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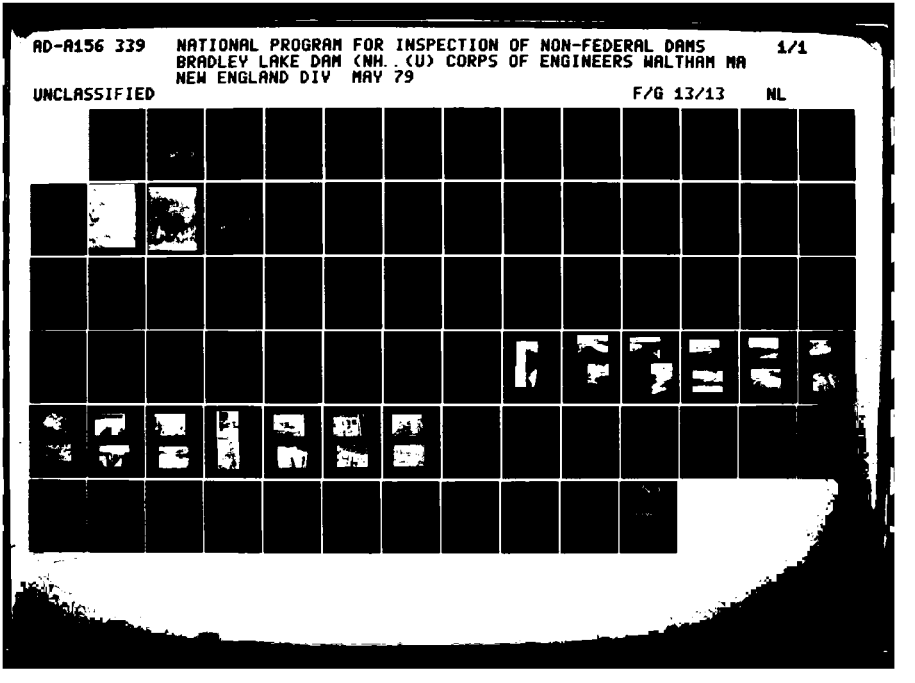

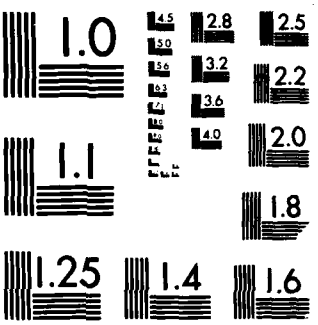

MERRIMACK RIVER BASIN

ANDOVER NEW HAMPSHIRE

BRADLEY LAKE DAM

NH 00034

NHWRB NO.8.02

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

MAY 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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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,

Merrimack River Basin
Andover, New Hampshire
Hameshop Brook

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

The dam is an earthen embankment structure, with a total length of 340 ft. and a maximum height of 19 ft. The dam is in fair condition. The inspection revealed that severe erosion in several areas of the upstream face of the dam was occurring, and a large slide area was noted to the left of the spillway. It is intermediate in size with a significant hazard classification.

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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

SEP 17 1979

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

I am forwarding to you a copy of the Bradley Lake 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 Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Town of Andover, Andover, New Hampshire.

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 Water Resources Board for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

BRADLEY LAKE DAM

NH 00034

NHWRB No. 802

MERRIMACK RIVER BASIN
ANDOVER, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LETTER OF TRANSMITTAL

FROM THE CORPS OF ENGINEERS TO THE STATE

TO BE SUPPLIED BY THE CORPS OF ENGINEERS

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No.:	00034
Name of Dam:	Bradley Lake Dam
Town:	Andover
County and State:	Merrimack, New Hampshire
Stream:	Hameshop Brook
Date of Inspection:	April 20, 1979

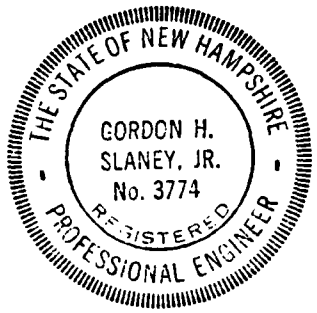
Bradley Lake Dam is an earthen embankment structure, with a total length of 340 feet and a maximum height of 19 feet. The dam was originally constructed in 1896 and the spillway and portions of the dam were reconstructed in about 1956. Engineering data available consisted of a set of plans dated September 1956, which show a plan of the dam and the spillway details. No construction plans or design calculations were available.

The visual inspection indicated that the dam is in generally fair condition. The inspection revealed that severe erosion in several areas of the upstream face of the dam was occurring, and a large slide area was noted to the left of the spillway. Also, visual inspection revealed erosion of bare soil on the crest of the dam, trees and brush growing on the dam and in the downstream channel.

Based on the dam's intermediate size and significant hazard classification in accordance with Corps of Engineers guidelines, the test flood is one half the Probable Maximum Flood (PMF), or 4,600 cfs. The one-half PMF routed outflow of 2,420 cfs will overtop the dam by 0.6 feet. With the water level at the top of the dam, the spillway will pass 75 percent of the routed test flood outflow.

It is recommended that the owner engage a qualified engineer to further evaluate the potential for overtopping, the adequacy of the spillway and determine what alternative measures are necessary to increase the spillway capacity. The owner should also repair the erosion and slide areas on the dam and establish grassy vegetation on the dam crest and downstream slopes.

The recommendation and remedial measures are described in Section 7 and should be addressed within one (1) year after receipt of this Phase I - Inspection Report by the owner.



Gordon H. Slaney, Jr.

Gordon H. Slaney, Jr.
Project Engineer

Howard, Needles, Tammen & Bergendoff
Boston, Massachusetts

This Phase I Inspection Report on Bradley 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 A. McElroy

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

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph W. Finegan, Jr.

JOSEPH W. FINEGAN, JR., CHAIRMAN
Chief, Reservoir Control Center
Water Control 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 by 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.

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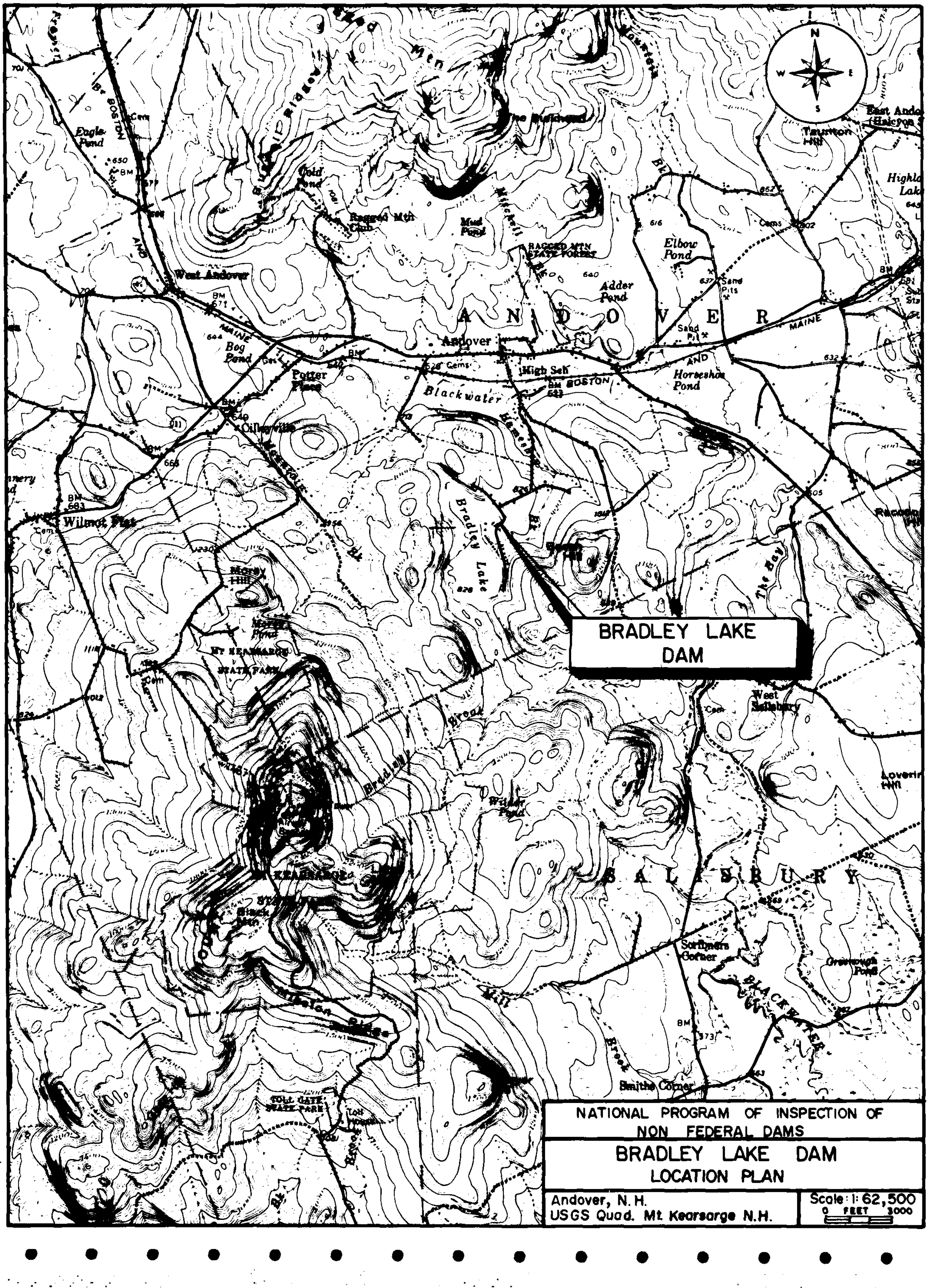
BRADLEY LAKE DAM - Overview from left abutment


BRADLEY LAKE
DAM
ANDOVER
SALISBURY
Andover
West Andover
Eagle Pond
Bog Pond
Potter Place
Cilleyville
Wilmot Flat
Elbow Pond
Adder Pond
Horseshoe Pond
Bradley Lake
Blackwater
High Sch
Ragged Mtn Club
Mud Pond
RAGGED MTN STATE FOREST
Taunton Hill
West Salisbury
Winslow Pond
Scribners Corner
Smiths Corner
Greenough Pond
TOLL GATE STATE PARK
MT KEARSARGE STATE PARK
The Bay
NATIONAL PROGRAM OF INSPECTION OF
NON FEDERAL DAMS
BRADLEY LAKE DAM
LOCATION PLAN
Andover, N.H.
USGS Quad. Mt. Kearsarge N.H.
Scale: 1: 62,500
0 FEET 3000

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
BRADLEY LAKE 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. Howard, Needles, Tammen & Bergendoff 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 Howard, Needles, Tammen & Bergendoff under a letter of October 23, 1978 from John P. Chandler, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0356 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. Bradley Lake Dam is located on Hameshop Brook approximately 1.7 miles upstream of its confluence with Blackwater River, in the Town of Andover, New Hampshire. The dam is shown on U.S.G.S. Quadrangle Mt. Kearsarge, New Hampshire, with approximate coordinates N43° 25'05", W71° 49' 20", Merrimack County, New Hampshire. Location of the dam is shown on the preceding page.

b. Description of Dam and Appurtenances. Bradley Lake Dam is an earthen embankment structure. The total length of the dam including the spillway section is, according to existing plans, approximately 340 feet. Maximum structural height of the dam, according to existing plans, is about 19 feet. The upstream face of the dam is on a 2 foot horizontal to a 1 foot vertical (2:1) slope. The top width averages about 8 feet with a 1½:1 slope on the downstream face. Along the downstream face of the dam is a 12' wide roadway set about 5 feet below the crest of the dam with the 1½:1 slope continuing to meet natural grade.

