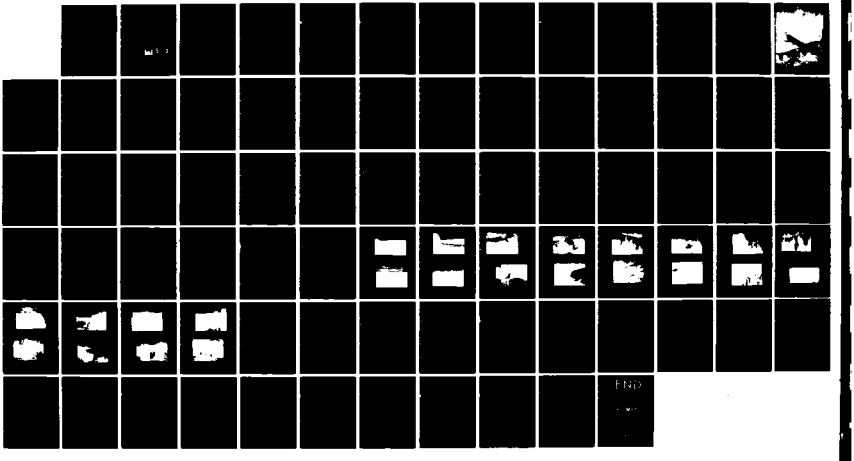
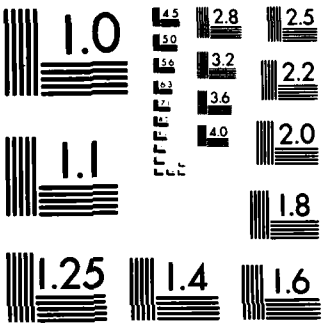
AD-A156 549 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 1/1
BELLAMY RESERVOIR DAM (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV FEB 79

UNCLASSIFIED F/G 13/13 NL





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

Copy

PISCATAQUA RIVER BASIN

MADBURY, NEW HAMPSHIRE

BELLAMY RESERVOIR DAM

NH 00471

NHWRB NO. 148.13

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

FEBRUARY 1979

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

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

REPLY TO
ATTENTION OF
NEDED

MAY 2 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 Bellamy Reservoir 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, City of Portsmouth, Portsmouth, New Hampshire 03801.

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 yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

BELLAMY RESERVOIR

NH 00471

NHWRB 148.13

PISCATAQUA RIVER BASIN
MADBURY, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No.: 00471

Name of Dam: Be'lamy Reservoir Dam

Town: Madbury

County and State: Strafford, New Hampshire

Stream: Bellamy River

Date of Inspection: November 17, 1978

Bellamy Reservoir Dam is a 462 foot long gravity concrete and earth embankment dam. The gravity concrete section is 322 feet long and has a maximum height of 38.5 feet. The earth embankment section is 140 feet long with a height of about 7 feet. Engineering data available consisted of a set of plans dated April 1959 showing plan, elevation and details of the dam. No construction specifications or design calculations were available.

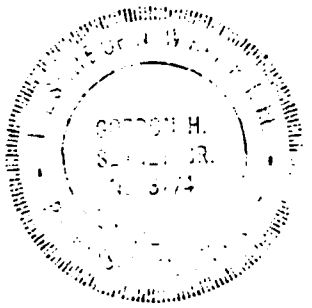
The visual inspection of Bellamy Reservoir Dam indicated that the dam is in good condition. The inspection revealed that trespassing on the embankment section of the dam has resulted in the formation of paths that are bare of vegetation on both the upstream and downstream slopes. There is also some erosion on the upstream slope of the embankment section near its juncture with the concrete section. The inspection also revealed some surface cracking and efflorescence of the concrete spillway section and the left training wall, rusting of the top and bottom truss cords at the right abutment of the service bridge, missing grating on the floor of the service bridge and fallen trees and brush growth in the spillway and outlet works discharge channels.

Based on its intermediate size and high hazard classification in accordance with the Corps guidelines the test flood is equal to the PMF. The spillway will pass the test flood and is considered adequate.

Based on the findings of the visual inspection and hydrologic and hydraulic analysis, there is no need for

further engineering studies or for major alterations to the dam. Provisions should be made by the owner to prevent trespassing on the slopes of the embankment section, establish a grassy vegetation on the paths that have been worn bare on the slopes of the embankment and repair the eroded upstream slope of the embankment section. Also, the top and bottom truss cords of the service bridge should be refurbished, the missing floor gratings should be replaced and the fallen trees and brush growth should be removed from the discharge channels.

The recommendations and remedial measures are described in Section 7 and should, unless otherwise specified, be addressed within two years after receipt of this Phase I - Inspection Report by the owner. Remedial measures regarding the embankment section should be addressed within one year.



Gordon H. Slaney, Jr.

Gordon H. Slaney, Jr., P.E.
Project Engineer

Howard, Needles, Tammen & Bergendoff
Boston, Massachusetts

This Phase I Inspection Report on Bellamy Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

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.

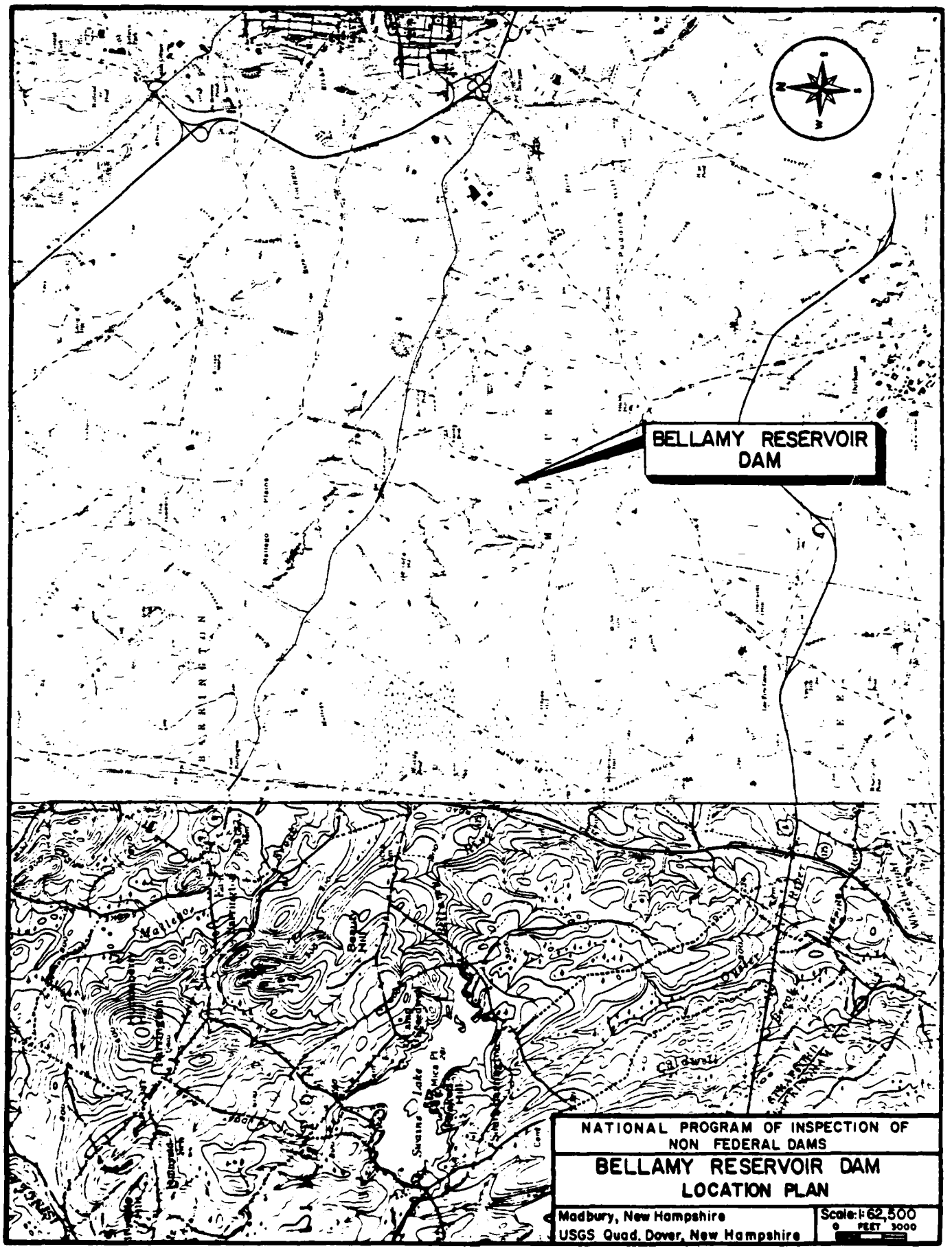
In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving 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 be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic anlayses. 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.

TABLE OF CONTENTS

BELLAMY RESERVOIR DAM - Overview from left abutment


BELLAMY RESERVOIR
DAM
NATIONAL PROGRAM OF INSPECTION OF
NON FEDERAL DAMS
BELLAMY RESERVOIR DAM
LOCATION PLAN
Madbury, New Hampshire
USGS Quad. Dover, New Hampshire
Scale: 1:62,500
0 FEET 3000

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
BELLAMY RESERVOIR 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. Bellamy Reserovir Dam is located on the Bellamy River in the Town of Madbury, New Hampshire. The dam is approximately 2.7 miles upstream from the Bellamy River crossing of Route 108 in Dover. The dam is shown on U.S.G.S. Quadrangle, Dover West, New Hampshire, with coordinates approximately N 43°10'-54", W 70°56'-54", Strafford County, New Hampshire. The location of the dam is shown on the Location Map immediately preceding this page.

b. Description of Dam and Appurtenances. Bellamy Reservoir Dam consists of a concrete gravity section and an

earth embankment section. The concrete section of the dam, consisting of fourteen 23 foot long spillway segments (monoliths), has a total length of about 322 feet. The earth embankment section, located between the left training wall of the spillway section and the left abutment, has a total length of about 140 feet. The maximum structural height, according to existing plans, is 38.5 feet for the concrete section and about 7 feet for the earth embankment section. The existing plans indicate that the concrete section of the dam is founded on bedrock.

The appurtenant structures consist of a concrete spillway, spillway channel and an outlet works structure. The spillway section consists of fourteen concrete segments (monoliths), three of which have a crest elevation of 135.0, and eleven segments with a crest elevation of 136.0.

The outlet works consist of an intake channel, a control tower containing four gates and a discharge channel. Of the four gates, two control intake and two control discharge from the gate chamber. Of the two intake gates and conduits, the low gate is located at elevation 110.5 and the high gate is located at elevation 123.0. Both discharge gates and conduits are of elevation 110.5; one of the gates controls discharge to the discharge channel, the other controls the water supply line to the City of Portsmouth's water supply system.

Figure 1, located in Appendix B, shows the plan of the dam and its appurtenant structures. Photographs of each structure are shown in Appendix C.

c. Size Classification. Intermediate (hydraulic height - 32 feet high, storage - 7,500 acre-feet) based on storage ($\geq$ 1,000 to 50,000 acre-feet) as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. The dam's potential for damage rates it as a high hazard classification. A major breach could result in a maximum flood wave stage of about 26.5 feet in Dover, 2.7 miles downstream. Structures that could be affected by a dam breach include an apartment complex located about two miles downstream and dwellings along Bellamy Road. A flood wave of the magnitude described could be expected to cause a substantial amount of damage and loss of life.

e. Ownership. This dam is owned by the City of Portsmouth, New Hampshire 03801.

f. Operator. This dam is maintained and operated by the City of Portsmouth, New Hampshire. The Superintendent of Water Works is Mr. Randy Collins. Telephone No. 603-436-2436.

g. Purpose of Dam. This dam is used for water supply for the City of Portsmouth. Water is pretreated in the reservoir with diffused air. Final treatment occurs seven miles downstream.

h. Design and Construction History. This dam was constructed in about 1962. Plans were prepared by Whitman and Howard Inc. and the Corps of Engineers and are on file with the New Hampshire Water Resources Board. This dam was designed and constructed to replace the City of Portsmouth's well water supply system which had to be abandoned during construction at Pease Air Force Base. No design or construction data other than the plans were disclosed.

i. Normal Operating Procedure. No data was disclosed for maintenance of reservoir water levels. Under normal operation, water supply is drawn from the high level intake with the low level intake closed. The 24 inch discharge line is usually partially open to provide downstream channel flow.

1.3 Pertinent Data

a. Drainage Area. The drainage area tributary to Bellamy Reservoir consists of approximately 22.4 square miles of flat to rolling terrain. In addition to the reservoir, 8 percent of the basin is made up of lake and swamp area. A large percentage of the lakes and swamps are located in the lower portion of the watershed. Contours in the basin range from about 400 feet to 135 feet MSL.

