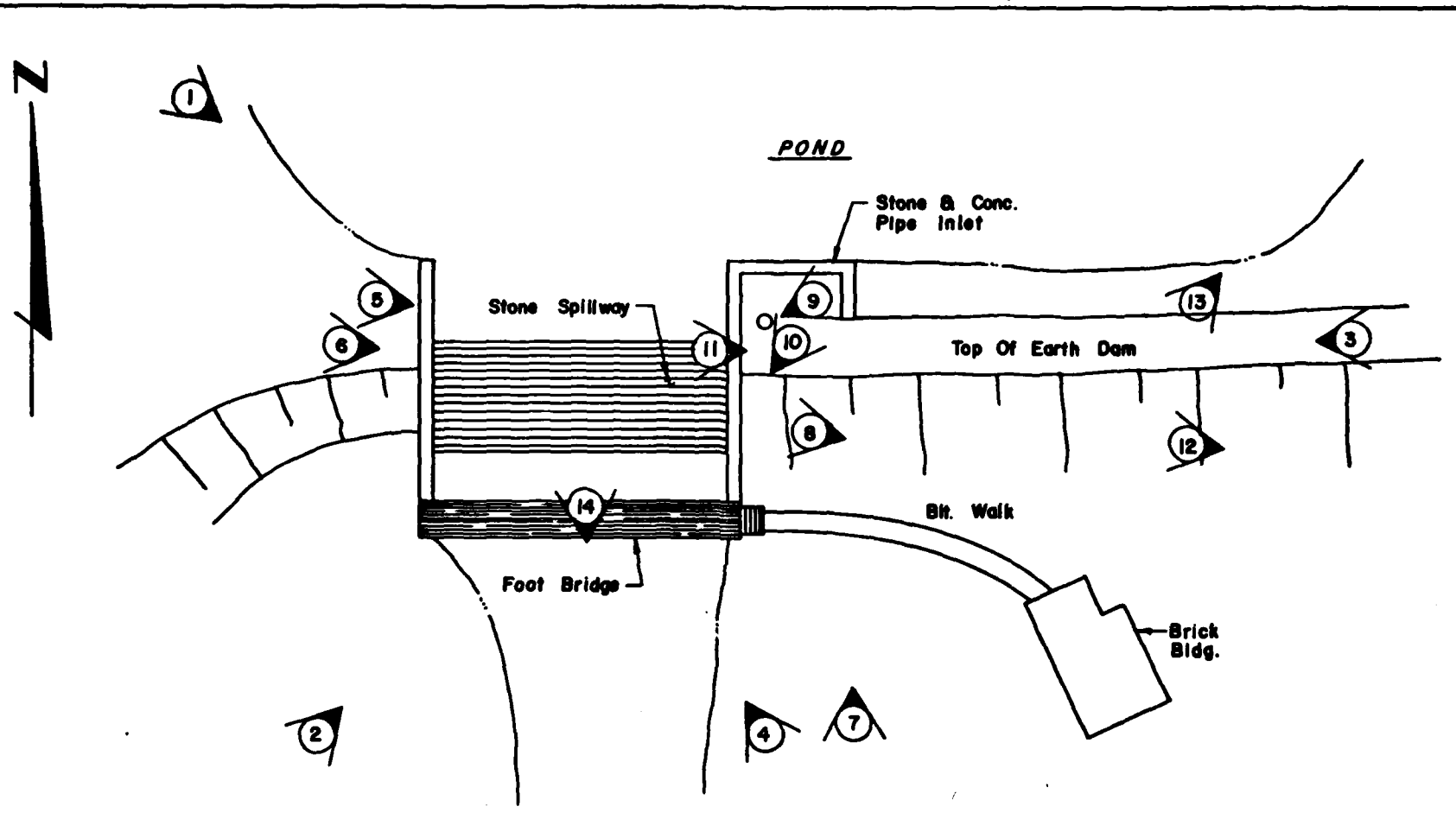
E

CRYSTAL LAKE DAM

3

APPENDIX C

PHOTOGRAPHS



LEGEND

5 Number refers to caption. Arrow indicates direction of photograph.

CRYSTAL LAKE DAM

PHOTO LOCATION MAP

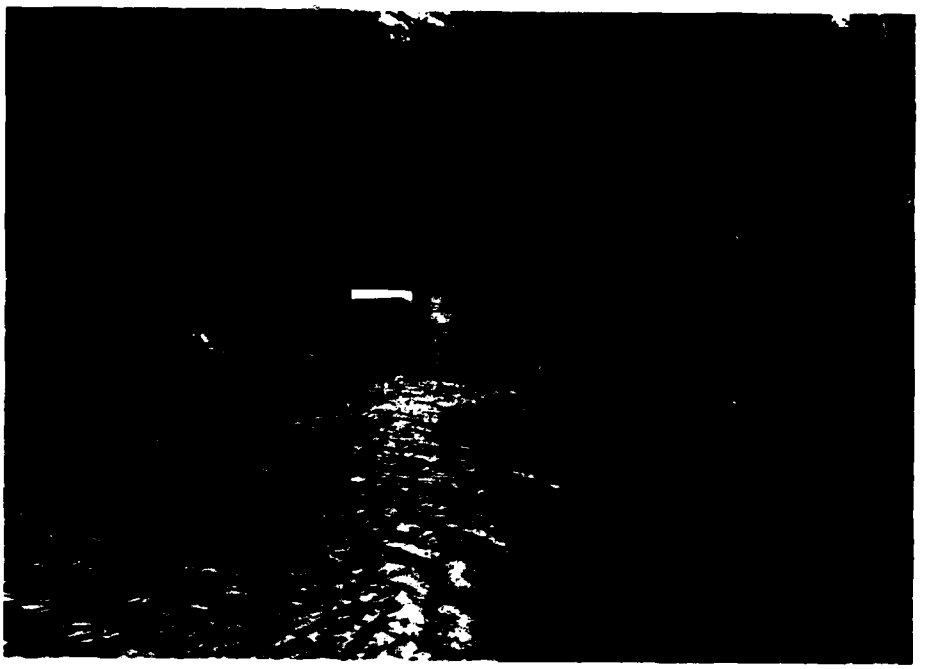


PHOTO #1: Upstream face of dam from right (south) side, looking toward spillway approach.

PHOTO #2: Downstream face of dam from right (south) side.

PHOTO #3: Crest of dam from left (north) abutment.

PHOTO #4: Spillway and service bridge.

PHOTO #5: Crest of dam, looking toward left (north) abutment.

PHOTO #6: Crest and downstream face.

PHOTO #7: Downstream face of dam, spillway channel in foreground.