The appurtenant works consist of a concrete and stone masonry spillway, spillway channel and outlet works. The spillway is horseshoe in shape, with three faces to the crest. Outlet works consist of a stoplog gate and pond drain pipe integral to the spillway. The outlet channel consists of two levels. The roadway deck is supported by the outlet walls on each side and by two piers one on each side of the low flow outlet channel.

Figures 1 and 2, located in Appendix B, show the plan of the dam and appurtenant structures. Photographs of each structure are shown in Appendix C.

c. Size Classification. Intermediate (hydraulic height - 19 feet - storage - 3,385 acre-feet) classification based on storage being between 1,000 and 50,000 acre-feet as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. The potential hazard to life and property poised by this dam is assigned a significant classification. Failure of dam at maximum pool would result in a downstream floodwave of approximately 12.7 feet in height. Although no homes downstream of the dam would be inundated, damage to three bridges crossing the stream could be expected along with severe erosion.

e. Ownership. This dam is owned by the Town of Andover, New Hampshire.

f. Operator. This dam is operated by the Andover Board of Water Commissioners, Andover, New Hampshire. The Chairman of the Board of Water Commissionsrs is Mr. Roy Meier. Telephone No. 603/735-5170.

g. Purpose of Dam. This dam is used to provide some additional storage of water for a municipal water supply for Andover, New Hampshire. Basically, the dam provides for additional pond area on Bradley Lake which is used for recreation.

h. Design and Construction History. Original construction of this dam was completed in 1896. About 1956, the spillway was replaced with the present structure. No in-depth design or construction data was disclosed.

i. Normal Operating Procedures. Under normal operation the Lake is left to maintain its own level. There is no seasonal operation of stoplogs or outlet works. The water supply intake for the Town of Andover is located in the southern portion of the Lake and is not part of the dam or appurtenant structure.

1.3 Pertinent Data

a. Drainage Area. The area tributary to Bradley Lake consists of 4.0 square miles of heavily wooded mountainous terrain. A good portion of the drainage area is on the eastern face of Mount Kearsarge. Maximum elevation is 2,937 feet MSL, and the full reservoir elevation is 828 feet.

The area around the reservoir is wooded and steep. There are approximately 20 summer camps around the pond. Several small islands are in the center of the reservoir along an east-west line which are part of a ridge which almost divides the Lake in half. The water supply intake is located in the southern half of the Lake.

b. Discharge at Dam Site

(1) The outlet works for Bradley Lake Dam consist of a 4 foot by 4 foot stoplog opening in the spillway set with an invert of 824.0, and a pond drain pipe 24 inches in diameter set approximately at elevation 815.0. Capacity of the stoplog opening with the reservoir at elevation 828.0 is approximately 105 cfs. Capacity of the pond drain pipe is about 61 cfs with the pond level at 828.0.

(2) The maximum discharge, recorded at the site, was noted on September 21, 1938 with an approximate depth of flow of 4 feet over the permanent spillway crest. Based on a drawing of the spillway in use in 1938, the maximum recorded discharge would be about 570 cfs.

(3) The spillway capacity with the water surface at the top of the dam is approximately 1,800 cfs at elevation 833.0.

(4) The spillway capacity with the water surface at the test flood elevation of 833.6 is approximately 1,960 cfs.

(5) The total project discharge at the test flood elevation of 833.6 is about 2,416 cfs.

c. Elevation (feet above MSL)

(1) Streambed at centerline of dam - 814.0.

(2) Maximum tailwater - unknown.

(3) Upstream portal invert diversion tunnel - 815.0 (estimated).

(4) Recreation pool - 828.0.

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

(6) Spillway crest (permanent spillway) - 828.0.

(7) Design surcharge - unknown.

(8) Top Dam - 833.0.

(9) Test Flood Surcharge - 833.6.

d. Reservoir (miles)

(1) Length of Maximum Pool - 1.0.

(2) Length of Recreational Pool - 1.0.

(3) Length of Flood Control Pool - N/A.

e. Storage (gross acre-feet)

(1) Recreation Pool - 2,535.

(2) Flood Control Pool - N/A.

(3) Spillway Crest Pool - 2,535.

(4) Top of Dam - 3,800.

f. Reservoir Surface (acres)

(1) Recreation Pool - 170.

(2) Flood Control Pool - N/A.

(3) Spillway Crest - 170.

(4) Test Flood Pool - 170.

(5) Top Dam - 170.

g. Dam

(1) Type - earth.

(2) Length - 340 feet.

(3) Height - 19.0 feet.

(4) Top Width - 8 feet.

(5) Side Slopes - upstream 2 horizontal:1vertical, downstream 1½:1.

(6) Zoning - unknown.

(7) Impervious core - unknown.

(8) Cutoff - unknown.

(9) Grout Curtain - unknown.

(10) Other - none.

h. Diversion and Regulating Tunnel

None.

i. Spillway

(1) Type - concrete weir "horseshoe" shape.

(2) Length of Weir - 50 feet.

(3) Crest Elevation - 828.0.

(4) Gates - 4 foot by 4 foot stoplog openning invert 824.0.

(5) U/S Channel - none.

(6) Downstream Channel. Immediately downstream of the dam the sides of the channel are protected by rock rip-rap for a distance of 20 to 25 feet. The channel banks and overbank areas are heavily wooded.

j. Regulating Outlets. The 24 inch pond drain is controlled by a gate set on the face of the spillway. There is no readily accessible operating mechanism for the gate. Invert of the pipe is about 815.0. The 4 foot square stoplog openning set at invert 824.0 can be controlled by manually lifting or placing the stoplogs.

SECTION 2
ENGINEERING DATA

2.1 Design

No original design data were disclosed for Bradley Lake Dam. Original construction of this dam was in 1896. The spillway section was replaced in about 1957. Two plans showing the general layout and details of the new spillway were made available.

2.2 Construction

No construction records were available for use in evaluating the dam.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. Engineering data available for Bradley Lake Dam is limited to the plans mentioned above. These plans are on file at the New Hampshire Water Resources Board, Concord, New Hampshire.

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. The field investigation indicated that the external features of Bradley Lake Dam substantially agree with those shown on the available plans.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of Bradley Lake Dam was made on April 20, 1979. The inspection team consisted of personnel from Howard, Needles Tammen & Bergendoff and Geotechnical Engineers, Inc. Representatives of the Town of Andover Board of Water Commissioners and the New Hampshire Water Resources Board were also present during the inspection. Inspection checklists, completed during the visual inspection are included in Appendix A. At the time of inspection the water level was approximately even with the top of the spillway. The upstream face of the dam could only be inspected above the water level.

b. Dam. Visual inspection of the dam indicated that the dam is in fair condition.

The dam consists of an earth embankment about 340 feet long with a concrete spillway and outlet works in the approximate center of the embankment. The present dam was probably built soon after 1956 (design drawings are dated September 20, 1956) to replace the original double wall, rock and timber dam built in 1896.

Slope protection was not visible on any portion of the exposed upstream slope except for the area from the right wall of the spillway to 20 feet right of the spillway wall. Moderate to severe erosion of unprotected areas of the upstream slope was observed. Vegetation on the upstream slope varied from totally absent to sparse grass to small brush.

Photo No. 5 shows the upstream slope to the right of the spillway as viewed from the right abutment area.

A large slide area was observed on the upstream slope from the left spillway wall to about 42 feet left of the spillway wall, as shown in Photo Nos. 2 and 11. The soil on the surface of the slide area was silty sand and appears to be actively eroding. The width of the slide measured from the water line to the scarp is about 11.5 feet. The scarp is located near the downstream edge of the crest. Apparently, the slide area has been used as a recreational beach. Approximately 10 feet to the left of the slide area, an erosion channel was observed in the upstream slope as shown in Photo No. 12. A more severe erosion channel was observed about 67 feet left of the left spillway.

wall as shown in Photo No. 10. The latter erosion channel was about 6 feet wide (parallel with crest) and 11 feet long (transverse to crest) and soft silt was observed at its base. Both erosion channels appeared to be actively eroding.

Crest

The crest of the dam is covered with silty sand, Photo No. 4. Horseshoe courts on the crest to the right of the spillway have caused erosion of the crest.

Portions of the crest to the left of the spillway have been eroded as a result of the slide area, Photo No. 11 and erosion channel, Photo No. 10.

Downstream Slope

A group of six trees (6 inches maximum diameter) was observed on the downstream slope about 10 feet from the center line of the dam. Another group of trees was observed to the left of the spillway as shown in Photo No. 4.

Stone walls, about 3 feet in height, are at the toe of the downstream slope adjacent to the right and left training walls of the spillway, Photo No. 13.

c. Appurtenant Structures. Visual inspection of the concrete spillway, outlet works structure and concrete spillway channel did not reveal any evidence of stability problems. The concrete surfaces appeared to be in generally good condition.

The spillway structure (Photo No. 9) consists of a gravity concrete wall with a cut-off wall and a 12 inch thick apron slab. The apron slab is at the bottom of the spillway channel. The spillway structure is in good condition as shown in Photo Nos. 14, 15 and 17.

The old spillway was a stone masonry structure. The downstream face of the old spillway can be seen in Photo No. 22. No seepage was observed from the downstream face of the spillway.

The outlet works consist of a 2 foot diameter pipe and a wooden control gate. The gate is below the water level and not visible. It was reported that it is inoperable.

The condition of the outlet pipe and the gate is unknown.

The spillway channel consists of a rectangular concrete structure as shown on Section E-E, Figure 1, located in Appendix B.

Four iron pipes are imbedded in the spillway of the dam. Apparently, these pipes are for support of a catwalk to the stop-log gate.

The two abutment walls and two piers supporting the timber roadway bridge are incorporated into the spillway structure (Photo Nos. 18 and 20). The roadway deck is in good condition.

Visual inspection of the retaining walls and concrete slabs indicated that the concrete is in generally good condition.

d. Reservoir Area. The area around the reservoir is wooded and steep. There are approximately 20 summer camps around the pond. Several small islands are in the center of the reservoir area along an east-west line which are part of a ridge which can almost divide the lake in half during low water. A water supply intake for the Town of Andover is located in the southern half of the lake.

e. Downstream Channel. Immediately downstream of the dam the sides of the channel are protected by rock rip-rap for a distance of 20 to 25 feet.