The reservoir consists of about 370 acres at the normal (top of spillway) pool elevation. No dwellings are located along the reservoir shores. There are three small islands in the reservoir and a roadway separates the upper one-third of the reservoir area.

b. Discharge at Dam Site

(1) The outlet works for the reservoir consists of two 24 inch diameter intake lines, one low level and one high level with inverts of 110.5 and 123.0 feet MSL, respectively. Water is discharged by one of two 24 inch diameter pipes, both set at about elevation 110.5. One 24 inch diameter line transports water to the City of Portsmouth's water treatment plant and the other discharges to the discharge channel.

(2) There are no records of maximum discharge at the dam site, however, in February of 1978, a depth of flow of

6 inches was measured at the crest of the high spillway. This would give a discharge of approximately 830 cfs.

(3) The spillway capacity with a water surface at the top of dam (elevation 142.0) would be approximately 19,390 cfs.

(4) The spillway capacity with the water surface at the test flood elevation of 141.9 feet is approximately 18,870 cfs.

(5) The total project discharge at the test flood elevation of 141.9 feet is 18,870 cfs.

c. Elevation (feet above MSL)

(1) Streambed at centerline of dam - 110.0.

(2) Maximum tailwater - see Section 5.

(3) Upstream portal invert diversion tunnel - 110.5. and 123.0.

(4) Recreation pool - N/A.

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

(6) Spillway crest (permanent spillway) - 135.0 low level and 136.0 high level.

(7) Design surcharge - unknown.

(8) Top Dam - 142.0.

(9) Test Flood Surcharge - 141.2.

d. Reservoir (miles)

(1) Length of Maximum Pool - 0.6 open fetch.

(2) Length of Recreational Pool - N/A.

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

e. Storage (gross acre-feet)

(1) Recreation Pool - N/A.

(2) Flood Control Pool - N/A.

(3) Spillway Crest Pool - high level 3,760.

(4) Top of Dam - 7,500.

f. Reservoir Surface (acres)

(1) Recreation Pool - N/A.

(2) Flood Control Pool - N/A.

(3) Spillway Crest - 370.

(4) Test Flood Pool - 700 approximate.

(5) Top Dam - 750.

g. Dam

(1) Type - concrete gravity dam.

(2) Length - 462 feet, overall.

(3) Height - 38.5 feet (maximum).

(4) Top Width - varies.

(5) Side Slopes - US = Vert.; DS = 1:1 approximate.

(6) Zoning - None.

(7) Impervious core - N/A.

(8) Cutoff - yes.

(9) Grout Curtain - unknown.

(10) Other - none.

h. Diversion and Regulating Tunnel

See Section j below.

i. Spillway

(1) Type - concrete ogee.

(2) Length of Weir — 253 feet at elevation 136

(3) Crest Elevation — 69 feet at elevation 135

(4) Gates - None.

(5) U/S Channel - None.

(6) Downstream Channel. Immediately downstream of the dam (200 feet), the channel is severely restricted by a culvert and embankment which is part of Mill Hill Road. The culvert has a 12x14 foot opening. The embankment is substantial, crossing the entire river valley. The low point on the roadway is approximately elevation 143.0, which is one foot higher than the top of the dam.

About 2 miles downstream of the dam there is an apartment complex located on the north bank of Bellamy River.

j. Regulating Outlets. The reservoir can be drained by a 24 inch outlet pipe set at approximately elevation 110.5. This pipe is controlled by a butterfly valve, located at the discharge end of the pipe. The outlet capacity of the 24 inch drain pipe is approximately 85 cfs. With no base flow and using only the 24 inch drain pipe, the reservoir could be drained in approximately 23 days. The two water supply intakes feed a 24 inch diameter transmission line. The intakes are controlled separately and also are valved at the head of the 24 inch main.

SECTION 2
ENGINEERING DATA

2.1 Design

Bellamy Reservoir Dam was constructed in 1962 for water supply purposes. A set of plans dated April 1959 prepared by Whitman & Howard, Inc. and the New England Division, Corps of Engineers, showing plan, elevation, typical sections and details is available at the State of New Hampshire Water Resources Board. No in-depth engineering data were found for this dam.

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. Other than the set of plans described above, no additional engineering data was found to be available.

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 judgment.

c. Validity. The field investigation indicated that the external features of Bellamy Reservoir Dam substantially agree with those shown on the available plans.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of Bellamy Reservoir Dam was made on November 17, 1978. The inspection team consisted of personnel from Howard, Needles, Tammen & Bergendoff and Geotechnical Engineers, Inc. Representatives of the State of New Hampshire Water Resources Board and the City of Portsmouth were also present during portions of the inspection. Inspection checklists, completed during the visual inspection are included in Appendix A. At the time of the inspection, the water level was approximately 5 feet below the permanent spillway elevation. No water was passing over the spillway. The upstream face of the dam could only be inspected above this water level.

b. Dam. The dam consists of a concrete gravity section, about 322 feet long, and an embankment section, about 140 feet long, extending from the north end of the concrete section to the north abutment. The crest of the concrete section is at elevation 135, and the crest of the embankment section is at elevation 145, according to the design drawings.

According to the design drawings, the concrete section is founded on bedrock. The appearance of bedrock outcrops at several locations near the downstream toe is consistent with the design drawings in this respect. There was no evidence of seepage under the concrete section of the dam, or at the base of the vertical retaining wall against which the downstream section of the earth embankment was placed at the north end of the concrete dam, or at the left abutment of the dam. Seepage under the concrete dam at the deepest part of the valley, if any, would not have been visible at the time of the inspection because of the tailwater against the downstream toe.

The embankment section, the crest of which is 10 feet higher than the crest of the concrete section, is generally covered with grass.

A few small trees are growing on the downstream slope of the embankment. There is a rockfill at the downstream toe of the embankment. There is one bare path down the downstream slope, apparently due to trespassing.

The upstream toe of the embankment section was above reservoir level at the time of the inspection, and bedrock

was exposed at the toe near the juncture between the embankment and the concrete dam. There are two bare paths down the upstream slope, apparently due to trespassing. There is also some erosion of the upstream slope of the embankment close to the vertical retaining wall against which the embankment was placed at the north end of the concrete dam.

There is no information in the available design drawings as to whether the embankment section is founded on bedrock or not.

No seepage was observed at the downstream slope or downstream toe of the embankment.

c. Appurtenant Structures. Visual inspection of the concrete spillway, spillway channel, outlet works, outlet works conduits and service bridge did not reveal any evidence of stability problems. The concrete surface and construction joints generally appeared to be in good condition except for some cracks in the concrete spillway surface. There was also evidence of efflorescence, a whittish crystalline deposit on the concrete surface at the construction joints. The location of the spillway surface cracks and efflorescence deposits are shown on Figure 1, located in Appendix B.

The spillway structure, shown in Photos 7, 8 and 10, consists of fourteen massive concrete segments, each 23 feet long, and two training walls. The concrete spillway surface is in good condition. There are, however, some surface cracks and efflorescence deposits, mostly concentrated around the construction joints, as can be seen in Photos 12, 13, 17 and 18. Field inspection of the training walls revealed concrete surface cracks and heavy efflorescence deposit on the left training wall (Photos 13, 14 and 15). Photo 14 indicates some spalling of the concrete surface.

The outlet works consists of an intake channel, a gate chamber with four control gates, two discharge conduits and a discharge channel. As the intake structure was below water, it was not inspected. Of the four gates located in the gate chamber, two are used for inlet control and two are used to control discharge from the gate chamber. The intake conduits are located at two levels, one at elevation 110.5, the other at elevation 123. Normally, the upper gate is used for water intake. The discharge conduits, each 24 inches in diameter, are both located at elevation 110.5. One conduit is for draining the reservoir, the other for transporting water to the City of Portsmouth's water system. As all gates were below water in the gate chamber, they could not be inspected. However, all parts of the gate chamber that could

be inspected, including concrete and gate guides, appeared to be in good condition.

The outlet works discharge channel has fallen trees within the channel limits and is lined with brush cover on both sides of the channel. The discharge channel appears to have a rock bottom.

The service bridge to the gate chamber is a simple span truss structure consisting of WT4 standard shapes as the truss cords and 1¼ angles as the truss diagonals. The floor consists of metal gratings, some sections of which are missing. The main carring members, bearing plates, connections, roofing and floor are generally in good condition. The top and bottom truss cords, however, are rusted at the right abutment. The bridge is supported by the right training wall and the gate chamber. The concrete in both supporting areas is in good condition.

The spillway discharge channel is the original Bellamy River bed. Visual inspection of the discharge channel showed it to be in generally good condition. There were several fallen trees and light brush growth along the sides of the channel. The bed of the discharge channel could not be totally inspected as it was below water (caused by the small four foot high dam immediately downstream).

d. Reservoir Area. The reservoir area has gently rolling terrain, partially wood covered and partially pasture land. A more detailed description of the drainage area is included in Section 1.3 of this report. There were no cottages or docks observed along the shoreline. Immediately upstream of the dam, the reservoir has four air lines providing a diffused air treatment of the water.

e. Downstream Channel. The spillway discharge channel and the outlet works discharge channel join together to form the downstream channel. Just below this junction and just above the Mill Hill Road culvert, the channel has a four foot vertical drop caused by a small "dam" located in the channel. This "dam" creates a pool of water which backs up to the toe of the spillway section. Below this "dam" the channel passes through a 12 foot wide by 14 foot high roadway culvert as shown in Photos 23 and 24. The channel below Mill Hill Road is a relatively clean, rock bottom channel, lined with overhanging trees.

3.2 Evaluation

Visual examination indicates that the dam is in good condition. No seepage was observed from the

foundation or abutments of either the concrete or embankment sections of the dam. The inspection revealed the following:

(a) Trespassing on the embankment section of the dam has resulted in the formation of paths that are bare of vegetation on both the upstream and downstream slopes. There is also some erosion on the upstream slope of the embankment section (the toe of which was founded on bedrock at an elevation above the reservoir level at the time of inspection) near its juncture with the concrete section. Routine maintenance and control of trespassing, however, should be sufficient to prevent any long-term stability problems due to erosion of the embankment.

(b) Some surface cracking and efflorescence of the concrete spillway section and the left training wall.

(c) Rusting of the top and bottom truss cords at the right abutment of the service bridge.

(d) Missing grating on the floor of the service bridge.

(e) Fallen trees and brush growth in the spillway and outlet works discharge channels.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedure

The Bellamy Reservoir Dam creates an impoundment of water which is used primarily as a water supply source. The normal operational procedure is to draw water from the reservoir and pipe it approximately seven miles to the City of Portsmouth's water treatment plant. In order to maintain a minimum downstream flow, the gate provided for the dewatering the reservoir is left in a partially open position.

4.2 Maintenance of Dam

This dam is visited on a frequent basis by personnel of the Portsmouth Water Works Department. These visits are primarily for surveillance of the reservoir for water quality control purposes. General maintenance is accomplished during these visits.

4.3 Maintenance of Operating Facilities

Maintenance on the operating facilities is done on an as needed basis.

4.4 Description of Warning Systems

There are no warning systems in effect at this facility.

4.5 Evaluation

The current operation and maintenance procedures for Bellamy Reservoir 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 as well as establishing a warning system to follow in event of flood flow conditions or imminent dam failure.

SECTION 5
HYDROLOGY AND HYDRAULIC ANALYSIS

5.1 Evaluation of Features

a. General. Bellamy Reservoir Dam is a composite structure consisting of a 322 foot long gravity concrete section and a 140 foot long earth embankment section giving a total length of 462 feet. The maximum structural height of the dam is 38.5 feet for the concrete section and about 7 feet for the earth embankment. The appurtenant structures consist of a concrete spillway, spillway channel and an outlet works structure. The spillway consists of two levels, one being 69 feet long at elevation 135.00 and one 253 feet long at elevation 136.00. The outlet works consist of an intake channel, a control tower containing four gates and a discharge channel. Of the four gates, two control intake and two control discharge from the gate chamber. Of the two intake gates and conduits, the low gate is located at elevation 110.5 and the high gate is located at elevation 123.0. Both discharge gates are at elevation 110.5; one of the gates controls discharge to the discharge channel, the other controls the water supply line to the City of Portsmouth's water supply system. Bellamy Reservoir Dam is classified as being intermediate in size having a maximum storage of 7,500 acre-feet.

b. Design Data. No hydrologic or hydraulic design data were disclosed for Bellamy Reservoir Dam.

c. Experience Data. The maximum discharge at this dam site is unknown. The maximum observed condition was reported to be 6 inches over the high spillway or about 830 cfs.

