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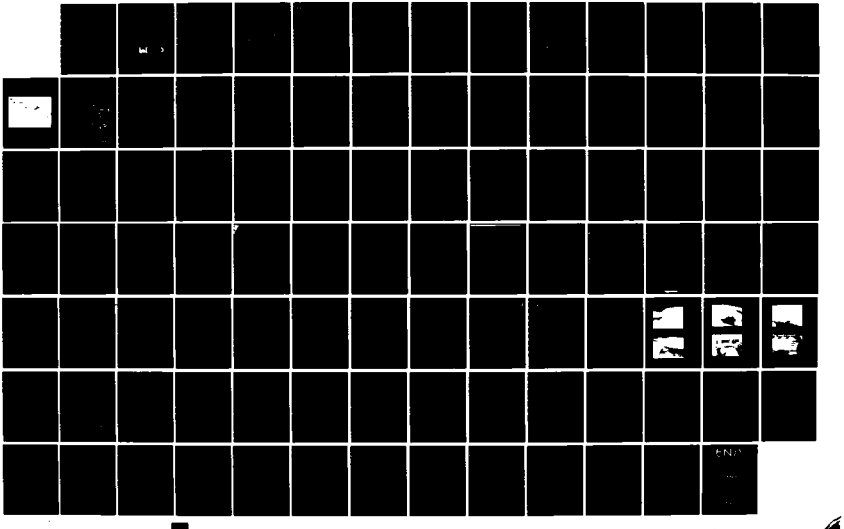
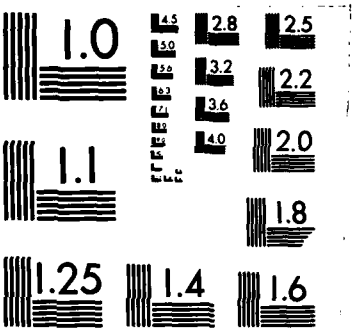




(2)

CONNECTICUT RIVER BASIN

BATH, NEW HAMPSHIRE

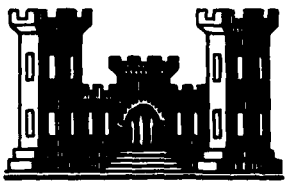
AMMONOOSUC RIVER DAM

NH 00061

NHWRB NO. 17.02

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



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

JUNE 1980

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19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

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Connecticut River Basin
Bath, New Hampshire
Ammonoosuc River

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

The dam is a concrete gravity overflow structure constructed between three depressions in a ledge outcropping that forms the bottom of the Ammonoosuc River Channel at this location. The dam is considered to be in poor condition. There are various major concerns which should be corrected to assure the continued performance of the dam. It is small in size with a significant hazard potential.

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424 TRAPELO ROAD
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REPLY TO
ATTENTION OF:
NEDED

OCT 17 1980

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

Dear Governor Gallen:

Inclosed is a copy of the Ammonoosuc River 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, New Hampshire Wood Products Corp., Bath, NH.

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

AMMONOOSUC RIVER DAM
NH 00061
NHWRB 17.02

CONNECTICUT RIVER BASIN
BATH, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No: NH 00061

Name of Dam: Ammonoosuc River Dam

Town: Bath

County and State: Grafton, New Hampshire

Stream: Ammonoosuc River

Date of Inspection: April 30, 1980

The Ammonoosuc River Dam is a concrete gravity overflow structure constructed between three depressions in a ledge outcropping that forms the bottom of the Ammonoosuc River Channel at this location. The maximum height of the dam is approximately 25 feet from the top of the gate operator platform to the lowest point of the ledge foundation of the overflow section. The overall length of the dam is approximately 365 feet between abutments. The total length of the man-made structures is about 273 feet. Located at the left abutment of the dam is the intake structure for a 26 feet wide by 9 feet high concrete penstock. Flow through the penstock is controlled by three 5.6 feet wide by 7.3 feet high penstock gates with lifting mechanisms and a bar rack. Located immediately to the right of the penstock gates is a waste gate opening which is also 5.6 feet wide and 7.3 feet high.

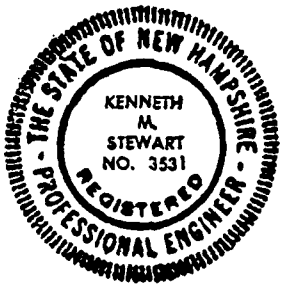
The dam impounds water from the Ammonoosuc River which, after passing over the spillway, flows in a southerly direction through the center of the town of Bath. The dam was apparently originally constructed to provide water power and later hydroelectric power to a mill at the site, but has been abandoned for that purpose since the adjoining mill was closed in 1969 and destroyed by fire in 1976. The generating equipment is currently not in use but is intact and the present owner has immediate plans to revitalize the electrical generating capability. The pool behind the dam is normally 0.63 miles in length with a surface area of about 24 acres. The maximum storage capacity at top of dam is about 520 acre-feet.

As a result of the visual inspection of this facility, the dam is considered to be in POOR condition. Major concerns are: the apparent erosion of the concrete overflow sections, including two large sections on the top of the dam that have broken free and the severe spalling and cracking on the crest of the dam over its entire length; the rotting wood in the penstock gates with 3 feet of silt built up behind them, the leakage through the gates, the severely spalled concrete of the penstock intake structure, with visible reinforcement at several locations and the heavy rust on the lifting mechanisms; the removal of the waste gate, the severe spalling of the concrete gate structure with visible reinforcement in a few locations and the inoperability of the lifting mechanism.

This dam is classified as SMALL in size and a SIGNIFICANT hazard structure in accordance with the recommended guidelines established by the Corps of Engineers. The test flood for this dam, therefore, ranges from the 100-year flood to one-half the Probable Maximum Flood (1/2 PMF). The 100-year flood was selected for this hydrologic analysis since the dam falls about midway in the range of storages given for the small size classification. The test flood inflow was estimated to be 50,800 cfs and resulted in a routed test flood outflow equal to 50,500 cfs which would overtop the dam crest by about 0.6 foot. The capacity of the man-made overflow sections with the water surface at the dam crest was estimated to be about 40,000 cfs, which is about 79 percent of the routed test flood outflow. An assumed breach with the water surface at the crest of the overflow sections would increase the stage along the immediate downstream channel to an elevation of about 488 feet (NGVD). The discharge resulting from this failure would approach the sill level of the mill located on the left bank a short distance downstream from the dam, possibly resulting in an economic loss to the owner. The potential for loss of less than a few lives of employees at the mill would exist.

It is recommended that the owner engage a qualified registered engineer to inspect the downstream face of the overflow sections under no flow conditions, to design and specify repairs for the erosion and spalling of the concrete overflow sections and the concrete intake structure, and to design and specify repairs to the penstock gates and to the waste gate.

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



Kenneth M. Stewart
Project Manager
N.H.P.E. 3531

S E A Consultants Inc.
Rochester, New Hampshire

This Phase I Inspection Report on Ammonoosuc River 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.

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, MEMBER
Water Control Branch
Engineering Division

ARAMAST MAHTESIAN, CHAIRMAN
Geotechnical Engineering Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

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

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and

rarity of such a storm event, finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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

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SECTION 5
EVALUATION OF HYDROLOGIC/HYDRAULIC FEATURES

5.1 General. Ammonoosuc River Dam is a series of concrete gravity overflow sections founded on ledge and extending between ledge outcroppings in the river channel. The overall length of the dam is about 365 feet, while the man-made portion of the dam is about 273 feet long. The overflow section of the dam has a maximum structural height of approximately 16 feet as measured from the crest of the overflow section to the ledge foundation. Adjacent to the left abutment is an inlet structure which has four sluice gates. Three of the gates lead to the penstock, while the fourth (waste gate) bypasses the penstock and discharges to the river channel at the toe of the dam. At the time of inspection, the waste gate by-passing the penstock was not in place, and water was discharging through the gate opening to the river channel. The penstock gates were all in place and closed.

The drainage area above Ammonoosuc River Dam is quite large and consists of hilly and mountainous terrain with numerous streams that feed the Ammonoosuc River. Ammonoosuc River Dam is a run of the river structure with a maximum storage of approximately 520 acre-feet.

5.2 Design Data. No hydrological or hydraulic design data were disclosed.

5.3 Experience Data. Data relating to known flood discharges and projected flood flows and elevations have been published in Flood Plain Information, Ammonoosuc River, Bath, New Hampshire, prepared by the Department of the Army, New England Division, Corps of Engineers, Waltham, Massachusetts, May, 1978. Data from this report indicated that the high water mark at the Ammonoosuc River Dam for the "March, 1936 Flood" was approximately 500.8 feet (NGVD) with an estimated discharge of about 24,000 cfs..

5.4 Test Flood Analysis. Due to the absence of detailed design and operational information, the hydrologic evaluation was performed utilizing data gathered during field inspection, watershed size and an estimated test flood determined from the Corps of Engineers guide curves. For this dam (small size and significant hazard), the test flood ranges from a 100-year flood to one-half the Probable Maximum Flood (1/2 PMF). The 100-year flood was selected for this analysis since the dam falls about midway in the range of storages given for the small size classification. Since the drainage area consists of a combination of hilly and mountainous terrain and the time of concentration is long due to the size of the watershed, the "rolling" curve from the Corps of Engineers set of guide curves, was used to estimate the maximum probable peak flow rate. The water surface behind the dam was assumed to be at an elevation of 494 feet prior to the test flood routing.

Based on an estimated maximum probable flood peak flow rate of 625 cfs per square mile and a drainage area of 325 square miles, the test flood inflow was estimated to be 50,800 cfs. The test flood was routed through the reservoir in accordance with the Corps of Engineers procedure for Estimating Effect of Surcharge Storage on Maximum Probable Discharge. The routed test flood outflow was estimated to be 50,500 cfs. This analysis indicated that the dam crest (top

SECTION 4
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. The Ammonoosuc River Dam is used primarily to impound water from the Ammonoosuc River. There are no written or routine operational procedures.

b. Description of Any Warning System in Effect. No written warning system exists for the dam.

4.2 Maintenance Procedures

a. General. The owner, New Hampshire Wood Products Corporation, Charles Diamond, Owner, is responsible for the maintenance of the dam. No formal maintenance plan exists.

b. Operating Facilities. No formal plan for maintenance of operating facilities was disclosed, although the owner has made some minor repairs to the penstock gates and indicated that repairs to the entire dam would begin late this summer to revitalize the hydroelectric production capabilities to be on line by 1983.

4.3 Evaluation

The current maintenance procedures for the Ammonoonuc River 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 establish a warning system to follow in event of flood flow conditions or imminent dam failure.

d. Reservoir Area. There are no signs of instability of the banks of the river channel upstream of the dam, although there is minor erosion of the bank immediately upstream of the bridge pier on the left abutment. Trees are growing on the steep left bank of the channel some distance upstream of the dam. The right side of the valley consists of a low, flat floodplain which is cultivated and generally free of trees and brush (See Photo No. 1).

e. Downstream Channel. The channel downstream of the dam is generally wide and unobstructed, although a mill building is located on the floodplain just downstream from the dam (See Photo No. 12). Immediately downstream of the dam, the channel bottom appears to be bedrock. Farther downstream the channel bottom appears to consist of sand, gravel, and boulders, and there appear to be no bedrock exposures.

3.2 Evaluation

On the basis of the visual inspection, Ammonoosuc River Dam appears to be in poor condition.

The apparent erosion of the concrete overflow sections, including two large sections on the top of the dam that have broken free and the severe spalling and cracking on the crest of the dam over its entire length are signs of serious structural problems and instability, and if allowed to continue, will cause a progressive lowering of the crest.

The rotting wood in the penstock gates with 3 feet of silt build-up behind them, making the gates inoperable; the leakage through the gates, the severely spalled concrete of the penstock intake structure, with visible reinforcement at several locations; and the heavy rust on the lifting mechanisms are all signs of considerable deterioration of the gates and surrounding structure. If these problems are not corrected, they could lead to further deterioration and eventual failure of the penstock gates and surrounding structure.

The removal of the waste gate, the severe spalling of the concrete gate structure with visible reinforcement in a few locations, and the inoperability of the lifting mechanism are all signs of considerable deterioration of the gate structure. If these problems are not corrected, they could lead to further deterioration and eventual failure of the waste gate structure.

The central portion of the man-made overflow section is about 10 feet high and is constructed between two ledge outcroppings in a "dog leg" configuration approximately 96 feet long (See Photo No. 2). A section of the top of the dam about 40 feet long and from 1 to 2 feet deep in the center of this portion of the man-made overflow section appears to have broken free. As seen beneath the flowing water, it appears that the entire crest of this portion of the dam is cracked and severely spalled.

The right portion of the man-made overflow section is about 2.5 feet high and begins at a high point in the ledge outcropping and extends approximately 54 feet in a "dog leg" configuration to a concrete wall at the right abutment (See Photo No. 6). This wall acts as a training wall for the dam and a retaining wall for the Boston and Maine Railroad line at the right abutment. As seen beneath the flowing water, it appears that the entire crest of this portion of the dam is cracked and spalled (See Photo No. 7). The concrete training wall is also spalled in a few locations with signs of efflorescence (See Photo No. 8). It cannot be determined on the basis of the visual inspection alone whether this wall is founded on soil or bedrock, or whether the right abutment of the concrete gravity section is soil or bedrock.

The left abutment immediately upstream from the dam consists of soil, but it cannot be determined on the basis of the visual inspection alone whether the left abutment of the concrete gravity section is soil or bedrock.

c. Appurtenant Structures. Located at the left abutment of the dam is the concrete intake structure (See Plans and Details in Appendix A and Photo No. 9). Three 5.6 feet wide by 7.3 feet high gates in this structure discharge to a 26 feet wide by 9 feet high concrete penstock. A bar rack is located just downstream from the penstock gates at the mouth of the penstock. The penstock extends from these gates, underneath the foundation of an old burned out mill, to a generator room. The penstock and generating facilities have not been in use since 1969. The penstock gates are closed and the lifting mechanisms are heavily rusted. Portions of the wooden gates are rotted, although some sections of wood planking have recently been replaced. All three gates are leaking slightly, and there is about 3 feet of silt on the penstock floor between the gates and the bar rack making the gates inoperable (See Photo No. 11). The entire concrete intake structure is severely spalled, with visible reinforcement at many locations (See Photo No. 10). A railing around the top of the intake structure, operator platform for the gates, is heavily rusted and some sections are missing (See Photo No. 10).

Located immediately to the right of the penstock gates is a waste gate opening which is also 5.6 feet wide and 7.3 feet high (See Photo Nos. 9 and 10). The wood gate has been removed and, according to the owner, lies on the floor of the river immediately upstream of the gate opening. The lifting mechanism is inoperable and the surrounding concrete is severely spalled with visible reinforcement at several locations (See Photo No. 10).

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Ammonoosuc River Dam is a run-of-river dam and, consequently, impounds a pond of small size. The drainage area is quite large, and consists of hilly and mountainous terrain. The majority of the drainage basin is heavily wooded. Development in the area is quite variable ranging from large sections of undeveloped land in White Mountain National Forest to more extensively developed portions around towns and tourist areas. The flood plain downstream from the dam is generally undeveloped.

The field inspection of Ammonoosuc River Dam was made on April 30, 1980. The inspection team consisted of personnel from S E A Consultants Inc. and Geotechnical Engineers, Inc. Inspection checklists, completed during the visual inspection, are included in Appendix A. At the time of inspection, water was passing over the entire length of the overflow section. The pool elevation was at approximately 495.5 NGVD. The upstream face of the dam could only be inspected above this water level. Inspection of the downstream face was not possible due to the discharge of water over the dam.

b. Dam. Ammonoosuc River Dam is a concrete gravity overflow structure constructed between three depressions in a ledge outcropping that forms the bottom of the Ammonoosuc River Channel at this location. The maximum height of the dam is approximately 25 feet from the top of the gate operator platform to the lowest point of the ledge foundation of the overflow section. The overall length of the dam is approximately 365 feet between abutments. The total length of the man-made structures is about 273 feet. The upstream face of the overflow section is vertical, and the downstream face has a slope approximately 4 feet vertical to 1 foot horizontal (4:1). The crest width is about 2 feet. Because water was flowing over the dam at the time of the inspection, it was not possible to make a detailed examination of the concrete in the dam or of the foundation. However, it appears that the dam is founded on bedrock since there are bedrock outcrops along the axis of the dam and immediately downstream of the dam.

The left portion of the man-made overflow section is about 16 feet high and begins at the penstock intake structure and extends approximately 82 feet toward the right abutment, terminating at a high point in the ledge outcropping (See Photo No. 4). At this point, there is one of three dry stone masonry piers constructed on the ledge that supports a covered bridge which spans the river immediately upstream from the dam. This portion of the dam is badly deteriorated and it appears that a section about 50 feet long and as much as 5 feet deep has broken free (See Plans and Details in Appendix A and Photo No. 4). As seen beneath the flowing water, it appears that the entire crest of this portion of the dam is cracked and severely spalled.