The downstream channel is the natural river bed as shown in Photo No. 23. A few small trees overhang the channel and there are small trees growing on the channel floor. There are small islands in the downstream channel which contain trees.

3.2 Evaluation

Visual examination indicates the dam is in fair condition. The inspection revealed the following.

(a) Severe erosion of the upstream slope has occurred in several areas.

(b) One large slide area was observed on the upstream slope to the left of the spillway.

(c) Brush growth on the upstream slope and tree growth on the downstream slope was observed.

(d) The crest is covered with bare soil and is eroding in several areas.

(e) There are trees growing in the downstream channel.

(f) The pond drain gate is inoperable.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedure

The Bradley Lake Dam is used primarily for recreation and also to provide for additional water supply storage. The water supply intake in the southern portion of the lake serves a portion of the residents of Andover. The northern end of the lake is used only for recreation. There are no set procedures for maintaining seasonal lake levels or releases. Stoplogs are adjusted occasionally as needed.

4.2 Maintenance of Dam

This dam is visited by members of the Andover Water Commission on an occasional basis.

4.3 Maintenance of Operating Facilities

Maintenance on the outlet works is done on an as needed basis. The stoplog gate is adjusted occasionally. The 24 inch diameter drain pipe has not been used, and it was reported that it is doubtful that it could be opened.

4.4 Description of Warning Systems

There are no warning systems in effect for this dam.

4.5 Evaluation

The current operation and maintenance procedures for Bradley Lake Dam are inadequate to insure that all problems encountered can be remedied within a reasonable period of time. The owner should establish a written operation and maintenance procedure and should also establish a warning system to follow in the event of flood flow conditions or imminent dam failure.

SECTION 5
HYDROLOGY & HYDRAULIC ANALYSIS

5.1 Evaluation of Features

a. General. Bradley Lake Dam is an earth embankment structure with an overall length of 340 feet and a structural height of 19 feet. A roadway runs along the downstream face of the dam. The appurtenant works consist of a 50 foot long, horseshoe shaped, concrete spillway with a concrete and stone masonry outlet channel through the dam. A wooden roadway deck is supported by the sides of the outlet channel and two piers. The outlet works consist of a 4 foot square stoplog gate and 24 inch diameter drain pipe.

The dam creates an impoundment used primarily for recreation and to provide additional storage for water supply for the Town of Andover, New Hampshire. The Bradley Lake Dam is classified intermediate in size having a maximum storage of 3,800 acre-feet.

b. Design Data. No hydrologic or hydraulic design data were disclosed for Bradley Lake Dam.

c. Experience Data. The maximum discharge at the dam site was noted in September of 1938 as being about 4 feet over the permanent spillway crest. Based on the spillway used at this time, this would produce a discharge of approximately 570 cfs.

d. Visual Observations. No evidence of damage to any portion of the project from overtopping was visible at the time of inspection.

e. Test Flood Analysis. As no detailed design and operational information are available, hydrologic evaluation was performed using dam information gathered by field inspection, watershed size and an estimated test flood equal to 1/2 the Probable Maximum Flood (PMF) as determined by guide curves issued by the Corps of Engineers. Based on a drainage area of 4.0 square miles, it was estimated that the test flood inflow at Bradley Lake Dam would be 4,600 cfs. Following the guidance for Estimating Effect of Surcharge Storage on Maximum Probable Discharge results in a routed test flood outflow of 2,410 cfs. As the maximum spillway capacity at the top of the dam is only 1,800 cfs (approximately 75 percent of the test flood discharge flow), the test flood will result in the dam being overtopped by approximately 0.6 feet.

f. Dam Failure Analysis. The impact of failure of the dam at maximum pool (top of dam) was assessed using the "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers. The analysis covered the reach extending from the dam to Lawrence Street about 9,100 feet downstream. The downstream river stage, with the spillway at full capacity, is 6.1 feet. Failure of the dam at maximum pool would probably result in a downstream flood wave about 12.7 feet high. Dwellings located downstream are constructed above this height but severe damage to property and possibly to some dwellings, resulting from erosion of the stream banks, would probably occur due to the steep channel. The stream passes under three bridges in this reach and damage could be expected.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The visual observations did not disclose any immediate stability problems. However, the following conditions, if allowed to continue, could lead to instability of the dam in the future: 1. erosion of the upstream slope, 2. exposed soil on crest, 3. trees on the downstream slope.

b. Design and Construction Data. The original Bradley Lake Dam, built in 1896, is shown in a sketch dated December 6, 1938. The original dam was constructed in about 1956 (the reconstruction plans are shown on drawings dated September, 1956; the 1956 plans also show portions of the original dam design).

The original dam was about 340 feet long and consisted of an upstream and downstream rock wall with earth in between. The upstream face had a plank facing. A spillway section was in the approximate center of the dam. According to past inspection reports, the dam is founded on earth.

c. Operating Records. No operating records were made available.

d. Post Construction Changes. In about 1956, the spillway section was reconstructed incorporating parts of the original spillway. An embankment with upstream and downstream slopes was added at this time. The transition from the original earth filled double rock wall dam to the present earth embankment is not discernable from the design drawings. An undated sketch of the embankment dam shows wood sheeting extending from the intersection of the downstream slope and crest to an unknown depth.

e. Seismic Stability. The dam is located in Seismic Zone 2, and in accordance with recommended Phase 1 quidelines does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection of Bradley Lake Dam indicates the dam is in fair condition. The inspection revealed the following:

(1) Severe erosion of the upstream slope has occurred in several areas.

(2) One large slide area was observed on the upstream slope to the left of the spillway.

(3) Brush growth on the upstream slope and tree growth on the downstream slope was observed.

(4) The crest is covered with bare soil and is eroding in several areas.

(5) There are trees growing in the downstream channel.

(6) The pond drain gate is inoperable.

The hydraulic analysis reveals that the spillway cannot pass the routed test flood without overtopping the dam.

b. Adequacy of Information. 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 judgment.

c. Urgency. This dam is in generally fair condition. The recommendations and remedial measures described in Sections 7.2 and 7.3 should be accomplished within 1 year after receipt of this Phase I Inspection Report by the owner.

d. Necessity of Additional Investigation. No additional investigation is needed to complete the Phase I inspection.

7.2 Recommendations

It is recommended that the owner engage a qualified engineer to do the following:

a. Further evaluate the potential for overtopping, the

adequacy of the spillway, and determine what alternative measures are necessary to increase the discharge capabilities of the dam.

b. Repair slide and eroded areas on the upstream slope and provide suitable upstream slope protection to prevent future erosion.

c. Remove large trees and root systems near the spillway section of the dam and provide a suitable backfill material.

7.3 Remedial Measures

a. Prevent trespassing on the embankment section of the dam, and establish grassy vegetation on the crest and downstream slopes.

b. Remove small trees in the channel immediately downstream of the dam.

c. The gate for the pond drain pipe should be made operable.

d. A written operational procedure and warning system to follow in the event of flood flow conditions or imminent dam failure should be developed. The warning system should outline the steps to be taken by local officials for altering downstream residents in case of emergency.

e. Institute a program of annual periodic technical inspections.

7.4 Alternatives

There are no practical alternatives to the recommendations of Sections 7.2 and 7.3 except that in an interim basis the owner may consider operating the reservoir at a lower level throughout the year so as to provide more storage for extreme flood events.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT BRADLEY LAKE DAM

DATE April 20, 1979

TIME 9:30

WEATHER Fair 45°F

W.S. ELEV. 828.0 U.S. 815± DN.S

PARTY:

1.	D. LaGatta GEI	6.	
2.	T. Keller GEI	7.	
3.	S. Mazur HNTB	8.	
4.	R. Yarsites HNTB	9.	
5.		10.	

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam	Dan LaGatta, Tom Keller	
2.	Spillway, Outlet and	Stan Mazur, Robert Yarsites	
3.	Downstream Channel		
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT BRADLEY LAKE DAM DATE April 20, 1979

PROJECT FEATURE Embankment Dam NAME D. P. LaGatta

DISCIPLINE Geotechnical Engineer NAME T. O. Keller

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	833.0
Current Pool Elevation	828.0
Maximum Impoundment to Date	unknown
Surface Cracks	Minor surface cracks from frost action.
Pavement Condition	No pavement.
Movement or Settlement of Crest	Erosion of upstream slope has caused erosion of crest.
Lateral Movement	None observed.
Vertical Alignment	No vertical misalignment observed.
Horizontal Alignment	No horizontal misalignment observed.
Condition at Abutment and at Concrete Structures	Good, however, some trees on abutments.
Indications of Movement of Structural Items on Slopes	No structural items.
Trespassing on Slopes	Beach area to left of spillway on upstream slope. Horseshoe pits on crest.
Sloughing or Erosion of Slopes or Abutments	Severe erosion of upstream slope.
Rock Slope Protection - Riprap Failures	None on upstream slope except close to spillway walls.
Unusual Movement or Cracking at or near Toes	Upstream toe not visible. Downstream toe condition is good.
Unusual Embankment or Downstream Seepage	None observed.
Piping or Boils	None observed.
Foundation Drainage Features	None.
Toe Drains	None.
Instrumentation System	None.
Vegetation	Trees on downstream slope. Brush on upstream slope.

PERIODIC INSPECTION CHECK LIST

PROJECT BRADLEY LAKE DAM DATE April 20, 1979

PROJECT FEATURE Approach/Discharge Channels NAME D. P. LaGatta

DISCIPLINE Geotechnical Engineer NAME T. O. Keller

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	No approach channel.
General Condition	
Loose Rock Overhanding Channel	
Trees Overhanging Channel	
Floor of Approach Channel	
b. Weir and Training Walls	
General Condition of Concrete	Good
Rust or Staining	None observed.
Spalling	None observed.
Any Visible Reinforcing	None observed.
Any Seepage or Efflorescence	None observed.
Drain Holes	None observed.
c. Discharge Channel	Discharge channel is river channel.
General Channel	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	A few trees overhanding channel.
Floor of Channel	Small trees in floor of channel.
Other Obstructions	Small islands with trees on islands.

PERIODIC INSPECTION CHECK LIST

PROJECT BRADLEY LAKE DAM — DATE April 20, 1979

PROJECT FEATURE Intake Channel/Structure — NAME D. L., T. K.

DISCIPLINE Geotechnical, Structural, Hydraulic — NAME S. M., R. Y.

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	This facility has no 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	Good.
Stop Logs and Slots	Slots are good; stop logs were removed.