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

e. Overtopping Potential. 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 the Probable Maximum Flood (PMF) as determined by guide curves issued by the Corps of Engineers. Based on a drainage area of 22.4 square miles, it was estimated that the test flood inflow at Bellamy Reservoir Dam would be 23,000 cfs. Following the guidance for Estimating Effect of Surcharge Storage on Maximum Probable Discharge results in a test flood discharge of 18,870 cfs. As the maximum spillway

capacity at the top of dam is 19,390 cfs, the spillway can pass the entire PMF without overtopping the dam.

The results of the PMF discharge given above discount the tailwater which would be created by the downstream culvert and embankment discussed in Section 1.3 i.(6). As the maximum discharge of the culvert is around 5,000 cfs when the water level is at elevation 143.0, the culvert headwater will submerge the dam spillway. It is estimated that the test flood elevation would be well above the top of dam with inclusion of the tailwater in the analysis.

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 Bellamy Road in Dover. The analysis does not include the effects of the Mill Hill Road embankment.

A major breach of dam would probably result in a total downstream flood stage, at Bellamy Road 2.7 miles downstream, of 26.5 feet. Structures that could be effected by the flood wave include an apartment complex located 2 miles downstream of the dam and several dwellings at Bellamy Road. Downstream of Black River Road (3.3 miles downstream of the dam) there are about 15 to 20 commercial and industrial structures along the banks of the Bellamy River that would be expected to sustain damage. A flood wave of this magnitude could be expected to cause a substantial amount of damage and loss of life.

As noted above, the analysis does not take into consideration the effects from the Mill Hill Road embankment. If this embankment held intact during the breach of dam outflow, a maximum flood stage downstream would be in the order of 12 feet (at 5,000 cfs) which would result in much less damage and significantly reduce the hazard to life.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The visual examination did not disclose any immediate stability problems. Trespassing on both the upstream and downstream slopes of the embankment section of the dam, and minor erosion of the upstream slope near the juncture of the embankment and concrete sections could lead to long-term instability if allowed to continue. Routine maintenance should be sufficient to prevent any long-term problems.

b. Design and Construction Data. Design drawings are available for the dam. They include logs of borings made during the design phase and cross sections of the concrete dam.

Grouting was called for in the plans, as follows: "Approximate limits of grout curtain to extend from Sta. 0+13 to Sta. 3+35. Curtain grout holes initially to be spaced 10'-0" c. to c. and approximately 25 feet in depth. Split spacing and area grouting to be determined from field conditions."

The only information given on the drawings with respect to the design of the cross section of the embankment is as follows: "Details of embankment fill for left abutment will be determined after excavation is completed." The maximum height of the embankment section is 7 feet.

c. Operating Records. No operating records pertinent to the structural stability of the dam were available.

d. Post Construction Changes. Since original construction in about 1962, a blower building and compressed air tubing has been added at the site. This addition was, however, for water quality purposes. No changes have been made to the dam, itself.

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

SECTION 7
ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination indicates that the dam is in good condition. The inspection revealed:

(1) Trespassing on the embankment section of the dam.

(2) Erosion of the upstream slope of the embankment section.

(3) Some surface cracking and effloresence of the concrete spillway section and the left training wall.

(4) Rusting of the top and bottom truss cords at the right abutment of the service bridge.

(5) Missing grating on the floor of the service bridge.

(6) Fallen trees and brush growth in the spillway and outlet works discharge channel.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definintive 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. Urgency. This dam is in good condition. The recommendations and remedial measures described in Sections 7.2 and 7.3 should, unless otherwise specified, be accomplished within two years after receipt of this Phase I Inspection Report by the owner. Remedial measures 7.3a and 7.3b should be addressed within one year.

d. Need for Additional Investigation. The findings of this inspection indicate that there is no need for additional investigation.

7.2 Recommendations

Based on the findings of the visual inspection and hydrologic and hydraulic analysis, there is no need for further engineering studies or for major alternations to the dam. The owner should, however, consider undertaking a study, in conjunction with the owner of Mill Hill Road, of the hydraulic effects of the Mill Hill Road culvert on channel discharge.

7.3 Remedial Measures

(a) Trespassing on the slope of the embankment section of the dam should be prevented, and grassy vegetation should be established on the paths that have been worn bare on the slopes of the embankment.

(b) The eroded area at the toe of the upstream slope of the embankment section should be repaired.

(c) The top and bottom truss cords of the service bridge at the right abutment should be refurbished and missing floor grating should be replaced.

(d) The surface cracks and efflorescence of the spillway section should be inspected periodically to monitor any changes in the conditions noted.

(e) The fallen trees and brush growth should be removed from the discharge channels. All trees and brush growth on left earth section of dam should also be removed.

(f) Develop a written operational procedure and warning system to follow in the event of flood flow conditions or imminent dam failure.

(g) Continue the technical inspection program on a bi-annual basis.

7.4 Alternatives

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

APPENDIX A

VISUAL CHECKLIST WITH COMMENTS

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Bellamy Dam

DATE November 17, 1978

TIME 9:00 a.m.

WEATHER Cold, Partly Cloudy

W.S. ELEV. 128.0 U.S. 110.0± DN.S

PARTY:

1. Gordon Slaney
2. Stan Mazur
3. Ronald Hirschfeld
4. Pattu Kesavan - N.H. Water Resources Board
5.
6.
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam	Ronald Hirschfeld	
2.	Spillway, Outlet Works	G. Slaney & S. Mazur	
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT Bellamy Dam DATE November 17, 1978

PROJECT FEATURE Dam Embankment NAME R. Hirschfeld

DISCIPLINE Geotechnical Engineer NAME

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	135.0
Current Pool Elevation	128.0
Maximum Impoundment to Date	136.5
Surface Cracks	None apparent.
Pavement Condition	Not paved.
Movement or Settlement of Crest	None apparent.
Lateral Movement	None apparent.
Vertical Alignment	Good.
Horizontal Alignment	Good.
Condition at Abutment and at Concrete Structures	Good. Minor erosion at upstream toe adjacent to concrete retaining wall.
Indications of Movement of Structural Items on Slopes	None apparent.
Trespassing on Slopes	Two paths worn bare on upstream slope, one on downstream slope.
Sloughing or Erosion of Slopes or Abutments	See comment under "Condition of Abutment...", above.
Rock Slope Protection - Riprap Failures	No riprap.
Unusual Movement or Cracking at or near Toes	None apparent.
Unusual Embankment or Downstream Seepage	None apparent.
Piping or Boils	None apparent.
Foundation Drainage Features	None apparent.
Toe Drains	Dumped rock at downstream toe near retaining wall at south end of embankment.
Instrumentation System	None apparent.
Vegetation	Uncut grass and a few trees about 6 inches in diameter on downstream slope.

PERIODIC INSPECTION CHECK LIST

PROJECT Bellamy Dam DATE November 17, 1978

PROJECT FEATURE Intake Channel/Structure NAME R. Hirschfeld

DISCIPLINE Geotechnical/Structural Engineers NAME S. Mazur

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	Good.
Bottom Conditions	Not visible beneath reservoir surface.
Rock Slides or Falls	None.
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	None.
b. Intake Structure	
Condition of Concrete	Intake structure was not visible above water level.
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT Bellamy Dam DATE November 17, 1978

PROJECT FEATURE Control Tower NAME S. Mazur

DISCIPLINE Structural/Hydraulic Engineers NAME G. Slaney

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	Outlet works structure consist of gate chamber and two conditions; the waste-water conduits and conduit to the City of Portsmouth Water System. Gates and control mechanisms are in good and operational condition.
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	Gates and operating mechanisms are located in gate chamber. Gates were not accessible for inspection. Control mechanisms are in good condition.
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 Bellamy Dam

DATE November 17, 1978

PROJECT FEATURE Outlet Work Conduits

NAME S. Mazur

DISCIPLINE Structural/Hydraulic Engineer

NAME G. Slaney

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	At the time of inspection, outlet works conduits were under water. These conduits are inclosed by mass of concrete and are probably in very good condition.
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECK LIST

PROJECT Bellamy Dam

DATE November 17, 1978

PROJECT FEATURE Outlet Structure/Channel

NAME R. Hirschfeld

DISCIPLINE Structural/Hydraulic/Geotechnical Engineers

NAME S. Mazur & G. Slaney

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Good.
Rust or Staining	None observed.
Spalling	None.
Erosion or Cavitation	None.
Visible Reinforcing	None.
Any Seepage or Efflorescence	None observed.
Condition at Joints	Good.
Drain Holes	None.
Channel	
Loose Rock or Trees Overhanging Channel	Some trees and brush overhanging channel.
Condition of Discharge Channel	Good.

PERIODIC INSPECTION CHECK LIST

PROJECT Bellamy Dam — DATE November 17, 1978

PROJECT FEATURE Outlet Works/Spillway — NAME R. Hirschfeld

DISCIPLINE Structural/Hydraulic/Geotechnical Engineers — NAME S. Mazur, G. Slaney

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good.
Loose Rock Overhanding Channel	None.
Trees Overhanging Channel	None.
Floor of Approach Channel	Not visible beneath reservoir surface.
b. Weir and Training Walls	
General Condition of Concrete	Good.
Rust or Staining	None.
Spalling	Some spalling at left training wall (Photo 14).
Any Visible Reinforcing	None.
Any Seepage or Efflorescence	Efflorescence at construction joints.
Drain Holes	None.
c. Discharge Channel	
General Channel	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	Some trees and brush overhanging channel.
Floor of Channel	Apparently bedrock.
Other Obstructions	Small weir downstream of dam maintains a shallow pool.

PERIODIC INSPECTION CHECK LIST

PROJECT Bellamy DATE November 17, 1978

PROJECT FEATURE Service Bridge NAME S. Mazur

DISCIPLINE Structural Engineer NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	
Bearings	Good (sliding plates).
Anchor Bolts	Good.
Bridge Seat	Good condition.
Longitudinal Members	Truss (4-WT4 with 14 angles as diagonals), good condition.
Under Side of Deck	
Secondary Bracing	
Deck	Grating, good condition; some sections are missing.
Drainage System	None.
Railings	Good.
Expansion Joints	None.
Paint	Good (top and bottom truss cords rusted at right abutment).
b. Abutment & Piers	
General Condition of Concrete	Bridge is supported by the dam structure, right training wall and gate chamber at 12th segment of the spillway section.
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

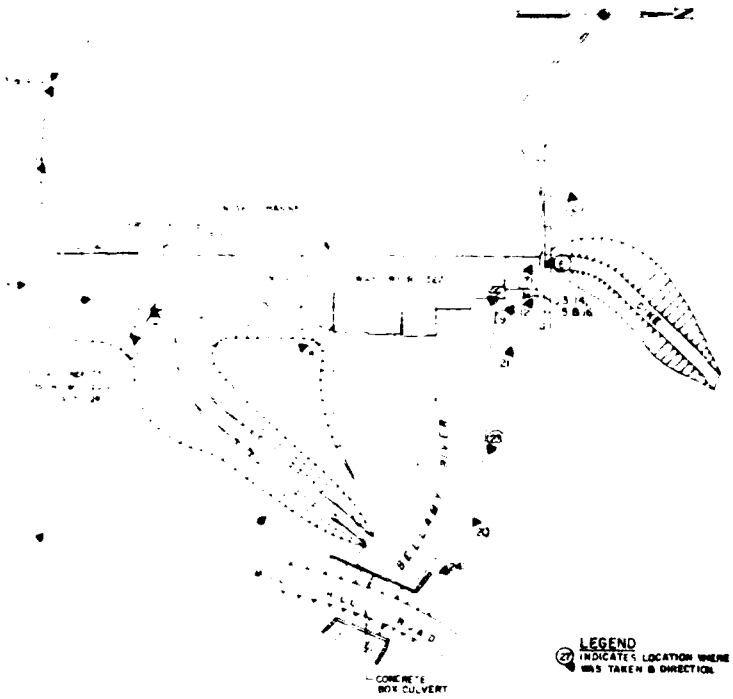
APPENDIX B

ENGINEERING DATA

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

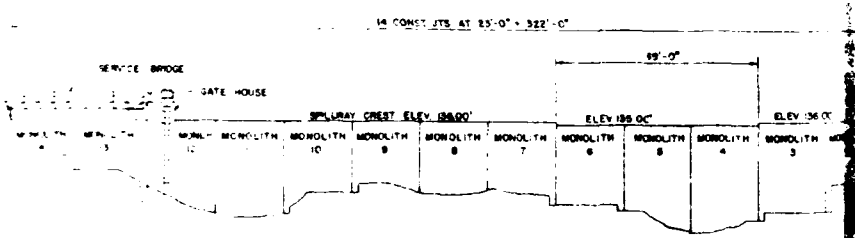
AVAILABLE ENGINEERING DATA

A set of drawings prepared by Whitman & Howard Inc. and the New England Division Corps of Engineers, dated April 1959, showing plans, elevations and details of the dam is available at the State of New Hampshire Water Resources Board, 37 Pleasant Street, Concord, New Hampshire 03301.