SECTION 2
ENGINEERING DATA

2.1 Design

No design data were found for the Ammonoosuc River Dam.

2.2 Construction

No construction records were found.

2.3 Operation

No engineering operational data were found.

2.4 Evaluation

a. Availability. No engineering data were available for the Ammonoosuc River Dam. A search of the files of the New Hampshire Water Resources Board and direct contact with the owner, revealed a limited amount of recorded information.

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. No engineering data were found to validate.

h. Diversion and Regulating Tunnel

Not applicable (see Section j below)

i. Spillway

(1) Type - concrete overflow section with concrete and ledge outcrop training walls

(2) Length of weir - 273 feet (entire overflow section)

(3) Crest elevation - 489.5 (minimum elevation of deteriorated overflow section)
495 (approximate original elevation of right portion of overflow section)
494 (approximate original elevation of left portion of overflow section)

(4) Gates - N/A

(5) U/S Channel - The banks upstream from the dam appear to be stable, although there is minor erosion of the bank immediately upstream from the bridge pier on the left abutment. Trees are growing on the steep left bank of the channel some distance upstream from the dam. The right side of the valley consists of a low, flat flood plain which is cultivated and generally free of trees and brush.

(6) D/S Channel - The channel downstream from the dam is generally wide and unobstructed. Immediately downstream from the dam the channel appears to be ledge (bedrock). Further downstream the channel bottom appears to consist of sand, gravel and boulders, and there appear to be no ledge exposures.

j. Regulating Outlets

(1) Invert - Four sluice gates - 488.6 (bottom of gate opening)

(2) Size - Four sluice gates - 5.6 feet wide x 7.3 feet high opening

(3) Description

(a) Penstock gates - Three gates constructed of 2-inch thick by 6-inch wide wood planks bolted together to form gate. One gate was missing two or three planks, but opening covered with plywood.

(b) Waste gate - Gate was missing.

(4) Control Mechanism

(a) Penstock gates - Manual crank lifting mechanisms, rusted but otherwise appear to be intact. Gates appear to be inoperable due to silt build-up behind gates.

(b) Waste gate - Manual crank lifting mechanism, which appears to have been vandalized and consequently missing mechanical hardware.

e. Storage (acre-feet)

(1) Normal pool - 100

(2) Flood control pool - N/A

(3) Spillway crest pool - 77.7

(4) Top of dam - 520

(5) Test flood pool - 570

f. Reservoir Surface (acres)

(1) Normal pool - 24

(2) Flood control pool - N/A

(3) Spillway crest - 18 (minimum elevation original crest - 494 feet)

(4) Test flood pool - 155

(5) Top of dam - 139

g. Dam

(1) Type - concrete gravity overflow structure

(2) Length - 365 feet (total length between abutments)
273 feet (length of man-made portion)

(3) Height - 25 feet maximum

(4) Top Width - 2 feet

(5) Side Slopes - vertical (upstream face)
4.0V to 1.0H (downstream face)

(6) Zoning - unknown

(7) Impervious core - unknown

(8) Cutoff - unknown

(9) Grout curtain - none

(10) Other - none

(8) The total project discharge (including flow over the railroad track at the right abutment) with the water surface at the top of the dam (Elev. 503.5 feet) was estimated to be 44,000 cfs (with the sluice gates closed) and 46,640 cfs (with the sluice gates open)

(9) The total project discharge with the water surface at the test flood elevation (Elev. 504.1 feet) was estimated to be 50,500 cfs.

c. Elevation (feet, NGVD) based on U.S.G.S. bench mark located near the dam (MAC No. 10, 1925, Elev. 505.02)

(1) Streambed at toe of dam - 479 (toe of man-made structure)
468 (toe of ledge)

(2) Bottom of cutoff - unknown

(3) Maximum tailwater - unknown

(4) Normal pool - 495

(5) Full flood control pool - N/A

(6) Spillway crest - 495 (approximate original elevation of right portion of overflow section)
- 494 (approximate original elevation of left portion of overflow section)
- 489.5 (minimum elevation of deteriorated overflow section)

(7) Design surcharge (Original Design) - unknown

(8) Top of dam - 503.5 (top of gate operator platform)
498.8 (top of right training wall)

(9) Test flood surcharge - 504.1

d. Reservoir (length in feet)

(1) Normal pool - 3300

(2) Flood control pool - N/A

(3) Spillway crest pool - 2970 (minimum elevation original crest - 494 feet)

(4) Top of dam - 7070

(5) Test flood pool - 7,400

i. Normal Operating Procedures. The Ammonoosuc River Dam at present is used primarily to retain the water of the Ammonoosuc River for conservational purposes. There is no normal operating procedure for this dam.

1.3 Pertinent Data

a. Drainage Area. The drainage area above Ammonoosuc River Dam covers approximately 325 square miles (208,000 acres), consisting of hilly and mountainous terrain. Numerous streams transecting the area feed the Ammonoosuc River. The topography in the drainage basin ranges from 6288 feet NGVD on top of Mount Washington to approximately 478 feet NGVD at the base of the dam. The majority of the basin is heavily wooded. Development in the drainage basin is quite variable ranging from large sections of undeveloped land in White Mountain National Forest to more extensively developed portions around towns and tourist areas.

b. Discharge at Damsite. Discharge at the damsite normally occurs over the concrete overflow sections, which provide a total weir length of 273 feet. Due to deterioration of the concrete, the elevation of the crest of the overflow sections varies considerably (See Plans and Details in Appendix B). A total of four sluice gates are located at the intake structure, three penstock gates which feed the penstock and one waste gate which discharges directly to the downstream river channel. The invert elevation of all four gates is approximately 488.6 feet (NGVD). At the time of inspection, the three penstock gates were in place and closed, and the waste gate was missing. The owner reported that the waste gate had been removed to increase project discharge.

(1) The capacity of the sluice gates, with the water surface at the top of dam (Elev. 503.5 feet), was estimated to be

(a) Waste gate - 660 cfs
(b) Three penstock gates - 1980 cfs

(2) Maximum known flood at damsite - "March, 1936 Flood", high water mark at approximately 500.8 feet (NGVD) with an estimated discharge of about 24,000 cfs.

(3) The ungated spillway capacity (man-made portions of overflow section only) with the water surface at the top of the dam (Elev. 503.5 feet) was estimated to be 40,000 cfs.

(4) The ungated spillway capacity (man-made portions of overflow section only) with the water surface at the test flood elevation (Elev. 504.1 feet) was estimated to be 45,000 cfs.

(5) Gated spillway capacity at normal pool elelvation - N/A

(6) Gated spillway capacity at test flood elevation - N/A

(7) The total spillway capacity with the water surface at the test flood elevation (Elev. 504.1 feet) was estimated to be 45,000 cfs.

The overall length of the dam is approximately 365 feet between abutments. The total length of the man-made structures is about 273 feet. The upstream face of the overflow section is vertical, and the downstream face has a slope approximately 4 feet vertical to 1 foot horizontal (4:1). The crest width is about 2 feet.

Located at the left abutment of the dam is the intake structure for a 26 feet wide by 9 feet high concrete penstock. Flow through the penstock is controlled by three 5.6 feet wide by 7.3 feet high penstock gates with lifting mechanisms and a bar rack. Located immediately to the right of the penstock gates is a waste gate opening which is also 5.6 feet wide and 7.3 feet high.

c. Size Classification. Small (height - 25 feet; storage - 520 acre-feet) based on storage (less than 1000 acre-feet and greater than or equal to 50 acre-feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant Hazard. An assumed breach in the Ammonoosuc River Dam would increase the stage along the immediate downstream channel by about 15 feet to an elevation of approximately 488 feet. The discharge resulting from this failure would approach the sill level of the mill located on the left bank a short distance downstream from the dam, possibly resulting in an economic loss to the owner. The potential for loss of less than a few lives of employees at the mill would exist. The stage of the failure discharge would decrease rapidly as it passes downstream.

e. Ownership. Several corporations have at one time or another owned the dam and adjoining mill complex; the present organization being New Hampshire Wood Products Corporation, Box A, Bath, New Hampshire 03740; Charles Diamond - owner. Telephone No. (603) 747-2202.

f. Operator. The dam is maintained and operated by Charles Diamond, owner, New Hampshire Wood Products Corporation, Box A, Bath, New Hampshire 03740. Telephone No. (603) 747-2202.

g. Purpose of Dam. The original purpose of the present structure was to provide water power and later electricity to the adjoining mill. At present, the mill is abandoned having been destroyed by fire. The penstock gates are closed, and the generating equipment is not in use, although the current owner has immediate plans to revitalize the electrical generating equipment.

h. Design and Construction History. Files at the state of New Hampshire Water Resources Board indicate a mill dam was in existence at this site as early as 1765. It is not known when the present structure was built, but according to records, was in existence by 1936. This structure provided water power to the mill to drive machinery, and by 1951, a small electric generator was added. The last reported use of hydro power for this dam was in 1969 when the mill was closed. A fire in 1976 destroyed the mill buildings, and there have been no changes to the dam since that time.

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
AMMONOOSUC RIVER 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. S E A Consultants Inc. has been retained by the New England Division to inspect and report on selected dams in the state of New Hampshire. Authorization and notice to proceed were issued to S E A Consultants Inc. under a letter of November 5, 1979 from William Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0008 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.

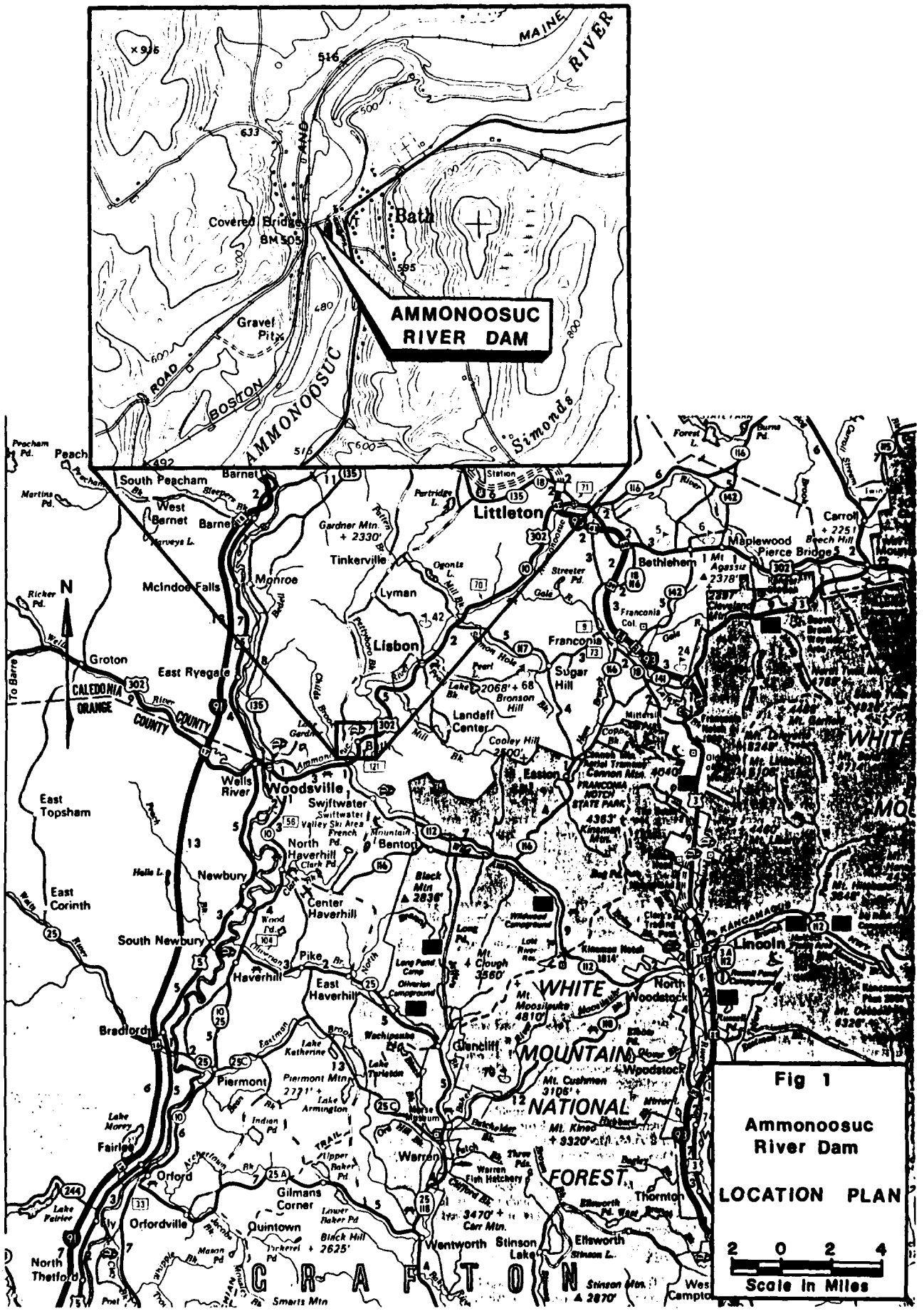
(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

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

1.2 Description of Project

a. Location. The Ammonoosuc River Dam is located in the center of the town of Bath, New Hampshire, immediately downstream from the Pettyboro Road covered bridge. The dam impounds water from the Ammonoosuc River which, after passing over the spillway, flows in a southerly direction 4.85 miles to the confluence with the Connecticut River. The dam is shown on U.S.G.S. Quadrangle, Lisbon, New Hampshire, with coordinates approximately at N44°10'00", W71°58'33", Grafton County, New Hampshire (See Location Plan).

b. Description of Dam and Appurtenances. The Ammonoosuc River Dam is a concrete gravity overflow structure constructed between three depressions in a ledge outcropping that forms the bottom of the Ammonoosuc River Channel at this location. The maximum height of the dam is approximately 25 feet from the top of the gate operator platform to the lowest point of the ledge foundation of the overflow section. The top of the gate operator platform was taken as the top of dam despite the fact that the right training wall is set nearly 5 feet lower in elevation, because a short distance beyond the right training wall the embankment rises sharply and effectively confines the flow so that only the Boston and Maine Railroad tracks would be affected by flow overtopping the right training wall.


AMMONOOSUC RIVER DAM
Covered Bridge
Bath
Gravel Pit
ROAD
BOSTON
AMMONOOSUC
Simonds
MAINE
RIVER
Littleton
Bethlehem
Lisbon
Franconia
Woodsville
Wells River
Groton
East Ryegate
Barnet
South Peacham
West Barnet
McIndoe Falls
Monroe
Tinkerville
Lyman
Landaff Center
Easton
Sugar Hill
Maplewood
Pierce Bridge
Carroll
Swiftwater
North Haverhill
Benton
East Topsham
Newbury
East Corinth
Center Haverhill
South Newbury
Haverhill
East Haverhill
Bradford
Piermont
Fairlee
Orford
Orfordville
Gilmans Corner
Quintown
North Thetford
Warren
Wentworth
Stinson Lake
Ellsworth
Thornton
Lincoln
North Woodstock
WHITE MOUNTAIN NATIONAL FOREST
GRAFTON
CALEDONIA
ORANGE
COUNTY
N
Fig 1
Ammonoosuc River Dam
LOCATION PLAN
2 0 2 4
Scale in Miles

X

OVERVIEW PHOTO - AMMONOOSUC RIVER DAM

of sluice gate operator platform) would be overtopped by approximately 0.6 foot. The capacity of the man-made overflow sections with the water surface at the dam crest was estimated to be approximately 40,000 cfs, which is about 79 percent of the routed test flood outflow.

5.5 Dam Failure Analysis. The impact of dam failure was assessed utilizing the "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs published by the Corps of Engineers. The analysis covered a reach extending a few hundred feet downstream. The prefailure flow with the water surface at the dam crest is significant. A cursory analysis of the downstream water surface elevations associated with the prefailure flow indicated that the mill building, which is located a short distance below the dam and is the only apparent hazard for this dam, would be inundated by the tailwater. Consequently, failure of the dam with the water surface at the top of dam would not increase the hazard potential of the dam. Therefore, the dam failure analysis was conducted with the water surface at the original overflow section crest. Based on this analysis, the Ammonoosuc River Dam has been classified as a significant hazard.

It was determined that the most probable location for an assumed breach to occur was in the overflow section between the left abutment and the ledge outcropping near the middle of the river. A failure length of 100 feet was used, which is about 37 percent of the total length of the man-made structures and represents the entire length of the aforementioned overflow section and a portion of the operator platform to which this overflow section is attached. Using a failure height of 16 feet the failure discharge was estimated to be approximately 10,800 cfs. Since a portion of the overflow section crest has broken away, there would be some discharge prior to failure. However, the prefailure discharge under these conditions is not significant, about 800 cfs, and therefore was not included with the dam failure calculations.