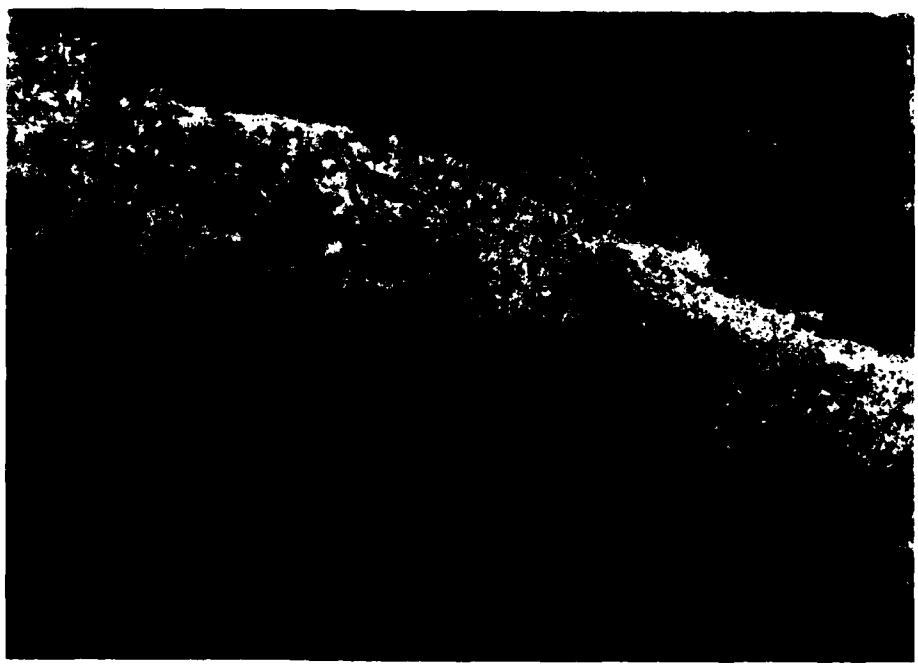


PHOTO #8: Downstream face of dam.

PHOTO #9: Right (south) spillway training wall.

PHOTO #10: Spillway channel. Note ledge at bottom.

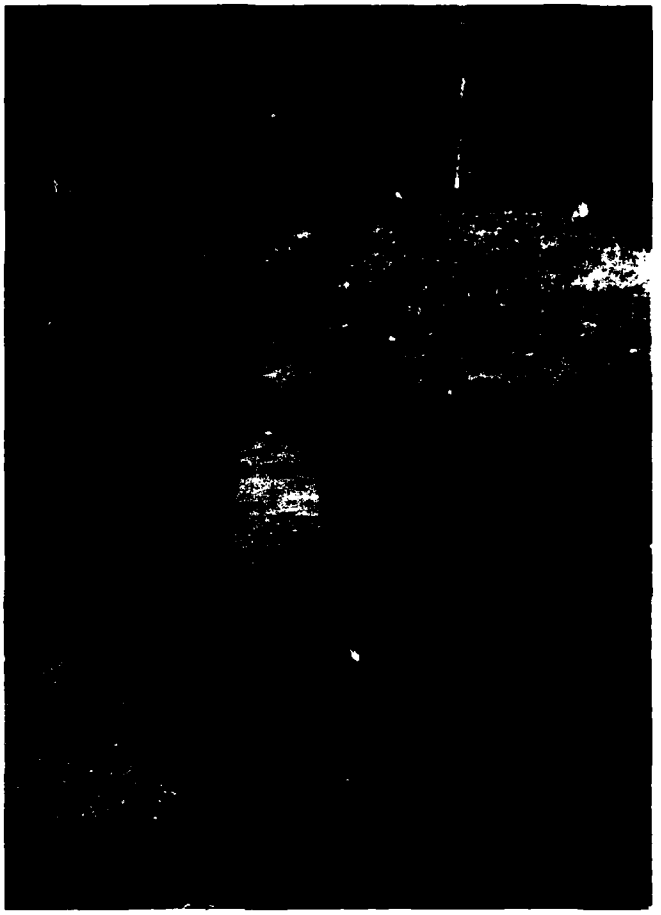


PHOTO #11: Crest of dam, looking toward left (north) abutment. Note concrete cove wall.

PHOTO #12: Left (north) abutment.

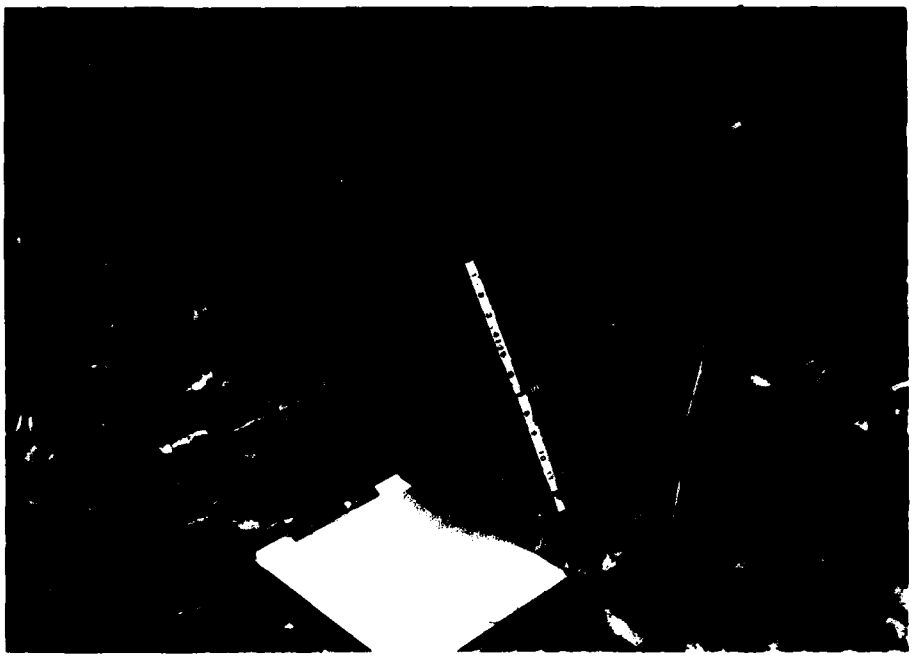


PHOTO #13: 8-in. dia. stump on upstream face; beaver cut.