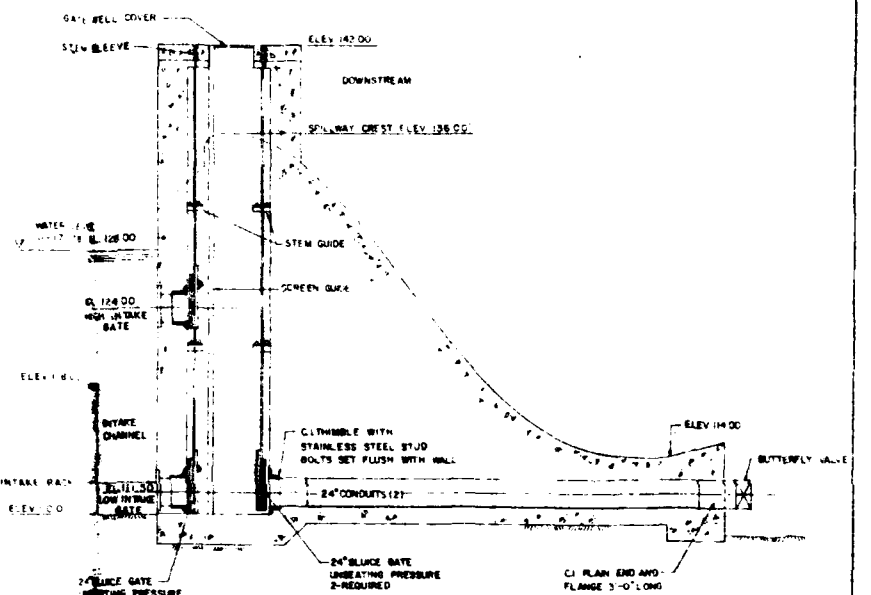


PLAN

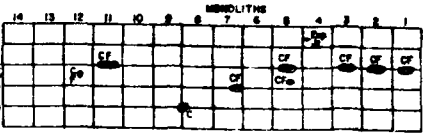
LEGEND
(27) INDICATES LOCATION WHERE PHOTO WAS TAKEN & DIRECTION



CROSS SECTION



SECTION THRU OUTLET STRUCTURE



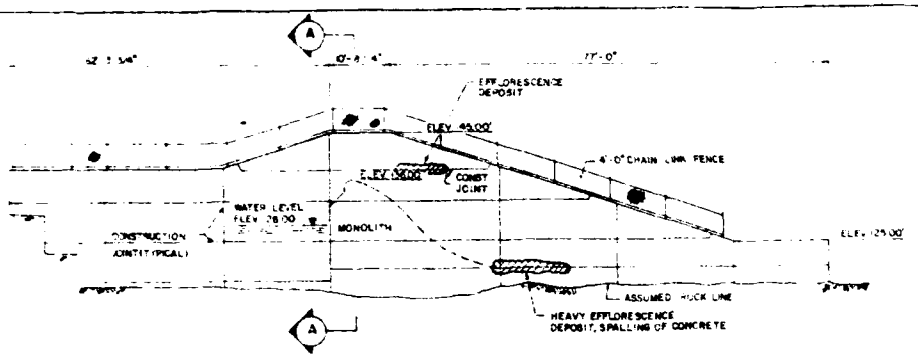
SCHEMATIC ELEVATION OF SPILLWAY SECTION
(DOWNSTREAM FACE)

NOTES

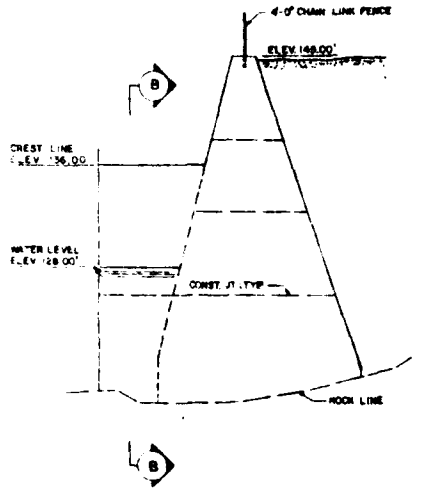
1. THE INFORMATION SHOWN ON THESE DRAWINGS IS BASED ON THE ORIGINAL CONSTRUCTION PLANS AND VISUAL OBSERVATIONS MADE DURING THE FIELD INSPECTION. DIMENSIONS OR MATERIALS INDICATED ON THESE DRAWINGS WHICH WERE BELOW GRADE OR WATER DURING THE TIME OF INSPECTION WERE NOT VERIFIED.
2. THE ELEVATIONS SHOWN ARE U.S.C. & G.S. DATUM

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

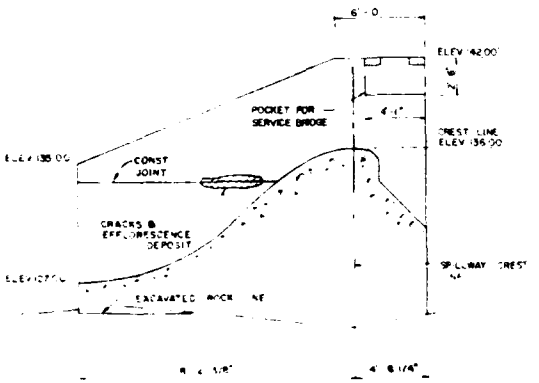
BELLAMY RESERVOIR DAM



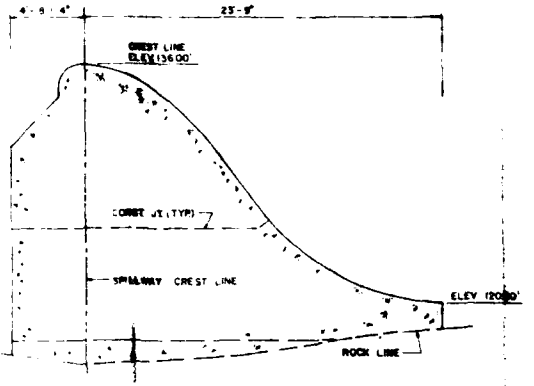
ELEVATION LEFT ABUTMENT



SECTION A-A



ELEVATION RIGHT ABUTMENT



SECTION B-B

NOTES

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. DATUM

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

BELLAMY RESERVOIR DAM

BELLAMY RIVER — MADBURY, NEW HAMPSHIRE

PAST INSPECTION REPORTS

No past inspection reports or engineering design data were found for the dam.

APPENDIX C

PHOTOGRAPHS

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

PHOTO NO. 1 - View looking upstream from roadway downstream of dam, showing reservoir, concrete spillway and discharge channel.

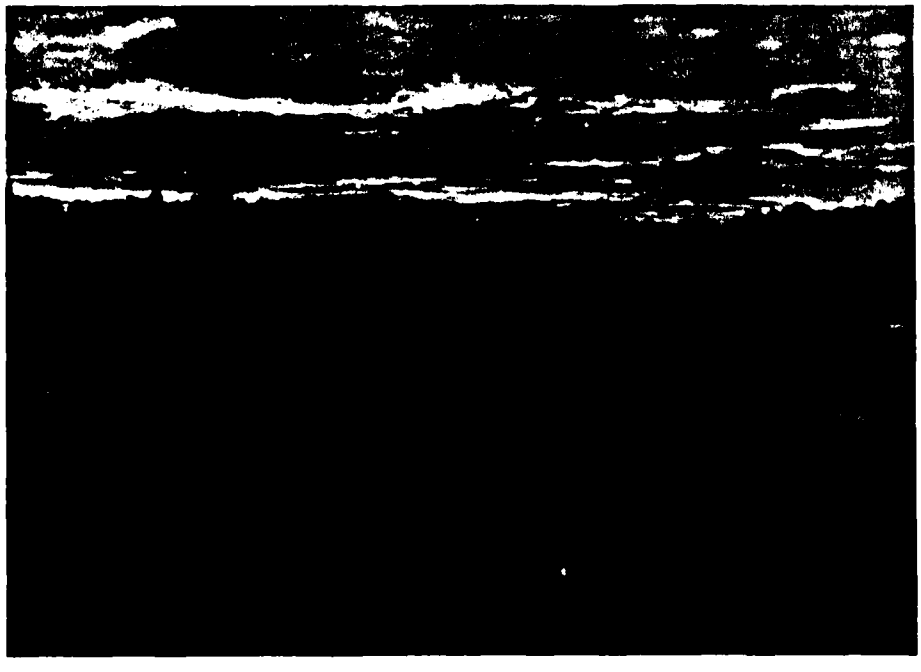


PHOTO NO. 2 - View of reservoir from enbankment at left abutment.

PHOTO NO. 3 - Series of two photos (3 & 4) taken clockwise from right side of reservoir showing reservoir, earth embankment and concrete spillway.

PHOTO NO. 4 - (See Photo No. 3).

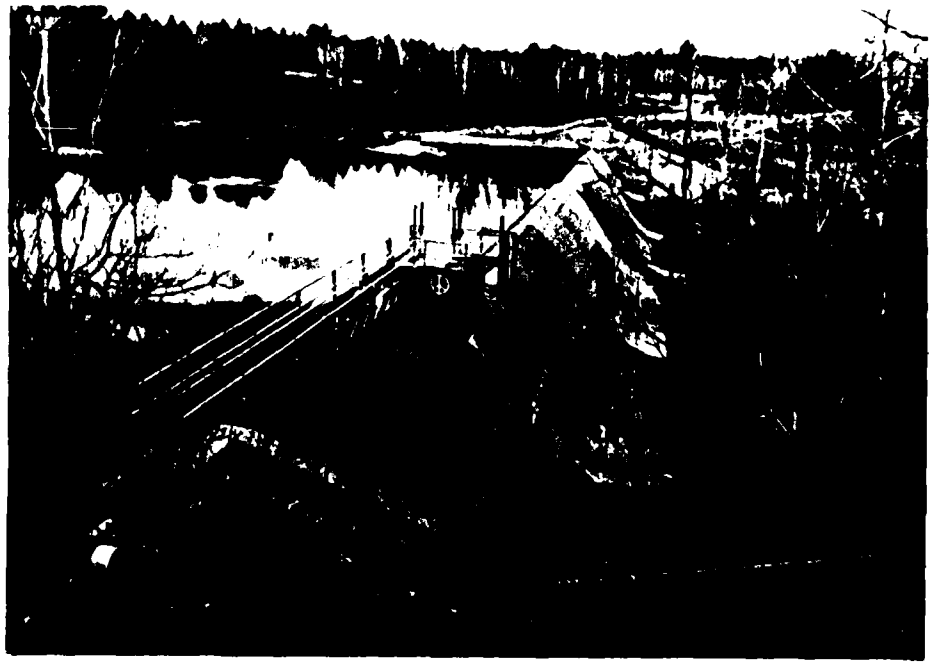


PHOTO NO. 5 - View of dam from right abutment.

PHOTO NO. 6 - View of dam from embankment at left abutment.

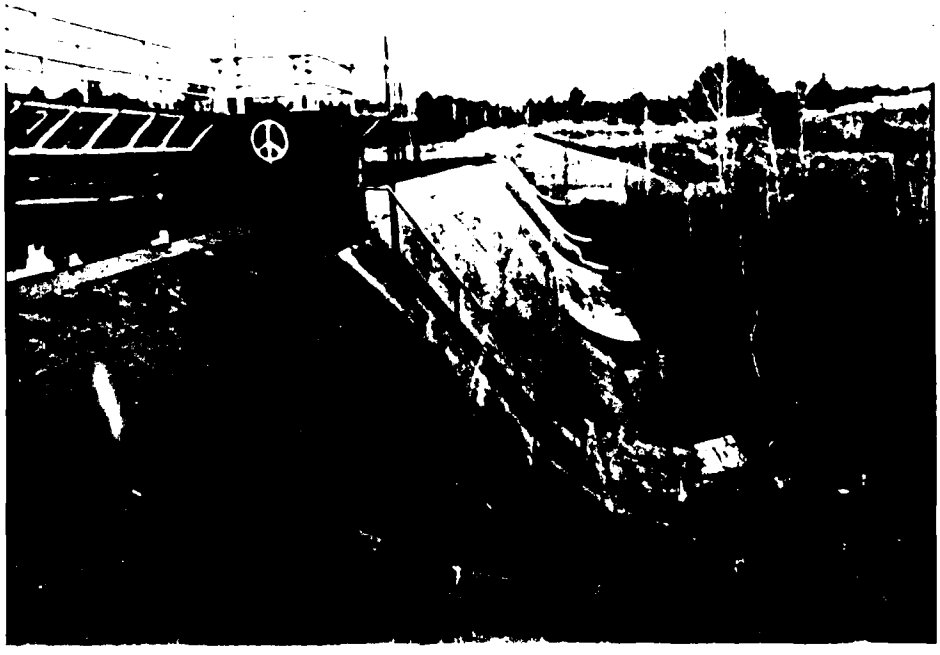


PHOTO NO. 7 - Downstream face of spillway from right abutment.