An assumed breach of the Ammonoosuc River Dam with the water surface at the crest of the overflow sections would increase the stage along the immediate downstream channel by about 15 feet to an elevation of approximately 488 feet (NGVD). The discharge resulting from this failure would approach the sill level of the mill located on the left bank a short distance downstream from the dam, possibly resulting in an economic loss to the owner. The potential for loss of less than a few lives of employees at the mill would exist. The stage of the failure discharge would decrease rapidly as it passes downstream.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual observations indicate the following potential structural problems:

(1) The apparent erosion of the concrete overflow sections, including two large sections on the top of the dam that have broken free and the severe spalling and cracking on the crest of the dam over its entire length are signs of serious structural problems and instability, and if allowed to continue, will cause a progressive lowering of the crest.

(2) The rotting wood in the penstock gates with 3 feet of silt built up behind them, making the gates inoperable; the leakage through the gates; the severely spalled concrete of the penstock intake structure, with visible reinforcement at several locations; and the heavy rust on the lifting mechanisms are all signs of considerable deterioriation of the gates and surrounding structure. If these problems are not corrected, they could lead to further deterioration and eventual failure of the penstock gates and surrounding structure.

(3) The removal of the waste gate, the severe spalling of the concrete gate structure with visible reinforcement in a few locations, and the inoperability of the lifting mechanism are all signs of considerable deterioriation of the gate structure. If these problems are not corrected, they could lead to further deterioration and eventual failure of the waste gate structure.

Because water was flowing over the dam, it was not possible to make a detailed visual examination of the concrete in the dam or of the foundation.

6.2 Design and Construction Data. No information regarding the original design or construction of the dam was found, although it is known that a mill dam was in existence at this location by 1765. It is not known when the present structure was built, but according to the files at the state of New Hampshire Water Resources Board, it was in existence by 1936.

6.3 Post-Construction Changes. By 1951 a small electric generator was added to the existing water power facility. The hydro facilities were retired from use in 1969 when the mill closed. A fire in 1976 destroyed the mill buildings, and there have been no changes to the dam since that time.

6.4 Seismic Stability

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

SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination indicates that Ammonoosuc River Dam is in poor condition. The major concerns with respect to the integrity of the dam are:

(1) The apparent erosion of the concrete overflow sections, including two large sections on the top of the dam that have broken free and the severe spalling and cracking on the crest of the dam over its entire length.

(2) The rotting wood in the penstock gates with 3 feet of silt built up behind them; the leakage through the gates; the severely spalled concrete of the penstock intake structure, with visible reinforcement at several locations; and the heavy rust on the lifting mechanisms.

(3) The removal of the waste gate, the severe spalling of the concrete gate structure with visible reinforcement in a few locations, and the inoperability of the lifting mechanism.

b. Adequacy of Information. The information available from the visual inspection is adequate to identify the problems mentioned in 7.2 and 7.3. However, because water was flowing over the crest of the dam at the time of the inspection, it was not possible to examine in detail the concrete in the dam or the foundation. The problems that have been identified will require the attention of a registered professional engineer qualified in the design and construction of dams who will have to make additional engineering studies to design or specify remedial measures. No additional information is needed for the purposes of this Phase I inspection.

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

7.2 Recommendations

The owner should retain a registered professional engineer qualified in the design and construction of dams to:

(1) Inspect the downstream face of the overflow sections under no flow conditions.

(2) Design and specify repairs for the erosion and spalling of the concrete overflow sections.

(3) Design and specify repairs to the penstock gates, lifting mechanisms, and for the erosion and spalling of the concrete penstock gate structure.

(4) Design and specify repairs to the waste gate, lifting mechanisms, and for the erosion and spalling of the concrete waste gate structure.

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

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Visually inspect the dam and appurtenant structures once a month.

(2) Engage a registered professional engineer qualified in the design and construction of dams to make a comprehensive technical inspection of the dam once a year.

(3) Establish a surveillance program for use during and immediately after periods of heavy rainfall, establish written procedures to be followed during flooding periods, and also establish a warning program to follow in case of emergency.

(4) Establish written maintenance and operating procedures.

7.4 Alternatives

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

APPENDIX A
INSPECTION CHECKLIST

INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT: Ammonoosuc River Dam, NH

DATE: April 30, 1980

TIME: 11:00 a.m.

WEATHER: Sunny, warm

W.S. ELEV. 495.5 (NGVD) U.S. 479.4 DN.S.

PARTY:

1. Kenneth Stewart, S E A
2. Robert Durfee, S E A
3. Bruce Pierstorff, S E A
4. Philip Upton, S E A
5. Ronald Hirschfeld, GEI
6.
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Structural Stability	K. Stewart/R. Durfee	
2.	Hydrololgy/Hydraulics	B. Pierstorff	
3.	Soils and Geology	R. Hirschfeld	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

INSPECTION CHECK LIST

PROJECT: Ammonoosuc River Dam, NH DATE: April 30, 1980

PROJECT FEATURE: Dam Embankment NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	494.0 left overflow section 495.0 center and right overflow section
Current Pool Elevation	495.5
Maximum Impoundment to Date	Unknown
Surface Cracks	Numerous throughout crest of dam
Pavement Condition	No pavement
Movement or Settlement of Crest	Two large sections of crest broken free. Entire length of crest deteriorated.
Lateral Movement	None observed
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Poor - concrete severely deteriorated at numerous locations.
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	None observed
Vegetation on Slopes	Some on slopes at abutments
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection - Riprap Failures	No riprap
Unusual Movement or Cracking at or near Toe	Not observable - beneath water surface
Unusual Embankment or Downstream Seepage	Not observable - beneath water surface
Piping or Boils	N/A
Foundation Drainage Features	Not observable - beneath water surface
Toe Drains	Not observable - beneath water surface
Instrumentation System	None

INSPECTION CHECK LIST

PROJECT: Ammonoosuc River Dam, NH DATE: April 30, 1980

PROJECT FEATURE: Dike Embankment NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
DIKE EMBANKMENT	No dike
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Vegetation on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	

INSPECTION CHECK LIST

PROJECT: Ammonoosuc River Dam, NH DATE: April 30, 1980

PROJECT FEATURE: Intake Channel NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	Some erosion of left river bank immediately upstream of outlet works
Bottom Conditions	Not visible beneath water surface
Rock Slides or Falls	None observed
Log Boom	None
Debris	Some debris at beginning of approach channel
Condition of Concrete Lining	Considerable spalling above water surface elevation
Drains or Weep Holes	None observed
b. Intake Structure	
Condition of Concrete	Considerable spalling above water surface elevation
Stop Logs and Slots	None

INSPECTION CHECK LIST

PROJECT: Ammonoosuc River Dam, NH DATE: April 30, 1980

PROJECT FEATURE: Control Tower NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	Control works located on top of penstock intake structure
a. Concrete and Structural	
General Condition	Very poor
Condition of Joints	Not observed
Spalling	Several locations of severe spalling
Visible Reinforcing	Several locations of visible reinforcement
Rusting or Staining of Concrete	Staining of concrete below lifting mechanisms
Any Seepage or Efflorescence	None observed
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	Minor leaks through penstock gates
Cracks	Minor
Rusting or Corrosion of Steel	Lifting mechanisms heavily rusted
b. Mechanical and Electrical	
Air Vents	None
Float Wells	None
Crane Hoist	None
Elevator	None
Hydraulic System	None
Service Gates, Emergency Gates	Waste gate removed, penstock gates(3) in place; fair condition
Lightning Protection System	None
Emergency Power System	None
Wiring and Lighting System	None

INSPECTION CHECK LIST

PROJECT: Ammonoosuc River Dam, NH DATE: April 30, 1980

PROJECT FEATURE: Transition and Conduit NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	26 feet wide by 9 feet high penstock
General Condition of Concrete	Poor
Rust or Staining on Concrete	Staining of concrete at bar rack
Spalling	Severe on inside lining
Erosion or Cavitation	Severe on inside lining
Cracking	Minor
Alignment of Monoliths	Good
Alignment of Joints	Good
Numbering of Monoliths	Unknown

INSPECTION CHECK LIST

.OJECT: Ammonoosuc River Dam, NH DATE: April 30, 1980

.OJECT FEATURE: Outlet Structure NAME: _____

SCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
JTLET WORKS - OUTLET STRUCTURE ND OUTLET CHANNEL	
neral Condition of Concrete	Not visible - beneath mill foundation
ist or Staining	Not visible - beneath mill foundation
alling	Not visible - beneath mill foundation
osion or Cavitation	Not visible - beneath mill foundation
sible Reinforcing	Not visible - beneath mill foundation
ıy Seepage or Efflorescence	Not visible - beneath mill foundation
ondition at Joints	Not visible - beneath mill foundation
rain Holes	None observed
hannel	
Loose Rock or Trees Overhanging Channel	None observed
Condition of Discharge Channel	Good

INSPECTION CHECK LIST

ROJECT: Ammonoosuc River Dam, NH DATE: April 30, 1980

ROJECT FEATURE: Spillway Weir NAME: _____

ISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
UTLET WORKS - SPILLWAY WEIR, PPROACH AND DISCHARGE CHANNELS	
Approach Channel	
General Conditions	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Not visible beneath water surface
Weir and Training Walls	
General Condition of Concrete	Very poor
Rust or Staining	Rusting at visible reinforcement
Spalling	Severe throughout structure
Any Visible Reinforcing	Visible reinforcement at several locations
Any Seepage or Efflorescence	Visible efflorescence at some locations
Drain Holes	None
Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Some trees overhanging channel
Floor of Channel	Not visib'e beneath water surface
Other Obstructions	None observed

INSPECTION CHECK LIST

)JECT: Ammonoosuc River Dam, NH DATE: April 30, 1980

)JECT FEATURE: Service Bridge NAME: _____

CIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
TLET WORKS - SERVICE BRIDGE	No service bridge
Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

NEW HAMPSHIRE WATER CONTROL COMMISSION

DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

AT DAM NO. 17.02

Bath : County Grafton

Ammonoosuc R

nary Conn R : Secondary Ammonoosuc

me

DATA

x. ft.: Min. ft.: Ave. 16 ~~5~~ ft.

Construction : Use of Power Industrial

ac. ft.: Storage ac. ft.

ION

Rack Opening

Bar : Material

Gross Sq. Ft.: Net sq. ft.

tes

er : Size ft. high x ft. wide

ion of Invert : Total Area sq. ft.

er : Material

: Length

er 2 : Makers (1) 42" -Morgan Smith 1-23" Leffel

HP. per unit ~~53~~ 217 : Total Capacity (500) 200 HP.

Dement C.F.S., per unit : Total cfs.

or

er

KW., per unit ; Total Capacity K. W.

er : Make

g-per unit : Total Capacity K. W.

—KWHRS

... : 19......

... : 19......

... : 19......

... : 19......

... : 19......

Cushman-Rankin Co Bath N H

By A A N A R L T HB Date October 13, 1938. 7/15/42

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

ON — STATE NO. 17.03

Bath : County Grafton

Ammonoosuc R

Primary Conn. R : Secondary Ammonoosuc R

Name

nates—Lat. 44° 10' : Long. 72° 01' -2,600

AL DATA

age area: Controlled ... Sq. Mi.: Uncontrolled ... Sq. Mi.: Total 327 Sq. Mi.

ll length of dam 225' ft.: Date of Construction

t: Stream bed to highest elev. 25' ft.: Max. Structure 12' ft.

-Dam : Reservoir
Gravity---C Type--Ledge Found. Concrete

PTION

Gates

e (Log Sluice)

nber : Size 22' ft. high x 2 ft. clear ft. wide

vation Invert : Total Area sq. ft.

st

Gates Conduit

mber : Materials

e ft.: Length ft.: Area sq. ft.

nkment

pe

ight—Max. ft.: Min. ft.

—Width : Elev. ft.

pes—Upstream on : Downstream on

gth—Right of Spillway : Left of Spillway

vay

terials of Construction Concrete

gth—Total ft.: Net 244' ft.

ight of permanent section—max. 15' ft.: Min. ft.

shboards—Type : Height ft.

vation—Permanent Crest [illegible] : Top of Flashboard

od Capacity 25,320 cfs.: 72.5 cfs/sq. mi.

ments

terials:

eeboard: Max. 3' ft.: Min. ft.

lworks to Power Devel.—(See "Data on Power Development")

R Cushman-Rankin Co. A 89 Beach St, Boston Bath N.H.

RKS

F[illegible] - needs repairs

tion By [illegible] HB Date October 18, 1938. 7/13/42

WATER CONTROL COMMISSION

STATE OF NEW HAMPSHIRE

Concord, New Hampshire

Rankin Co.,
Bath, N.H.

RE: Ammonoosuc River Dam. W. C. C. No. 17.02

Gentlemen:

In order that we may determine the magnitude and extent of the flood of September 21-24 just passed, we are requesting the various dam owners in the State to supply us with the following information:

1. Was this dam injured? Ans. No

2. If so, to what extent? Ans. x

3. Did all flashboards go out? Ans. Half of them did.

4. What was the maximum height of water over the permanent crest of spillway? Ans. About Nine (9) Feet

5. At what day and hour did the maximum flood height reach your dam? Ans. Sept. 21, 7:30 P. M.

6. Any other interesting information regarding the flood or rain fall may be given on the back of this sheet, or attach sheets.

Will you please return this letter with as much information as you can give us as promptly as possible. A self-addressed envelope is attached hereto.

We thank you for your cooperation.

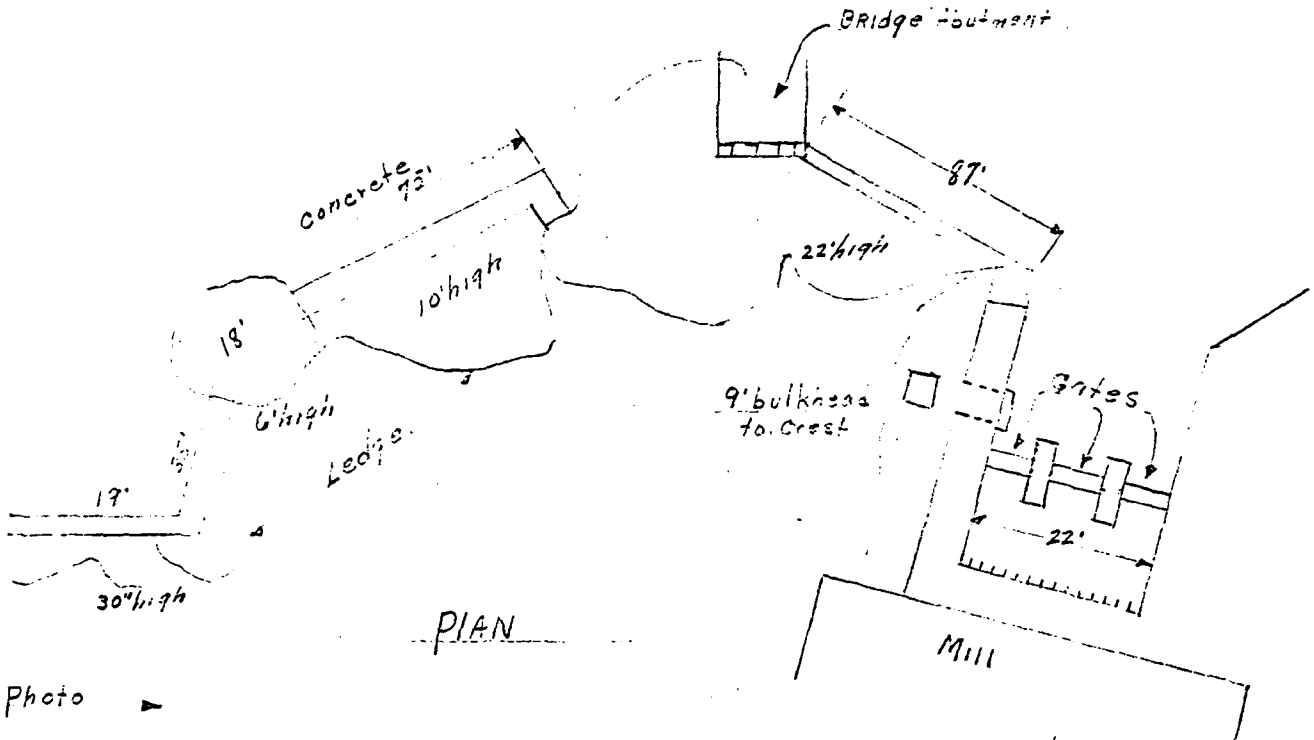
Very truly yours,

Richard S. Holmgren

Richard S. Holmgren
Chief Engineer

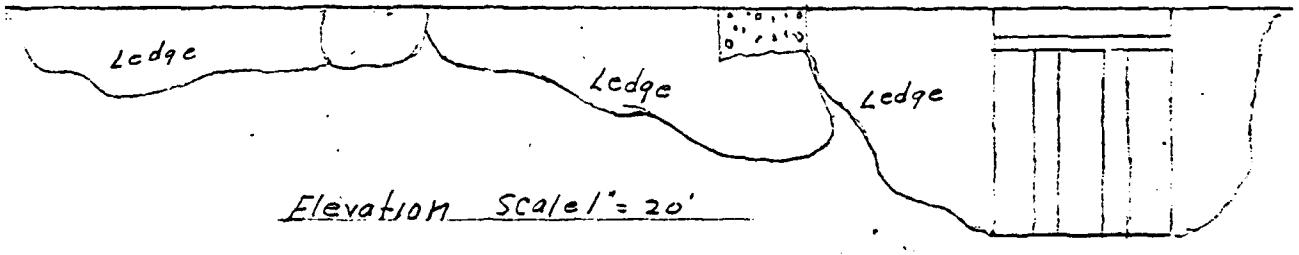
CDC:CMB
Enc.