PERIODIC INSPECTION CHECK LIST

PROJECT BRADLEY LAKE DAM

DATE April 20, 1979

PROJECT FEATURE Service Bridge

NAME S. Mazur

DISCIPLINE Structural Engineer

NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	None
Bearings	Note: Timber roadway bridge over the spillway channel is supported by piers and abutments which are part of the spillway channel. The bridge was in good condition.
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

PERIODIC INSPECTION CHECK LIST

PROJECT BRADLEY LAKE DAM DATE April 20, 1979

PROJECT FEATURE Control Tower NAME

DISCIPLINE Structural Engineer NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	This facility has no control tower.
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	

PERIODIC INSPECTION CHECK LIST

PROJECT BRADLEY LAKE DAM DATE April 20, 1979

PROJECT FEATURE Transition and Conduit NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	None
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECK LIST

PROJECT BRADLEY LAKE DAM — DATE April 20, 1979

PROJECT FEATURE Outlet Structure/Channel — NAME S. Mazur

DISCIPLINE Structural Engineer — NAME R. Yarsites

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Gate of outlet works. Structure is not operational. Spillway structure is the only way of outletting water.
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	None
Any Seepage or Efflorescence	None
Condition at Joints	Good
Drain Holes	No drain holes were found.
Channel	Good condition.
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	Note: Outlet channel and discharge channel for spillway are one in the same.

APPENDIX B

ENGINEERING DATA

1. LIST OF DESIGN, CONSTRUCTION AND MAINTENANCE RECORDS
2. PAST INSPECTION REPORTS
3. PLAN AND DETAILS

AVAILABLE ENGINEERING DATA

A set of drawings (3 sheets) dated September 1956 showing a plan and details of the present spillway section, and a sketch dated December 6, 1938 showing the original dam are available at the State of New Hampshire Water Resources Board, 37 Pleasant Street, Concord, New Hampshire 03301.

PAST INSPECTION REPORTS

August 27, 1953

Senator James C. Cleveland
4 Park Street
Concord, New Hampshire

Dear Senator Cleveland:

In accordance with our telephone conversation several days ago concerning improvement of the lake level of Bradley Lake, I have been to the Lake and looked over the situation at the dam.

The Water Resources Board has some funds under our so-called "Small Dams Bill". However, these funds are promised for 3 dams at this time. We do not expect, of course, that we can get any more funds under this Bill until the next Legislature.

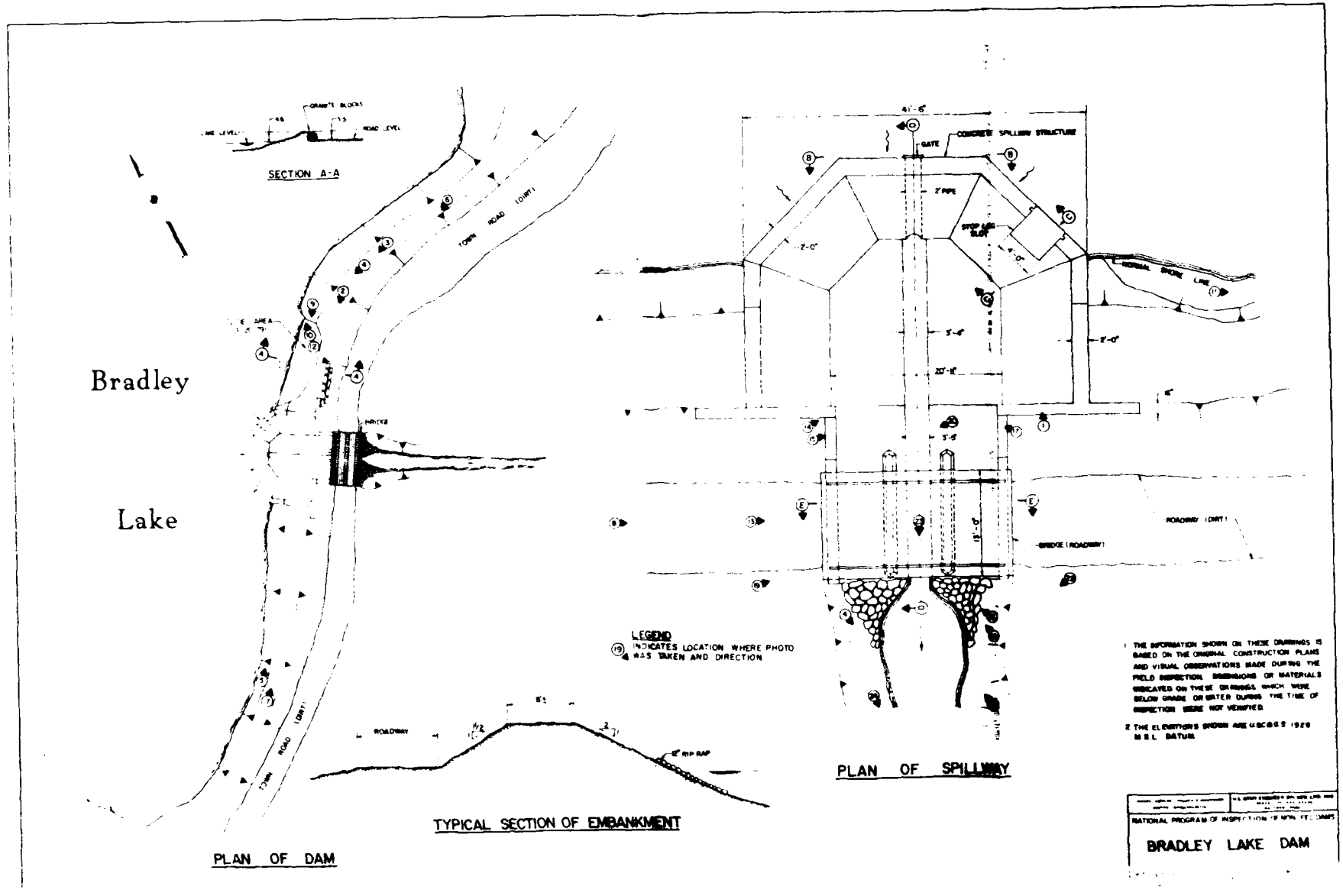
With regard to methods and cost of repairing the dam, I do not have all the information that I would like to have at this time. My principal lack of information concerns methods of establishing a copper dam and critical levels for the intake pipes of the Andover Water supply. Assuming that these two items will be taken care of at a reasonable cost, it is my opinion that the minimum concrete repair work could be done at the dam for a cost in the vicinity of $10,000. I repeat that this is a minimum amount of repair work and a more desirable job would probably cost around $12,000 or $13,000. Essentially, the $10,000 would replace the present spillway structure with concrete extending far enough to cut off all leaks. There is also some provision in this $10,000 to replace the wood sheeting for a distance of 40 to 50 feet either side of the spillway with a concrete cutoff extending down far enough to stop the leakage. It is my opinion that this cutoff should actually extend for a distance of about 100 feet either side of the spillway. If definite action should be taken to repair this dam, there are some other alternatives which should be discussed, such as raising the road 4 or 5 feet and making the road fill part of the dam.

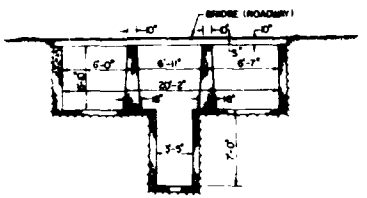
We will be pleased to give you any possible assistance and to discuss this further with you.

Very truly yours,

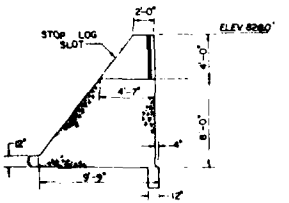
Leonard R. Frost
Water Resources Engineer

lrf:c

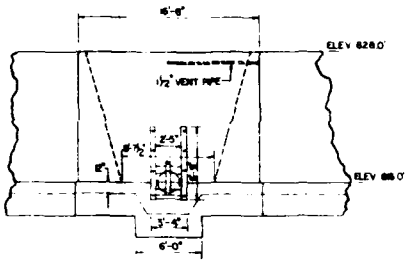

Bradley
Lake
SECTION A-A
TOWN ROAD (DIRT)
BRIDGE
AREA
PLAN OF DAM
TYPICAL SECTION OF EMBANKMENT
LEGEND
INDICATES LOCATION WHERE PHOTO WAS TAKEN AND DIRECTION
CONCRETE SPILLWAY STRUCTURE
GATE
2" PIPE
STOP LOG SLOT
BRIDGE (ROADWAY)
ROADWAY (DIRT)
PLAN OF SPILLWAY
1. THE INFORMATION SHOWN ON THESE DRAWINGS IS BASED ON THE ORIGINAL CONSTRUCTION PLANS AND VISUAL OBSERVATIONS MADE DURING THE FIELD INSPECTION. DIMENSIONS OR MATERIALS INDICATED ON THESE DRAWINGS WHICH WERE BELOW GRADE OR WATER DURING THE TIME OF INSPECTION WERE NOT VERIFIED.
2. THE ELEVATIONS SHOWN ARE U.S.C.&G.S. 1929 M.S.L. DATUM.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
BRADLEY LAKE DAM



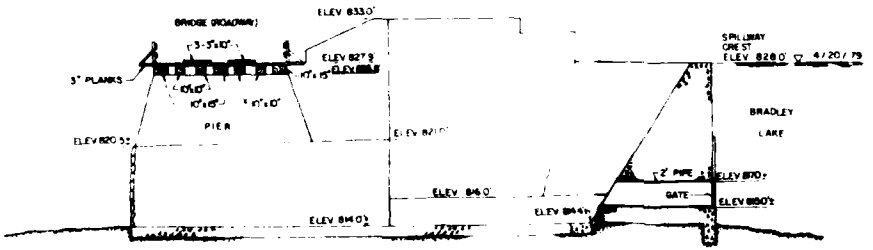
SECTION E-E



SECTION C-C



SECTION B-B



SECTION D-D

1 THE INFORMATION SHOWN ON THESE DRAWINGS IS BASED ON THE ORIGINAL CONSTRUCTION PLANS AND VISUAL OBSERVATIONS MADE DURING THE FIELD INSPECTION. DIMENSIONS OR MATERIALS INDICATED ON THESE DRAWINGS WHICH WERE BELOW GRADE OR WATER DURING THE TIME OF INSPECTION WERE NOT VERIFIED.

2 THE ELEVATIONS SHOWN ARE U.S.C. & G.S. 1929 M.S.L. DATUM.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

BRADLEY LAKE DAM

APPENDIX C

PHOTOGRAPHS

FOR LOCATION OF PHOTOS, SEE FIGURE 1
LOCATED IN APPENDIX B

PHOTO NO. 1 - View of reservoir from dam.

PHOTO NO. 2 - View slide area to left of the spillway structure.

PHOTO NO. 3 - View of downstream slope as viewed from right abutment.

PHOTO NO. 4 - View of dam crest from left abutment.

PHOTO NO. 5 - View of upstream slope from right abutment.

PHOTO NO. 6 - View of downstream face of dam and roadway from left side.

PHOTO NO. 7 - View of dam on right side.

PHOTO NO. 8 - View of downstream face of dam from right side.

PHOTO NO. 9 - View of spillway from left portion of dam.

PHOTO NO. 10 - View of erosion area located 67 feet left of the left spillway wall.