PHOTO NO. 8 - Downstream face of spillway from left side of dam.

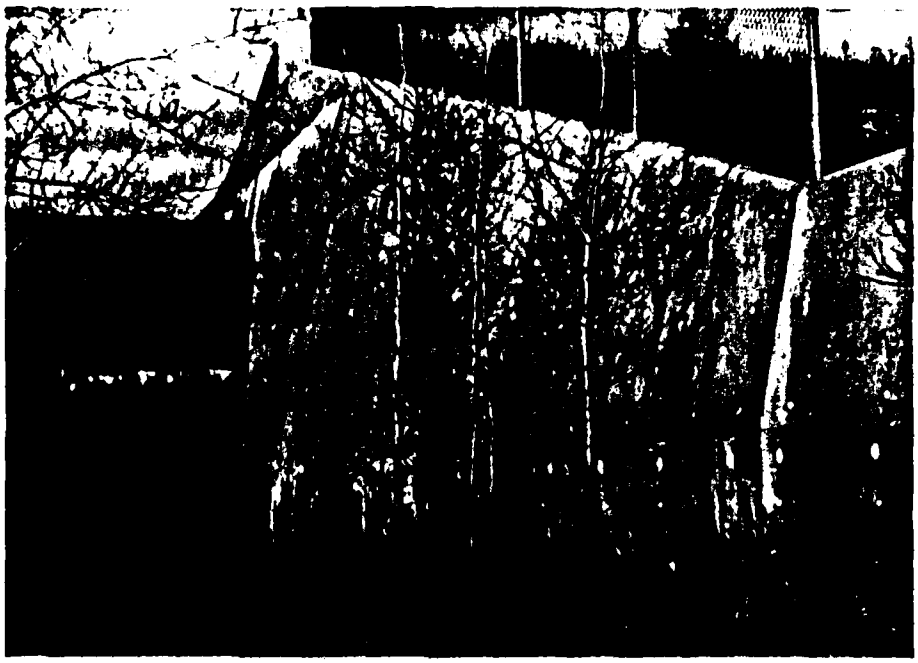


PHOTO NO. 9 - Elevation of left training wall from downstream side of dam.

PHOTO NO. 10 - Bedrock exposed at downstream toe of concrete spillway section at right abutment. No signs of seepage.

PHOTO NO. 11 - View of earth embankment at left abutment from downstream of dam.

PHOTO NO. 12 - Left training wall and concrete spillway. Evidence of efflorescence at construction joints.

PHOTO NO. 13 - Series of three photos (13, 14 & 15) taken at left training wall showing evidence of efflorescence, from general location to close-up details, at construction joints.

PHOTO NO. 14 - (See Photo No. 13).

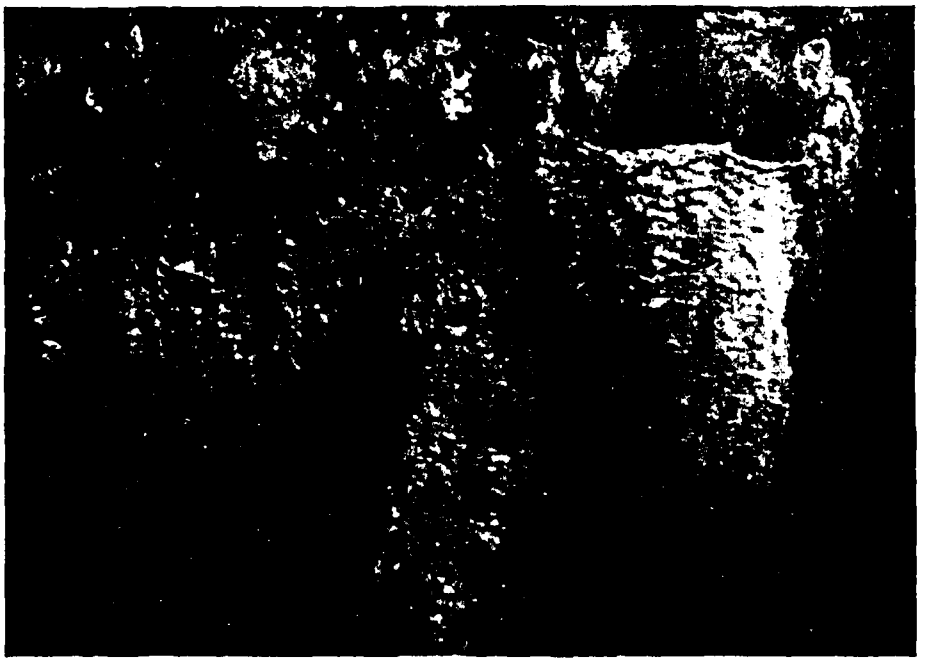


PHOTO NO. 15 - (See Photo No. 13).

PHOTO NO. 16 - Close-up view of concrete surface at segment 1, spillway structure.

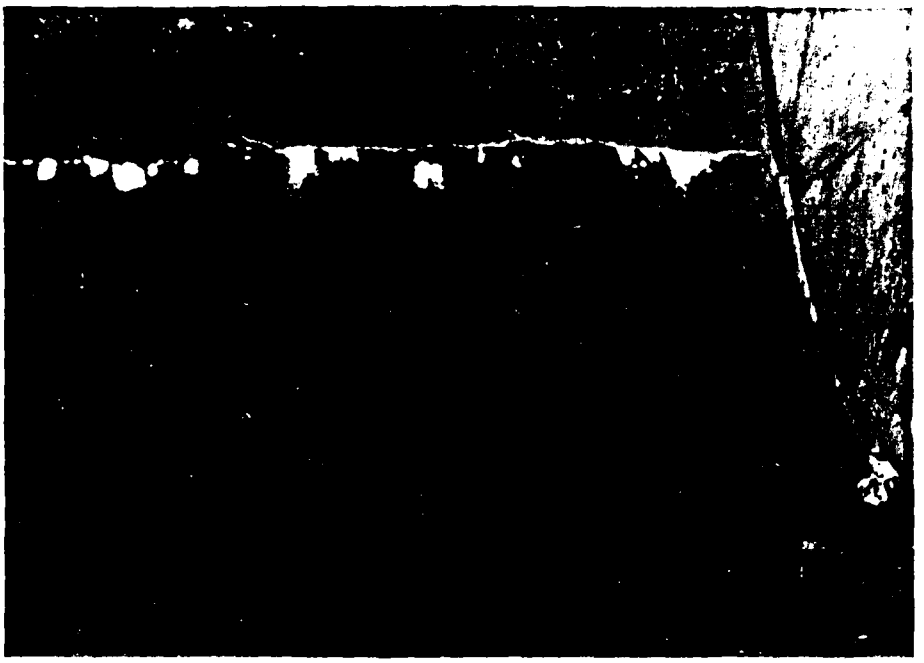


PHOTO NO. 17 - Series of two photos (17 & 18) showing conditions of expansion and construction joints at spillway structure.

PHOTO NO. 18 - (See Photo No. 17).

PHOTO NO. 19 - Outlet works structure with service bridges from right bank of reservoir.

PHOTO NO. 20 - General view of discharge channel.

PHOTO NO. 21 - Discharge channel at left training area.

PHOTO NO. 22 - View looking downstream from spillway structure showing outlet works discharge channel.

PHOTO NO. 23 - Series of two photos (23 & 24) showing discharge channel and culvert structure under roadway.

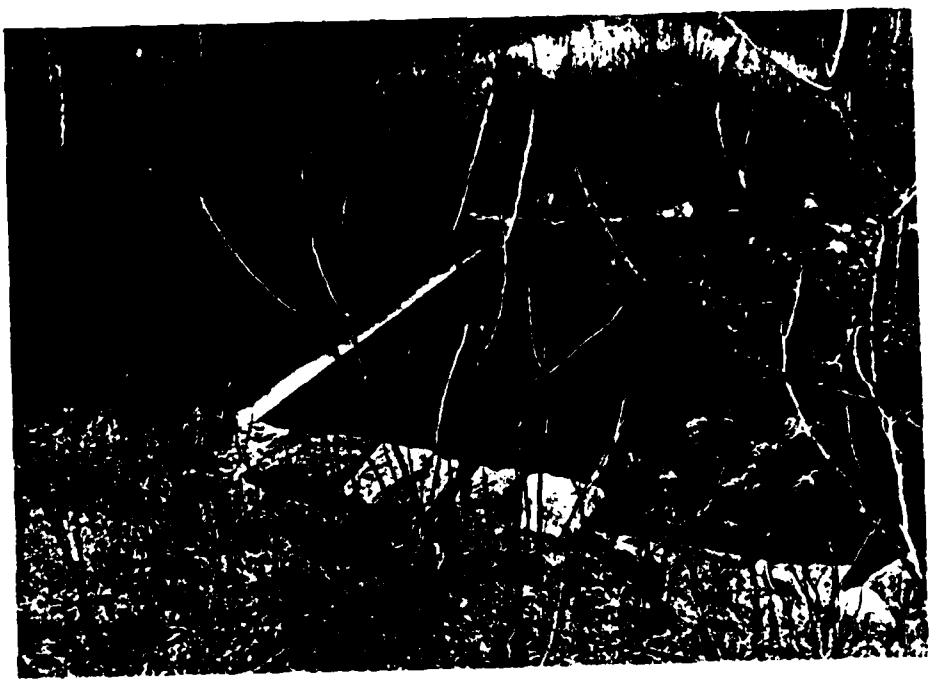


PHOTO NO. 24 - (See Photo No. 23).

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 12/8/78	Job No 5628-11-16
	Checked by [illegible]	Date 2/23/79	Sheet No 1

For Bellamy Res

HYDRAULICS & HYDROLOGY

Bellamy Reservoir Dam Located across the Bellamy River in the Town of Madbury, N.H. in the Salmon Falls River Basin.

Classification: Size: Intermediate
Hazard: High

Basic Data D.A. 22.4 sq mi HNTB check
Upstream basin two main tributary AVE .0055
8% lakes & swamps

Reservoir: Normal Pool elev 136.0
storage 3760 acre-ft
Max Pool elev 142.0
storage 7505 acre-ft
Surface Area - 370 acres
use vertical prism from elev 140 to 144