HIRE PROJECT ... FILE 17.02
URCES SUBJECT Ammonoosuc BATH ... ACC ...
N. H. Conn. R Ammonoosuc Cushman Rankin Co
COMPUTER ... CHECKER R L T CONT. FROM ACC. CONT. ON ACC. SUMMARY ON ACC. DATE 9/6/39

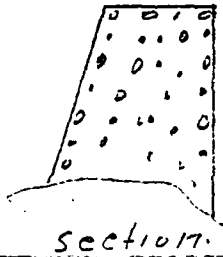


PLAN

Photo ►



Elevation Scale 1" = 20'



Section

Form E80

NEW HAMPSHIRE WATER RESOURCES BOARD

QUESTIONNAIRE

WATER POWERS OF NEW HAMPSHIRE

Cushman Rankin Company
Bath
New Hampshire

Gentlemen:

We maintain in this office a list of the water power installations in New Hampshire. In recent months we have had several inquiries concerning the water power installations in the State and have found that our information is in some cases out of date.

We are, therefore, bringing this information up to date and request your cooperation by filling in the questionnaire below with data on your development, and return it to us in the enclosed stamped envelope.

Very truly yours,

R. S. Holmgren

RSH:GMB
Encl.

Richard S. Holmgren
Chief Engineer

Dam No. 17.02 : Location: Ammonoosuc River at Bath

1. Will you please check or correct:

	Our Data	Your Corrections
Drainage Area - Sq.Mi.	327	?
Head - feet	16.5	16.
Capacity (Total)	275	200
Wheel - H.P.		
Generator - K.W.		

2. Is the power plant now in operation? Yes

3. If not, is the equipment in operable condition? Yes

4. Is the dam in good repair? Fair - needs repair

(Signed) W. P. Rankin Inc

Date July 15-1942

NEW HAMPSHIRE WATER RESOURCES BOARD
State House Annex
Concord, N. H.

December 4, 1961

The Cushman-Rankin Company
Bath, N.H.

Dear Sir:

To bring our records of hydro-electric power installations up to date, we are requesting you to furnish the following information on your generators in use at the present time:

_____ reported as 14 KW in 1951

presently using None KW generators.

January 8, 1962

Gentlemen:

The Cushman-Rankin Company was liquidated in 1953 after a disastrous fire on ~~xxxxx~~ July 1, 1952.

Kenneth M. Rankin

Yours very truly,

Francis C. Moore
Francis C. Moore
Civil Engineer

DIAMOND WOODWORKING CO.
Box A
Bath, New Hampshire 03740

Tel. (603) 747-2202

July 20, 1973

WATER RESOURCES BOARD
105 Loudon Rd.
Concord, N. H.

Gentlemen:

We wish to report the following flood damage to the dam located below the covered wooden bridge at Bath, N. H. on June 30, 1973.

1. A section at the top of the dam approximately 100 ft. long and from two to five feet deep has broken free on the side closest to Route 302.

2. A section at the top of the dam approximately 20 feet long and one foot deep has broken free on the west side of the dam.

We would appreciate it if your department will make a record of the above damage, and inspect it as soon as possible.

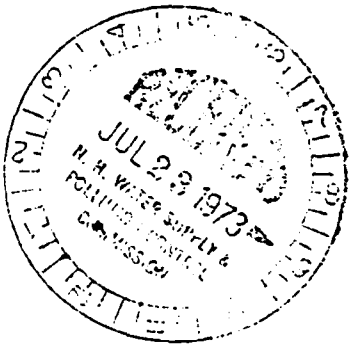
Sincerely,

Charles M. Diamond

CHARLES M. DIAMOND
DIAMOND WOODWORKING CO.

CMD/mr

7/26/73
Talked with Cioff. Concerning this. Date checked
Letter, PCM



M E M O R A N D U M

DATE: October 6, 1973

FROM: Pattu D. Kesavan, Water Resources Engineer

SUBJECT: Complaint from Diamond Woodworking Co. - Bath - #17.02

TO: Vernon A. Knowlton
Chief Engineer, Water Resources Board

The Diamond Woodworking Company wrote a letter to this office regarding a flood damage to the dam which it claims to have occurred during June 30, 1973.

Peter Merkes has talked to the Bath Selectmen, who are of the opinion that the damage claimed by the Diamond Woodworking Company is not legitimate, and the dam was in that condition for several years. Also, as this is a private dam, the Corps of Engineers dam team did not prepare a DSR, and I assume that they informed this fact to the Diamond Woodworking Company.

I inspected the dam in October 3, 1973, accompanied by Mr. Charles Diamond. I was informed that Mr. Diamond bought the dam and the mill in April, 1973. The dam is situated across the Ammonoosuc River under the old covered bridge. (See photos).

I told Mr. Diamond that this is a privately owned dam, and there is little that the State or the Federal Disaster Assistance Program could do.

PDK:js

M E M O R A N D U M

DATE: February 20, 1974

FROM: Francis C. Moore, Civil Engineer

SUBJECT: Diamond Woodworking Co. Dam - Bath - #17.02

TO: Vernon A. Knowlton, Chief Water Resources Engineer

On February 15, 1974, I inspected the results of ice jams above the Bath dam There was negligible ice jamming in the power pool above this dam. By viewing the river above the power pool, there was considerable ice jamming of agricultural land. This caused some debris, trash and gravel buildup on agricultural land.

The flood gate at the Bath dam is only 3'x 5' from top of dam. This would pass about 160 cubic feet per second or 0.5 cubic feet per second per square mile. This would give negligible relief during floods.

I talked with Charles Diamond, owner, who said he was being granted a small Business Loan of $40,000 to rehabilitate the hydroelectric generator. This will include rebuilding of the intake structure. The flood gate is frozen in and a 10-ton hydraulic jack cannot at present open the gate. Upon rebuilding of the intake structure, this flood gate and a serious leak in the dam about fifty feet from the intake structure will be sealed off.

FCM:js

Diamond Woodworking Company
Bath
New Hampshire

RE: REPAIRS NECESSARY TO YOUR DAM, BATH - #17.02

1. Eroded concrete on spillway is to be repaired.

State of New Hampshire

WATER RESOURCES BOARD

37 Pleasant St.
CONCORD 03301

December 4th, 1974

Diamond Woodworking Company
Bath, NH 03740

CERTIFIED MAIL

Dear

On October 3 th, 1974, an engineer of the New Hampshire Water Resources Board inspected your dam located on Ammonoosuc River in the Town of Bath.

This dam, #17.02 in the files of the New Hampshire Water Resources Board, is classified as a menace structure, and as such, must be maintained in a manner so that this structure would not endanger the public safety, nor become a "Dam in Disrepair".

As a result of this inspection, the several items noted on the attached sheet were found to be deficient and should be corrected immediately.

Under the provisions of Chapter 482:42-59, by petition from the selectmen of the town of mayor of any municipality or upon its own motion, the Board may conduct a public hearing for the determining of whether or not said dam is a "Dam in Disrepair". Should such a finding be determined, the owner would be requested to make the repairs within a specified time period. Upon failure to do so, the town, by the provisions of these statutes, may take the dam.

This office would appreciate receipt of your proposed schedule of these repairs, within 30 days receipt of this letter, and should no response be received within this time period, the Board may direct that a public hearing be conducted and a formal order be issued requiring that the necessary repairs be made or that this dam be breached.

If you have any questions regarding the above, please contact us at your convenience.

Very truly yours,

George M. McGee, Sr.
Chairman

gmmg/vak:js
enclosure
cc: Town Clerk

PAST INSPECTION REPORTS

AVAILABLE ENGINEERING DATA

Cross section information for the Ammonoosuc River Channel and top of dam generated for a flood plain information report for Bath, New Hampshire, prepared for the Army Corps of Engineers by Dubois & King in May of 1978 were obtained from the Army Corps of Engineers, New England Division, Waltham, Massachusetts.

Other than the cross section information mentioned above and records of past inspection reports on file at the State of New Hampshire, Water Resources Board, 37 Pleasant Street, Concord, New Hampshire 03301, no in-depth engineering calculations, as-built drawings, or specifications were found.

APPENDIX B

ENGINEERING DATA

1702

State of New Hampshire
PUBLIC SERVICE COMMISSION

C O P Y

August 17, 1936

Mr. W. P. Rankin
The Cushman-Rankin Co.
Bath, New Hampshire

Dear Sir:

We are in receipt of your letter of August 12, 1936 regarding inspection of your dam in Bath.

In classifying your dam as being in fair condition, our Inspector based his report on the looks of the dam. This dam structurally is in first class condition, but as you have said the face is badly pitted. Also Mr. Blake said there was a little seepage in a ledge crevice which was probably due to the frost action on the ledge.

You are correct in saying we classified this dam a menace due to its height and location rather than its condition. We can offer no suggestions concerning the repair of your dam other than refacing, and at such time we will change our report of condition, fair, to condition, very good.

Yours very truly,

N. H. PUBLIC SERVICE COMMISSION

D. Waldo White
Chief Engineer

DWW/a

Form E1A
4845

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-5236

TOWN: BATH	TOWN NO.: 2	STATE NO.: 17.02
RIVER / STREAM: Ammonoosuc River		
DRAINAGE AREA:	POND AREA:	
DAM TYPE: Gravity	FOUNDATION NATURE OF: Ledge	
MATERIALS OF CONSTRUCTION: Concrete		
PURPOSE OF DAM: POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM: Approx. 25'	TOP OF DAM TO SPILLWAY CRESTS: 9'	
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM: 244'		LENGTH OF DAM: Approx. 285'
FLASHBOARDS TYPE, HEIGHT ABOVE CREST: None		
OPERATING HEAD CREST TO N. T. W.: 16'	TOP OF FLASHBOARDS TO N. T. W.:	
WHEELS, NUMBER KINDS & H. P.: 1-42" Morgan Smith - 207 HP; 1-23" Leffel - 68 HP		
GENERATORS, NUMBER KINDS & K. W.:		
H. P. 90 P. C. TIME 100 P. C. EFF.:	H. P. 75 P. C. TIME 100 P. C. EFF.:	
REFERENCES, CASES, PLANS, INSPECTIONS:		

REMARKS

OWNER: Cushman - Rankin

CONDITION: Fair

MENACE: Yes. Will be subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made July 22, 1936, according to notification to owner dated July 14, 1936, and bill for same in enclosed.

D. Waldo White
Chief Engineer

August 6, 1936
Copy to Owner

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Connecticut NO. 2 — I-5286

RIVER Ammonoosuc River MILES FROM MOUTH 4.95 AE D.A.-SQ.MI. 327 AE

TOWN Bath OWNER Cushman-Rankin Co., Bath USGS

LOCAL NAME OF DAM

BUILT ______ DESCRIPTION Gravity - Conc. on ledge found.

POND AREA -ACRES ______ DRAWDOWN-FT. ______ POND CAPACITY-ACRE FT. ______

HEIGHT-CREST TO BED OF STREAM-FT. 25 ± MAX. ______ MIN. ______

OVERALL LENGTH OF DAM-FT. 265 ± MAX.FLOOD HEIGHT ABOVE CREST-FT. ______

PERMANENT CREST ELEV. U.S.G.S. 495.4 AE LOCAL GAGE ______

TAILWATER ELEV.U.S. G.S. 479.9 AE LOCAL GAGE ______

SPILLWAY LENGTHS-FT. 244 FREEBOARD-FT. 9

FLASHBOARDS-TYPE,HEIGHT ABOVE CREST None

WASTE GATES-NO. WIDTH MAX.OPENING DEPTH SILL BELOW CREST

REMARKS Fair condit. Max High water 513.7 AE

4 ± into Connecticut R.

POWER DEVELOPMENT

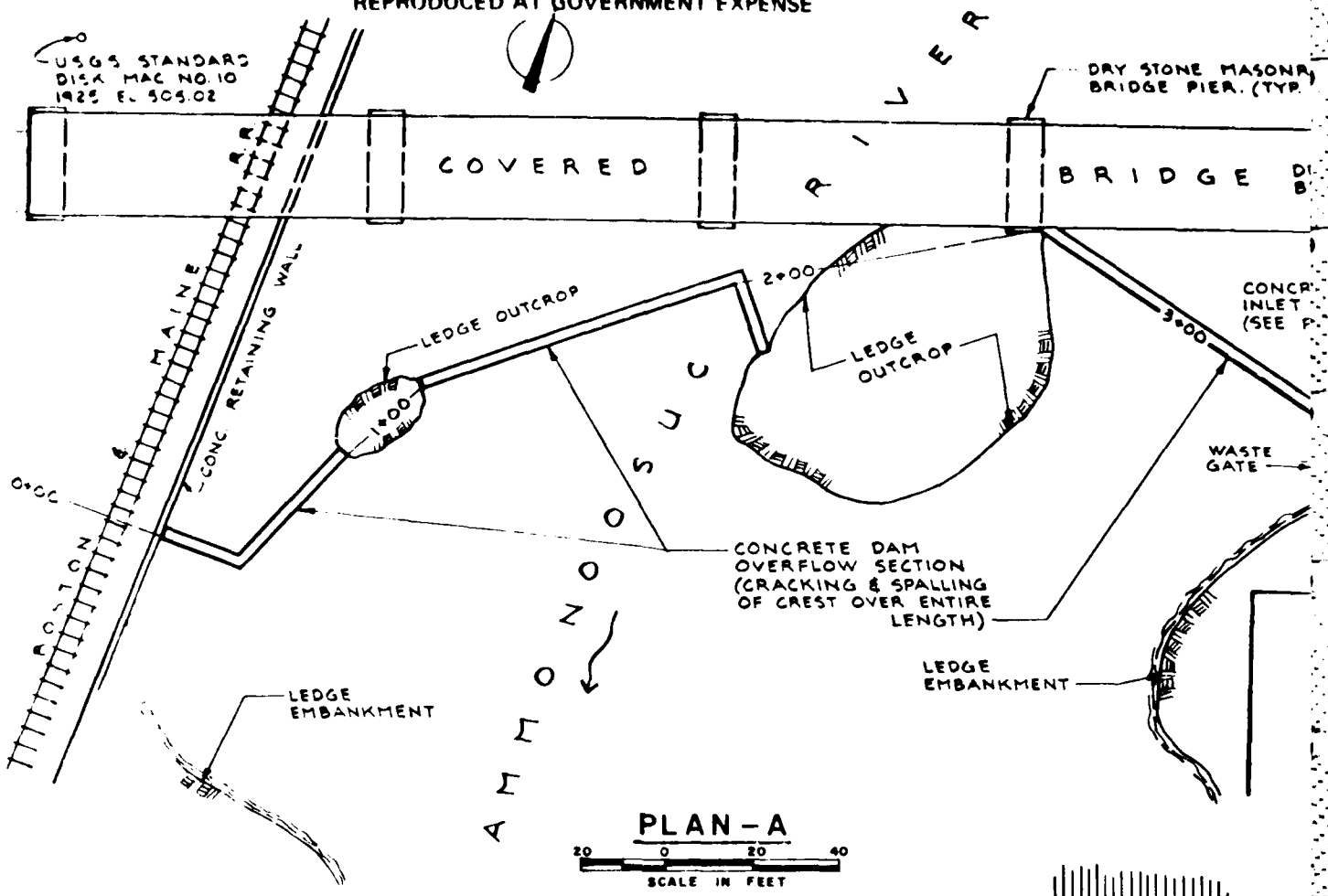
UNITS	NO.	RATED HP.	HEAD FEET	C.F.S. FULL GATE	KW.	MAKE
	1	207	16	156-5		42" Morgan-Smith
	1	68	16			23" Leffel
		500 USGS				
	2				150 e.a.	unknown WRB
		500 AE	16.5 AE			