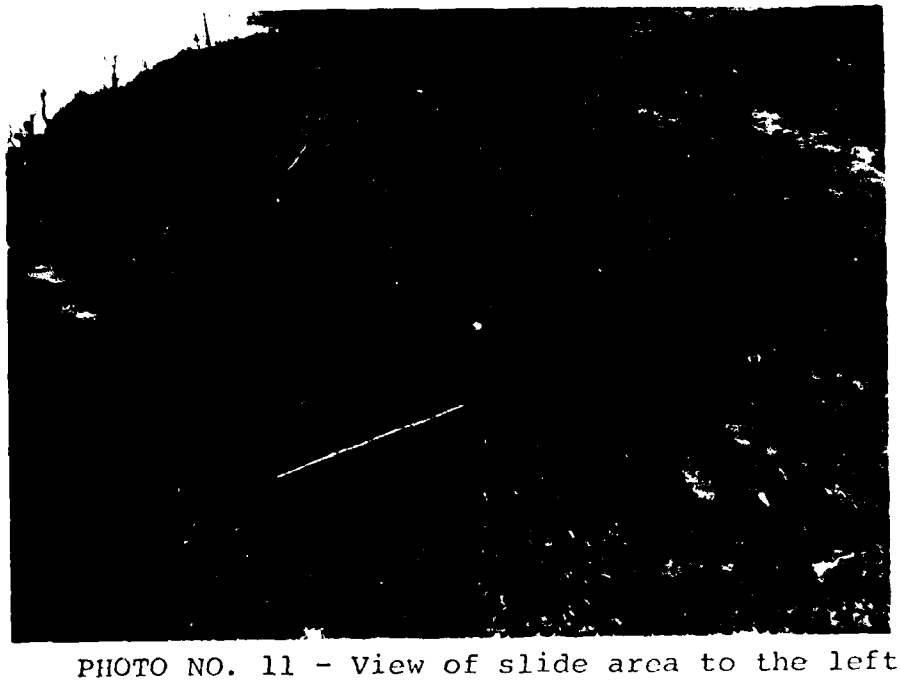


PHOTO NO. 11 - View of slide area to the left of the spillway, scale open to 3 feet.

PHOTO NO. 12 - View of erosion area located about 10 feet to the left of the slide area shown in Photo No. 11.

PHOTO NO. 13 - View of roadway bridge from right side of spillway.

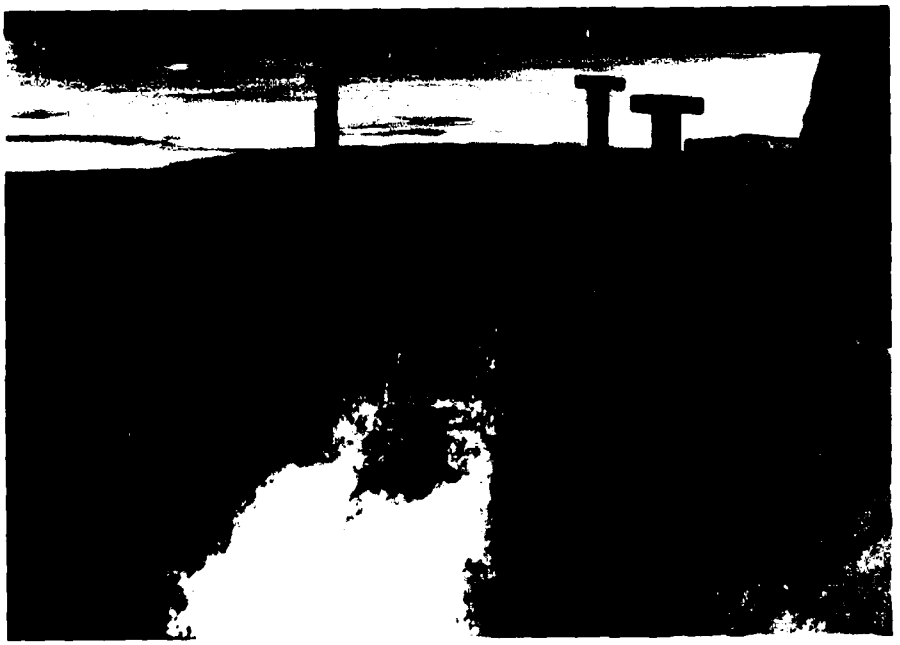


PHOTO NO. 14 - View of stoplog outlet in spillway.

PHOTO NO. 15 - View of left side of spillway.

PHOTO NO. 16 - View of left, downstream side of outlet works.

PHOTO NO. 17 - View of right side of spillway.

PHOTO NO. 18 - View of downstream side of outlet works.

PHOTO NO. 19 - View of roadway deck and downstream side of spillway.

PHOTO NO. 20 - View of underside of roadway and left side of outlet works.

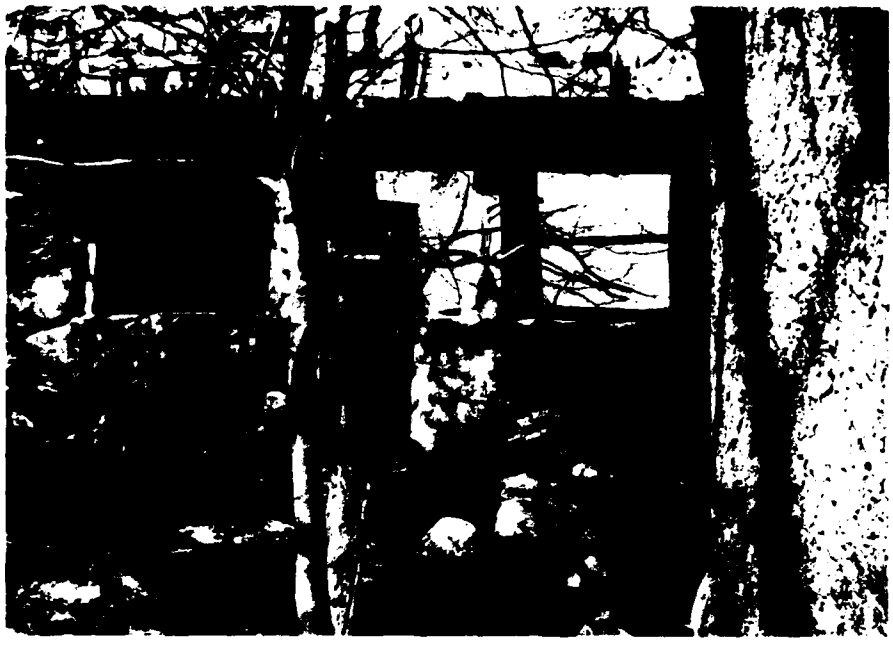


PHOTO NO. 21 - View of channel immediately downstream of dam.

PHOTO NO. 22 - View of downstream face of outlet works from left bank.

PHOTO NO. 23 - View of downstream channel from roadway.

PHOTO NO. 24 - View channel, looking downstream.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 12/5/78	Job No. 5628-1142
	Checked by TWM	Date 6/15/79	Sheet No. 1
For BRADLEY LAKE DAM			

HYDRAULICS & HYDROLOGY

Bradley Lake Dam located in Andover, N.H. across the Hameshop Brook in the Merrimack R. Basin.