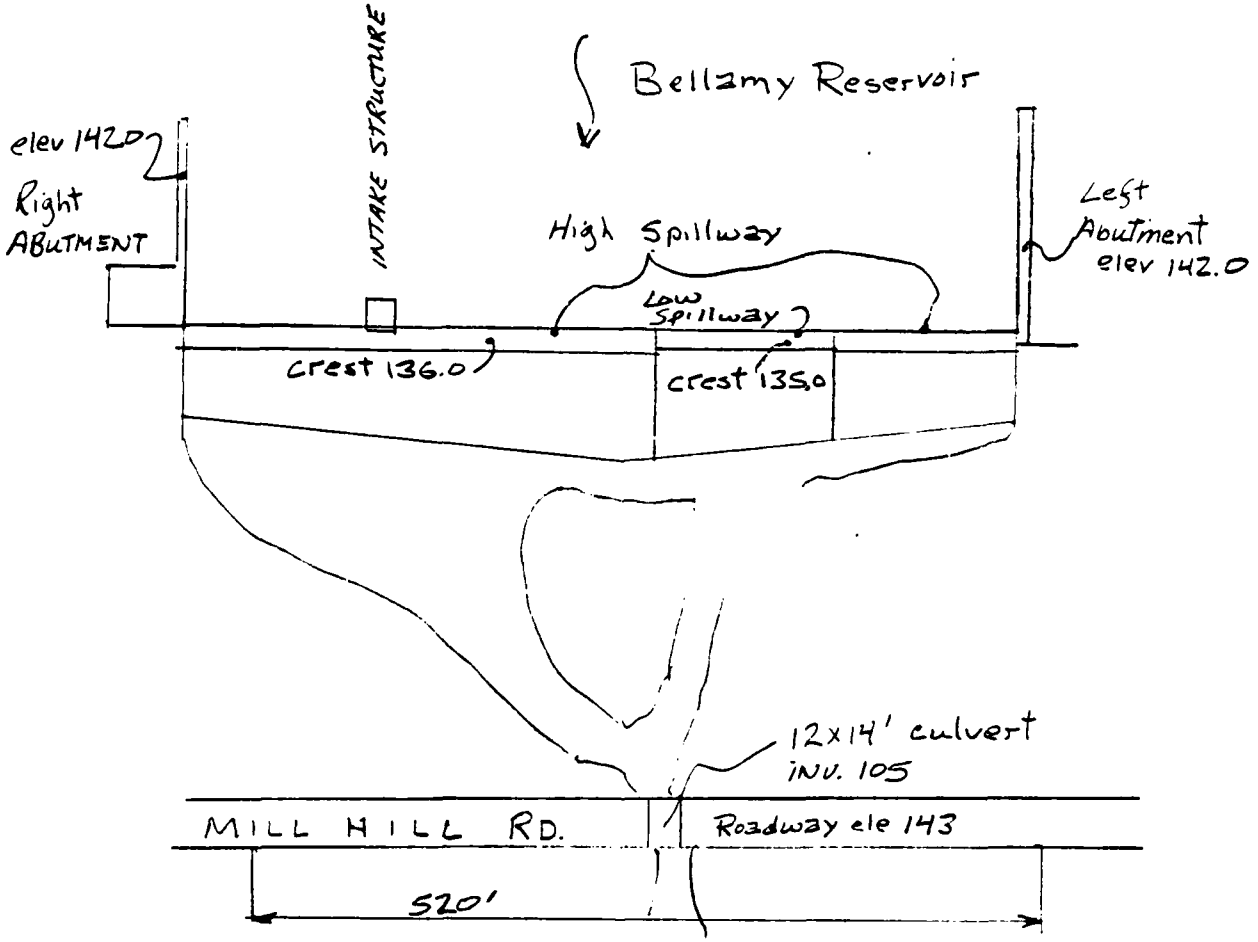
Dam: Concrete-gravity
Total length across valley 322 ft
Max height 32 ft

Spillway: concrete weir
two levels
Crest 135 - Length 69'
Crest 136 Length 253'

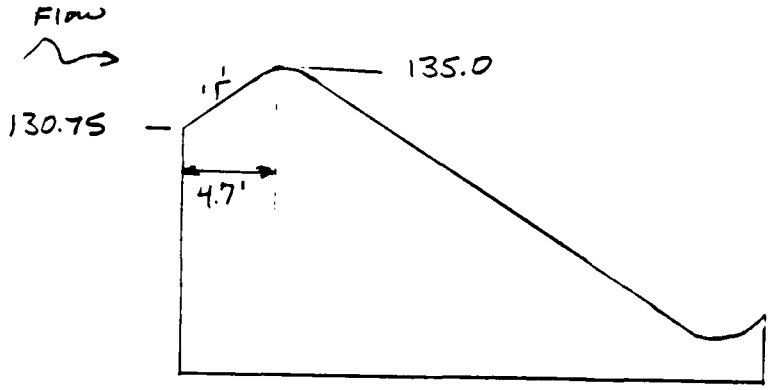
Outletworks 24" ϕ discharge to brook
30" ϕ water supply
two level intake:

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 12/8/78	Job No 50-8-11-16
	Checked by [illegible]	Date 2-3-79	Sheet No 2

For Bellamy Res.



PLAN OF DAM



Spillway X section for low level - similar for high level

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 12/8/78	Job No 5628-11-16
	Checked by DNM	Date 4/3/79	Sheet No 3
For Bellamy Res.			

Step 1 Calculation of Spillway Design Flood

Classification Size: Intermediate
Hazard: High

Hydrologic Evaluation Guideline Recommends

PMF for Spillway Design flood.

Two upstream tributaries - ave slope .0065 ft/ft
Basin Type Between Rolling & Flat with most of flat area in lower basin. Total of 8% lakes & swamps in basin located above reservoir

Rolling Basin	1420 csm	@ 22.4 sq mi
Flat Basin	620 csm	@ 22.4 sq mi
Ave -	1020 csm	

SDF 1020 csm x 22.4 sq mi = 23000 cfs.

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 12/8/78	Job No. 5628-11-16
	Checked by VMD	Date 1/23/79	Sheet No. 4
For Bellamy Res.			

Step 2 Calculation of SDF Surcharge

Consider - outflow From outlet works negligible
- Any Flow over abutments & embankments negligible
- Mill Hill Road is constructed on an embankment which is a minimum of 38 ft above the streambed elev of 105.0 the only openning is a culvert 12'x14' this major obstruction creates extreemly high tailwater conditions which will be shown, however in the dam analysis the tailwater will not be considered.

Spillway $Q = CLH^{3/2}$ where $C = 3.88$

Low level crest 135.0 $L = 69$ ft

$$Q_L = 3.88(69) H_L^{3/2} = 268 H_L^{3/2}$$

High level crest 136.0 $L = 69 + 184' = 253'$

$$Q_H = 3.88(253) H_H^{3/2} = 981. H_H^{3/2}$$

Stage-Discharge

Elev	Low level H	Low level Q	High level H	High level Q	Q_{Total}
138	3	1390	2	2780	4,170
140	5	2990	4	7850	12,840
141	6	3930	5	10,970	14,900
142	7	4960	6	14.430	19390
143	8	6060	7	18,170	24,230

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 12/18/78	Job No 5628-11-16
	Checked by PWM	Date 2/23/79	Sheet No 5

For Bellamy Res

Step 3 Calculation of Surcharge Effect

for storage see fig 1.a -3550 acre ft for net

$Q_{P_1} = 23{,}000$ cfs

Surcharge$_1$ = 7.8 ft elev 142.8 ft

$$Stor_1 = \frac{4600 \text{ acre-ft} \times 12 \text{ in/ft}}{22.4 \text{ sq mi} \times 640 \text{ acre/mi}^2} = 3.85 \text{ in}$$

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{Stor_1}{19}\right) = 23{,}000\left(1 - \frac{3.85}{19}\right) = 18{,}339 \text{ cfs}$$

Surcharge$_2$ = 6.78 ft = 141.78 elev

$$Stor_2 = \frac{3840 \text{ acre ft} \times 12}{22.4 \times 640} = 3840 \times .00084 = 3.23 \text{ in}$$

$$Stor_{AVE_1} = \frac{3.85 + 3.23}{2} = 3.54 \text{ in}$$

$$Q_{P_3} = 23{,}000\left(1 - \frac{3.54}{19}\right) = 18{,}715 \text{ cfs}$$

Surcharge$_3$ = 6.87 ft = elev 141.87

$Stor_3 = 3900 \times .00084 = 3.28$ in

$$Stor_{AVE} = \frac{3.54 + 3.28}{2} = 3.41 \text{ in}$$

$$Q_{P_4} = 23{,}000\left(1 - \frac{3.41}{19}\right) = 18{,}872 \text{ cfs}$$

Surcharge$_4$ = 6.9 ft = elev 141.9

$Stor = .00084 \times 3910 = 3.28$ in

Stor values close use outflow Q_{P_4}

Outflow = 18,870 cfs elev. 141.9.

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 12/8/78	Job No 5628-11-16
	Checked by [illegible]	Date 2/23/79	Sheet No 6
For Bellamy Res.			