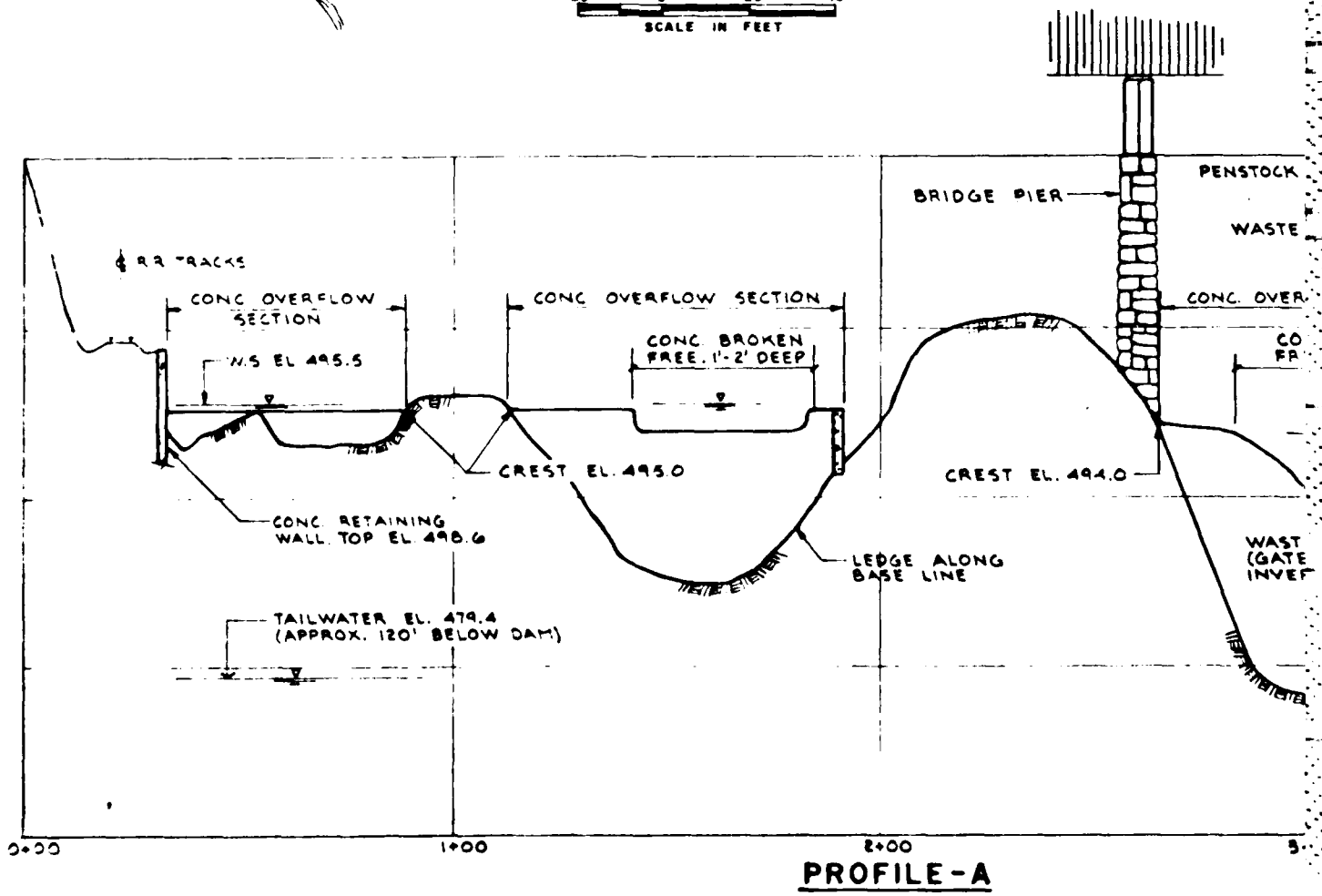
USE Power

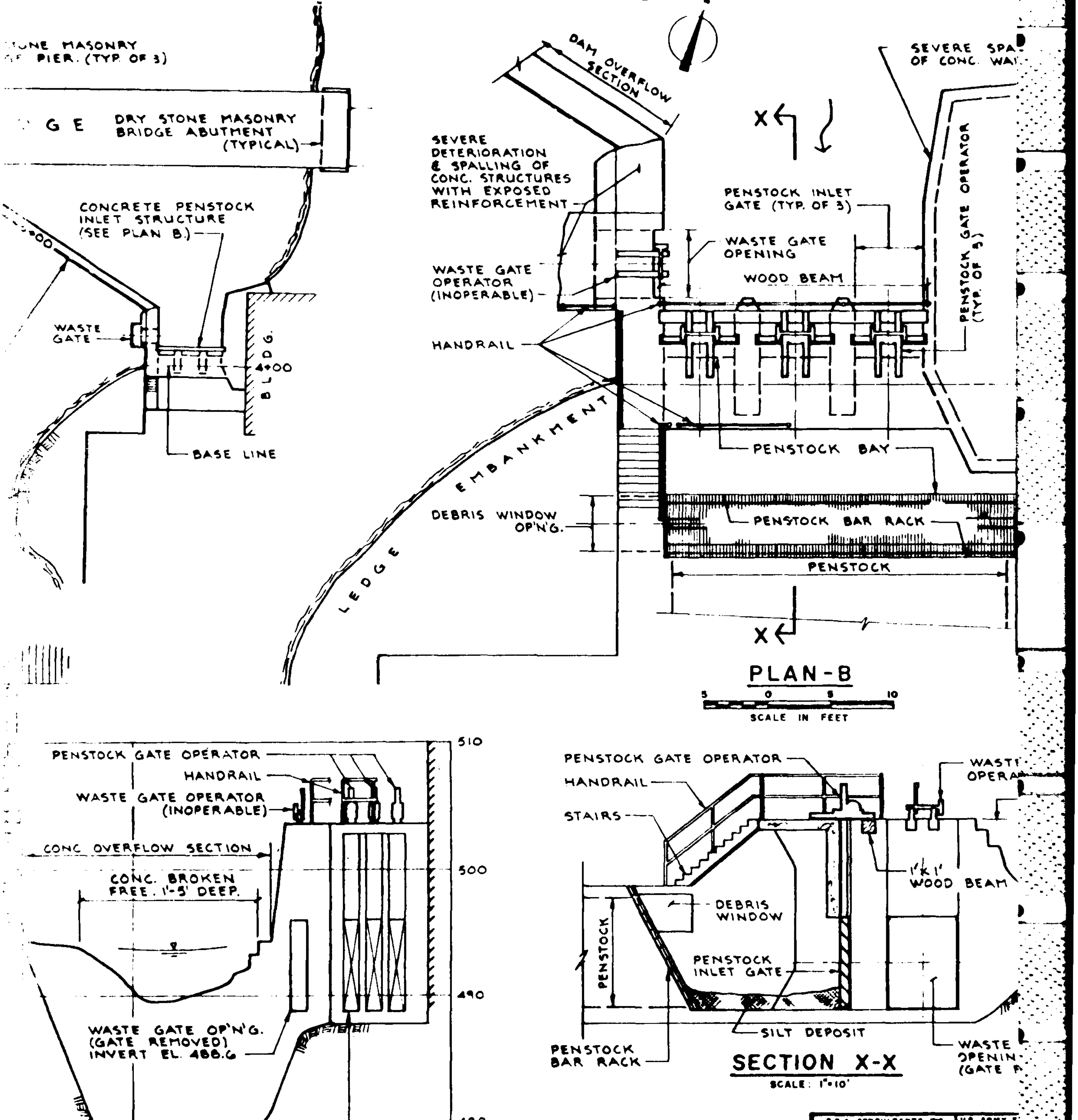
REMARKS

DATE 7/31/36

PLANS AND DETAILS







NOTES:

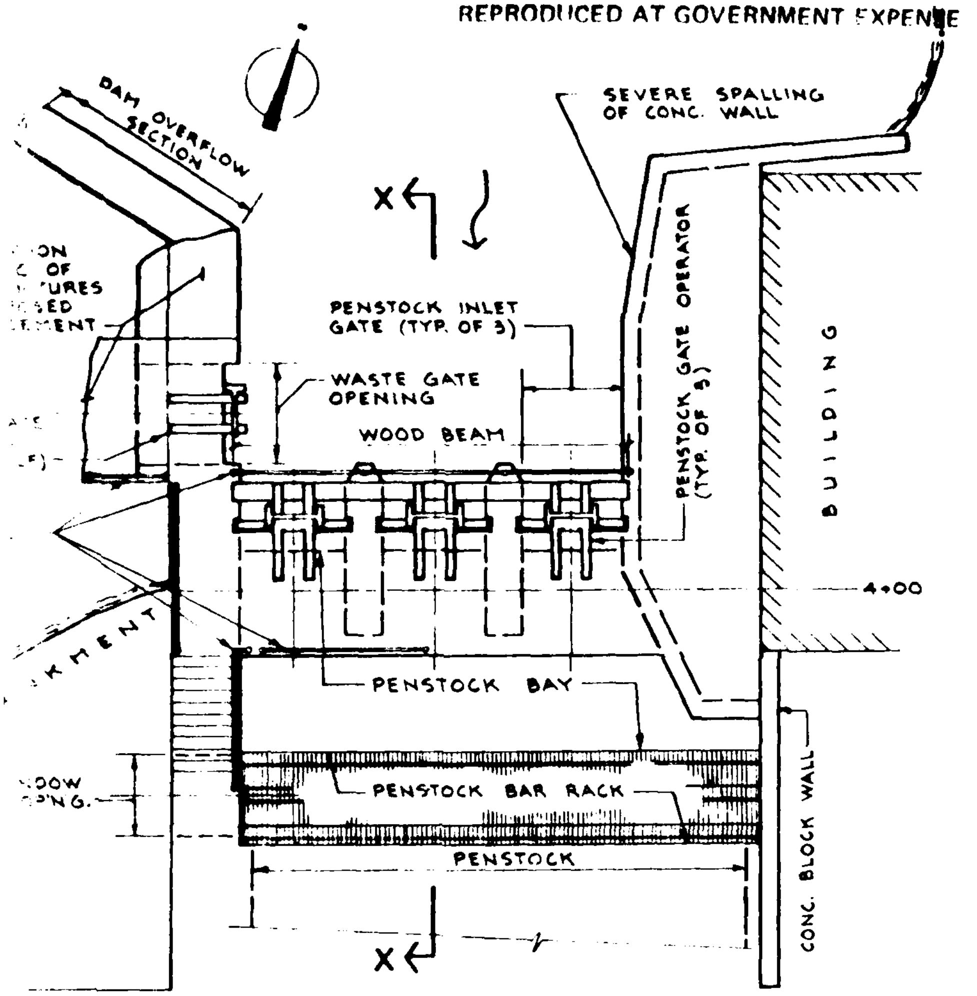
1.) The elevations shown are based on NGVD obtained from USGS Standard Disk MAC No. 10 [illegible] approximately [illegible] of the right abutment of Ammonoosuc River Dam.

2.) The information shown on this drawing is based on the existing [illegible] and visual observations made during the field inspection. Dimensions or materials indicated on this drawing which were below grade or water during the time of inspection were not verified.

E.E.A. CONSULTANTS INC. BOSTON, MA — ROCHESTER, NH | US ARMY E

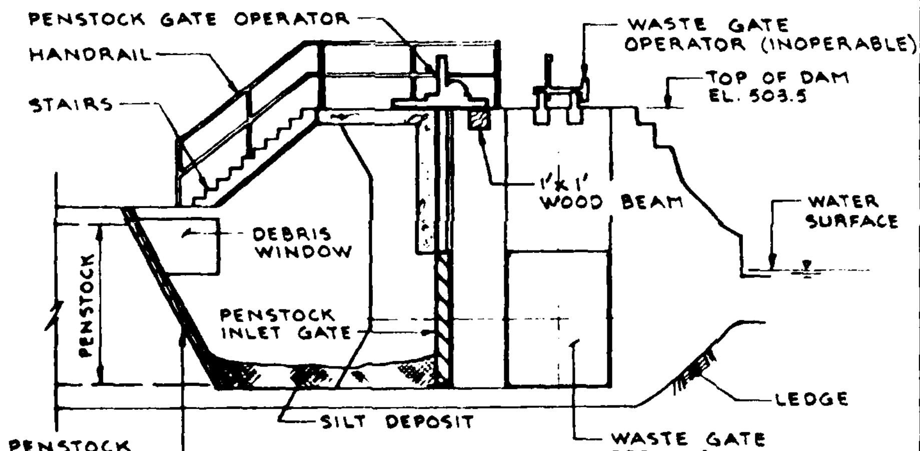
NATIONAL PROGRAM OF INSPECT

AMMONOOSUC R



PLAN-B

SCALE IN FEET (5, 0, 5, 10)



SECTION X-X

SCALE: 1"=10'

The [illegible] based on [illegible] [illegible] Disk MAC [illegible] located approximately [illegible] of the right abutment of Ammonoosuc River Dam.

The information shown on this drawing [illegible] based on the existing sketches and [illegible] made during the field [illegible]. Dimensions [illegible] materials [illegible] on this drawing which were below grade or water during the time of inspection were not verified.