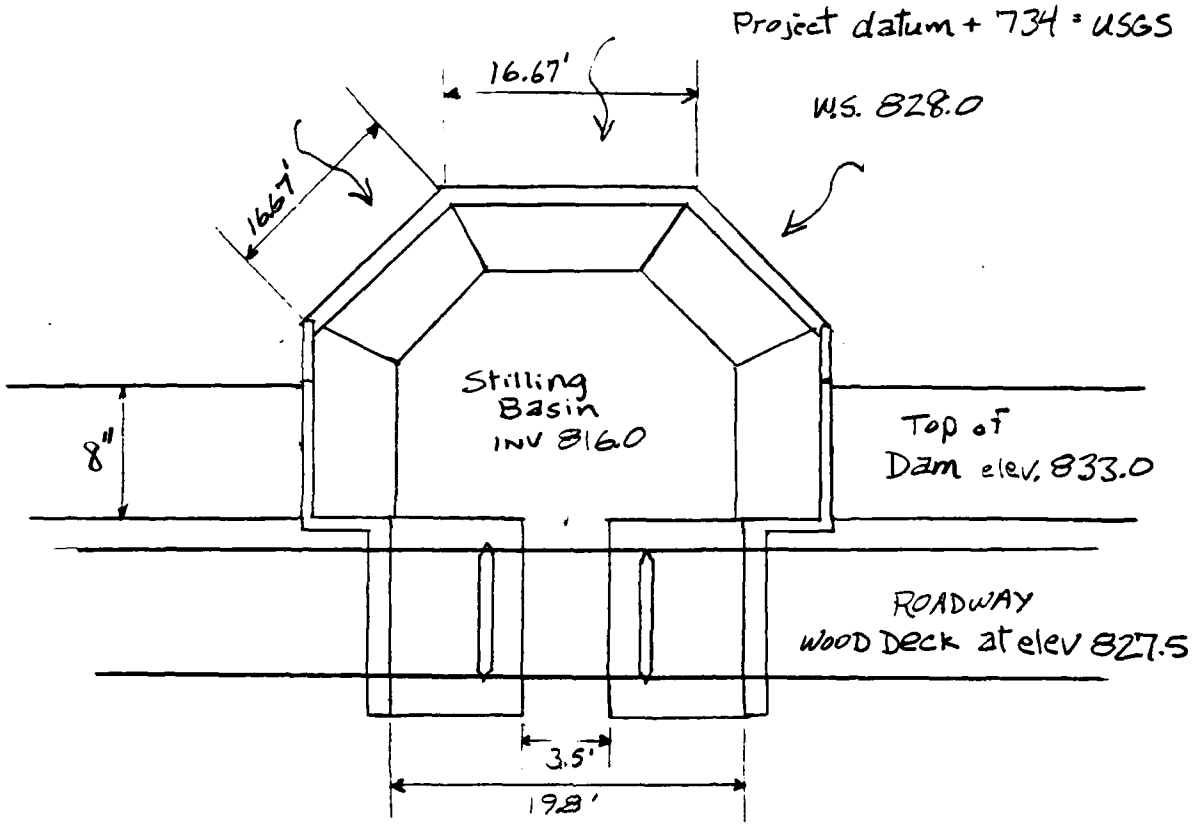
Classification

Size: intermediate
hazard: Significant

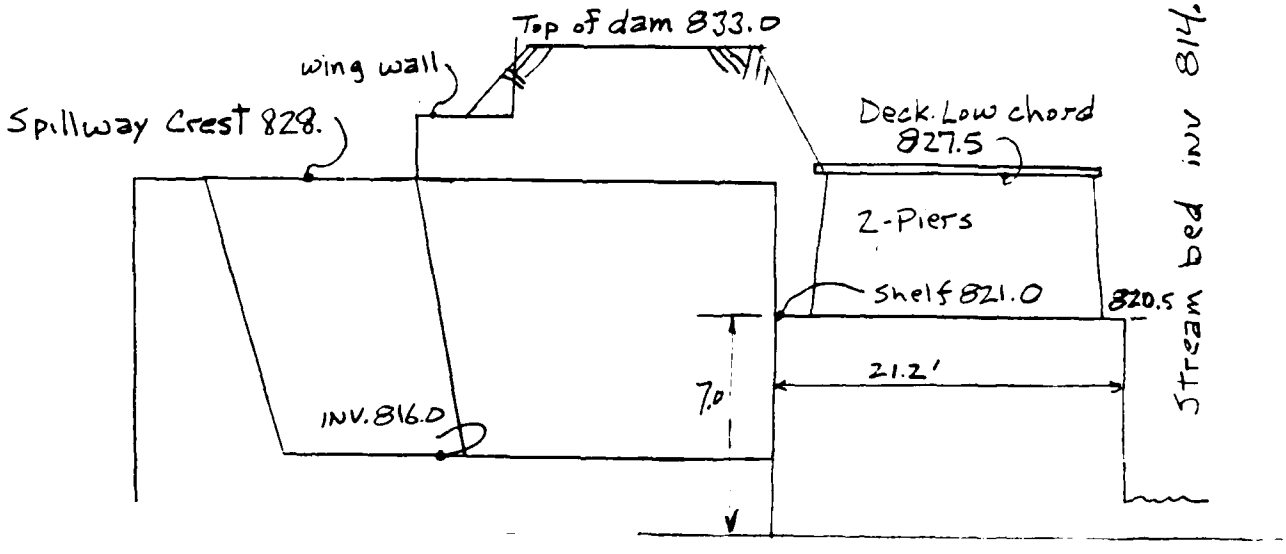
Basic Data

D.A. 4.0 sq.mi.
Upstream Basin: Mountainous.
Reservoir: Normal @ elev. 828.0
Storage 2535 acre-ft
Max pool @ elev 833.0
Storage 3800 acre-ft
Surface Area 170 acres
Dam: earth
Length: 340 ft
Height 19.0 ft
down stream slope 2:1
upstream slope 3:1
Spillway: Concrete "U" weir
Length 50 ft
Crest elev 828.0
Outlet works
1. 4'x4' openning w/ stop logs
invert @ 824.0
2. 24" ϕ pipe inv. 814.0

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 12/5/78	Job No 628-11-12
	Checked by MWB	Date 5/15/79	Sheet No 2
For Bradley Lake			



Plan of Dam & Spillway



Profile thru Spillway

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 12/5/78	Job No 5628-11-12
	Checked by PNB	Date 5/15/79	Sheet No 3
For Bradley Lake			

Step 1 Calculation of Test flood Inflow

Classification: size: intermediate
Hazard: Significant

Hydrologic Evaluation Guideline Recomends use of ½ PMF to full PMF

PMF = 2300 cfs/mi² use ½ PMF as size classification on low end of range

Test Flood Inflow = ½ × 2300 × 4 = 4600cfs Mountainous Curve

Q_{P_1} = 4600cfs

Step 2 Calculation of Test Flood Surcharge

Q_{P_1} = inflow = 4600cfs

Consider: 1. 24"ϕ outlet pipe closed
2. Stop logs in 4'×4' openning in place.
3. Wooden roadway deck immediately downstream will not effect flows.

Spillway $Q_s = CLH_s^{3/2}$

$C = 3.50$ Crest = 828.0

$L = 50$ ft

$Q_s = 3.50(50)H_s^{3/2}$

$Q_s = 175 H_s^{3/2}$

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 4/23/79	Job No. 5628-11-12
	Checked by [illegible]	Date 5/15/79	Sheet No. 4
For Bradley			

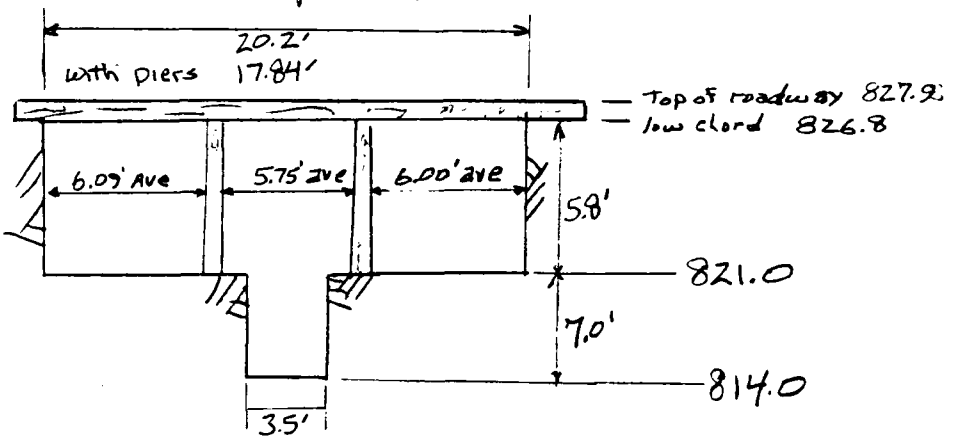
Dam $Q_D = C L H^{3/2}$

where: $C = 3.05$ Crest = 833.0

$L = 340' - 40'$ spillway section $= 300'$

$Q_D = 915 H_D^{3/2}$

Check downstream channel tailwater and X-section of spillway under the roadway.



Spillway outlet channel is the constricting section
Assume flow passes thru critical depth in section

critical depth $\frac{Q^2}{g} \cdot \frac{A^3}{\text{Top width}}$ $Q = \sqrt{\frac{A^3 g}{T}}$

Assume zero velocity in spillway basin & neglect friction losses to obtain w.s. in basin

Table 1

Elev 814 Bottom Outlet Channel dc	Area	Top width	Q	V	h_v	Basin Water Surface Elevation	
7	24.5	3.5	367				
9	60.18	17.34	627	10.42	1.69	824.69	
11	95.86	17.34	1261	13.15	2.69	827.69	Surcharge on weir
12.8	127.97	17.34	1945	15.20	3.59	830.39	← roadway deck washed out
14	152.21	20.2	2371	15.58	3.77	831.77	
15	172.41	20.2	2858	16.58	4.27	833.27	
16	192.61	20.2	3375	17.52	4.77	834.77	

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 4/24/79	Job No 5628-11-12
	Checked by [illegible]	Date 5/15/79	Sheet No 5
For Bradley			

Dam-Spillway stage-discharge curve see fig 1

Stage	Hs	Qs	HDam	QDAM	QTotal
828.0	0 ft	0 cfs	-	-	0 cfs
830.0	2.0	495	-	-	495
831.0	3.0	910	-	-	910
831.77	3.77	1270	-	-	1270
weir is submerged from outchannel backwater see below					
833.47	5.47	1945	.47 ft	295 cfs	2240
834.58	6.58	2371	1.58	1817	4,188
835.89	7.89	2858	2.89	4495	7,353
837.25	9.25	3375	4.25	8017	11,392

Submerged weir calculations

$$Q_{downstream} = C \times L_{weir} H_1^{1.5} \left[1 - \left(\frac{\text{downstream water surface} - \text{weir crest}}{H_1}\right)^{1.5}\right]^{.385}$$

elev 828.0

Trial & error solution for H_1

See table 1

$Q_{Downstream}$	Basin Downstream watersurface	H_1 calculated	weir stage Water Surface
1945	830.39	5.47	833.47
2371	831.77	6.58	834.58
2858	833.27	7.89	835.89
3375	834.77	9.25	837.25

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 4/26/79	Job No 5628-11-12
	Checked by PNB	Date 5/15/79	Sheet No. 6
For Bradley			

Step 3 Estimate of surcharge storage effect

$Q_{P_1} = 4600$ cfs Runoff: 9.5" or ½PMR of 19"

$Surcharge_1 = 6.78$ ft

$$Stor_1 = \frac{6.78 \text{ ft} \times 12"/\text{ft} \times 170 \text{ acre}}{4 \text{ sq mi} \times 640 \text{ acre/mi}^2} = 6.78' \times .80 = 5.40 \text{ in}$$

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{Stor_1}{9.5}\right) = 4600\left(1 - \frac{5.4}{9.5}\right) = 1985 \text{ cfs}$$

$Surcharge_2 = 5.21$ ft

$Stor_2 = 5.21 \text{ ft} \times .80 = 4.17$ inches

$$Stor_{Ave} = \frac{Stor_1 + Stor_2}{2} = \frac{5.40 + 4.17}{2} = 4.78 \text{ inches}$$

$$Q_{P_3} = Q_{P_1}\left(1 - \frac{Stor_{Ave}}{9.5}\right) = 4600\left(1 - \frac{4.78}{9.5}\right) = 2285 \text{ cfs}$$

$Surcharge_3 = 5.46$ ft

$Stor_3 = 5.46 \text{ ft} \times .80 = 4.37$ inch

$$Stor_{AVE2} = \frac{Stor_{ave_1} + Stor_3}{2} = \frac{4.78 + 4.37}{2} = 4.57 \text{ in}$$

$$Q_{P_4} = 4600\left(1 - \frac{4.57}{9.5}\right) = 2385 \text{ cfs}$$

$Surcharge_4 = 5.57$ ft

$Stor_4 = 5.57 \text{ ft} \times .80 = 4.46$ in

$$Stor_{AVE3} = \frac{Stor_{AVE2} + Stor_4}{2} = \frac{4.57 + 4.46}{2} = 4.51 \text{ in}$$

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 4/26/79	Job No 5628-11-12
	Checked by [illegible]	Date 5/15/79	Sheet No. 7
For Bradley			

$Q_{PS} = 4600\left(1 - \frac{4.51}{9.5}\right) = 2416$ cfs

Surcharge = 5.58 ft Stor = 4.46 inches

Stor values close to within 2% use Q_{PS}.