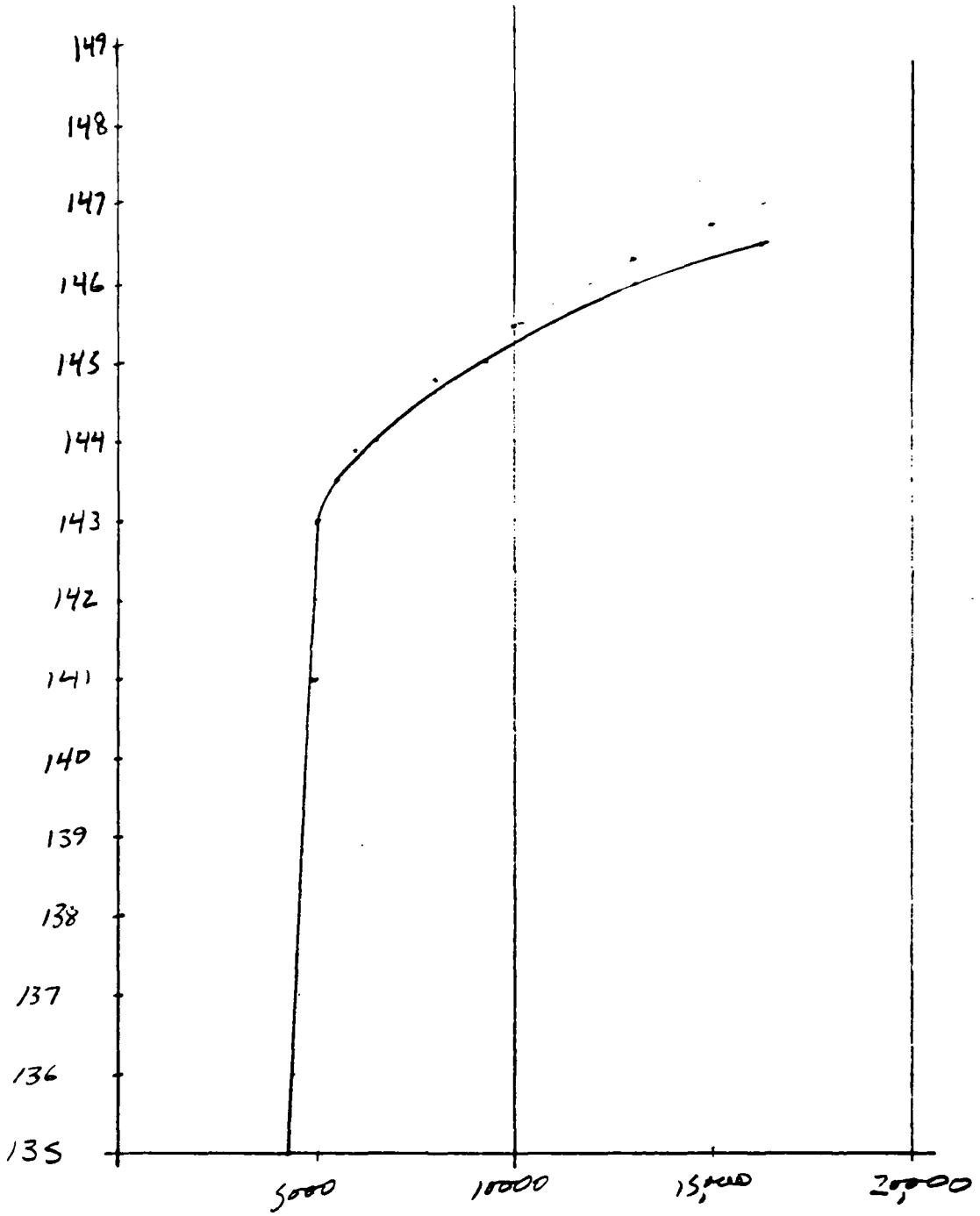
Conclusions

1. Reservoir Storage will reduce the SDF at the outlet from 23,000 cfs to 18,870 cfs or by 18%.

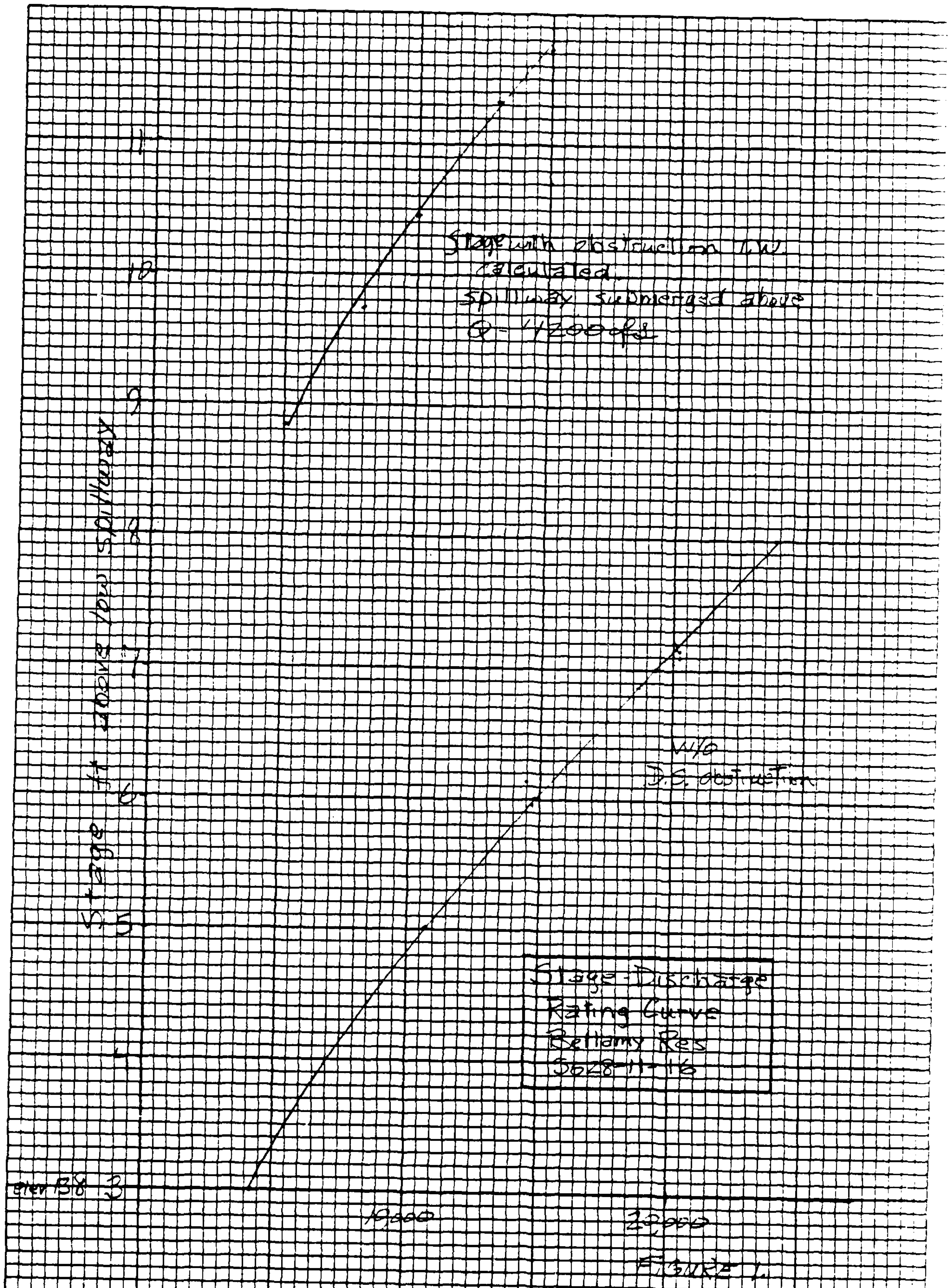
2. The spillway & storage capacity can safely pass 100% to the Test flood discharge.

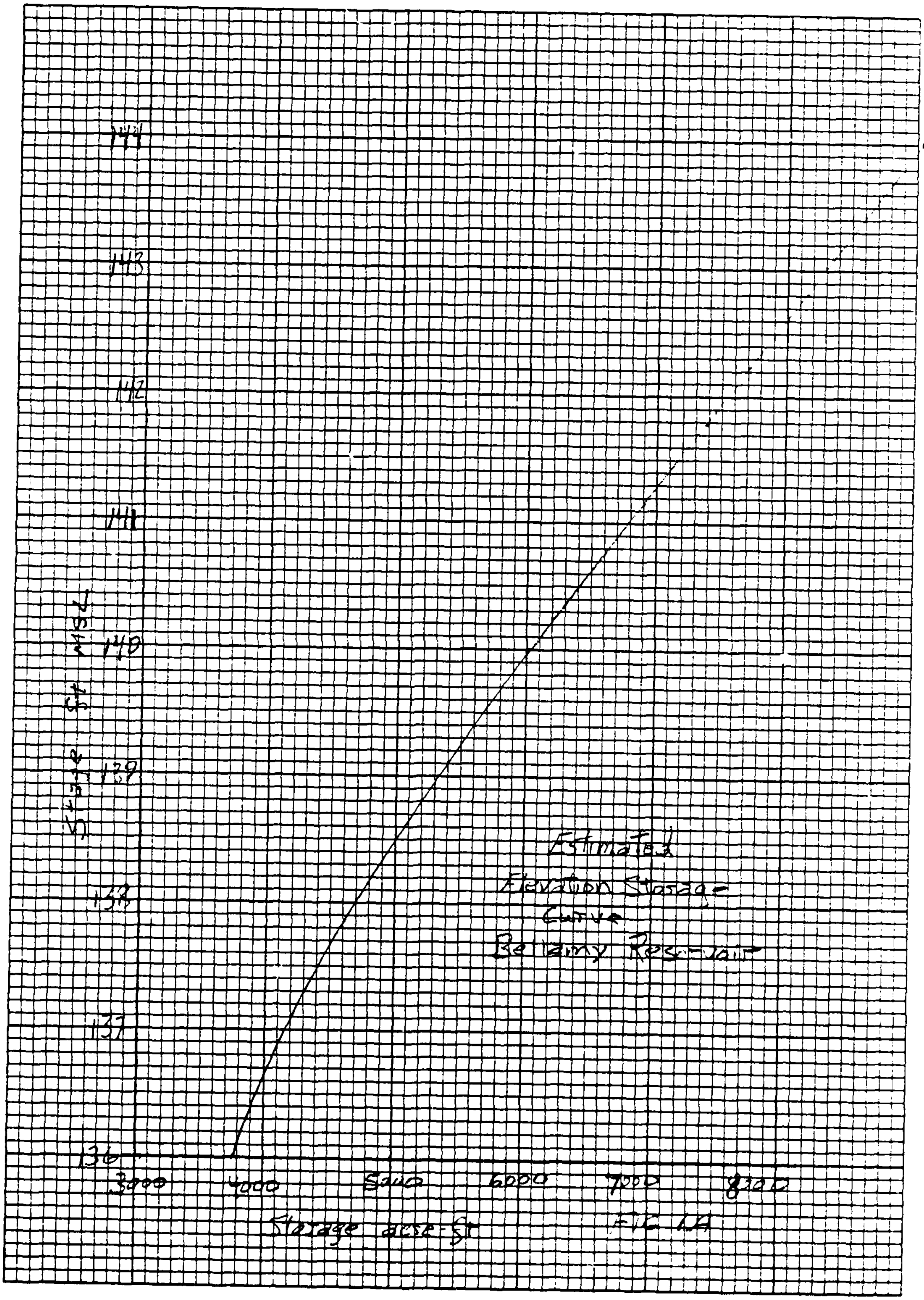
3. At the test flood discharge of 18,870 cfs the dam will not be over-topped

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by	Date	Job No
For	Checked by VJW	Date 2/23/79	Sheet No



Tailwater due to Mill Hill Road Culvert & embankment


Stage with obstruction D.S. calculated
spillway submerged above Q- 1200 cfs
W/O D.S. obstruction
Stage-Discharge Rating Curve Bellamy Res 3628-11-16
Stage ft above low spillway
elev 138
3
5
6
7
8
9
10
11
10,000
20000
Figure 1


144
143
142
141
140
139
138
137
136
Stage ft msl
3000
4000
5000
6000
7000
8000
Storage acre-ft
Estimated
Elevation Storage
Curve
Bellamy Reservoir
FIG 4A

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 1/13/78	Job No 562811-16
	Checked by VHM	Date 2/23/79	Sheet No 1

For BELLAMY RIVER

ESTIMATION OF DOWNSTREAM HYDROGRAPH

STEP 1 Reservoir Storage.

Surface Area
370 acres HNTB @ elv 136
62 acres @ elv 120
750 acres @ elev 140
750 acres @ elv 144

Storage - Stage

Elev	Area	depth	increment Acre ft	Storage
110	0	0	0	0
120	62	10	310	310
136	370	16	3455	3765
140	750	4	2240	6005
144	750	4	3000	9005

See fig 12

Maximum Storage 7505 acre-ft elev 142

STEP 2 Peak Outflow

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

W_b = 40% of dam width = (.4)(322)

y_o = total height from stream bed to pool (142 − 110)

$$Q_{P_1} = \frac{8}{27}\sqrt{g}\,(.40)(322)(32)^{3/2} = 39{,}200 \text{ cfs}$$

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RJ	Date 3/13/79	Job No 5140
	Checked by [illegible]	Date 3/15/79	Sheet No. 2
For Bellamy Res.			

Step 3 Stage Discharge

Reach 1 $S = .006$ ft/ft

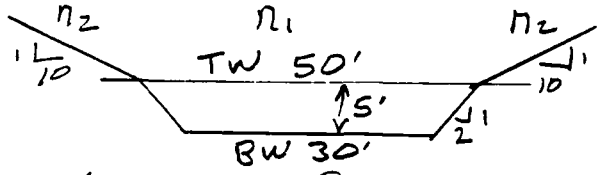
$n_1 = .035$ $n_2 = .08$

$L = 3100$

Reach 2 $S = .0018$ ft/ft

$n_1 = .035$ $n_2 = .08$

$L = 11{,}000$ End at Bellamy Drive in Dover



Valley x sec Reach 1&2

Stage - Discharge

Reach 1 Stage	Discharge
5	1625
10	6935
15	17342
20	34319
25	59164
Reach 2	
5	890
10	3798
15	9499
20	18797
25	32405
30	50,974

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 3/13/79	Job No 5140
	Checked by VNB	Date 3/15/79	Sheet No 3
For Bellamy Res.			

Step 4 Reach Outflow

S = net Storage 5676

Q_{P_1} = 50834 cfs = outflow + 60% of Spillway discharge

Stage$_1$ = 23.5

Area$_1$ = 4547 sq ft

$V_1 = \frac{4547 \times 3100}{43560} = 324$ acre ft $< \frac{7505}{2}$

Reach length OK

Q_{P_2} trial $= Q_{P_1}\left(1 - \frac{324}{7505}\right) = 48600$ cfs

Stage$_2$ = 22.9 ft

Area$_2$ = 4299 sq ft

$V_2 = \frac{4299 \times 3100}{43560} = 306$ acre-ft

$V_{ave} = \frac{324+306}{2} = 315$ acre ft

$Q_{P_2} = 50{,}834\left(1 - \frac{315}{7505}\right) = 48600$ cfs

Reach 2 $Q_{P_1} = 48{,}600$ cfs

Stage$_1$ = 29.3 ft

area$_2$ = 7320 sq ft

$V_2 = \frac{7320 \times 11000}{43560} = 1848.$ acre-ft $< \frac{7505}{2}$

Reach length ok

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 3/13/79	Job No 5140
	Checked by VRW	Date 3/15/79	Sheet No. 4
For Bellamy Res			