S E A CONSULTANTS INC. BOSTON, MA — ROCHESTER, NH	US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

AMMONOOSUC RIVER DAM

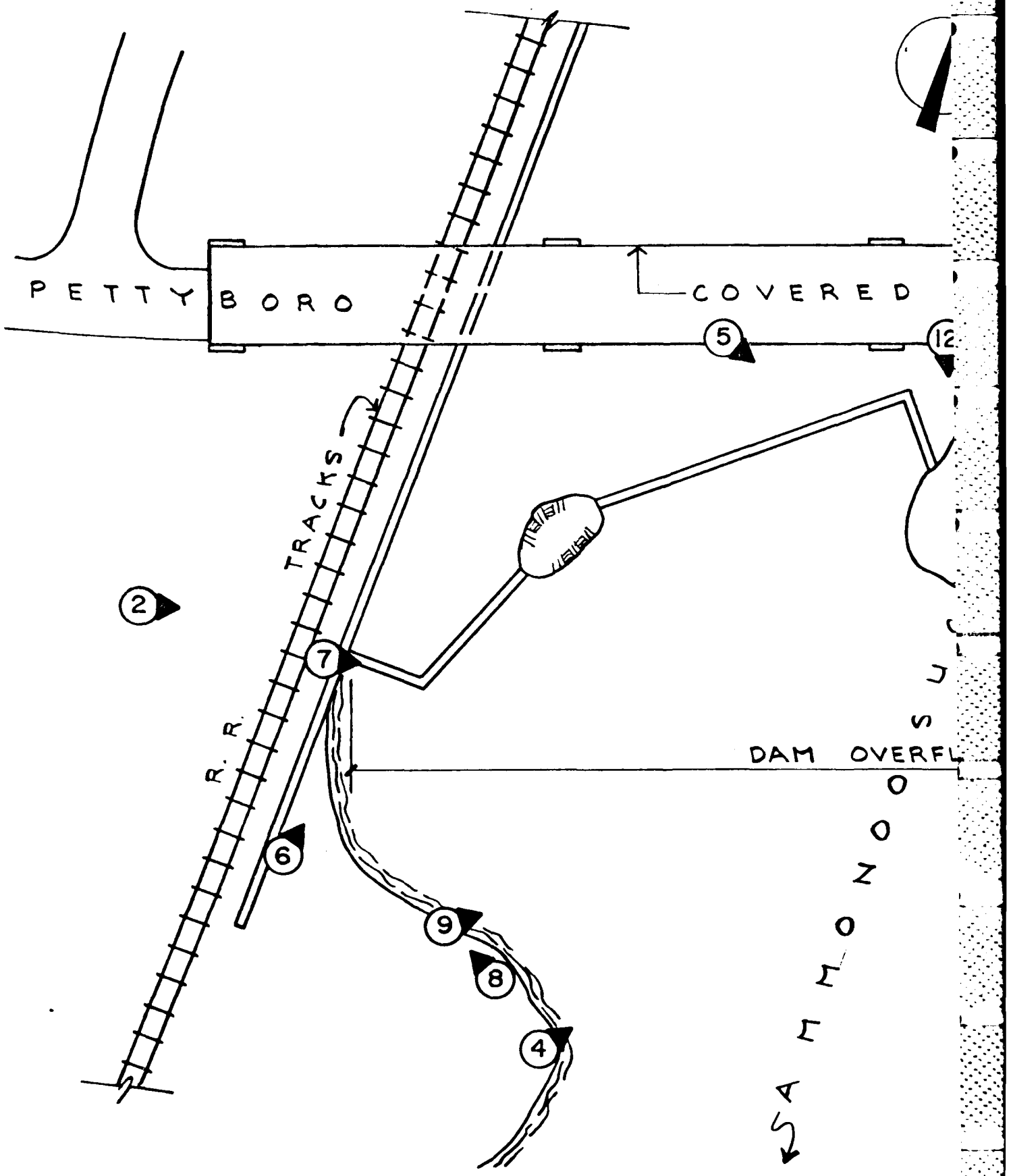
BATH, NEW HAMPSHIRE

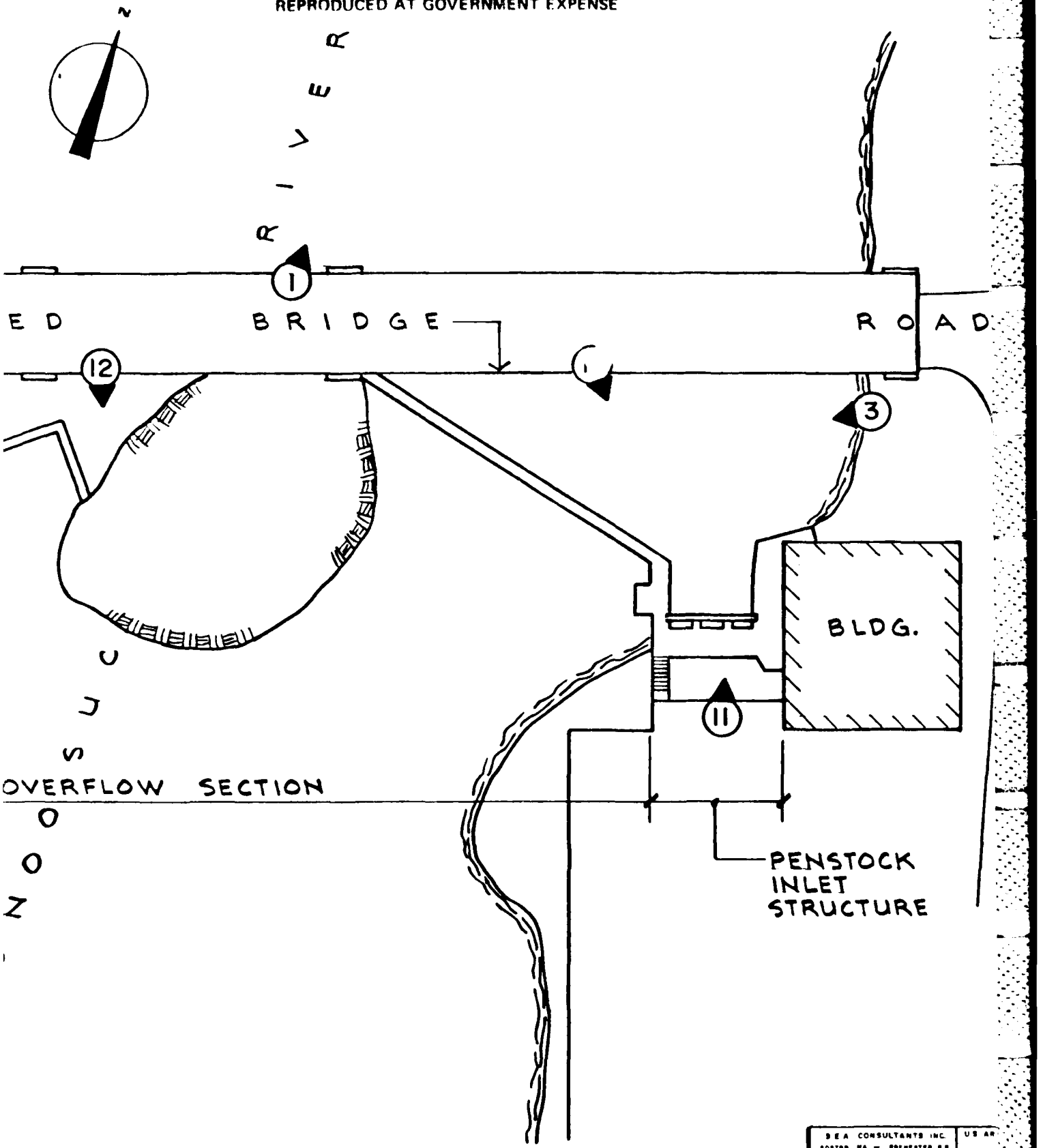
SCALE: AS NOTED
DATE: JUNE 1980

3073

APPENDIX C

SELECTED PHOTOGRAPHS





SEA CONSULTANTS INC.
BOSTON, MA — ROCHESTER, NY

US AR

NATIONAL PROGRAM OF INSP

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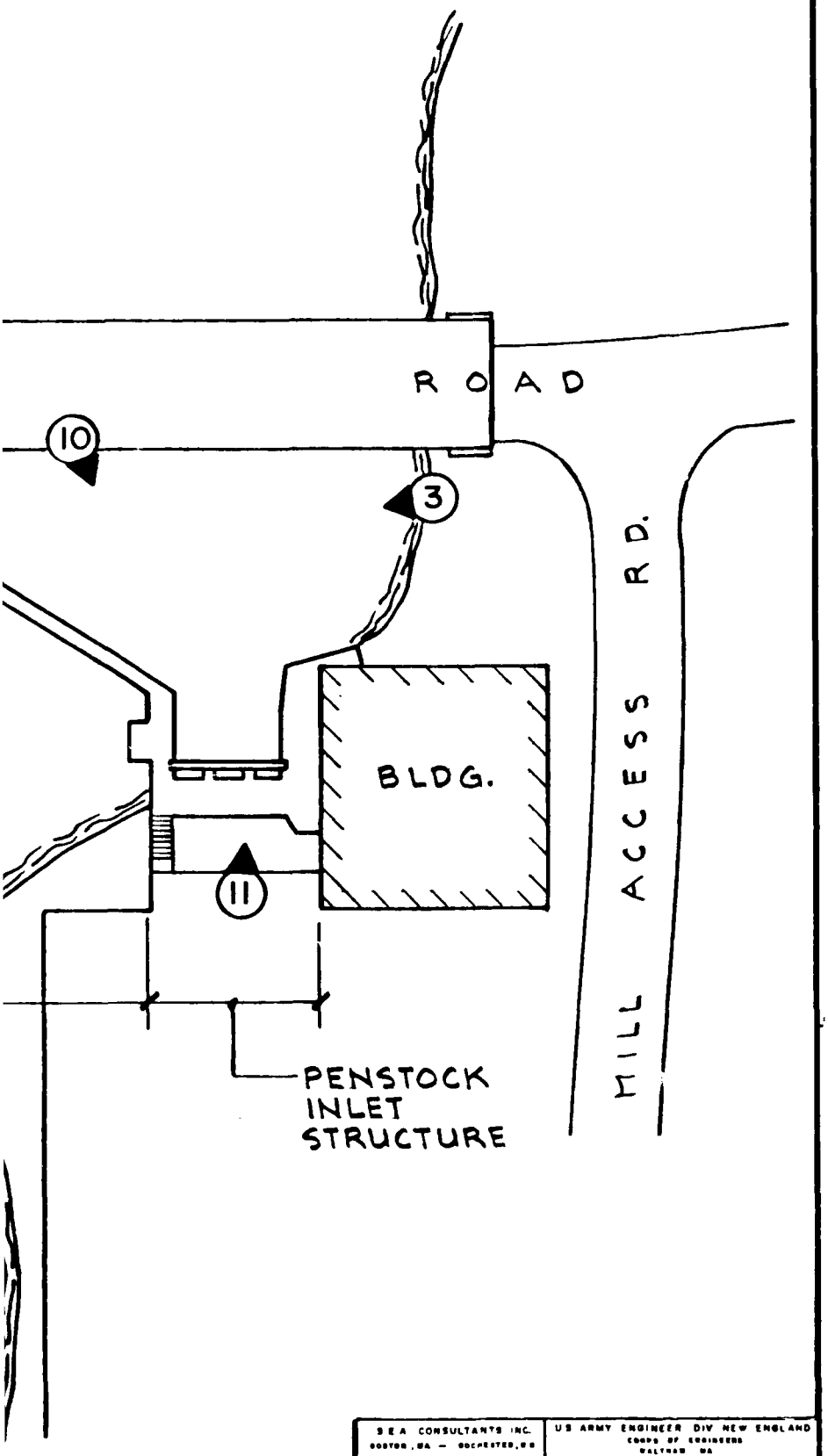
RIVER
PHOTO



SEA CONSULTANTS INC. BOSTON, MA — ROCHESTER, NH	US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM MA

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

AMMONOOSUC RIVER DAM PHOTO INDEX

BATH, NEW HAMPSHIRE

SCALE AS NOTED
DATE JUNE 1980

3 of 3

Photo No. 1 - General view of upstream channel from bridge.

Photo No. 2 - View of left abutment and crest of dam from right abutment.

Photo No. 5 - Close-up of crest of central portion of overflow section.

Photo No. 6 - Downstream face of right portion of overflow section.

Photo No. 9 - Downstream face of intake structure.

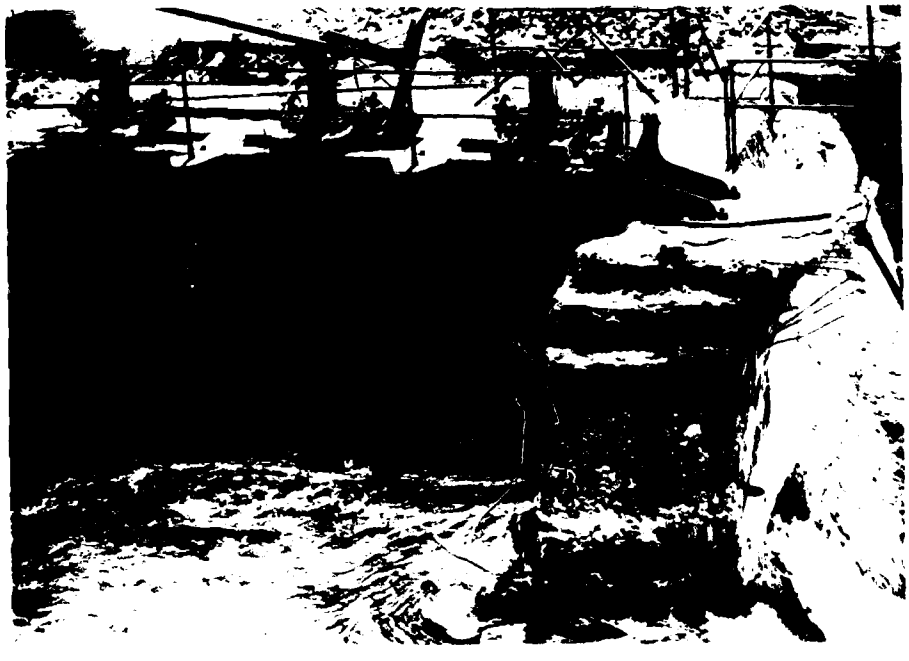


Photo No. 10 - Close-up of upstream face of intake structure.

c. Compute V_2 using $Q_{P2(TRIAL)}$

From Figure 3 determine stage for $Q_{P2(TRIAL)}$

Stage = 488.0 feet

X-area = 3,176 ft² (above elev 473.0)

$$V_2 = \frac{(125 \text{ feet})(3{,}176 \text{ ft}^2)}{43{,}560 \text{ ft}^2/\text{acre}}$$

V_2 = 9.1 acre-feet

d. Average V_1 and V_2 and compute Q_{P2}

(1) $V_{avg} = \frac{V_1 + V_2}{2}$

$$V_{avg} = \frac{9.5 \text{ ac-ft} + 9.1 \text{ ac-ft}}{2}$$

V_{avg} = 9.3 acre-feet

(2) $Q_{P2} = Q_{P1}\left(1 - \frac{V_{avg}}{S}\right)$

$$Q_{P2} = (10{,}900 \text{ cfs})\left(1 - \frac{9.3}{77.7}\right)$$

Q_{P2} = 9,500 cfs

3. STEP 3: Prepare stage-discharge curve for Reach 1

a. Pertinent Data

(1) Reach length = 125 feet

(2) See discussion in Section V of the Hydrologic Calculations pertaining to stage-discharge curve

b. See Figure 3 for stage-discharge curve

4 STEP 4: Estimate Reach Outflow

a. Determine stage for Q_{P_1} = 10,800cfs from Figure 3 and find volume in reach

(1) Stage = +88.6 feet

(2) Volume in reach = (reach length) (cross-sectional area of channel)

X-area = 3,323 ft² (above elev +73.0)

$$\text{Volume} = V_1 = \frac{(125\text{ ft})(3{,}323\text{ ft}^2)}{43{,}560\text{ ft}^3/\text{acre}}$$

$$= 9.5 \text{ acre-ft}$$

b. Determine $Q_{Pz(TRIAL)}$

$$Q_{Pz(TRIAL)} = Q_{P1}\left(1 - \frac{V_1}{S}\right)$$

$$Q_{Pz(TRIAL)} = (10{,}800\text{cfs})\left(1 - \frac{9.5}{77.7}\right)$$

$$Q_{Pz(TRIAL)} = 9{,}470\text{cfs}$$

4 Reach 1

1. STEP 1: Determine reservoir storage at time of failure

from previous calcs Storage = 77.7 acre-ft

2. STEP 2: Determine Peak Failure Outflow, Q_{P1}

a. $Q_{P1} = (8/27)\, W_b\, g^{1/2}\, Y_o^{3/2}$

where: W_b = Breach width (max 40% of total length of dam)

$= (0.40)(273 \text{ feet})$

$= 109$ feet*

* 109 feet of failure would resume the failure of two separate portions of overflow section, therefore use 100 feet which would consist length of left portion of overflow section and part of center pier

Y_o = Total height of man-made overflow section

≈ 16 feet

$$Q_{P1} = (8/27)(100 \text{ feet})\,(32.2)^{1/2}\,(16 \text{ feet})^{3/2}$$

$$Q_{P1} \approx 10{,}800 \text{ cfs}$$

the dam which would be about 8 feet above the sill of the mill building. It is apparent that the relatively small amount of additional discharge resulting from failure of the dam under the aforementioned conditions would not increase the hazard to the mill building or any other structures further downstream. Consequently, the hazard classification for this dam should be based on failure of the dam with the water surface at the crest of the overflow section.

2. Since a portion of the overflow section has broken away some prefailure discharge would result when this dam is failed at the approximate elevation of the original spillway crest. However this prefailure discharge is not significant when compared to the dam failure discharge and therefore has not been considered in subsequent calculations.

Using "Rule of Thumb" Guidance for Estimating Downstream Failure Hydrographs Examine the Impact of Dam Failure with the Water Surface at the Original Crest of the Overflow Section

1. Pertinent Data

a. Failure occurs with water surface at approximate elevation of original overflow section crest $\approx$ 494 feet (NGVD)

Using "Rule of Thumb" Guidance for Estimating Downstream Failure Hydrographs Examine the Impact of Dam Failure with Water Surface at Crest of Dam

A. Pertinent Data

1. Failure occurs with water surface at crest of dam (Top of gate operator platform)

elevation = 503.5 feet

2. Storage at crest of dam = 520 acre-feet

B. Since the overflow section extends almost the entire length of the dam, the tailwater resulting from discharge over the dam with water surface at the crest of dam will be significant. Therefore the impact of the tailwater resulting from this discharge must be examined. If the hazard resulting from failing the dam with the water surface at the crest of the dam is not significantly greater than that resulting from the no failure tailwater, then the hazard classification for the dam should be determined by failing the dam with the water surface at the spillway or overflow section crest.