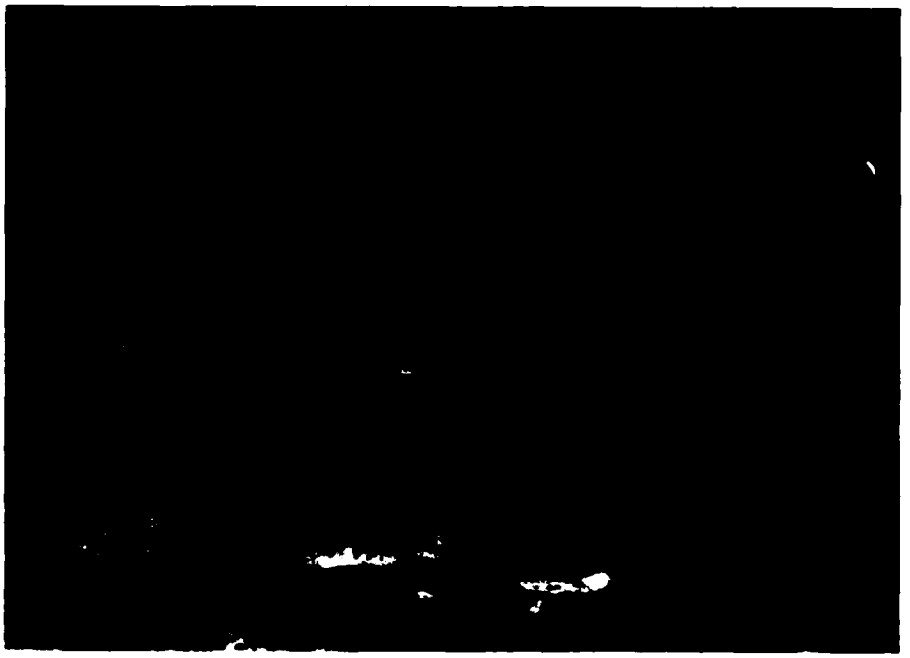


PHOTO #14: Spillway channel from service bridge.

PHOTO #15: Reservoir Area.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

JOB CRYSTAL LAKE DAM
HARRINGTON

FLAHERTY-GIAVARA ASSOCIATES
ENVIRONMENTAL DESIGN CONSULTANTS
ONE COLUMBUS PLAZA, NEW HAVEN, CONN 06510/203/789-1260

SHEET NO. 1 OF
BY DRS DATE 11-30-79
CHK'D. BY RAC DATE 1-21-80

DETERMINATION OF SPILLWAY TEST FLOOD

A. SIZE CLASSIFICATION

Storage Volume (Ac.-Ft.)	63
Height of Dam (Ft.)	36
Size Classification	SMALL

B. HAZARD POTENTIAL CLASSIFICATION

Category	Loss of Life	Economic Loss
Low	None expected	Minimal
Significant	Few	Appreciable
High	More than few	Excessive

Hazard Classification: HIGH

C. HYDROLOGIC EVALUATION GUIDELINES

Hazard	Size	Spillway Test Flood
Low	Small	50 to 100-Year Frequency
	Intermediate	100-Year Frequency to 1/2 PMF
	Large	1/2 PMF to PMF
Significant	Small	100-Year Frequency to 1/2 PMF
	Intermediate	1/2 PMF to PMF
	Large	PMF
High	Small	1/2 PMF to PMF
	Intermediate	PMF
	Large	PMF

Spillway Test Flood: 1/2 PMF

*Based upon "Recommended Guidelines for Safety Inspection of Dams" Department of the Army, Office of the Chief of Engineers, November 1976.

FLAHERTY-GIAVARA ASSOCIATES
ENVIRONMENTAL DESIGN CONSULTANTS
ONE COLUMBUS PLAZA, NEW HAVEN, CONN. 06510/203/789-1260

DETERMINATION OF THE

MAXIMUM PROBABLE FLOOD (MPF)

A. Drainage Area in Square Miles 9.02

B. Watershed Characteristic: Flat & Coastal

(Rolling)

Moutainous

C. M.P.F. in CFS/Square Mile,* 1900

M.P.F. = (CFS/Square Mile) x (Area in Square Miles)

1900 x 9.02 = 7638

½ PMF = ½ (7638) = 3819 CFS

*Based upon the figure "Maximum Probable Flood Peak Flow Rates" U.S. Army Corps of Engineers, December 1977.

FLAHERTY-GIAVARA ASSOCIATES
ENVIRONMENTAL DESIGN CONSULTANTS
ONE COLUMBUS PLAZA, NEW HAVEN, CONN. 06510/203/789-1260

THE PMP RAINFALL IS 23.5 INCHES FOR A 6 HR DURATION, 24 HR STORM. USING A 20% FACTOR FOR IMPERFECT FIT, THE EFFECTIVE RAINFALL IS 18.8 INCHES (SEE FIG. 15, DESIGN OF SMALL DAMS).

RUNOFF

BASED ON AN ASSUMED CN VALUE OF 80 (FOR GLACIAL TILL SOILS), RUNOFF THE PMF IS 17.0 INCHES (FIG. A-9 "DESIGN OF SMALL DAMS).

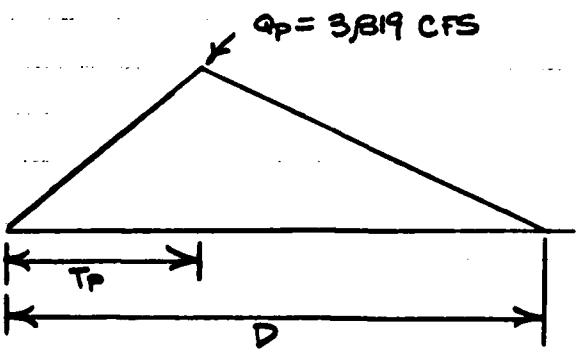
SPILLWAY TEST FLOOD RUNOFF = 1/2 (17in) = 8.5 in.

VOLUMN OF RUNOFF = $(8.5''/12''/FT)(4.02\ mi.^2)(640\ AC/mi.^2)$ =

= 1822 AC-FT

HYDROGRAPH

A TRIANGULAR HYDROGRAPH IS TO BE USED FOR THE ROUTING OF THE TEST FLOOD THROUGH THE RESERVOIR. PEAK FLOW EQUALS 3819 CFS, SET DURATION OF RUNOFF SO AS TO CONTAIN VOLUMN OF RUNOFF, AND RECEEDING LIMB EQUALS TWICE THE RISING LIMB.



$VOL = 1822\ AC\text{-}FT = \frac{1}{2} Q_p D \qquad D = \frac{1822\ AC\text{-}FT}{0.5(3819\ CFS)} =$

$$= \frac{(1822)(43560\ ft^2/AC)}{0.5(3819\ CFS)(60\ SEC/MIN)(60\ MIN/HR)} = 11.5\ HRS$$

SAY T_p = 4.0 HOURS , D = 12.0 HOURS

FLAHERTY-GIAVARA ASSOCIATES
ENVIRONMENTAL DESIGN CONSULTANTS
ONE COLUMBUS PLAZA, NEW HAVEN, CONN 06510/203/789-1260

FROM INFLOW TRIANGULAR HYDROGRAPH

Q_p = 3,819 CFS
T_p = 4.0 HRS
D = 12.0 HRS.

TIME (HRS)	INFLOW (CFS)
0	0
1	954
2	1909
3	2864
4	3819
5	3341
6	2864
7	2386
8	1909
9	1432
10	954
11	477
12	0

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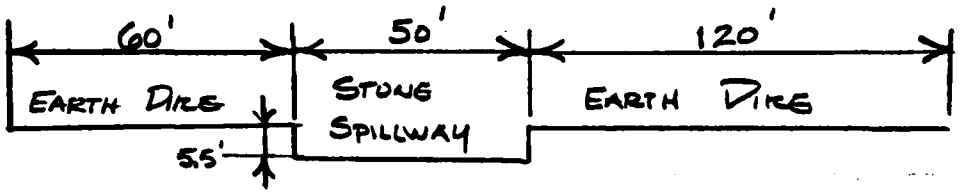
ENVIRONMENTAL DESIGN CONSULTANTS
ONE COLUMBUS PLAZA, NEW HAVEN, CONN. 06510/203/789-1260

SPILLWAY AND OVERFLOW SECTION DATA

N.T.S.