$Q_{outflow} = 2416$ cfs

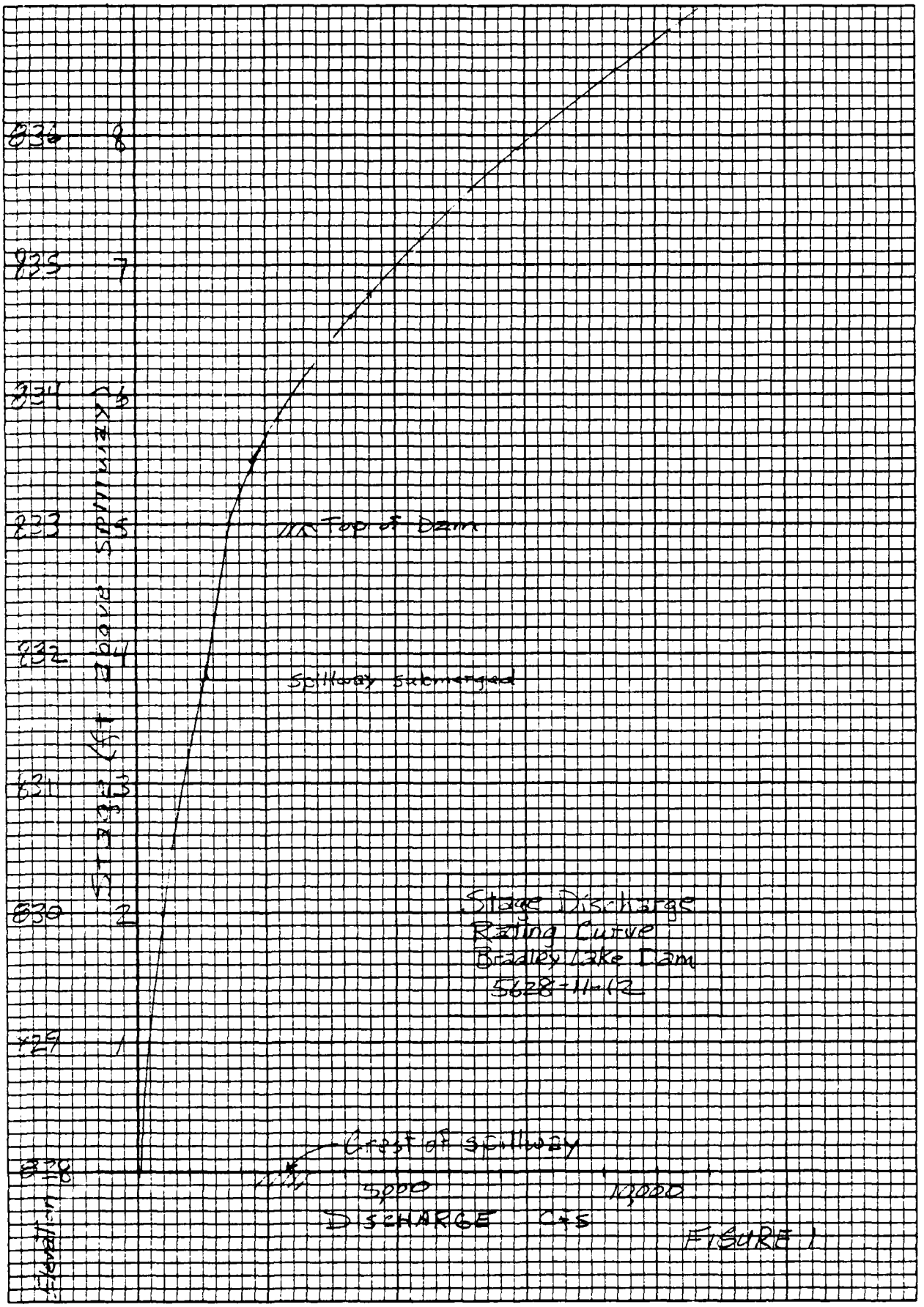
Surcharge = 5.58 ft = elev. 833.58 ft

Conclusions

1. Reservoir storage will reduce the Inflow at the outlet from 4600 cfs to 2416 cfs or by 47%

2. The spillway & storage capacity can safely pass 2000cfs or 75% of the Test flood.

3. At the test flood discharge of 2416 cfs the dam will be overtopped by .58 ft.



Stage Discharge
Rating Curve
Bradley Lake Dam
5628-11-12

FIGURE 1

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 11/28/78	Job No. 5628-11-12
	Checked by [illegible]	Date 5/15/79	Sheet No. 8
For BRADLEY LAKE			

ESTIMATE OF DOWNSTREAM Damage

Step 1 Reservoir Capacity

Normal 2535 acre-ft
@ elev. 94.0 Project Datum

Max - 3800 acre-ft
@ elev. 99.0

Step 2 Peak Failure Outflow

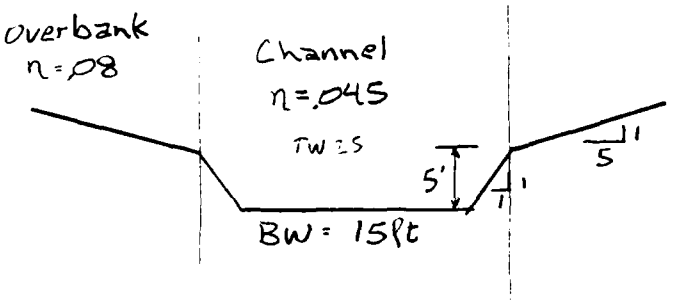
$Q_{P_1} = 8/27 \sqrt{g}\, W_b\, Y_o^{3/2}$

W_b = 40% of Dam length = (.40)(340)

Y_o = height-streambed to max. pool elev. = 833 - 814 = 19.0 ft

$Q_{P_1} = 8/27 \sqrt{g}\, (.40)(340)(19)^{3/2} = 18{,}900$ cfs

Step 3 Stage - Discharge Curve



Reach Characteristics

L = 9100 ft
S = 2.3%
n = .045 channel
.08 overbank

Stage	Discharge
5	1140
10	5050
15	13,280
18	20,930

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 4/18/79	Job No 5628-11-12
	Checked by [illegible]	Date 5/15/79	Sheet No. 7
For BRADLEY LAKE			

Step 4 Flood Wave Routing "Rule of Thumb"

Breach of Dam $Q = 18{,}900$ cfs
Spillway top of dam $Q = 1800$ cfs
$Q_{P_1} = 20{,}700$ cfs

at Dam Stage 1 = 18.0 ft Area$_1$ = 1270 □'

$$V_1 = \frac{1270 \times 9100}{43{,}560} = 265 \text{ acre ft} < \frac{3800}{2}$$

Reach length OK

$$Q_{P_2 \text{ trial}} = Q_{P_1}\left(1 - \frac{V_1}{S}\right) = 20{,}700\left(1 - \frac{265}{3800}\right) = 19{,}400 \text{ cfs}$$

Stage$_2$ = 17.45 ft Area$_2$ = 1186 □'

$$V_2 = \frac{1186 \times 9100}{43560} = 248 \text{ acre ft}$$

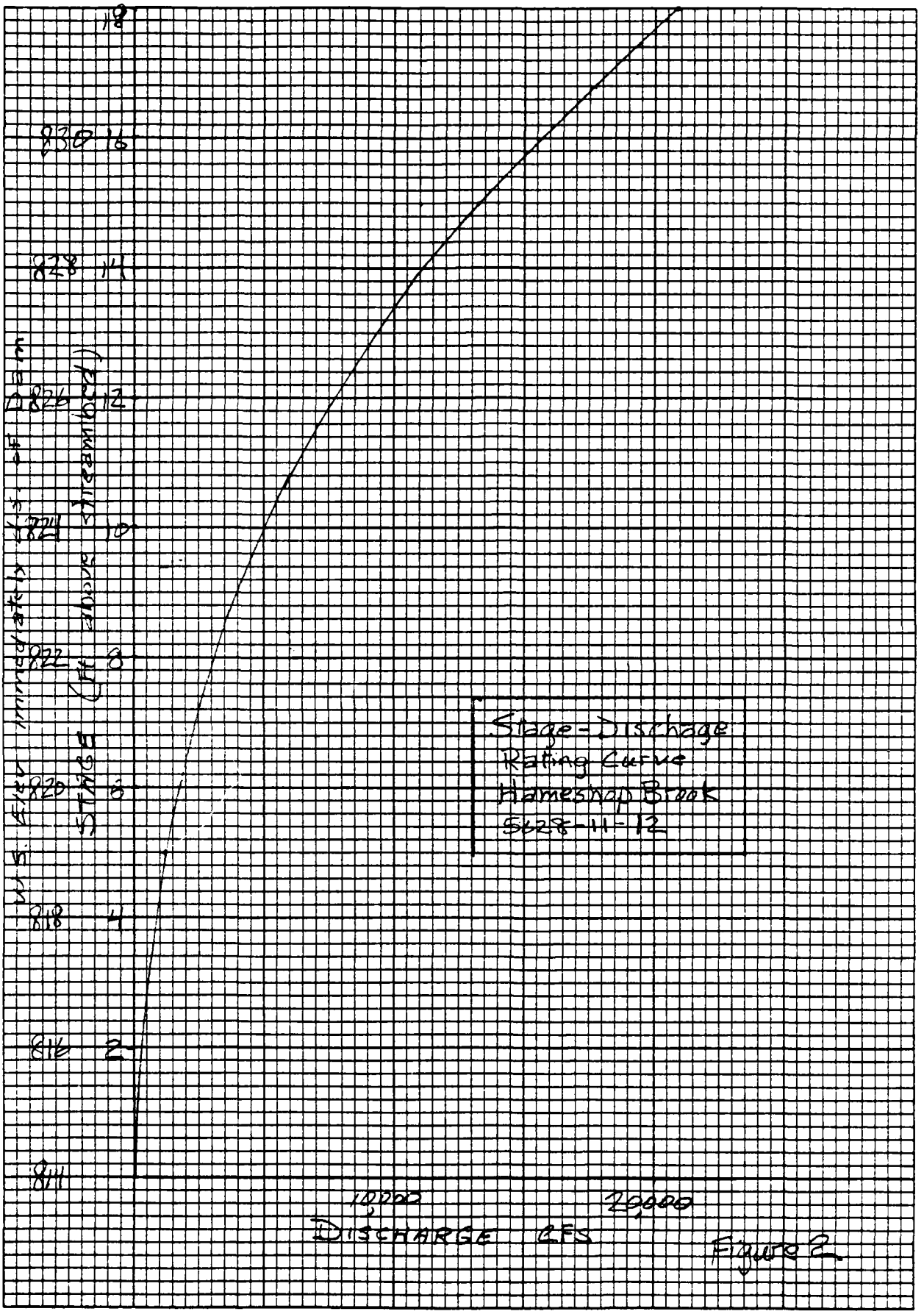
$$V_{ave} = \frac{V_1 + V_2}{2} = \frac{265 + 248}{2} = 256 \text{ acre ft}$$

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{V_{ave}}{S}\right) = 20{,}700\left(1 - \frac{256}{3800}\right) = 19{,}450 \text{ cfs}$$

Reach Outflow 19,450 cfs
Stage 17.46 ft

Since 17.46 ft is greater than 2/3 of Dam height use 2/3 rule for downstream floodwave. Thus, downstream floodwave = 19(2/3) or 12.7 ft