1. From Figure 1 the discharge over the overflow section would be about 44,000 cfs with the water surface at the crest of dam. This discharge would result in a water surface elevation in the stream reach immediately downstream of

b. determine $STOR_2$

$$STOR_2 = \frac{(570 \text{ ac-ft} - 77.7 \text{ ac-ft})(12"/\text{ft})}{(325 \text{ sq. mi})(640 \text{ ac/sq. mi})}$$

$$= 0.028 \text{ inches}$$

c. Average $STOR_1$ and $STOR_2$

$$STOR_{AVG} = \frac{STOR_1 + STOR_2}{2}$$

$$STOR_{AVG} = \frac{0.029_{in} + 0.028_{in}}{2}$$

$$STOR_{AVG} = 0.0285 \text{ inches}$$

$STOR_2$ and $STOR_{AVG}$ agree favorably accept routed test flood outflow equal to 50,500 cfs at a surcharge elevation of 504.1 feet

(2) Subtract "dead storage" (below elev 494.0) from storage at surcharge elevation and insert in equation below

STOR$_1$ = $\frac{\text{volume of storage (as acre-inches)}}{\text{drainage area}}$

$$STOR_1 = \frac{(580 \text{ ac-ft} - 77.7 \text{ ac-ft})(12''/\text{ft})}{(325 \text{ sq. mi})(640 \text{ ac/sq. mi})}$$

$STOR_1 = 0.029$ inches

c. determine Q_{p2}

$$Q_{p2} = Q_{p1}\left(1 - \frac{STOR_1}{9.5''}\right)$$

$$Q_{p2} = (50{,}800 \text{ cfs})\left(1 - \frac{0.029''}{4.75''}\right)$$

$Q_{p2} = 50{,}500$ cfs

STEP 3: Determine surcharge height and $STOR_2$ to pass Q_{p2} and then Q_{p3}

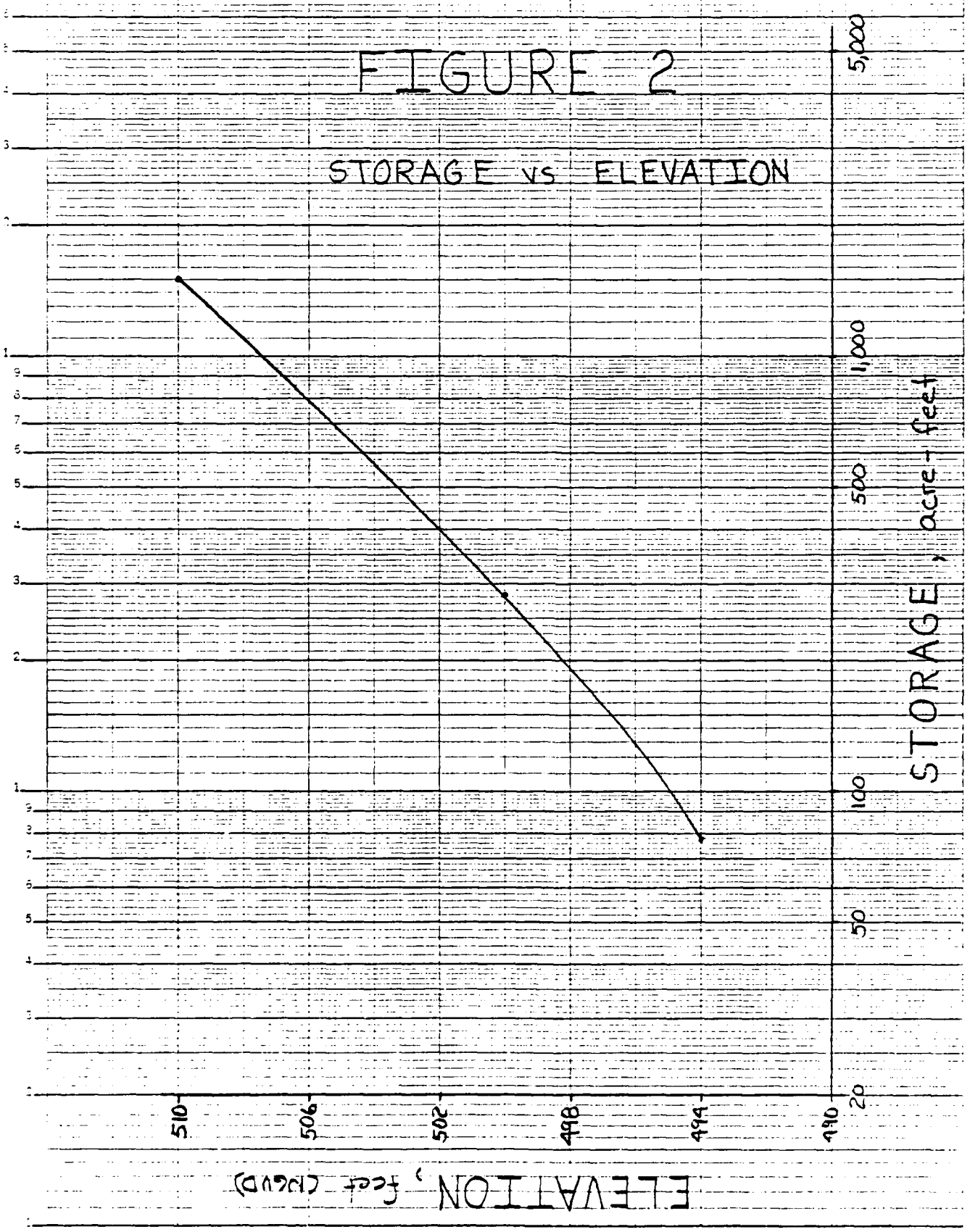
a. Figure 1 determine surcharge height to pass $Q_{p2} = 50{,}500$ cfs

Surcharge elevation ≈ 504.1 ft
normal permanent crest elev ≈ 494.0 ft
surcharge height ≈ 10.1 ft

Storage at surcharge elevation ≈ 570 ac-ft

FIGURE 2

STORAGE vs ELEVATION



B. Effect of surcharge storage on max. prob. discharge

1. Pertinent Data

a. Drainage area = 325 square miles
b. Characteristics of basin - combination of hilly and mountainous
c. Test flood = 100yr or 1/4PMF use rolling curve due to potential ups-ream storage
d. Follow Army Corps' procedure

2. STEP 1: Determine Peak Inflow Q_{P1} from Guide Curve

a. the maximum probable discharge was estimated to be 625 cfs/sq.mi

$\therefore$ PMF $= (325 \text{ sq.mi})(625 \text{ cfs/sq.mi})$

$\approx 203,000$ cfs

1/4 PMF $\approx$ 50,800 cfs

3. STEP 2: Determine surcharge height to pass Q_{P1}, $STOR_1$, and Q_{P2}

a. From figure determine surcharge height to pass $Q_{P1} = 50,800$ cfs

Surcharge elevation $\approx$ 504.2 ft
Normal permanent crest elev $\approx$ 494.0 ft
Surcharge height $\approx$ 10.2 feet

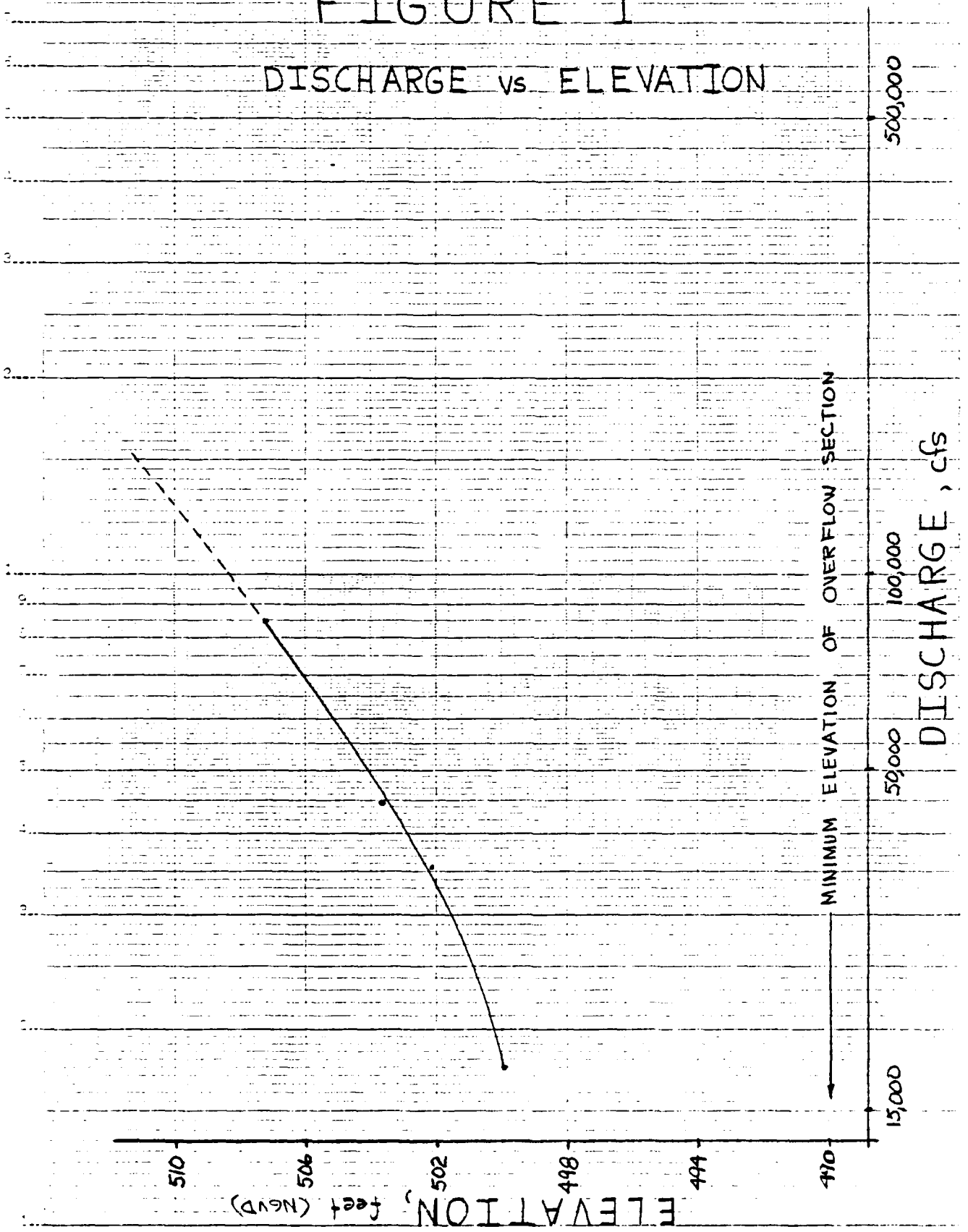
b. Determine volume of surcharge $STOR_1$ in inches of runoff

(1) obtain storage at surcharge elevation from Figure 2 $\approx$ 580 acre-ft

Ammonoosuc River Dam Job # 274-7901

FIGURE 1

DISCHARGE vs ELEVATION



* Notes: (1) elevations - NGVD
(2) Pond Surface Areas - Surface areas at 510', 500', and 494' planimetered from maps included in Flood Plain Information, Ammonoosuc River, Bath, N.H. prepared by Dept. of Army, NED, Corps of Engineers, May, 1978
(3) Storage - utilized river cross-section data developed during preparation of the above referenced Flood Plain Information report to estimate storage at elevations 510, 500, and 494

C. Spillway Information

1. Discharge at the dam site occurs over various portions of the concrete overflow sections cast on and between ledge outcroppings in the river channel. The normal permanent crest elevation appears to have been at 494 feet. However, a relatively large segment of the overflow section adjacent to the penstock inlet structure has broken out. The invert of this section is now at an elevation of approximately 499.5 feet

II Estimate Effect of Surcharge Storage on Maximum Probable Discharge

A. Develop stage-discharge curve for outflow from dam complex

1. Data developed from computer analyses completed by the Army Corps for the above referenced Flood Plain Information report were used to prepare the stage-discharge curve. The appropriate data points are as follows: (see Figure 1)

Storm Event	Water Surface Elevation, feet	Discharge, cfs
10-yr	499.55	17,900
50-yr	502.16	35,700
100-yr	503.60	44,600
500-yr	507.21	84,900

I. Basic Data

A. Drainage Area

1. 325 square miles – as defined on U.S.G.S. sheet and then planimetered

2. Drainage area has topography ranging from hilly to mountainous, use point midway between rolling and mountainous curve to estimate Maximum Probable Flood Peak Flow Rate

B. Dam and Storage Information

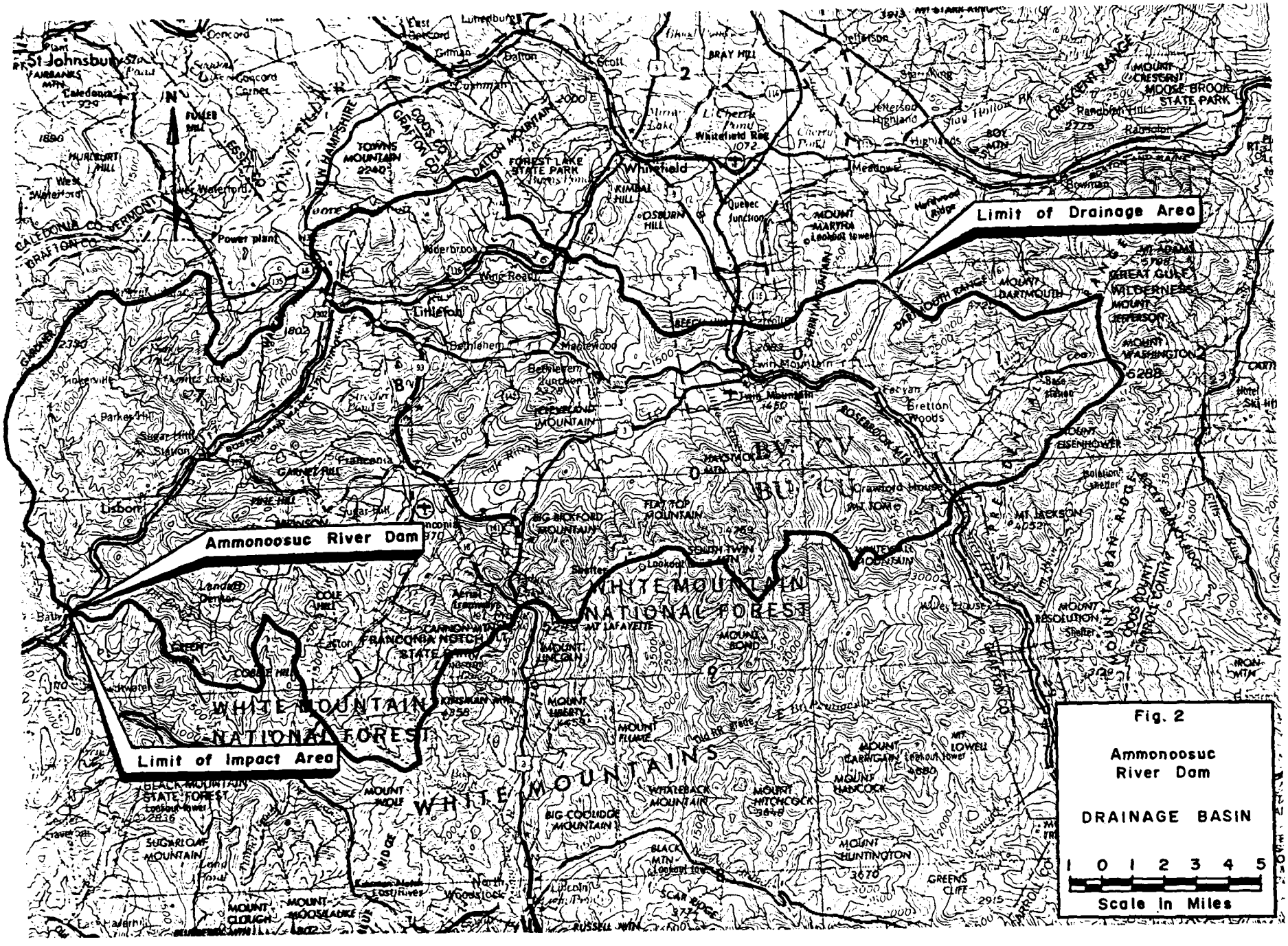
1. Size Classification: SMALL based on storage (≥ 50 acre-ft and < 1000 acre-ft)

   as indicated below – storage at crest of dam estimated to be 520 acre-feet

2. Hazard Potential: Significant

3. Storage Information

Descriptive Information	Elevation * (feet)	Surface * Area (acres)	Storage * (acre-feet)
510' contour	510.0	300	1,500
Top of dam, gate operator platform	503.5	139	520
500' Contour	500.0	52	232
min. elevation of original overflow section crest	494.0	18	77.7


Limit of Drainage Area
Ammonoosuc River Dam
Limit of Impact Area
WHITE MOUNTAIN NATIONAL FOREST
WHITE MOUNTAINS
Fig. 2
Ammonoosuc River Dam
DRAINAGE BASIN
1 0 1 2 3 4 5
Scale in Miles

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

B. Reach 2

1. STEP 3: Prepare stage-discharge curve for Reach 2

   a. Pertinent Data

      (1) Reach length = 750 feet

      (2) See discussion Section V of the Hydrologic Calculations pertaing to stage-discharge curves

   b. See Figure 3 for stage-discharge curve

2. STEP 4: Estimate Reach Outflow

   a. Determine stage for Q_{P2} = 9,500 cfs from Figure 3 and find volume in reach

      (1) Stage ≈ 487.3 feet

      (2) Volume in reach = (reach length) (cross-sectional area of channel)