SEGMENT	ITEM	C	LENGTH	ELEV.
1	EARTH DIKE	2.5	60'	728.5
2	STONE SPILLWAY	3.0	50'	723.0
3	EARTH DIKE	2.5	120	728.5

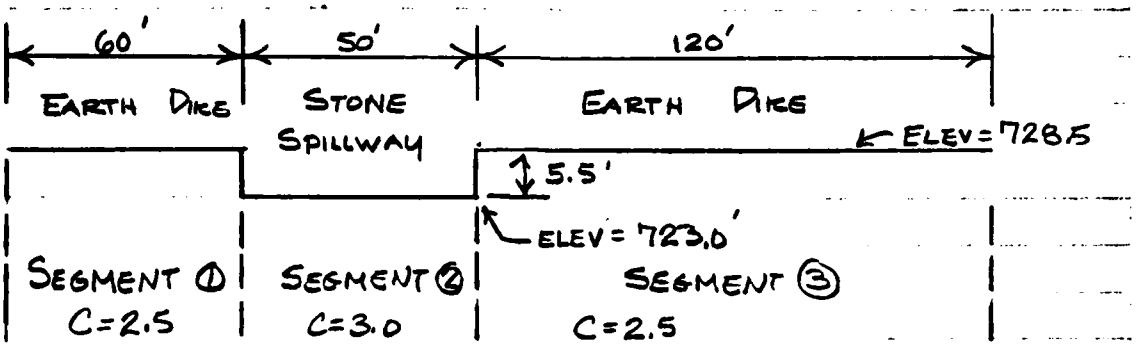
IE = 723.0 IV = 0.0 E = 723 A = 5.5 E = 740 A = 9.0

PROJECT CRYSTAL LAKE DAM
TORRINGTON

FLAHERTY-GIAVARA ASSOCIATES
ENVIRONMENTAL DESIGN CONSULTANTS
ONE COLUMBUS PLAZA, NEW HAVEN, CONN. 06510/203/789-1260

SHEET NO. 6 OF
BY RAC DATE 1-22-9
CHK'D. BY JGM DATE

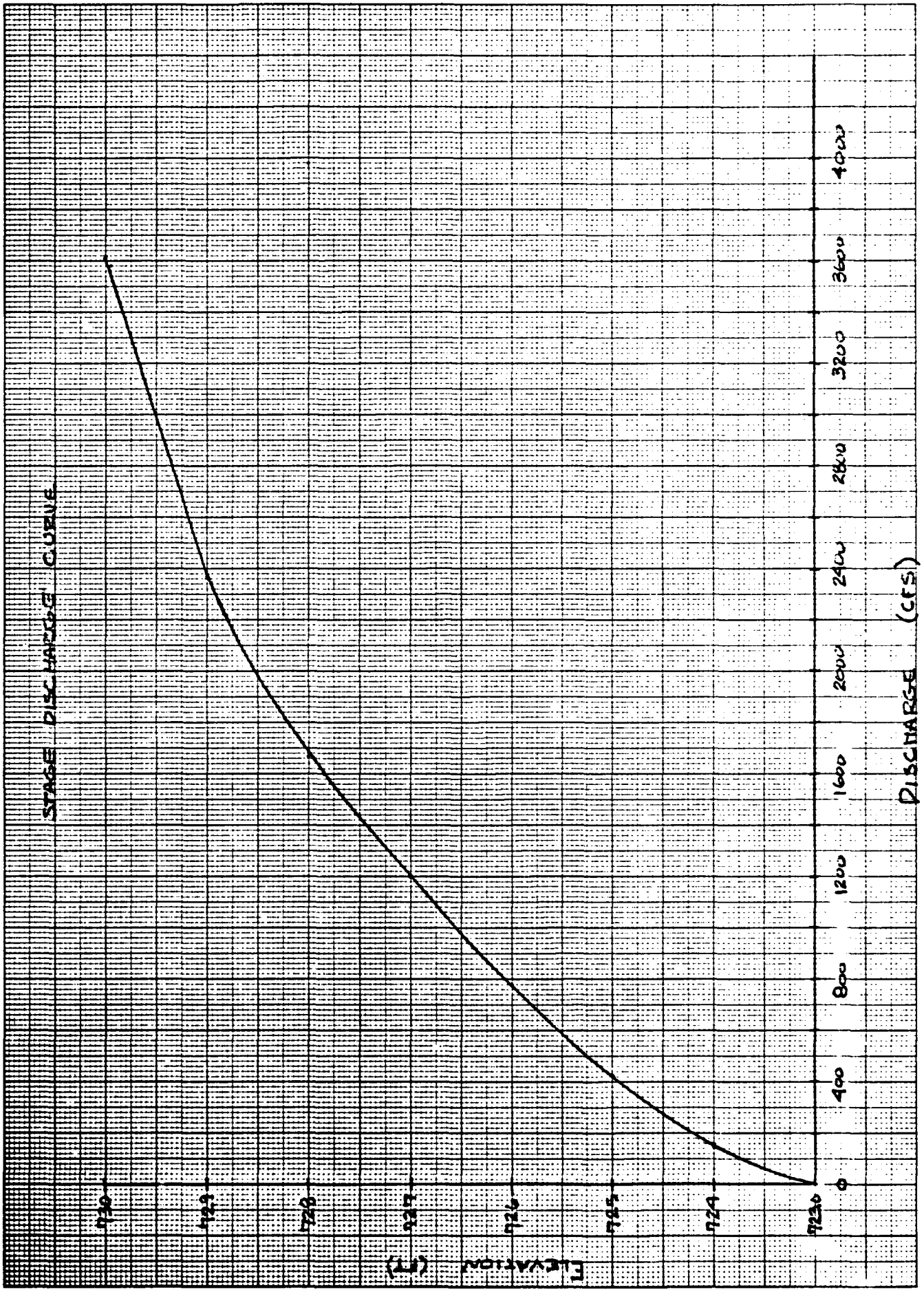
STAGE DISCHARGE DATA



ELEV	724	725	726	727	728	729	730
$Q_1 = C_1 L_1 H_1^{3/2}$						53	276
$Q_2 = C_2 L_2 H_2^{3/2}$	150	424	779	1200	1677	2205	2778
$Q_3 = C_3 L_3 H_3^{3/2}$						106	551
TOTAL	150	424	779	1200	1677	2369	3605