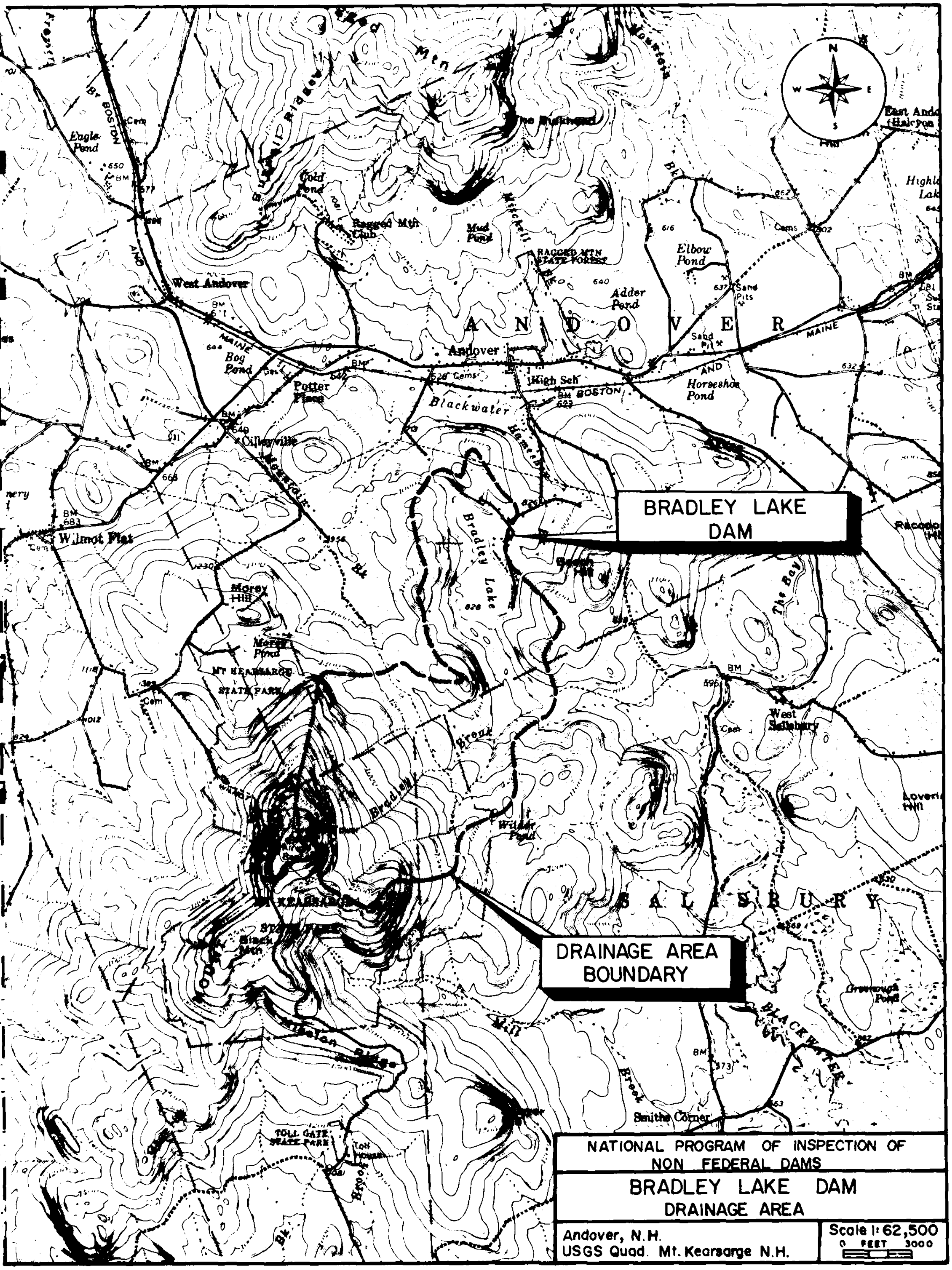
Downstream floodwave 12.7 ft

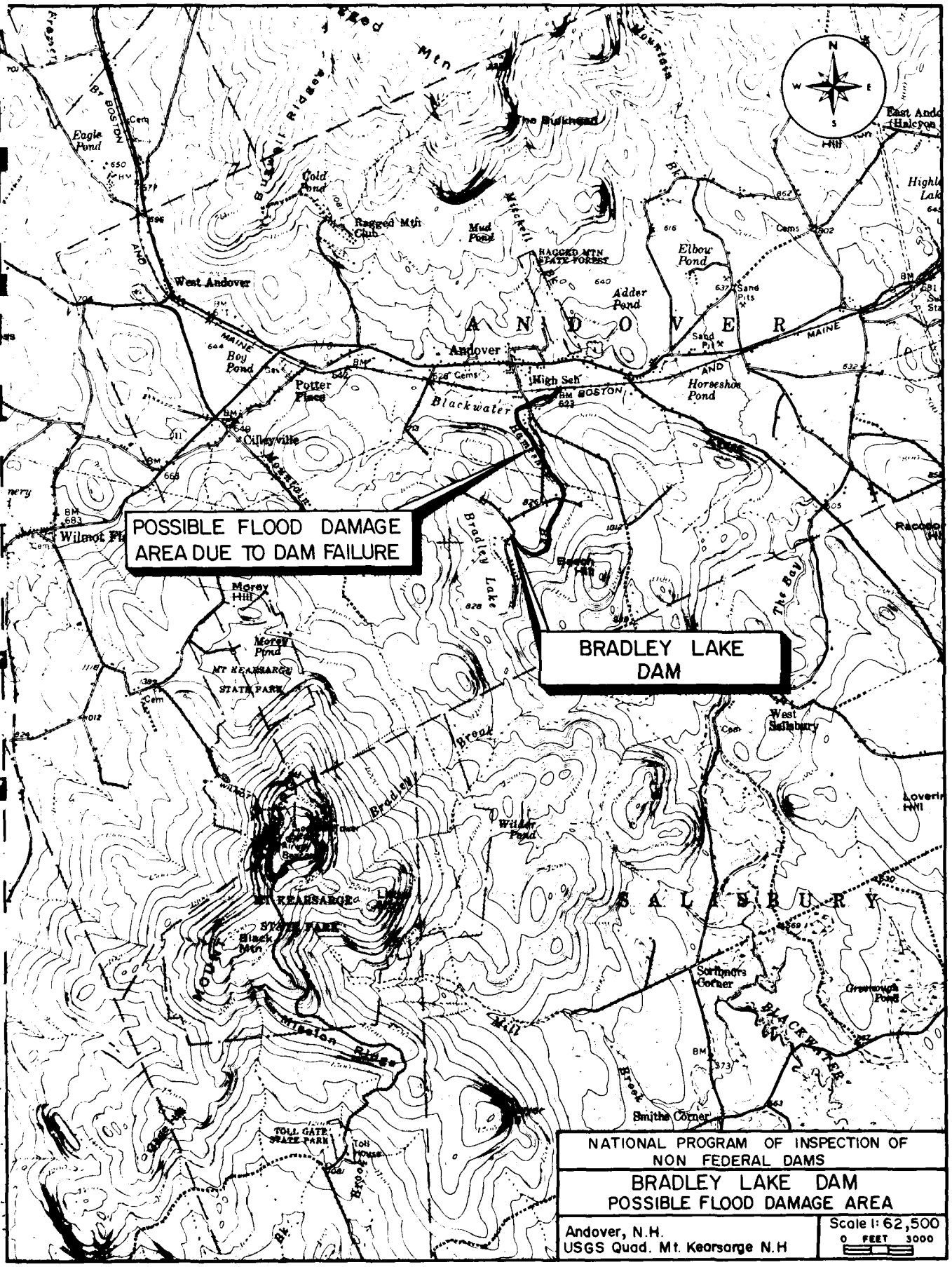


Stage-Discharge
Rating Curve
Hamesnap Brook
5b28-11-12

Figure 2

10x10 TO THE INCH


BRADLEY LAKE
DAM
DRAINAGE AREA
BOUNDARY
Andover
West Andover
Wilmot Flat
Bradley Lake
West Salisbury
Smiths Corner
NATIONAL PROGRAM OF INSPECTION OF
NON FEDERAL DAMS
BRADLEY LAKE DAM
DRAINAGE AREA
Andover, N.H.
USGS Quad. Mt. Kearsarge N.H.
Scale 1: 62,500
0 FEET 3000



NATIONAL PROGRAM OF INSPECTION OF NON FEDERAL DAMS

BRADLEY LAKE DAM
POSSIBLE FLOOD DAMAGE AREA

Andover, N.H.
USGS Quad. Mt. Kearsarge N.H

Scale 1: 62,500
0 FEET 3000

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	COUNTY	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
[illegible]	013 02	[illegible] LAKE DAM	[illegible]	7149.4	21MAY79

POPULAR NAME	NAME OF IMPOUNDMENT
	BRADLEY LAKE

BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI)	POPULATION
01 05	HARESHOP BROOK	ANDOVER	1	1138

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCT HEIGHT (FT)	HYDRAU HEIGHT (FT)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT)	NORMAL (ACRE-FT)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
[illegible]	1896	RS	19	19	5860	255[illegible]	ED	N	N	N	N	21MAY79

REMARKS

[illegible] 22 SPILLWAY REBUILT 1952

SPILLWAY			MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	PROPOSED (MW)	NAVIGATION LOCKS
343	0	50	1[illegible]	7600			

OWNER	ENGINEERING BY	CONSTRUCTION BY
[illegible]	NH WATER RES BD	NH FISH [illegible] DEPT

REGULATORY AGENCY

DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
	NONE	NH WATER RES BD	NH WATER RES BD

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
[illegible] NEEDLES TAMMEN BERGENDOFF	26APR79	PUBLIC LAW 92-367 8AUG1972

REMARKS

[illegible] SA17-AC

INVENTORY OF DAMS IN THE UNITED STATES

STATE	COUNTY	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	INSPECT DATE DAY	MO	YR
[illegible]	[illegible]	ATLEY LAKE DAM	[illegible]	7149.4	21	MAY	79

POPULAR NAME	NAME OF IMPOUNDMENT
	BRADLEY LAKE

RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI)	POPULATION
[illegible] HAMPSHIRE BROOK	ANDOVER	1	1150

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUC HEIGHT (FT)	HYDRAUL HEIGHT (FT)	IMPOUNDING CAPACITY MAXIMUM (ACRE-FT)	IMPOUNDING CAPACITY NORMAL (ACRE-FT)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
[illegible]	1890	RS	19	14	5800	2535	FED	N	N	N	N	21MAY79

REMARKS

1-HOUSE 22-SPILLWAY REBUILT 1952

DAM	SPILLWAY LENGTH (FT)	SPILLWAY TYPE	SPILLWAY GATES	MAXIMUM DISCHARGE (CFS)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PRESENTLY USED (MW)	NAVIGATION LOCKS LENGTH (FT)	LOCK WIDTH (FT)	LOCK WIDTH (FT)	LOCK WIDTH (FT)	LOCK WIDTH (FT)
2	343	G	50	[illegible]	7600							

OWNED	ENGINEERED BY	CONSTRUCTED BY
[illegible] OF ANDOVER	NH WATER RES BD	NH FISH [illegible] DEPT

REGULATORY AGENCY		
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
[illegible]	[illegible]	NH WATER RES BD	[illegible] WATER RES BD

INSPECTED BY	INSPECTION DATE DAY	MO	YR	AUTHORITY FOR INSPECTION
[illegible] AND KEELER [illegible] BENNINGTON	20	APR	79	PUBLIC LAW 92-367 AUG 1972

REMARKS

[illegible] SALT AC

END

FILMED

8-85

DTIC