      X-area = 3,065 ft² (above elev 475.0)

      $$\text{Volume} = V_1 = \frac{(750 \text{ ft})(3{,}065 \text{ ft}^2)}{43{,}560 \text{ ft}^2/\text{acre}}$$

      $$= 52.8 \text{ acre-ft}$$

   b. Determine $Q_{P3(TRIAL)}$

      $$Q_{P3(TRIAL)} = Q_{P2}\left(1 - \frac{V_1}{S}\right)$$

      $$Q_{P3(TRIAL)} = (9{,}500 \text{ cfs})\left(1 - \frac{52.3}{77.7}\right)$$

      $$Q_{P2(TRIAL)} = 3{,}050$$

c. Compute V_2 using $Q_{P3(TRIAL)}$

From Figure 3 determine stage for $Q_{P3(TRIAL)}$

Stage ≈ 482.0 feet

X-area = 1615 ft² (above elev. 473.0)

$$V_2 = \frac{(750\ ft)(1615\ ft^2)}{43{,}560\ ft^2/acre}$$

V_2 = 27.8 ac-ft

d. Average V_1 and V_2 and compute Q_{P3}

(1) $V_{avg} = \frac{V_1 + V_2}{2}$

$$V_{avg} = \frac{52.8\ ac\text{-}ft + 27.8\ ac\text{-}ft}{2}$$

V_{avg} = 40.3 acre-feet

(2) $Q_{P3} = Q_{P2}\left(1 - \frac{V_{avg}}{S}\right)$

$$Q_{P3} = (9{,}500\ cfs)\left(1 - \frac{40.3}{77.7}\right)$$

Q_{P3} = 4,570 cfs

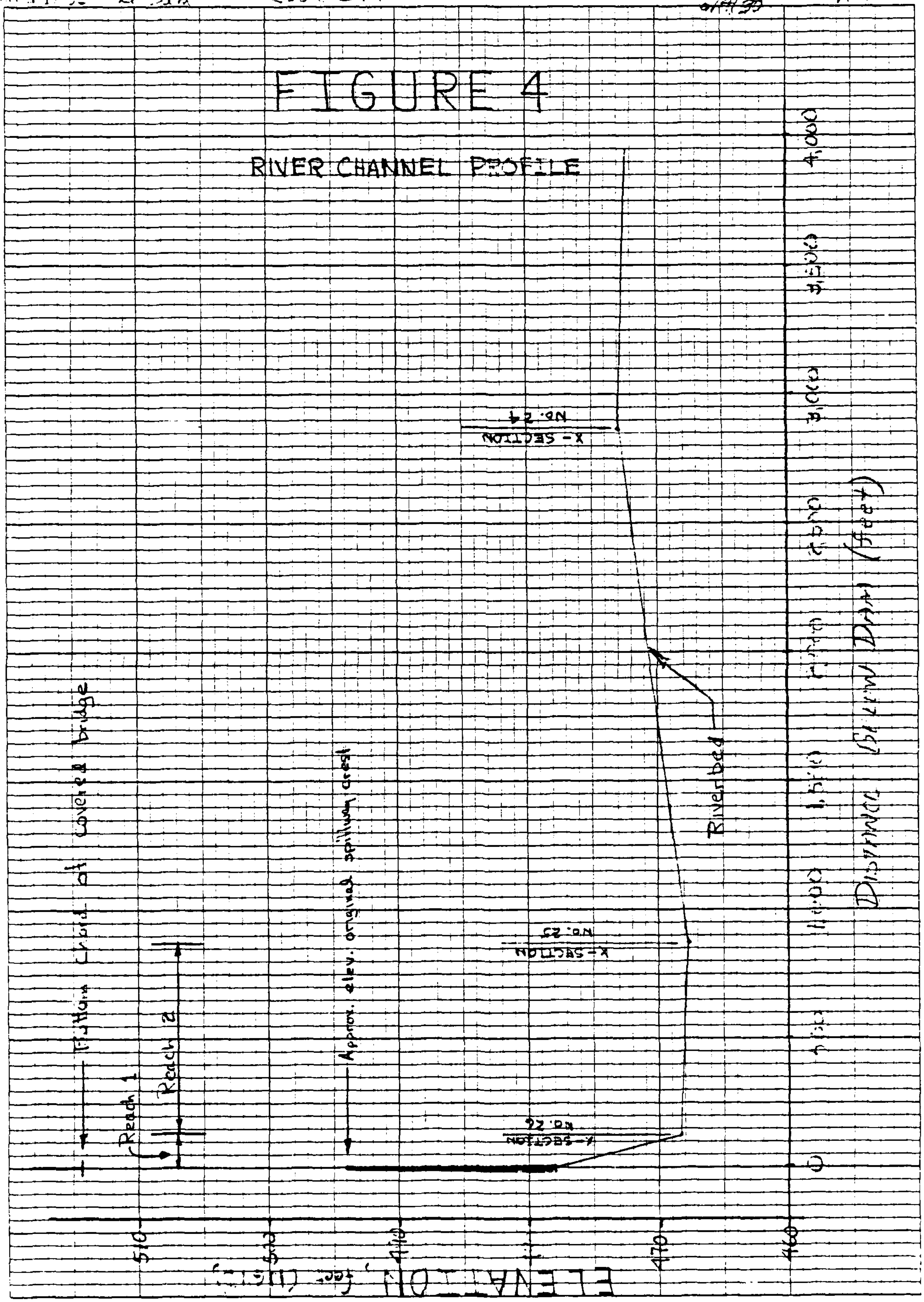
Amarosa River Dam Job # 274-7901 6/93 KMS

FIGURE B

DISCHARGE VS ELEVATION

FIGURE 4

RIVER CHANNEL PROFILE



V. Discharge through channel below the dam

A. Information developed during the preparation of Flood Plain Information, Ammonoosuc River, Bath, New Hampshire (Army Corps May, 1978) indicated the river channel has an adverse slope within the first 2800 feet below the dam. Consequently, estimates of discharge through this portion of the channel cannot be obtained utilizing Mannings Equation, with the assumption that the hydraulic gradient is essentially equal to the bottom slope. Since cross-section data for various cross-sections below the dam and discharge through these cross-sections were made available to us by the Army Corps, we have utilized this information to develop stage-discharge curves for stream reaches below the dam.

1. The cross-section information was used to develop the three cross-sections shown in Figures 5, 6 & 7

2. The discharges associated with various storm events (10-yr, 50-yr, 100-yr and 500-yr events) exceeded the dam failure discharge. Therefore it was necessary to project below the 10-yr event to include the dam failure discharge in the range of flows covered by the stage discharge curves. Discussion relevant to these projections follows.

   a. It should be noted that due to the adverse channel bottom slope between the dam and river cross section no. 34 (approx. 2800 feet below the dam, a pool with surface elevation about 473 feet (NGVD) will form below the dam under no flow conditions. With reference to Figure 5, assume that all flow through river cross section no. 36 occurs above elevation 473 feet (NGVD)

B. Estimate water surface elevation in X-section 26 resulting from dam failure discharge utilizing data from Army Corps computer analysis of Ammonoosuc River

1. Pertinent Data

a. Dam failure discharge = 10,900 cfs

b. Hydraulic gradient - will assume hydraulic gradient essentially equal to that computed for 10-year storm event with Army Corps water surface profile computer program - 0.000642

c. Channel X-section shown in Figure 5 of these calculations. - Note that above elevation 483.2 the channel side slopes are essentially vertical. Therefore, above this elevation the channel width changes very little and the length of the wetted perimeter (W_p) increases by a factor of twice the increase in depth of flow. Also, an average value for W_p can be estimated for an expected range of water surface elevations. For the subsequent calcs. a value of 260 feet was utilized

d. $n = 0.06$, based on information included with computer analysis

2. Utilizing the above information, Manning's Equation can be used to determine the channel cross-sectional area required to pass the failure discharge. The X-area can then be used to determine the water surface elevation.

$$Q = A \frac{1.486}{n} R^{2/3} S^{1/2}$$

where: $R = \frac{A}{W_p}$

$$10{,}800 \text{ cfs} = A\left(\frac{1.486}{0.06}\right)\left(\frac{A}{260}\right)^{2/3}(0.00064)^{1/2}$$

$$10{,}800 \text{ cfs} = 0.0154\ A^{5/3}$$

$$A = 3218 \text{ ft}^2$$

3. Water surface elevation

a. X-area required for dam failure discharge = X-Area between elev 483.2' & elev. 473.0' + (Avg Channel Width)(Water depth above elev. 483.2')

$$3218 \text{ ft}^2 = 2000 \text{ ft}^2 + (245 \text{ ft})(\text{Water depth above } 483.2')$$

$$\text{Water depth above } 483.2' \approx 5.0 \text{ feet}$$

b. Elevation of water surface = 483.2 feet + 5.0 feet

$$= 488.2 \text{ feet}$$

c. This point has been plotted on Figure 3 and compares favorably with the assumed linear projection of the stage-discharge curve below the 10-yr event.

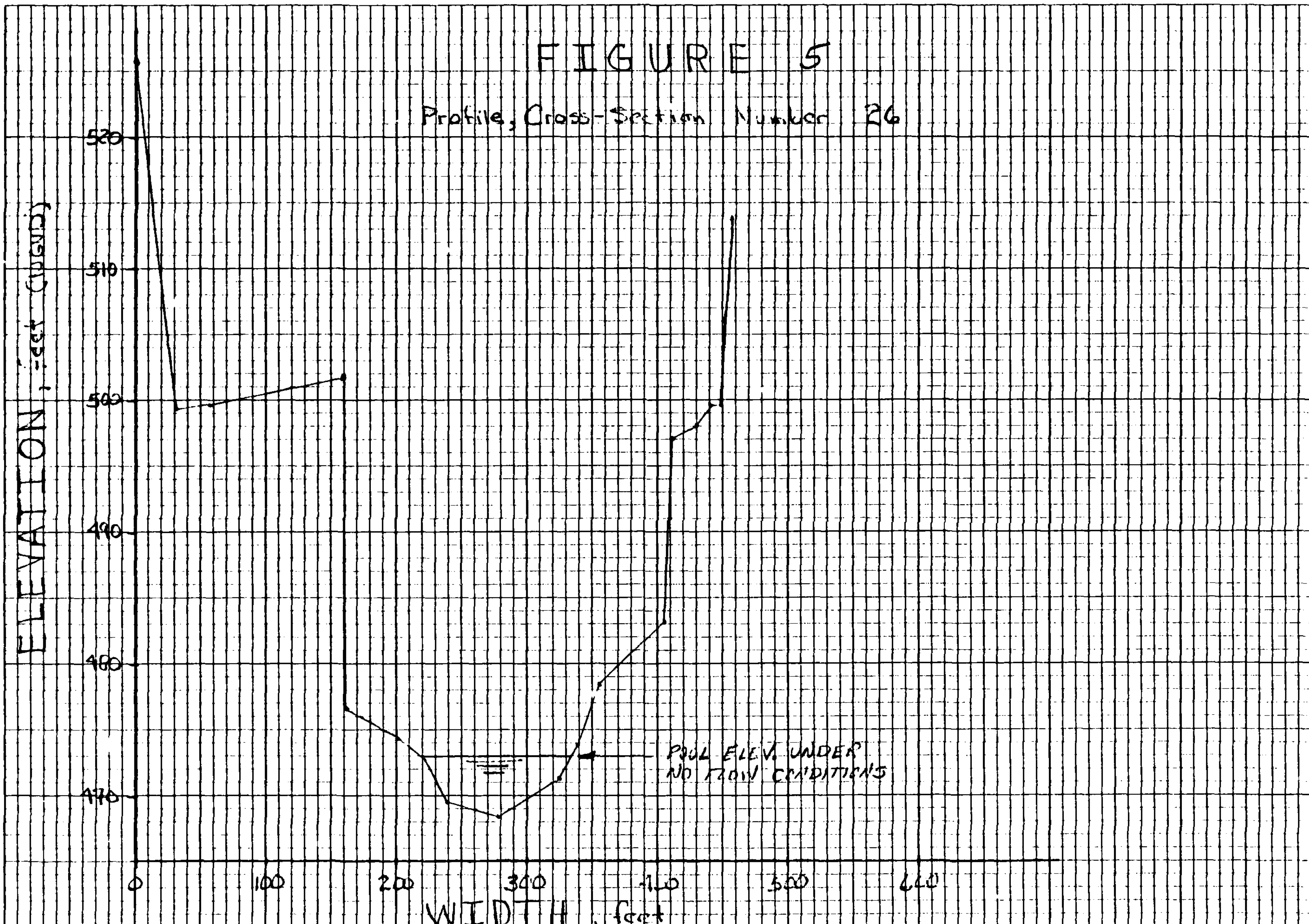
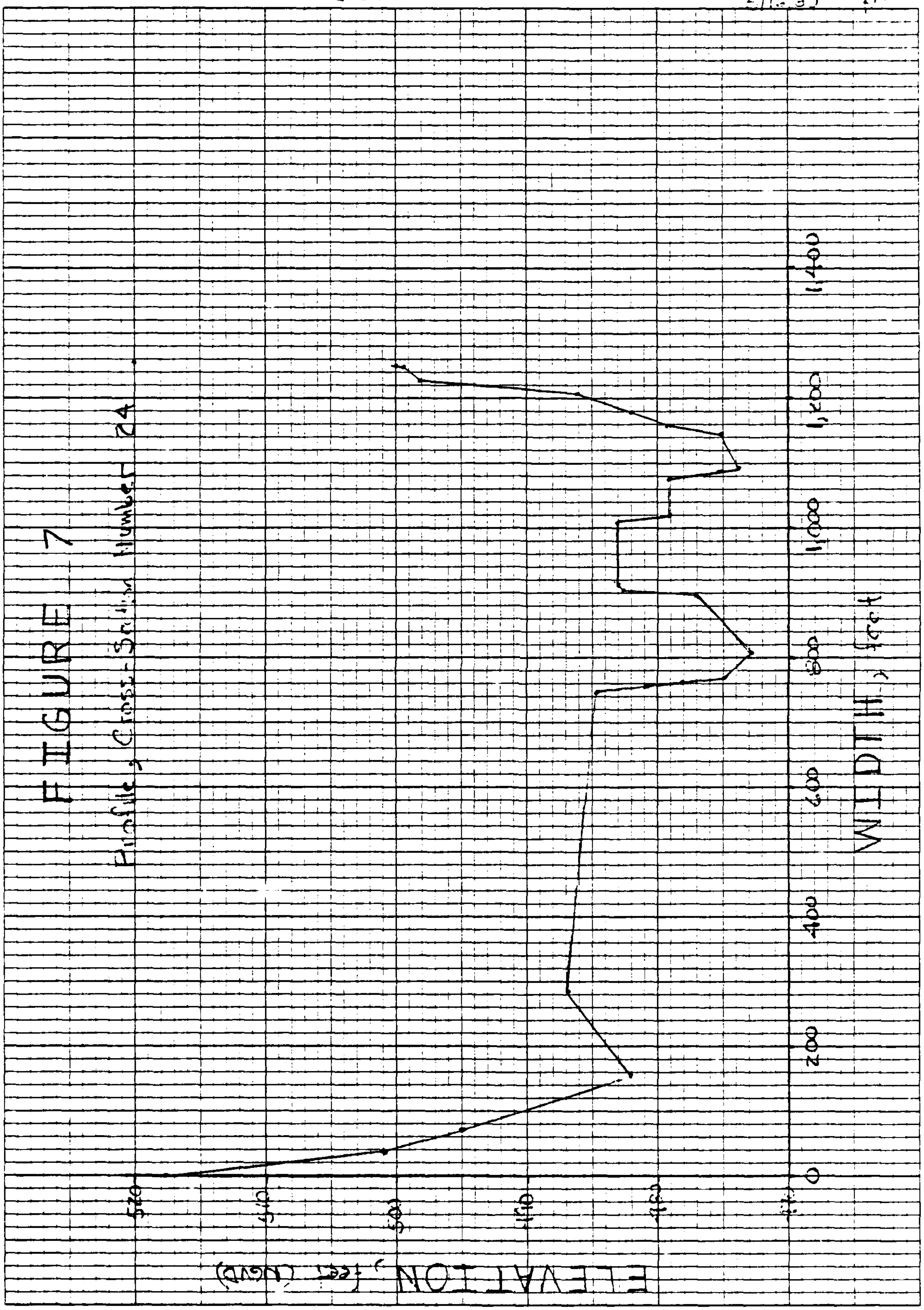


FIGURE 5
Profile, Cross-Section Number 26
ELEVATION, feet (NGVD)
520
510
500
490
480
470
WIDTH, feet
0
100
200
300
400
500
600
POOL ELEV. UNDER
NO FLOW CONDITIONS

...c River Dam Job# 274-7901

FIGURE 6
Profile, Cross-Section, Hungry Ho...

Monocacy River Dam Job # 274-7901



APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY | MO | YR
NH	01	NED	NH	009	02				AMMONOOSUC RIVER DAM	4410.0	7158.6	16JUN80

POPULAR NAME	NAME OF IMPOUNDMENT

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	AMMONOOSUC RIVER	BATH	0	743

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)
PGOT		H	16	16	520	100

DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
NED	N	N	N	N	

REMARKS
20-1977 STATE CENSUS 21-CONCRETE

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
2	365	U	273	40000	280		.3									

OWNER	ENGINEERING BY	CONSTRUCTION BY
NH WOOD PRODUCTS CORP	UNKNOWN	UNKNOWN

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NH WATER RES BOARD	NH WATER RES BOARD	NH WATER RES BOARD	NH WATER RES BOARD

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION
SEA CONSULTANTS INC	30APR80	PL 92-367

REMARKS

END

FILMED

8-85

DTIC