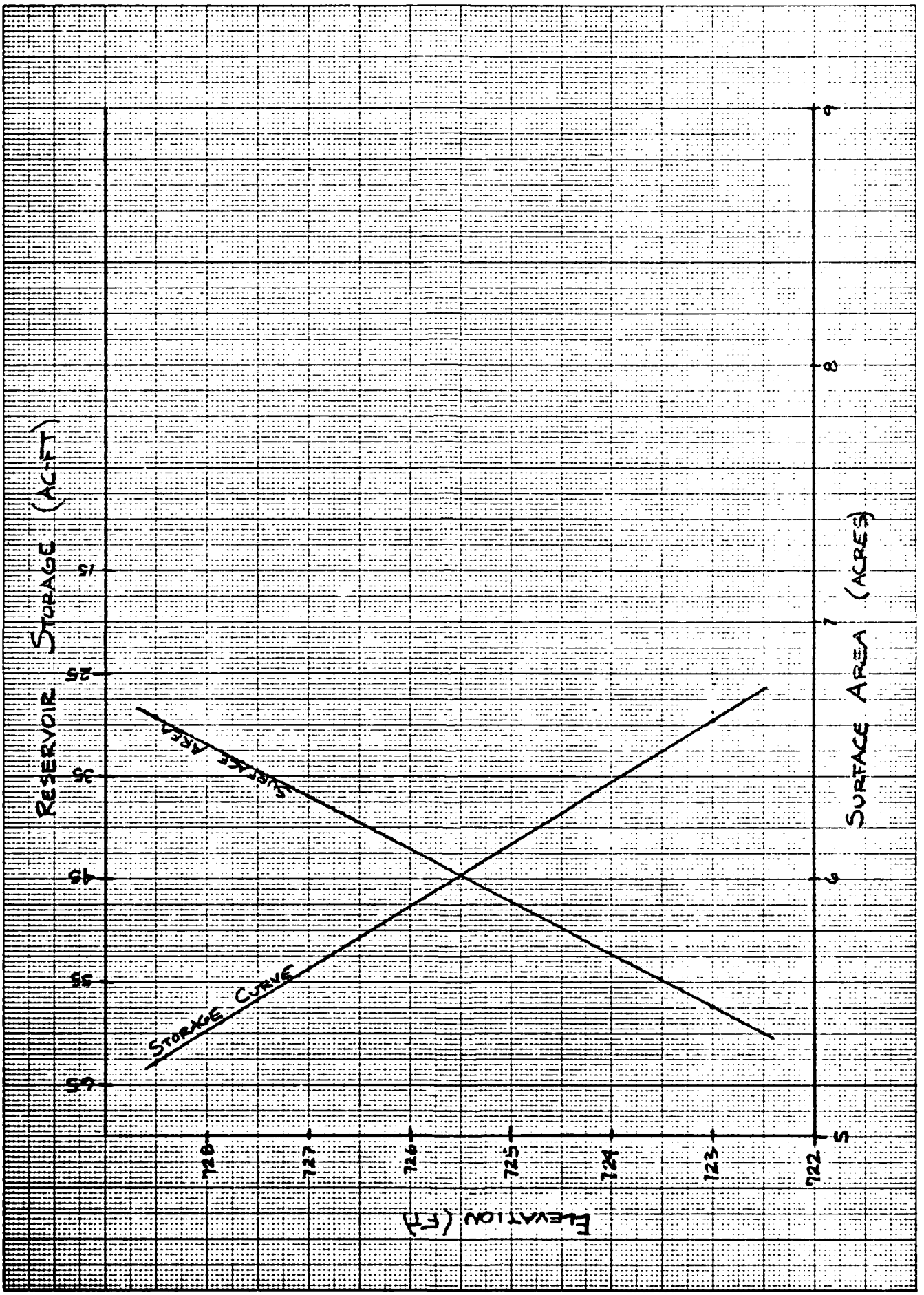
CRYSTAL LAKE DAM

RAC 1-22-80
PB 2-11-80



CRYSTAL LAKE DAM

RAC 2-8-80
PB 2-11-80



CRYSTAL LAKE DAM799010 FLOOD ROUTING RAC JAN. 22, 1980

INPUT DATA: UNSUBMERGED WEIR
SEGMENT 1 DISCHARGE COEFFICIENT = 2.5 LENGTH OF WEIR = 60 ELEVATION OF WEIR = 728.5
SEGMENT 2 DISCHARGE COEFFICIENT = 3 LENGTH OF WEIR = 50 ELEVATION OF WEIR = 723
SEGMENT 3 DISCHARGE COEFFICIENT = 2.5 LENGTH OF WEIR = 120 ELEVATION OF WEIR = 728.5
IE=723.0 IV= 0.0 E=723.0 A= 5.50 E=740.0 A= 9.00

HOUR	INFLOW	MASS INFLOW	WATER EL.	TAIL WATER	OUTFLOW	MASS OUTFLOW	STORAGE(R)	STORAGE(A)
0.00	0CFS	0.00AC-F	723.00FT	.00FT	0CFS	0.00AC-F	0.00AC-F	0.00AC-F
0.00	0CFS	0.00AC-F	723.00FT	0.00FT	0CFS	0.00AC-F	0.00AC-F	0.00AC-F
1.00	954CFS	39.42AC-F	725.52FT	0.00FT	601CFS	24.87AC-F	14.54AC-F	14.54AC-F
2.00	1,909CFS	157.72AC-F	728.31FT	0.00FT	1,835CFS	125.61AC-F	32.11AC-F	32.11AC-F
3.00	2,864CFS	354.95AC-F	729.36FT	0.00FT	2,766CFS	315.80AC-F	39.15AC-F	39.15AC-F
4.00	3,819CFS	631.11AC-F	730.12FT	0.00FT	3,788CFS	586.68AC-F	44.43AC-F	44.43AC-F
5.00	3,341CFS	926.98AC-F	729.86FT	0.00FT	3,415CFS	884.37AC-F	42.60AC-F	42.60AC-F
6.00	2,864CFS	1,183.38AC-F	729.43FT	0.00FT	2,860CFS	1,143.70AC-F	39.68AC-F	39.68AC-F
7.00	2,386CFS	1,400.33AC-F	729.08FT	0.00FT	2,448CFS	1,363.07AC-F	37.25AC-F	37.25AC-F
8.00	1,909CFS	1,577.80AC-F	728.50FT	0.00FT	1,939CFS	1,544.39AC-F	33.41AC-F	33.41AC-F
9.00	1,432CFS	1,715.86AC-F	727.70FT	0.00FT	1,529CFS	1,687.72AC-F	28.13AC-F	28.13AC-F
10.00	954CFS	1,814.46AC-F	726.60FT	0.00FT	1,025CFS	1,793.31AC-F	21.14AC-F	21.14AC-F
11.00	477CFS	1,873.59AC-F	725.45FT	0.00FT	575CFS	1,859.49AC-F	14.10AC-F	14.10AC-F
12.00	0CFS	1,893.30AC-F	723.87FT	0.00FT	123CFS	1,888.39AC-F	4.91AC-F	4.91AC-F

CRYSTAL LAKE DAM 799010 RAC APRIL 11, 1980

FGA FLOOD WAVE ROUTING

APPROXIMATE FLOOD WAVE ROUTING BASED UPON U.S. ARMY CORPS OF ENGINEERS' "RULE OF THUMB GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS" DATED APRIL, 1978.