$$Q_{P_2\,Trial} = 48600\left(1 - \frac{1848}{7505}\right) = 36600 \text{ cfs}$$

Stage 2 = 26.2

$Area_2 = 6066 \text{ ft}^2$

$$V_2 = \frac{6066 \times 11000}{43560} = 1532 \text{ acre ft}$$

$$V_{ave} = \frac{1848 + 1531}{2} = 1690 \text{ acre ft}$$

$$Q_{P_2} = 48600\left(1 - \frac{1690}{7670}\right) = 37600 \text{ cfs}$$

Stage = 26.5 ft

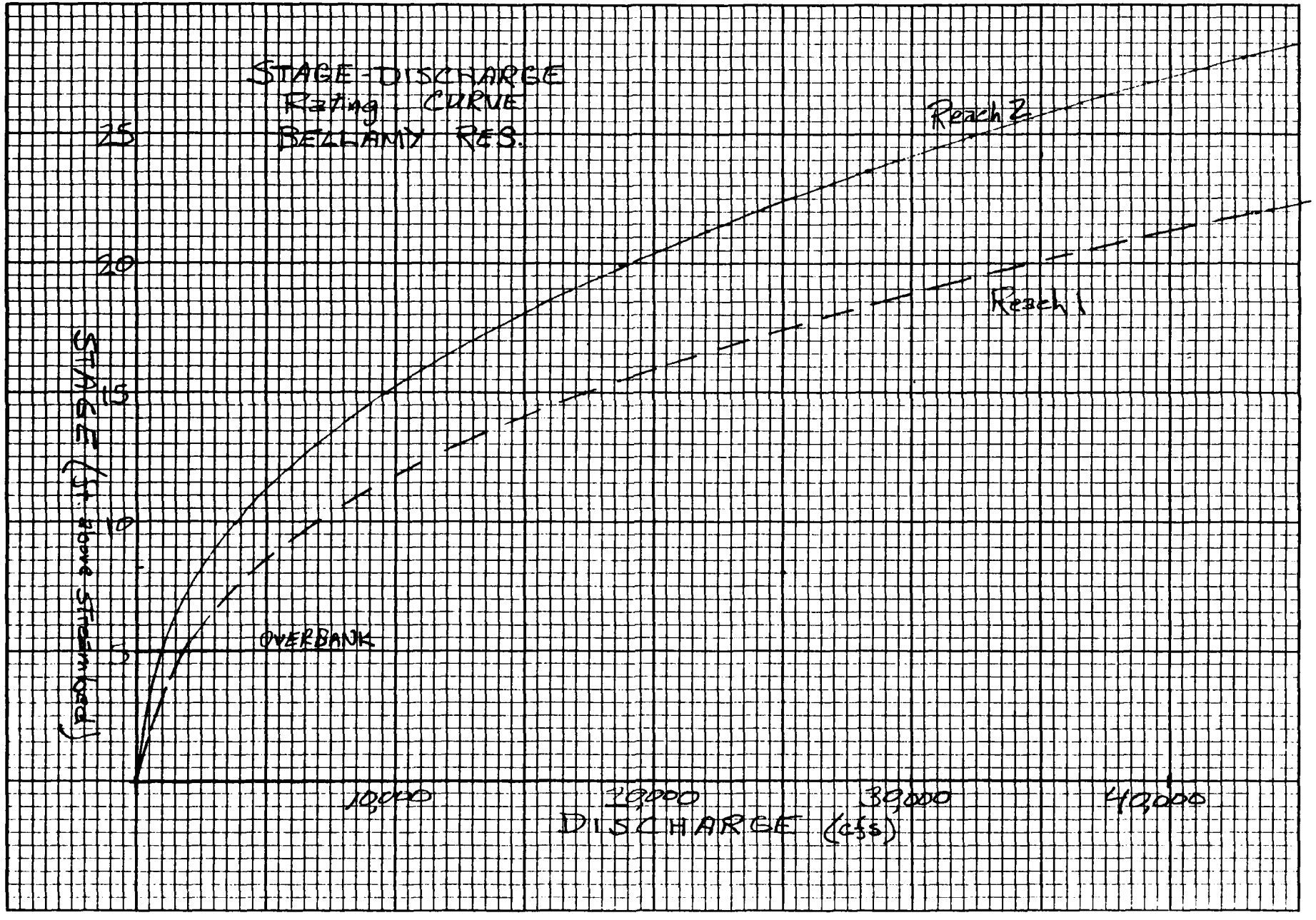
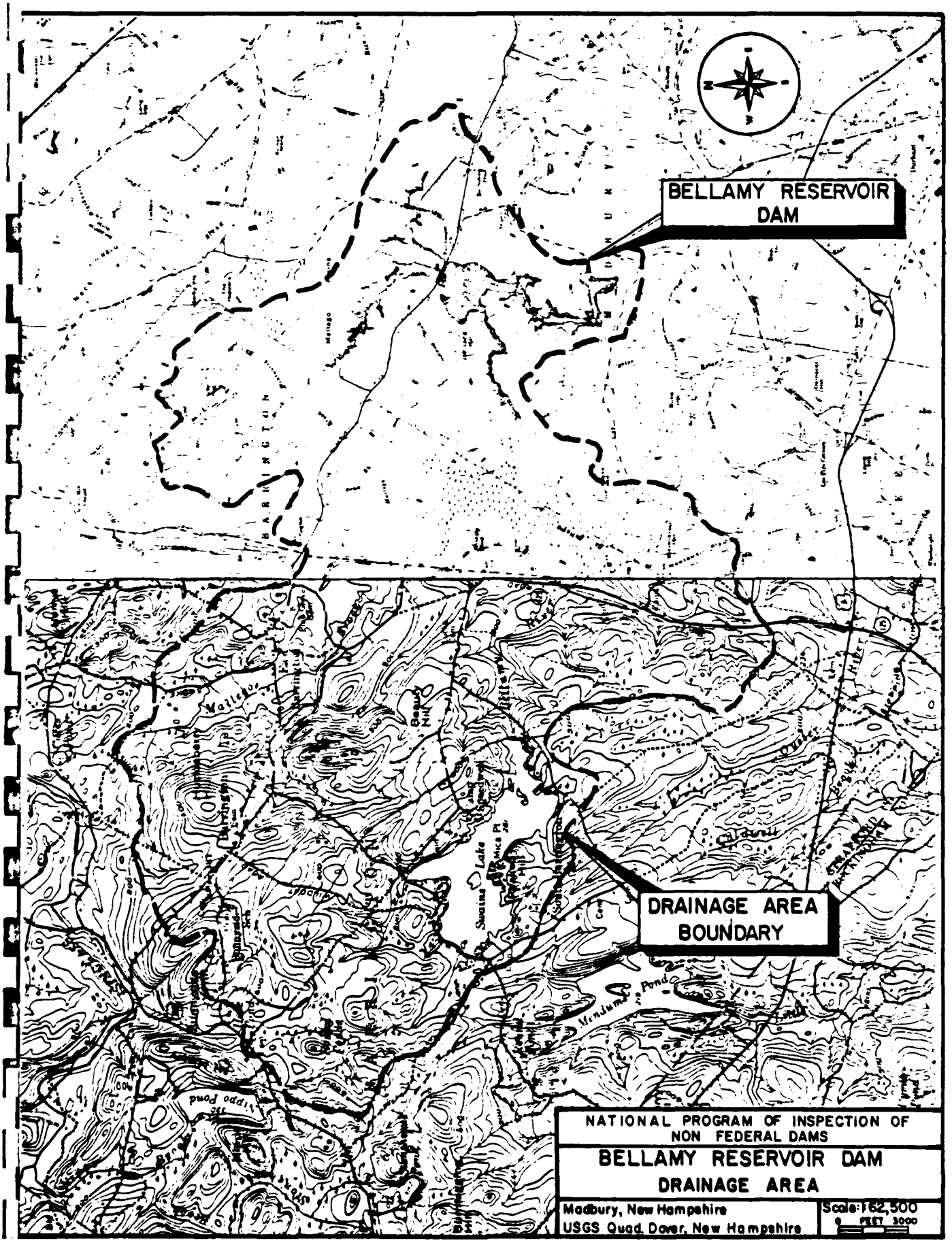
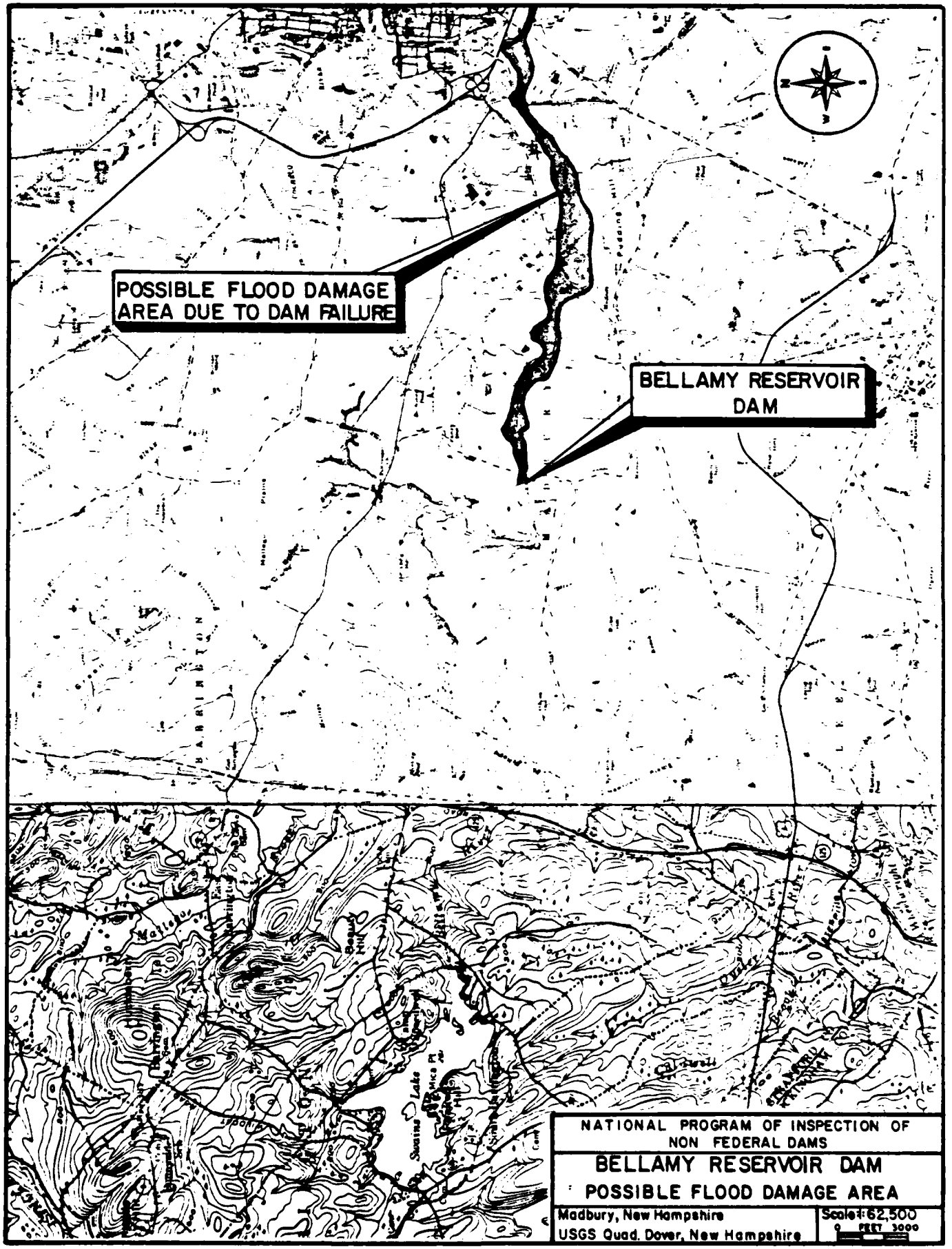


FIG. 2


BELLAMY RESERVOIR DAM
DRAINAGE AREA BOUNDARY
NATIONAL PROGRAM OF INSPECTION OF NON FEDERAL DAMS
BELLAMY RESERVOIR DAM
DRAINAGE AREA
Madbury, New Hampshire
USGS Quad. Dover, New Hampshire
Scale: 1:62,500
0 FEET 3000


POSSIBLE FLOOD DAMAGE AREA DUE TO DAM FAILURE
BELLAMY RESERVOIR DAM
N
W
E
S
NATIONAL PROGRAM OF INSPECTION OF NON FEDERAL DAMS
BELLAMY RESERVOIR DAM
POSSIBLE FLOOD DAMAGE AREA
Madbury, New Hampshire
USGS Quad. Dover, New Hampshire
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

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY | MO | YR
NH	470	NED	[illegible]	017	01				BELLAMY RESERVOIR DAM	4310.9	7056.9	15DEC78

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
BELLAMY RESERVOIR DAM	BELLAMY RESERVOIR

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	A	BELLAMY RIVER	DOVER	4	25000

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	(27) IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	(28) INSPECTION DIST	(29) OWNERSHIP FED	(30) REGULATORY FED	(31) PRV/FED	(32) SCS	(33) VER/DATE
CTRC	1960	S	38	36	5670	5760	NED	N	N	N	N	21FEB79

(34) REMARKS
24=CONCRETE

(35) D/S HAS	(36) SPILLWAY LENGTH	(36) SPILLWAY TYPE	(36) SPILLWAY WIDTH (FT.)	(37) MAXIMUM DISCHARGE (FT.)	(38) VOLUME OF DAM (CY)	(39) POWER CAPACITY INSTALLED (MW)	(39) POWER CAPACITY PROPOSED (MW)	(40) NAVIGATION LOCKS NO	(40) LENGTH (FT.)	(40) WIDTH (FT.)	(41) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(42) WIDTH (FT.)	(43) LENGTH (FT.)	(43) WIDTH (FT.)
Y	662	U	522	19491												

(44) OWNER	(45) ENGINEERING BY	(46) CONSTRUCTION BY
CITY OF PORTSMOUTH	SWITZER & HOWARD	CORPS OF ENGINEERS

(47) REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE

(48) INSPECTION BY	(49) INSPECTION DATE DAY | MO | YR	(50) AUTHORITY FOR INSPECTION
CHARLES MERRILL TAYLOR BERGENDORFF	17NOV78	PUBLIC LAW 92-367 AUG 1972

(51) REMARKS
SC-A225 SA37DAC

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NH 00471	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Bellamy Reservoir 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 1979 13. NUMBER OF PAGES 48
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,

Piscataqua River Basin
Madbury, New Hampshire
Bellamy River

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

TCe dam is a 462 ft. long gravity concrete and earth embankment dam. The dam is judged to be in good condition. It is intermediate in size with a high hazard potential. The test flood is equal to the PMF. Based on the findings of the visual inspection and hydrological and hydraulic analysis, there is no need for further engineering studies or for major alterations to the dam.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

END

FILMED

8-85

DTIC