INITIAL STATION = 0 40
INITIAL BASE FLOW = 1,935 CFS
INITIAL WAVE HEIGHT = 36.0 FT.
ASSUMED BREACH WIDTH = 40.0 FT
INITIAL RESERVOIR STORAGE = 63 ACRE-FT
COMPUTED FLOOD WAVE PEAK FLOW = 14,517 CFS
TOTAL FLOOD WAVE PEAK FLOW = 16,452CFS

STATION 0+90

OFFSET	ELEV.	OFFSET	ELEV.	OFFSET	ELEV.
		N = 0.070			
-570.0 FT	760.0 FT	-200.0 FT	750.0 FT	-80.0 FT	710.0 FT
-12.0 FT	710.0 FT	-8.0 FT	707.0 FT	8.0 FT	707.0 FT
12.0 FT	710.0 FT	70.0 FT	710.0 FT	130.0 FT	730.0 FT
190.0 FT	740.0 FT	210.0 FT	750.0 FT	250.0 FT	760.0 FT
530.0 FT	770.0 FT				

AREA	WETTED PERIMETER	N	VELOCITY	FLOW
1,003.5 SF	187.7 FT	0.070	15.8 FPS	15,953CFS

INVERT	DEPTH	W. SURFACE	AREA	VELOCITY	FLOW	SLOPE
707.0 FT	8.6 FT	715.6 FT	1,003 SF	15.8 FPS	15,953 CFS	0.0600

BASE FLOW = 1,935 CFS BASE STAGE = 711.3 FT.

STATION 4+60

OFFSET	ELEV.	OFFSET	ELEV.	OFFSET	ELEV.
		N = 0.070			
-350.0 FT	750.0 FT	-210.0 FT	740.0 FT	-20.0 FT	700.0 FT
-12.0 FT	688.0 FT	-8.0 FT	685.0 FT	8.0 FT	685.0 FT
12.0 FT	688.0 FT	50.0 FT	700.0 FT	180.0 FT	750.0 FT
230.0 FT	770.0 FT				

AREA	WETTED PERIMETER	N	VELOCITY	FLOW
699.1 SF	88.0 FT	0.070	20.5 FPS	14,347CFS

INVERT	DEPTH	W. SURFACE	AREA	VELOCITY	FLOW	SLOPE
685.0 FT	16.0 FT	701.0 FT	699 SF	20.5 FPS	14,347 CFS	0.0590

BASE FLOW = 1,935 CFS BASE STAGE = 691.1 FT.

STATION 10 +0

OFFSET	ELEV.	OFFSET	ELEV.	OFFSET	ELEV.
		N = 0.070			
-680.0 FT	700.0 FT	-500.0 FT	670.0 FT	-100.0 FT	660.0 FT
-12.0 FT	650.0 FT	-8.0 FT	647.0 FT	8.0 FT	647.0 FT
12.0 FT	650.0 FT	50.0 FT	650.0 FT	110.0 FT	660.0 FT
500.0 FT	670.0 FT	610.0 FT	680.0 FT	860.0 FT	700.0 FT

AREA	WETTED PERIMETER	N	VELOCITY	FLOW
761.0 SF	159.7 FT	0.070	15.9 FPS	12,103CFS

INVERT	DEPTH	W. SURFACE	AREA	VELOCITY	FLOW	SLOPE
647.0 FT	9.4 FT	656.4 FT	761 SF	15.9 FPS	12,103 CFS	0.0700

BASE FLOW = 1,935 CFS BASE STAGE = 651.8 FT.

STATION 15 +0

OFFSET	ELEV.	OFFSET	ELEV.	OFFSET	ELEV.
		N = 0.070			
-1220.0 FT	680.0 FT	-1050.0 FT	670.0 FT	-970.0 FT	660.0 FT
-610.0 FT	650.0 FT	-150.0 FT	650.0 FT	-40.0 FT	640.0 FT
-12.0 FT	639.0 FT	-8.0 FT	636.0 FT	8.0 FT	636.0 FT
12.0 FT	639.0 FT	70.0 FT	640.0 FT	220.0 FT	650.0 FT
340.0 FT	680.0 FT				

AREA	WETTED PERIMETER	N	VELOCITY	FLOW
1,110.5 SF	253.9 FT	0.070	8.4 FPS	9,350CFS

INVERT	DEPTH	W. SURFACE	AREA	VELOCITY	FLOW	SLOPE
636.0 FT	9.4 FT	645.4 FT	1,110 SF	8.4 FPS	9,350 CFS	0.0220

BASE FLOW = 1,935 CFS BASE STAGE = 641.7 FT.

STATION 20 +0

OFFSET	ELEV.	OFFSET	ELEV.	OFFSET	ELEV.
		N = 0.070			
-550.0 FT	650.0 FT	-270.0 FT	640.0 FT	-12.0 FT	631.0 FT
-8.0 FT	629.0 FT	8.0 FT	629.0 FT	12.0 FT	631.0 FT
100.0 FT	650.0 FT	450.0 FT	700.0 FT		

AREA	WETTED PERIMETER	N	VELOCITY	FLOW
1,121.3 SF	271.2 FT	0.070	6.4 FPS	7,254CFS

INVERT	DEPTH	W. SURFACE	AREA	VELOCITY	FLOW	SLOPE
629.0 FT	9.3 FT	638.3 FT	1,121 SF	6.4 FPS	7,254 CFS	0.0140

BASE FLOW = 1,935 CFS BASE STAGE = 635.0 FT.

STATION 26 +0

OFFSET	ELEV.	OFFSET	ELEV.	OFFSET	ELEV.
		N = 0.070			
-500.0 FT	650.0 FT	-450.0 FT	640.0 FT	-35.0 FT	630.0 FT
-12.0 FT	627.0 FT	-8.0 FT	625.0 FT	8.0 FT	625.0 FT
12.0 FT	627.0 FT	200.0 FT	630.0 FT	480.0 FT	640.0 FT
550.0 FT	650.0 FT				

AREA	WETTED PERIMETER	N	VELOCITY	FLOW
1,306.2 SF	422.2 FT	0.070	3.7 FPS	4,925CFS

INVERT	DEPTH	W. SURFACE	AREA	VELOCITY	FLOW	SLOPE
625.0 FT	7.6 FT	632.6 FT	1,306 SF	3.7 FPS	4,925 CFS	0.0070

BASE FLOW = 1,935 CFS BASE STAGE = 630.8 FT.

STATION 36 +0

OFFSET	ELEV.	OFFSET	ELEV.	OFFSET	ELEV.
		N = 0.070			
-220.0 FT	650.0 FT	-30.0 FT	630.0 FT	-20.0 FT	620.0 FT
-12.0 FT	617.0 FT	-8.0 FT	615.0 FT	8.0 FT	615.0 FT
12.0 FT	617.0 FT	90.0 FT	620.0 FT	700.0 FT	630.0 FT
800.0 FT	650.0 FT				

AREA	WETTED PERIMETER	N	VELOCITY	FLOW
790.3 SF	285.9 FT	0.070	4.1 FPS	3,304CFS

INVERT	DEPTH	W. SURFACE	AREA	VELOCITY	FLOW	SLOPE
615.0 FT	7.7 FT	622.7 FT	790 SF	4.1 FPS	3,304 CFS	0.0100

BASE FLOW = 1,935 CFS BASE STAGE = 621.6 FT.

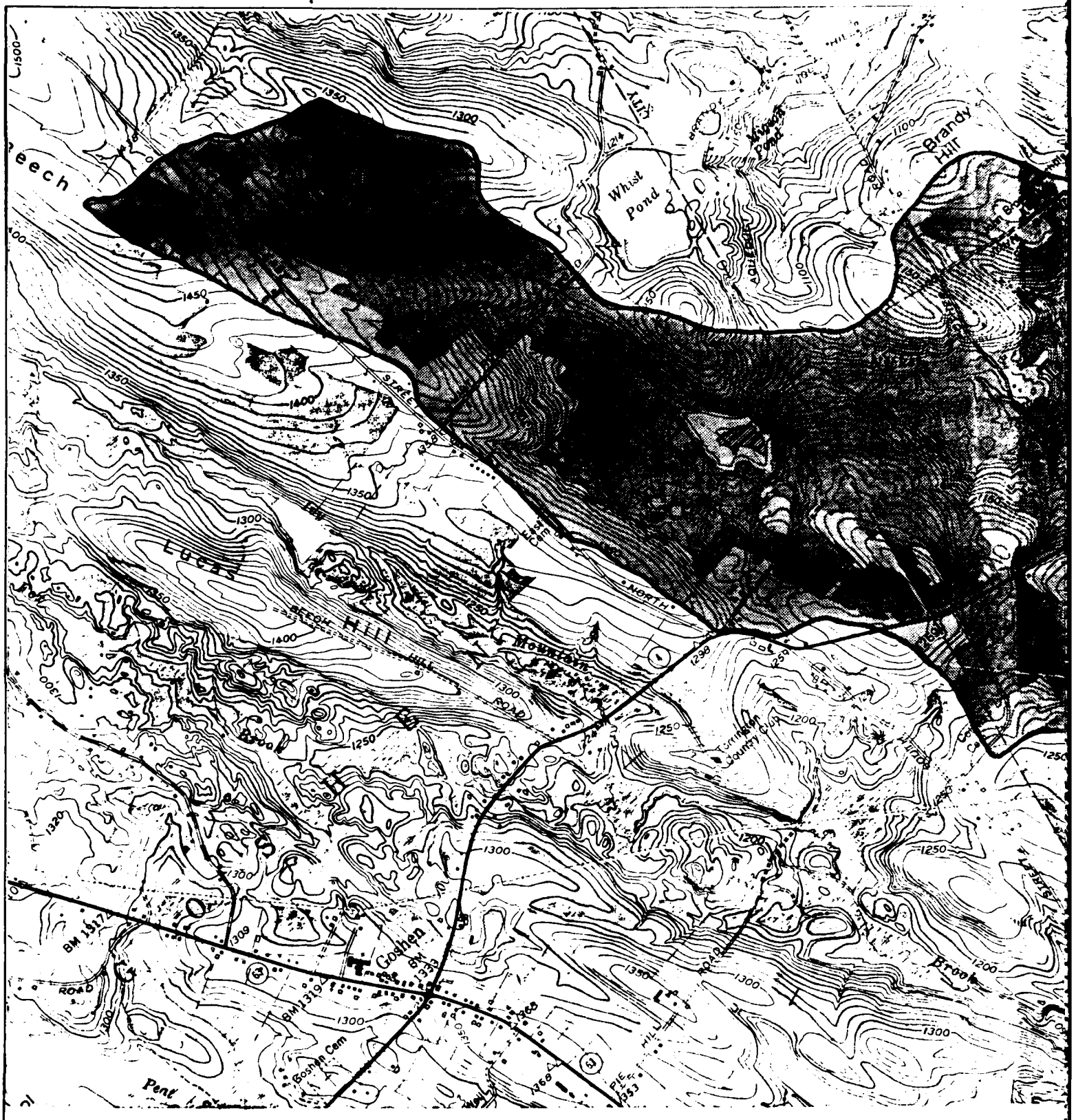
STATION 45+50

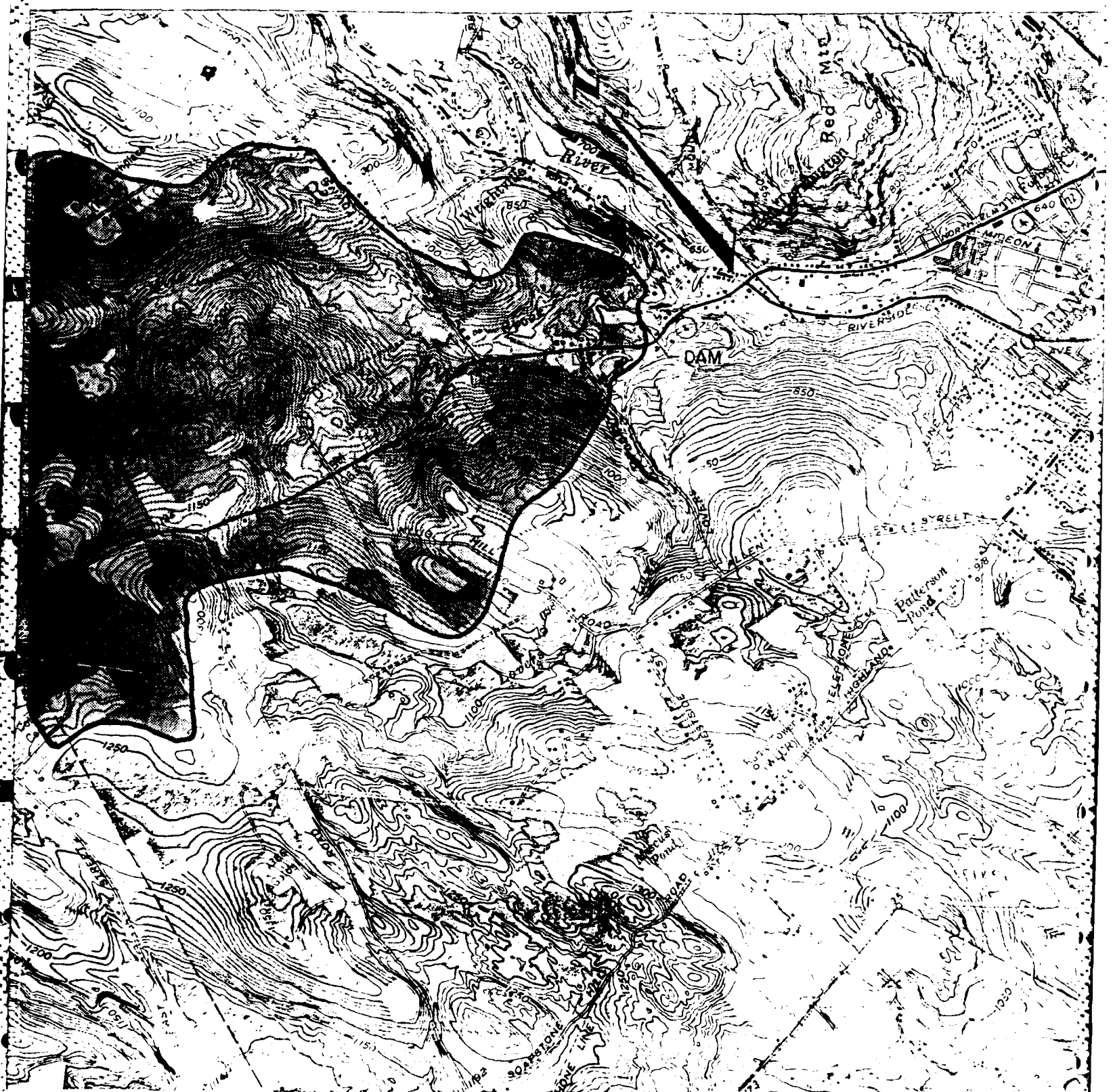
OFFSET	ELEV.	OFFSET	ELEV.	OFFSET	ELEV.
		N = 0.070			
-250.0 FT	650.0 FT	-70.0 FT	620.0 FT	-20.0 FT	610.0 FT
-12.0 FT	607.0 FT	-8.0 FT	605.0 FT	8.0 FT	605.0 FT
12.0 FT	607.0 FT	30.0 FT	610.0 FT	250.0 FT	620.0 FT
450.0 FT	630.0 FT	550.0 FT	650.0 FT		

AREA	WETTED PERIMETER	N	VELOCITY	FLOW
522.6 SF	152.4 FT	0.070	5.0 FPS	2,646CFS

INVERT	DEPTH	W. SURFACE	AREA	VELOCITY	FLOW	SLOPE
605.0 FT	8.7 FT	613.7 FT	522 SF	5.0 FPS	2,646 CFS	0.0110

BASE FLOW = 1,935 CFS BASE STAGE = 612.8 FT.


Whist Pond
Brandy Hill
Mountain
ROAD
Goshen
Brook
SCALE IN FEET
2000 1000 0 2000

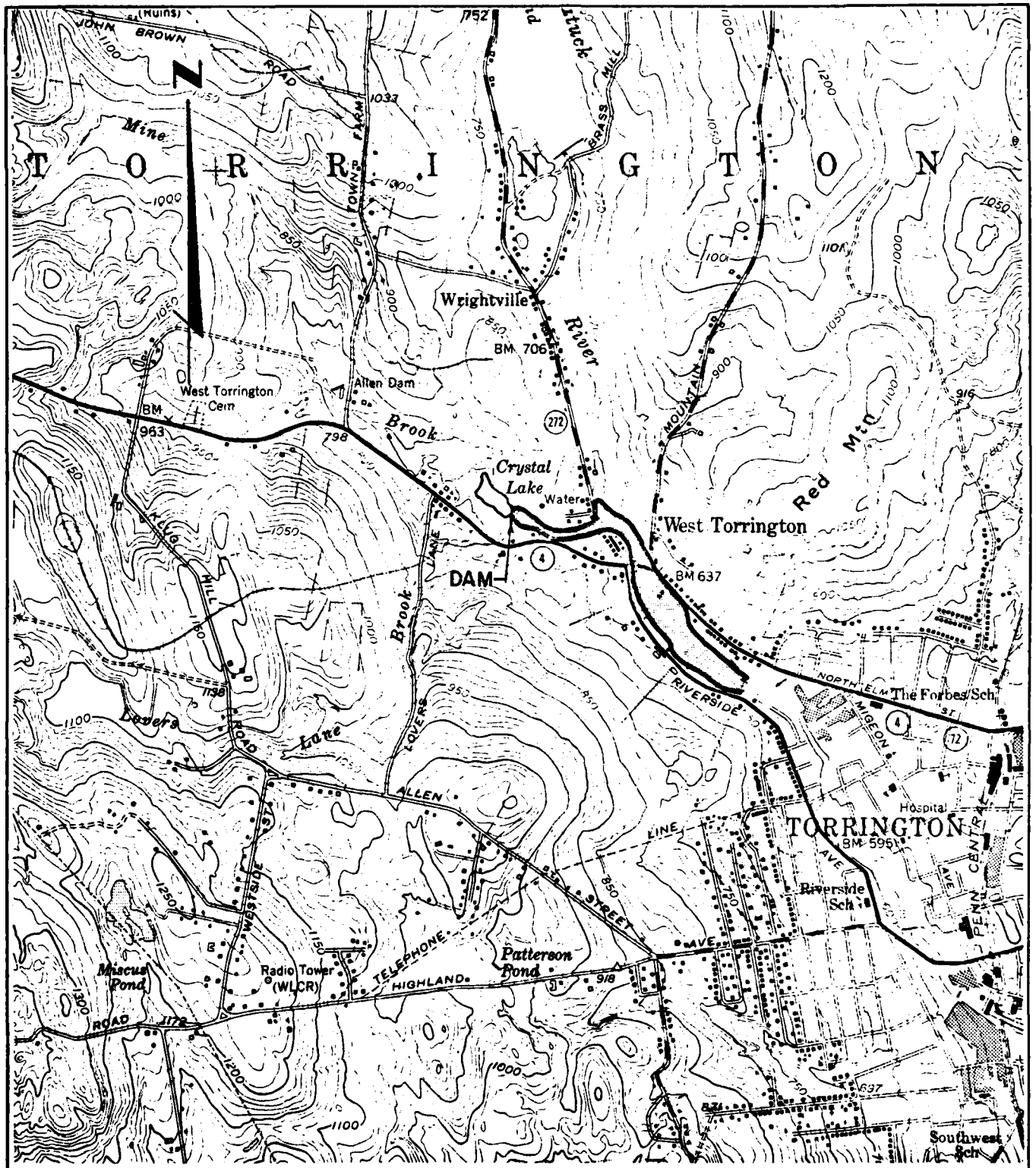


CRYSTAL LAKE DAM

DRAINAGE MAP

TORRINGTON , CONNECTICUT

FLAHERTY • GIAVARA ASSOCIATES P.C.



IMPACT AREA

SCALE IN FEET

2000 1000 0. 2000

CRYSTAL LAKE DAM
DAM FAILURE ANALYSIS
IMPACT AREAS
TORRINGTON, CONNECTICUT

FLAHERTY • GIAVARA ASSOCIATES, P.C.

D-19

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME