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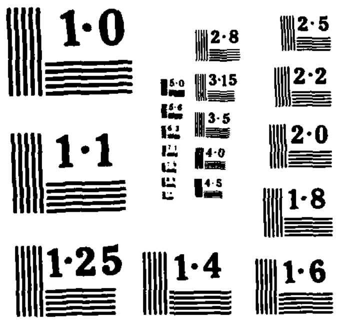
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MERRIMACK RIVER BASIN

ALLENSTOWN – PEMBROKE, NEW HAMPSHIRE

WEBSTER DAM

NH 00378

NHWRB 190.03

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

MARCH 1979

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ALlenstown - Pembroke, New Hampshire
Suncook River

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

The dam is a concrete gravity structure with natural ground separating a concrete ogee spillway from a diversion canal near the right end of the dam. The length of the dam is about 250 ft. The dam is small in size with a significant hazard potential. The test flood is between the 100 yr. and ½ the PMF. The dam is considered to be in fair condition at the present time. The wastegate andcanal headwork structure are in very poor condition. Technical inspections should be scheduled every year.

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

REPLY TO
ATTENTION OF:
NEDED

JUN 18 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 Webster 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, Thomas Hodgson and Sons, Inc., Canal Street, Suncook, New Hampshire 03275.

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

WEBSTER DAM
NH 00378

MERRIMACK RIVER BASIN
PEMBROKE-ALLENSTOWN, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification No.:	NH 00378
NHWRB No.:	190.03
Name of Dam:	WEBSTER DAM
Town:	Pembroke-Allenstown
County and State:	Merrimack County, New Hampshire
Stream:	Suncook River
Date of Inspection:	November 7, 1978

BRIEF ASSESSMENT

Webster Dam is a concrete gravity structure with natural ground separating a concrete ogee spillway from a diversion canal near the right end of the dam. The total length of the dam is approximately 250 feet with the spillway accounting for 154 feet of the total length. None of the control gates at the dam are operable. Leakage of varying amounts was observed through several gates. The dam was originally built in 1917 downstream from a previously existing dam and was altered in 1923. The original owner was Suncook Mills of Suncook, N.H., who used the dam for power generation at a downstream mill. According to the records of the New Hampshire Water Resources Board, Thomas Hodgson and Sons, Inc. of Suncook, N.H. owns the dam.

The dam lies on the Suncook River across the town lines of Pembroke and Allenstown, NH and, with the possible exception of some recreational activity, serves no purpose. The drainage area of the dam is 259 square miles. The dam's maximum impoundment of 165 acre-feet and height of 18 feet place the dam in the SMALL size category. In the event of a dam failure, considerable property damage would result but little or no loss of life is expected. Because of this the dam rates a SIGNIFICANT hazard potential classification.

Based on the size and hazard potential classifications and in accordance with the Corps' guidelines, the Test Flood (TF) is between the 100-year flood and one-half the Probable Maximum Flood (PMF). The selected inflow of 15,100 cfs, corresponding to the 100-year inflow, is appropriate because the hazard potential classification falls on the low side of the SIGNIFICANT category. Under this flow the peak flow would be 8.5 feet above the spillway crest or about 1.3 feet above the right portion of the dam and 0.8 feet above the left portion of the dam.

Webster Dam is in FAIR condition at the present time. The waste gate and canal headwork structure are in VERY POOR condition. It is recommended that further investigations be made to determine the adequacy of the spillway. It is also recommended that investigations be made into the extent and location of the seepage through the waste gate and into the future use of the headworks structure. A formal emergency warning system should be instituted. Upon completion of these investigations, appropriate corrective measures should be taken to allow continued use of the dam. Among other items, corrective measures should include the restoration of the waste gate to operating use and the control of seepage into the canal through the headworks structure. Recommended remedial measures include the repair of the right upstream training wall which shows significant concrete deterioration and removal of the fill on the left downstream abutment so that this area can be inspected. In light of the dam's FAIR condition, technical inspections should be scheduled every year.

The recommendations and improvements outlined above should be implemented within one year of receipt of this report by the owner.

William S. Zoino
New Hampshire Registration 3226

Nicholas A. Campagna, Jr.
California Registration 21006

This Phase I Inspection Report on Webster 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, MEMBER
Foundation & Materials Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

JOSEPH W. FINEGAN, JR., CHAIRMAN
Chief, Reservoir Control Center
Water Control 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 unsafe conditions be detected.

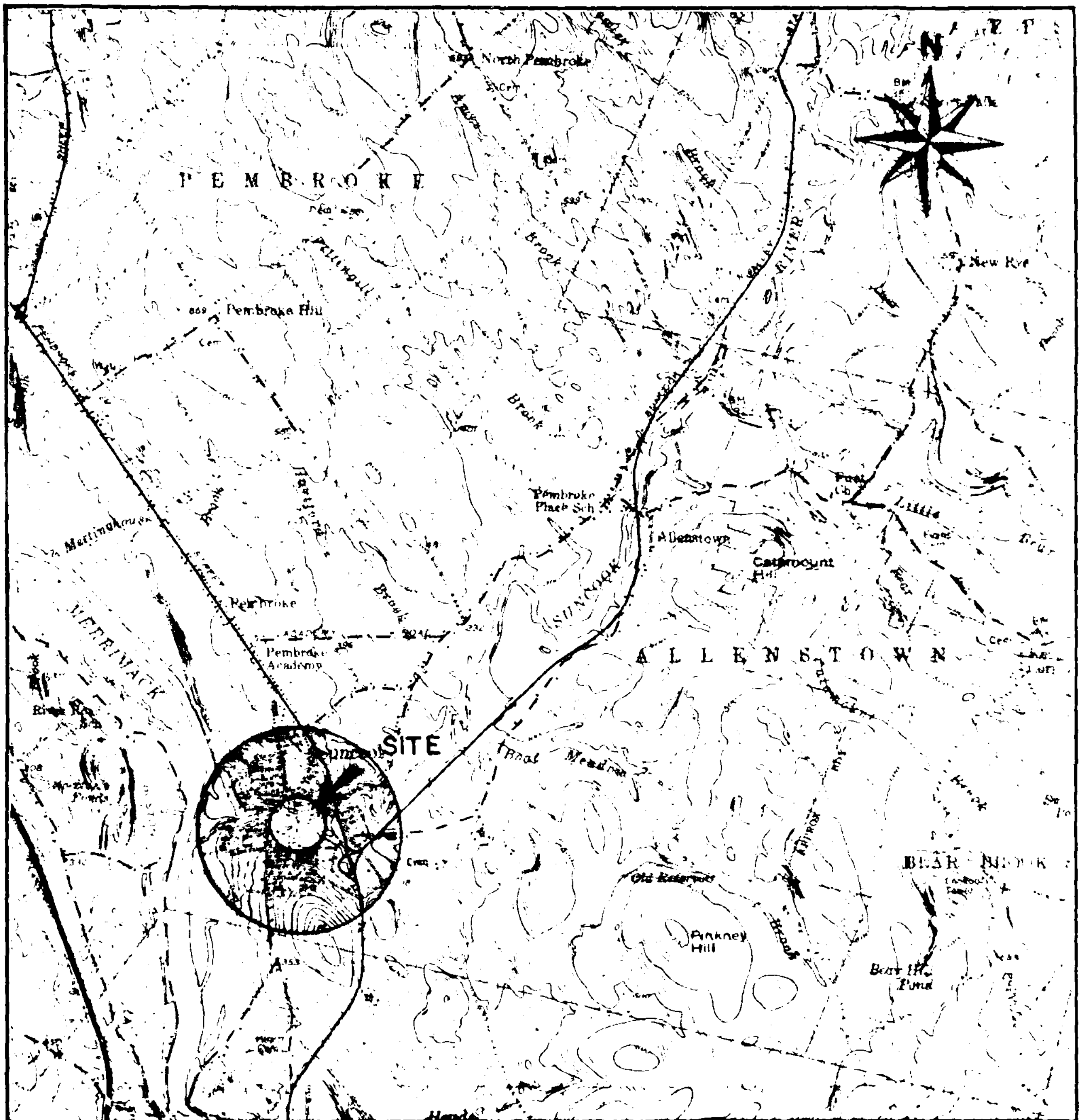
Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the Test Flood should not be interpreted as necessarily posing a highly inadequate condition. The Test Flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

Table of Contents - Cont. Page

Overview of spillway from concrete wall between main channel and diversion channel

Overview of dam from upstream of left abutment



FROM: USGS SUNCOOK, N.H. QUADRANGLE MAP

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC. GEOTECHNICAL CONSULTANTS NEWTON UPPER FALLS, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCUS PLAN

WEBSTER DAM — NEW HAMPSHIRE

FILE No. 2201

SCALE AS NOTED

DATE NOVEMBER 1978

PHASE I INSPECTION REPORT

WEBSTER 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. Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD) 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 was issued to GZD under a letter of November 28, 1978 from Colonel Max B. Scheider, Corps of Engineers. Contract No. DACW 33-79-C-0013 has been assigned by the Corps of Engineers for this work.

(b) Purpose

(1) Perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

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

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

(c) Scope

The program provides for the inspection of non-federal dams in the high hazard potential category based upon location of the dams and those dams in the significant hazard potential category believed to represent an immediate danger based on condition of the dam.

1.2 Description of Project

(a) Location

Webster Dam lies on the Suncook River at the Pembroke and Allenstown, NH town lines approximately 1,400 feet downstream from where the Route 3 bridge crosses the Suncook River and about 4,000 feet upstream from the confluence of the Suncook and Merrimack Rivers. The dam is accessible by foot from roadways on either side of the Suncook River. The portion of USGS Suncook, NH quadrangle presented previously shows this locus. Figure 1 of Appendix B presents a detail of the site developed from the inspection visit and the map.

(b) Description of Dam and Appurtenances

Webster Dam is a concrete gravity dam with natural ground separating the canal from the right end of the spillway. The total length of the dam is about 250 feet with the concrete ogee spillway accounting for 154 feet of the dam. Other major portions of the dam are the headworks structure leading to the canal, the concrete-faced natural ground section separating the canal and the spillway, a concrete structure forming the end of the dam at the left abutment which has a "U" shape, and a training wall extending along the right bank. A waste gate is monolithically cast at the right end of the spillway. The right concrete training wall and waste gate structure have top elevations approximately 7.2 feet above the spillway crest. The concrete structure at the left end of the spillway, which ties into the natural ground has a top elevation of 7.7 feet above the spillway crest.

The headworks structure consists of a badly deteriorated brick structure which houses the gate mechanisms for the four gates controlling flow into the channel leading downstream to former mills. The gate mechanisms are no longer operable although the canal has water in it because of seepage or leakage around the gates.

(c) Size Classification

The dam's maximum impoundment of 165 acre-feet and height of 18 feet are less than the 1,000 acre-foot impoundment and 40 foot height limits for SMALL dams as recommended by the Corps' of Engineers guidelines.

(d) Hazard Potential Classification

The appropriate hazard potential classification for this dam is SIGNIFICANT because of the possibility of significant economic loss but little chance for loss of life in the event of a dam failure as discussed in Section 5 (f).

(e) Ownership

According to the records of the New Hampshire Water Resources Board (NHWRB), Thomas Hodgson and Sons, Inc., located on Canal Street, Suncook, N.H. 03275 is the owner of the dam.

(f) Operator

The dam is not operated.

(g) Purpose of Dam

The dam was originally constructed to provide water for use in power generation at a downstream mill. At present the dam is not being used for power generation but it does provide a pond for upstream residents on its shore.

(h) Design and Construction History

The dam was originally designed and constructed about 1917 and replaced an older dam that was situated just upstream from the present dam site. The dam was designed by Arthur T. Safford of Lowell, MA and was constructed by the H.P. Cummings Construction Company of Ware, MA and Woodsville, N.H.

The entire dam foundation is cut into rock and according to John W. Storrs of Concord, N.H., the rock provided a good toe for the dam. Mr. Storrs was a consulting engineer in Concord and was called to inspect the dam foundation and to observe other aspects of the construction. In 1923 the records indicate that some alterations were made to the dam. It appears that the gate house structure was added at that time.

The original owner of the dam was Suncook Mills of Suncook, N.H. which contracted the construction of 1917. Thomas Hodgson and Sons, Inc. is the present owner of the dam according to records of the NHWRB.

(i) Normal Operational Procedures

No operational procedures are performed at the dam.

1.3 Pertinent Data

(a) Drainage Area

The total drainage area of the dam is 259 square miles. The drainage area is primarily a rural, forested area with little development.

(b) Discharge at Damsite

(1) Outlet Works

At present there are no operating outlet works at the dam site. The four gates controlling flow into the canal, which used to provide water for power generation at a downstream mill, are not operable. The waste or sluice gate located at the right end of the spillway is also not operable, although there is significant flow through the gate structure.

(2) Maximum Flood

There are no records of the maximum flood at the site after construction of the dam. The flood of record at China Dam about 2,200 feet downstream is 12,000 cfs on March 19, 1936.

(3) Spillway capacity at maximum pool el. 280.2:

11,010 cfs

(c) Elevation (ft. above MSL)

(1) Top of Dam: El. 280.2

(2) Maximum pool: El. 280.2

(3) Recreational pool: El. 273.0

(4) Spillway crest: El. 273.0

(5) Streambed at centerline: El. 262

(d) Reservoir

(1) Length: maximum pool - 8300 ft ±
recreational pool - 4800 ft ±

(2) Storage: maximum pool - 165 acre-feet
recreational pool - 60 acre-feet

(3) Reservoir surface: maximum - 34 acres ±
recreational - 15 acres ±

(e) Dam

(1) Type: concrete gravity

(2) Length: 250 ft.

(3) Height: 18.2 ft.

(4) Top width: 2 ft. at spillway

(5) Side slopes: U/S 1 horizontal to 7 vertical (spillway)

D/S ogee spillway

(f) Spillway

(1) Type: concrete gravity; ogee section

(2) Length of weir: 154 feet

(3) Crest elevation: 273.0

(4) U/S channel: broad approach from pond

(5) D/S channel: full width of river; river relatively narrow and confined by steep banks

(g) Regulatory Outlets

See Section 1.3 (b) (1).

SECTION 2 - ENGINEERING DATA

2.1 Design Records

The design of the dam is quite simple and incorporates no unusual features. Pertinent design drawings of the dam and the gate house, which was constructed in 1923, are included in Appendix B.

2.2 Construction Records

Some construction data was available for review. In particular, a copy of an inspection report dated January 26, 1917 describing the dam's rock foundation was of interest. The remainder of the construction records are of peripheral concern only.

2.3 Operational Records

No operational records of value were available for the dam.

2.4 Evaluation of Data

(a) Availability

The design drawings are reasonably comprehensive. Because of the availability of these drawings, a satisfactory assessment for availability is warranted.

(b) Adequacy

Although some design data and calculations are available, an in-depth review of the dam cannot be done solely on the basis of these data. Therefore, in addition to the available design drawings and calculations, this assessment is based on visual inspection, past performance, and sound engineering judgment.

(c) Validity

Since the observations of the inspection team generally confirm the information contained in the design drawings, a satisfactory evaluation for validity is indicated.

SECTION 3 - VISUAL OBSERVATION

3.1 Findings

(a) General

Webster Dam is in FAIR condition at the present time. The gate house and waste gate structures are in VERY POOR condition. The waste gate requires investigation into the source of seepage while the gate house should be investigated to determine whether it should be removed or repaired.

(b) Dam

(1) Left Abutment Structure (Item A, see Figure on page B-4)

This structure is located at the left end of the spillway and ties into the natural slope which forms the left abutment. The structure is a concrete gravity structure approximately 33 feet long normal to the spillway axis with upstream and downstream return walls. The upstream return wall, which is approximately 10 feet upstream from the spillway axis, runs parallel to the spillway axis for about 50 feet before intercepting natural high ground. The downstream return wall also runs parallel to the spillway axis, but it is only 14 feet long. Upstream of the crest line the structure is about 19 feet high. From a point five feet downstream from the crest line, the top of the structure slopes at 1 to 1 for a distance of 12 feet, and then is level for 7 feet before turning to the left bank. The lower portion of the abutment structure is 7 feet high.

The condition of the structure is good. The top surface of the structure shows evidence of surface spalling while the face, from the spillway crest to an elevation 4 feet higher, has minor surface erosion. A construction joint is open on the downstream side of the left training wall at the spillway crest elevation. This joint has eroded over a triangular surface area approximately 18 inches long, 12 inches high, and 12 inches deep. The downstream return is in good condition showing no evidence of cracks, spalls, or efflorescence. At the downstream return wall there is a diagonal hairline crack originating at its corner and continuing to the left for approximately 3 feet.

On the downstream side considerable fill has recently been dumped over the slope and makes inspection of the natural ground at the abutment impossible. This fill consists of waste rock and silt presumably from the apartment complex presently under construction at the left abutment.

(2) Spillway (Item B, See Figure on pg. B-4)

The ogee spillway, which is approximately 11 feet high and 154 feet long, is constructed of rubble concrete and has a front batter of 1 horizontal to 7 vertical. Vertical construction joints are located at approximately the third points. Weep hole openings approximately 8 inches square are located at the downstream base of the structure at about the midpoint of each of the spillway segments.

The downstream side of the spillway structure is in good condition with the exception of minor surface erosion. Minor spalling and erosion has occurred along the two vertical construction joints. The surface erosion on the downstream face is random but in some areas there is evidence of mortared patches 2 to 3 square feet in area which have subsequently been eroded to a depth of one-half inch. There is no evidence of seepage through the weep holes. There is minor joint erosion between the base of the spillway and the rock foundation.

(3) Waste Gate Structure (Item C, See Figure on pg. B-4)

This concrete structure, located between the right end of the spillway is 9.5 feet long and 11 feet deep. A five foot square timber sluice gate is located at the upstream end of the structure. The gate is mounted on a timber frame structure equipped with two rack gears. These gears are activated by spindle gears. The gate is operated with two hand wheels which drive a bull gear and gearing train equipped with a safety ratchet.

The concrete of the structure is cracked, effloresced, exuded, spalled, and eroded and can be classified as being in very poor condition. Seepage at the rate of about 10 cfs appears to come through voids in the concrete side wall adjacent to the spillway.

The upstream face of the gate structure has much cracking and associated efflorescence. In some instances, these cracks are up to 2 inches wide, 2 inches deep, and 6 feet long.

The left vertical face adjacent to the spillway shows similar signs of deterioration, and the interface with the spillway is eroded up to 4 inches in depth and 2 inches in height. The downstream face is severely spalled over approximately one third of its face exposing cyclopean concrete with the remainder of the face having many cracks, some of which are effloresced. The spalling is up to six inches in depth. The sloping downstream header has closely spaced uniform cracks in an arch type formation above the tunnel and spalling has occurred. The concrete on this surface is effloresced and exuded.

Observations revealed that a large amount of seepage occurs through the eroded left sidewall of the outlet tunnel about 4 feet above its invert. The location of the erosion is the interface of the upstream gate structure wall and the spillway. The left side wall of the tunnel is eroded for a height of 2 feet, for a horizontal distance of 10 feet, and for a depth of up to 15 inches. The vertical interface between the downstream end of this structure and the spillway is similarly eroded. The amount of erosion on the right side of the outlet tunnel is similar to the amount on the left side. It was also observed that a mass of cyclopean concrete masonry approximately 15 inches wide, 30 inches long, and 15 inches thick was lying in the downstream channel. The concrete apparently came from the tunnel wall. The concrete on the roof is severely spalled and effloresced. Exudation and stalactites were also observed on the roof. The progressive deterioration of this structure could lead to localized breaching of the dam and could adversely affect the spillway.

The sluice gate itself is no longer operational, but it is chained and padlocked to prevent vandalism. The sluice gate is damaged and leaking badly with an inoperable lifting mechanism. The steel plates reinforcing the two vertical guides are deteriorated and corroded. Past repairs consisted of spiking additional steel plates to the guides and additional timber bracing. These remedial measures have since deteriorated.

(4) <u>Concrete Wall Between Spillway and Headworks (Item D, see Figure on pg. B-4)</u>

This concrete gravity structure is constructed in the shape of an inverted "U", its right end curving into a tangent wall which forms the left forebay wall extending to the gate house. The portion of the structure adjacent to the waste gate structure is normal to the spillway axis and about 33 feet long. The upstream end is approximately 20 feet long parallel to the spillway axis and then curves towards the gate house (headworks) on a radius of approximately 34 feet for a distance of 30 feet where it joins the left forebay wall. The top of the upstream portion of the structure and the top of the left forebay wall are at the same level. The portion of the structure downstream of the spillway crest line has been constructed in the same configuration as the left abutment structure. Available plans indicate that the back batter of these gravity structures is 3 horizontal to 12 vertical with a top width of 18 inches.

The base of the structure is eroded over its entire length. The erosion is approximately 4 to 6 inches in height and in some instances 12 inches deep. Three effloresced cracks, two vertical and one horizontal, are located on the vertical face downstream of the gate structure.

Numerous drain pipes are encased in the structure, and minor seepage is evident on the downstream return wall of the structure. Minor efflorescence was noted at the base of the wall.

The top surface of the wall connecting to the gate structure is deteriorated over its entire surface. The vertical face is deteriorated over approximately 60 percent of its area with the depth of spalling being up to 6 inches. The exposed back surface of the wall is spalled and eroded to a depth of 6 inches. The cyclopean concrete is in extremely poor condition.

The upstream face of the structure and the adjacent gate structure have many areas of concrete erosion, efflorescence, and random cracking. One horizontal crack located approximately 3 feet above the spillway crest elevation is 2 inches wide and 2 inches deep.

The top surface of this structure, which has been topped with cement concrete masonry, is generally in good condition.

(5) Headworks Structure and Approach Training Wall

(a) Headworks Structure (Item E, see Fig. on pg. B-7)

This structure, which is located over a discharge canal, is 33 feet wide and 16 feet deep. The structure is constructed on a concrete foundation supported by the canal walls and three intermediate concrete piers. The side walls are brick bearing walls which support a wood framed flat roof. The structure houses four 5.3 foot by 12.4 foot manually operated timber sluice gates in front of 5 foot by 11.5 foot sluiceway openings. Provisions for stop logs are located in both the upstream piers and in the piers downstream of the structure. The intermediate piers are 2 feet, 4 inches in width and extend upstream into the forebay approximately 3 feet, 2 inches and downstream into the canal for a distance of 14 inches. A concrete service platform 3 feet, 8 inches wide and 12 inches thick spans over the forebay canal walls and intermediate piers adjacent to the headworks structure. Steel nosings approximately 9 feet high are cast into all the piers. Access into the structure's service floor, which is about 25 feet above the canal bottom, consists of an exterior steel stairway located on its left side.

All four sluice gates are identical in construction and are mounted on timber frames, each equipped with two rack gears. These gears are activated by spindle gears. The gates are operated by two hand wheels which drive a bull gear and gearing train equipped with a safety ratchet.

The downstream canal is approximately 31 feet wide with side walls consisting of concrete-faced stone masonry.

This canal formerly served as the sluiceway to mills located downstream. The canal is no longer in use.

The gate house is in extremely poor condition. The concrete platform over the sluiceway entrances is spalled over approximately 10 percent of its surface area. The downstream brick masonry wall has been destroyed over 50 percent of its face and the roof has fallen in. The concrete wall on the downstream side is severely deteriorated, consisting of a series of horizontal cracks, spalls, and random cracking. There is efflorescence and exudation on the surface of the structure. The right wall has 3 horizontal cracks and secondary vertical and horizontal cracking with efflorescence and exudation. The condition of the left wall is similar to that of the right wall. The upstream face of the concrete wall has a series of horizontal cracks.

The gate inlets are eroded at the normal water surface. The extreme right side of the inlet adjacent to the right upstream training wall is eroded over a distance of approximately 6 to 8 feet, a height of 2 feet, and a depth of up to 12 inches. The other inlet walls are less eroded. The erosion at the left upstream training wall is approximately 4 feet high, 6 inches wide, and up to 6 inches deep.

All four gates which are housed in the headworks are in extremely poor condition. The operating mechanisms for the two left gates are dismantled at the present time. Furthermore, the stems of these gates are broken and are inoperable. The operating mechanisms of the two remaining gates are intact but have not been maintained. The timber frames of these two gates are in poor condition because of deterioration at the bottom part of the frame about 3 feet above the water level. The access stairway, located outside the building, is in fair condition. Portions of the operating mechanisms for the two left gates have been discarded on the left side of the building.

(b) Right Upstram Training Wall (Item F, see Fig. on pg. B-4)

This wall, which is approximately 275 feet long, is laid out in three basic segments. The first segment starts at the headworks structure and traverses upstream normal to the headworks structure for approximately 115 feet and serves as the right forebay wall. The second segment angles at approximately 30° towards the right bank and is approximately 80 feet long. The last segment deflects approximately 45° towards the right bank and is approximately 80 feet long. An abutment for a former trash rack structure was formerly located at the intersection of the first and second wall segments. This trash rack extended diagonally across the present forebay canal to the present alignment of the concrete wall at the right end of the spillway. The remains of this abutment has been incorporated into the existing training wall.

The first segment of the training wall consists of the original stone masonry wall, which was capped with concrete and at a later date was faced and further capped with concrete. The second and third segments of this wall, which consist of cement concrete, have been faced and capped with concrete. The entire length of this wall was subsequently capped with an additional 18 inches. In general the top width of the three wall segments is 18 inches with the exception of a portion of the first segment which is 5 feet wide below the base of the 18 inch x 18 inch concrete cap. Encased pipe sockets are prevalent throughout the entire length of the upstream segment which indicate the former location of pipe rail stanchions. Reinforcing bars, 7/8 inch in diameter, spaced approximately 3 feet on centers, are embedded in the wall cap at isolated locations on the wall. Their purpose is unknown.

This training wall is in very poor condition. There is severe spalling, cracking and efflorescence over 75 percent of its length and surface area. The top of this wall is completely spalled up to depths of 18 inches and is disintegrating. There are cracks in this wall approximately 4 to 6 inches wide and 12 inches deep. The original wall adjacent to the upstream bend has cracked horizontally over a distance of approximately 10 feet and the top of the wall is leaning outward by approximately 3 inches. This crack is approximately 1-1/2 inches wide. This cracking is attributed to expansion forces generated from the massive wall located immediately downstream. The poor condition of this wall is attributed to poor quality concrete, moisture intrusion, alternate freeze and thaw cycles, and ice damage.

(c) Left Upstream Canal Training Wall (Item G, see Fig. on pg. B-7)

This concrete gravity wall, approximately 16 feet long, is constructed on a tangent and is a continuation of the curved portion of the wall extending from the intermediate structure located between the spillway and the gate house. The wall terminates at the upstream side of the headworks structure.

The left upstream training wall is excessively cracked, spalled, and effloresced. The spalling covers approximately 30 percent of the overall wall area and is located in the vicinity of the water line. In some instances, the spalling has progressed to approximately 4 feet above the spillway crest elevation. There are vertical construction joints which have opened. A horizontal crack is located approximately 3 feet above the spillway crest elevation and extends over the entire length of this wall. This crack is continuous with the crack described for the wall extending to the spillway.

The back side of this wall is exposed for approximately 4 feet of its height. This side of the wall, from the existing ground line up to 2 feet above the ground surface, is spalled, cracked, and effloresced.

Except as noted, the deterioration of the concrete at this dam is caused by moisture intrusion which has been subjected to alternating freeze and thaw cycles and ice damage.

3.2 Evaluation

Based on the visual observations, the condition of Webster Dam is FAIR. The gate house and waste gate structures are in very poor condition and require further engineering investigations to determine the best means of repairing the structures. The visual inspection permitted an overall satisfactory evaluation of those items which affect the safety of the structure.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

No operational procedures are performed at the dam. None of the gates are operable although some leakage does occur through the gates and gate structures. This is particularly true of the waste gate structure. In general water flows in an uncontrolled manner over the spillway.

4.2 Maintenance of Dam

No maintenance of the dam is performed.

4.3 Maintenance of Operating Facilities

No maintenance of the operating facilities is performed.

4.4 Description of Warning System

No warning system is in effect for the dam.

4.5 Evaluation

The dam's present FAIR condition is a direct result of the lack of maintenance of the dam and its operating facilities.

SECTION 5 - HYDRAULICS/HYDROLOGY

5.1 Evaluation of Features

(a) General

Webster Dam is a run-of-the-river dam on the Suncook River at Suncook, New Hampshire. The dam is just downstream of the Route 3 bridge across the Suncook River and about eight-tenths of a mile from the river's confluence with the Merrimack River. The dam is a concrete gravity structure with a 154-foot concrete ogee spillway. There is a waste gate at the right end of the spillway which is not operable. To the right of the spillway there is a headworks structure with 4 sluice gates and a canal downstream. These gates are not operable.

(b) Design Data

Data sources available for Webster Dam include prior inventory and inspection reports. The New Hampshire Water Control Commission's "Data on Water Power Developments in New Hampshire (April 26, 1939), and "Record of Dam No. 190.03" (October 13, 1939); the New Hampshire Water Resources Board's "Inventory of Dams and Water Power Developments" (August 2, 1934), "Water Power Developments in New Hampshire" (January 28, 1948), and "Water Powers of New Hampshire" (July 10, 1942); and the Public Service Commission of New Hampshire's "Dam Record" (undated) and "Dams in New Hampshire (June 5, 1918) provide much of the basic data for the dam. Inspection reports from June 5, 1918; June 14, 1950; December 5, 1977; and September 7, 1978 are available for the dam. For this dam numerous documents from the 1917 construction are available (Contract, Specifications, Inspection Report), as are 1917, 1920, and 1939 plans of the dam. There are also several letters dated in 1978 in which the New Hampshire Water Resources Board attempts to identify the dam's owner.

More recent data includes a 1977 Flood Insurance Study by Anderson-Nichols and Company, Inc. (ANCO) which covers this portion of the Suncook River. This work included 10, 50, 100, and 500-year peak inflows; cross-section data at various points on the Suncook River (including Webster Dam and the dams and bridges downstream); and HEC-2 runs for the 10, 50, 100, and 500-year flows.

(c) Experience Data

No records of flow or stage are known to be available for Webster Dam. The flood of record at China Dam about 2,200 feet downstream is 12,100 cfs on March 19, 1936 (from USGS Water Supply Paper 798, "The Floods of March 1936.")

(d) Visual Observations

Webster Dam is a concrete run-of-the-river dam on the Suncook River about 1400 feet upstream of the Main Street Bridge in the towns of Allenstown and Pembroke, New Hampshire.

The channel downstream of Webster Dam is rather narrow and confined between steep banks. The first 700 feet of this channel are steeply sloping before entering the small pool behind Pembroke Dam. The only structures of interest in this reach of the river are the mill buildings on the right bank at an elevation of 255.0 feet and the Main Street Bridge which crosses the river just upstream of Pembroke Dam. Beyond Pembroke Dam the river immediately enters the pool of China Dam which is located about 2,200 feet downstream of Webster.

There is a built up area on the right bank of the river in the vicinity of China Dam. A number of homes, located upstream of China Dam are situated at an elevation of about 239 feet, while some homes are located at about elevation 216 in the area below China Dam. About 800 feet downstream of China Dam the river is crossed by a conduit bridge having a clear span of about 98 feet. China Mill is at an elevation of 205 feet above MSL slightly downstream of the bridge. Below this structure the floodplain of the river widens considerably before joining the Merrimack River another 1,400 feet further on.

(e) Test Flood Analysis

The hydrologic conditions of interest in this Phase I investigation are those required to assess the dam's overtopping potential and its ability to safely allow an appropriately large flood to pass. This requires using the discharge and storage characteristics of the structure to evaluate the impact of an appropriately sized Test Flood. None of the original hydraulic and hydrologic design records are available for use in this study.

Guidelines for establishing a recommended Test Flood based on the size and hazard classification of a dam are specified in the "Recommended Guidelines" of the Corps of Engineers. The impoundment of less than 1,000 acre-feet and the height of less than 40 feet classify this dam as a SMALL structure.

The appropriate hazard classification for this dam is SIGNIFICANT because of the possibility of significant economic losses downstream in the event of a dam failure. The increase in flooding caused by a failure would pose a threat to property, though only a minimal threat of loss of life. The properties most likely to be affected are the mill 1,000 feet downstream of Webster Dam, the Main Street bridge, Pembroke Dam, and the mill at Pembroke Dam.

As shown in Table 3 of the Corps of Engineers' "Recommended Guidelines," the appropriate Test Flood for a dam classified as SMALL in size with a SIGNIFICANT hazard potential would be between the 100-year flow and 1/2 of the probable maximum flood (PMF). ANCO's FIS study gives a 100-year flow at this dam of 15,100 cfs and 500-year flow of 23,400 cfs. The 1/2 PMF can be considered equivalent to the 500-year flow. Since the hazard classification is on the low side of SIGNIFICANT, the 100-year flow of 15,100 cfs is appropriate for use as the Test Flood for this dam. The peak elevation created by the flow of 15,100 cfs would be 281.5 feet MSL, 8.5 feet above the spillway crest, 1.3 feet above the right side of the dam and 0.8 feet above the left side of the dam.

Although Webster Dam would be overtopped by 1.3 feet at the Test Flood of 15,100 cfs (the 100-year inflow), it is not clear that this overtopping would create a serious risk of dam failure.

(f) Dam Failure Analysis

The peak outflow that would result from the failure of Webster Dam is estimated using the procedure suggested in the Corps of Engineers New England Division's April 1979 "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs," as clarified in a December 7, 1978 meeting at the Corps' Waltham office. Failure is assumed to occur with the water surface elevation at the top of the right side of the dam, 7.2 feet above the spillway crest (elevation 280.2). The discharge just prior to failure at this level is given by the Stage-Discharge curve developed in Appendix D as approximately 11,500 cfs. This flow is between the estimated 10-year and 50-year flows. The tailwater prior to failure would be at about elevation 270.9 feet above mean sea level (MSL), 2.1 feet below the level of the spillway crest.

For an assumed 60 foot wide gap in the spillway the resulting increase in flow would be 2,900 cfs, or a total flow of 14,000 cfs. This would have a noticeable effect on downstream flooding at some locations.

The Suncook River downstream of Webster Dam flows through the middle of Suncook, New Hampshire. Because of the high flows and small storage available, downstream attenuation of the failure hydrograph would be negligible and is ignored. The area along the river is heavily developed, and there are several locations at which the effect of dam failure on flooding is of interest. Stage-discharge curves for these locations are determined from ANCO HEC-2 results and from BASIC computer programs developed for this study.

The sudden increase in flow at failure would raise the tailwater 1.4 feet, from 270.9 to 272.3 feet MSL. There is no damage potential immediately downstream of the dam because of the high banks and lack of development. The first location at which increased damage is likely is the old mill building along the right bank of the river just upstream of the Main Street bridge. The low point of the mill is at approximately elevation 255.0 MSL. Prior to failure of Webster Dam the water level at this location would be 259.1 feet MSL, or just over 4 feet of flooding. After failure it is estimated that the elevation would be increased to about 261.3 feet MSL, to a flooding depth of 6.3 feet. The additional 2 feet or more of flooding at this location represents about a 50 percent increase in discharge which could result in a significant increase in flood damage.

The next location which might be affected by dam failure is the Main Street bridge. Here, the elevation would increase from about 258.8 feet to 261.0 feet MSL, which is from about 2.1 feet below the low chord to 0.1 feet above the low chord. This amount of submergence is not expected to result in damage to the bridge.

The next area of potential damage is the Pembroke Dam just downstream of the Main Street bridge. The flood stage at this dam would be increased by failure of Webster Dam from 12.3 feet above the spillway (elevation of 256.4 feet MSL, 8.3 feet above the lower abutments) to 14.1 feet above the spillway (elevation 258.2 feet MSL, 10.1 feet above the lower abutment). This 1.8 foot rise would increase the height of overtopping of the abutments of the dam from 8.3 feet to 10.1 feet and could raise the level of flooding at the mill at Pembroke Dam and increase the danger of failure of this dam.

About 600 feet downstream of Pembroke Dam there are about five homes on the north bank of the Suncook, at an elevation of about 239 feet MSL. The pre-failure outflow of 11,100 cfs would create a water surface elevation of 235.7 feet MSL. This would increase to 236.8 feet MSL after failure with the flow of 14,000 cfs. Thus the water surface would remain below the level of the houses.

China Dam which is about 750 feet downstream of Pembroke Dam and 2,200 feet downstream of Webster Dam would also be influenced by the failure of Webster Dam. At the pre-failure flood flow of 11,100 cfs the China Dam crest would be overtopped slightly by about 0.6 feet. At the higher flows produced by dam failure, the overtopping of China Dam would be increased to about 1.7 feet over the dam crest.

Below China Dam are about three houses on the north bank (at an elevation of 216 feet MSL) and a mill on the south bank. These structures are at high enough elevation to escape significant damage from flooding. About 2,200 feet below China Dam the Suncook enters the Merrimack River.

One other hazard-creating possibility is that failure of Webster Dam could cause failure at Pembroke Dam. This event would not seriously threaten the five houses 650 feet downstream of Pembroke Dam. The joint failure flow of 16,500 cfs would generate a water surface of 237.7 feet, still more than a foot below the level of the houses.

The chart which follows summarizes the effects of flooding on downstream locations.

Location	Flood Elevation	Elevation Before Failure	Elevation After Failure	Effect of Failure
Mill 1000' downstream	255	259.1	261.3	2.2 foot increase in flooding level
Main St. Bridge	-	258.8	261.0	Increase of 2.2 feet to 0.1 feet above low chord
Pembroke Dam	(spillway @ 244.1)	256.4	258.2	1.8 foot increase in head over the spillway and in flooding in mill at dam
Five houses 650' downstream of Pembroke Dam	239	235.7	236.8	None
China Dam	(spillway @ 225.8)	233.4	234.5	1.1 foot increase in head at spillway

Fail"re at low head would generate a peak failure outflow of about 4,200 cfs which would pose little problem downstream.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

(a) Visual Observations

The field investigation revealed no significant displacement or distress that would warrant the preparation of structural stability calculations based on assumed sectional properties and engineering factors. However, field investigations should be conducted to clearly ascertain the condition of the gate structure located to the right of the spillway and the origin of the seepage through the structure.

The right upstream training wall, the headworks structure and the waste gate structure are in very poor condition. There is considerable spalling, erosion, and cracking of concrete in these structures. There was approximately 10 cfs leaking through a hole in the waste gate structure. The sluice gates in the headworks structure are broken and inoperable.

(b) Design and Construction Data

No as-built plans or calculations of value to a stability assessment are available for this dam.

(c) Operating Records

No operating records are available for the dam.

(d) Post Construction Changes

The numerous alterations to the training walls conducted during the lifetime of this dam and headworks did not reduce its structural stability. The relocation of the gate house and subsequent changes to the training walls did not adversely affect the dam's stability.

(e) Seismic Stability

The dam is located in Seismic Zone No. 2, and in accordance with recommended Phase 1 guidelines, does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

(a) Condition

The Webster Dam is in FAIR condition at the present time. The waste gate and headworks are in VERY POOR condition.

(b) Adequacy of Information

The lack of as-built engineering data does not permit a definitive review of the dam. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Urgency

The engineering studies and recommendations should be implemented by the owner within one year of receipt of the Phase 1 inspection report.

(d) Need for Further Investigation

Additional investigations are required as recommended in Paragraph 7.2.

7.2 Recommendations

It is recommended that the tasks outlined below be undertaken by the owner within one year.

(a) Perform an engineering investigation of the extent and location of seepage through the waste gate (Item C). This would include draining the lake to a level where a detailed examination of the gate could be performed. Repair of the waste gate and its structure should be performed upon completion of the investigation.

(b) Perform further hydraulic/hydrologic analyses to determine the adequacy of the spillway.

(c) Evaluate rehabilitation or sealing the sluice gates and repair or demolition of the headworks structure (Item E) and implement the findings.

7.3 Remedial Measures

Webster Dam requires the following maintenance improvements:

a) Repair or replace all spalled or eroded concrete on the left upstream training wall (Item G), the right upstream training wall (Item F), and the wall between the spillway and headworks structure (Item D).

b) Remove fill from the left downstream abutment (Item A) and inspect the abutment area. Repair spalled concrete.

c) Repair all spalled concrete in spillway (Item B).

d) Monitor the seepage on the downstream return wall between the spillway and gate house noting any change in quantity or turbidity (Item D).

e) Perform technical inspections of the dam every year.

f) Institute a formal written flood emergency warning system.

7.4 Alternatives

One possible alternative would be to breach the dam.

APPENDIX A

VISUAL INSPECTION CHECKLIST

INSPECTION TEAM ORGANIZATION

Date: November 7, 1978

NH 00378
WEBSTER DAM
Allenstown-Pembroke, New Hampshire
Suncook River
NHWRB

Weather: Overcast, $50^{O}F \pm$

INSPECTION TEAM

Nicholas A. Campagna	Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD)	Team Captain
William S. Zoino	GZD	Foundations
Robert Minutoli	GZD	Soils
Andrew Christo	Andrew Christo Engineers (ACE)	Structural
Paul Razgha	ACE	Concrete
Richard Laramie	Resource Analysis, Inc.	Hydrology

The inspection team was accompanied by Mr. Pattu Kesavan of the New Hampshire Water Resources Board.

Webster Dam
Allenstown-Pembroke, NH

November 7, 1978
NH 00378

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
DAM SUPERSTRUCTURE		
a. General		
Vertical alignment and movement	AC	No deficiencies noted
Horizontal alignment and movement		No deficiencies noted
B. Left Abutment Structure		
Condition of concrete		Good
Spalling		Minor surface spalling on top of wall
Erosion		Minor surface erosion from spillway crest to 4 feet above level. Triangular surface area 18" long, 12" high and 12" deep at construction joint downstream of spillway crest line
Cracking		Horizontal construction joint open downstream at crest elevation. The upstream return wall has two minor vertical cracks. Diagonal hairline crack 3' long on downstream return wall
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence	AC	Minor efflorescence on upstream return wall

Webster Dam
Allenstown-Pembroke, NH

November 7, 1978
NH 00378

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Seepage	AC	None noted. Abutment on downstream side covered with recently placed loose fill from new apartment development. This could cover up any abutment seepage
C. Right Spillway Abutment Structure		
Condition of concrete		Very poor
Spalling		Extensive. The top surface of wall adjacent to gate structure has completely spalled and its vertical face is spalled over 60% of its surface. This spalling is up to 6" deep. The back surface is completely spalled up to 6" in depth
Erosion		The interface between the abutment base and bedrock is eroded over entire length 4" to 6" high and up to 12" deep. High degree of erosion on its upstream face up to 4" deep
Cracking		Two vertical and one horizontal cracks on vertical face downstream of gate structure and considerable random cracking. Horizontal crack on upstream face 2 feet above spillway crest 2" wide and 2" deep approximately 20' long
Rusting or staining of concrete	AC	None noted

Webster Dam
Allenstown-Pembroke, NH

November 7, 1979
NH 00378

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Visible reinforcing	AC	None noted
Efflorescence		Face of wall adjacent to the spillway and upstream face are highly effloresced
Seepage		Minor on downstream return wall. Less than 0.1 gpm
D. Right Headworks Upstream Training Wall		
Condition of concrete		Very poor
Spalling		In excess of 75% of its length and surface area. Top of wall spalled and disintegrated 18" deep over entire length
Erosion		Over 50% of its length at crest level up to 8" high and 2" deep
Cracking		Random cracks 4" to 6" wide and approximately 12" deep. One section of wall has horizontal crack 10' long and 1.5" wide. Top of wall leaning outwards 3".
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence		Over entire upper portion of wall
Seepage	AC	None noted
E. Left Upstream Training Wall		
Condition of concrete	PR	Very poor

Webster Dam
Allenstown-Pembroke, NH

November 7, 1979
NH 00378

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Spalling	PR	Over 30% of the wall face. Back side of wall spalled 2' high over its entire length
Erosion		Over its entire length at crest level up to 2" deep
E. Left Upstream Training Wall (continued)		
Cracking		Vertical construction joints opened. Horizontal crack over entire length of wall 3' above crest
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence		Over 50% of wall face
Seepage	PR	None noted
OUTLET WORKS		
A. Spillway		
Condition of concrete	AC	Fair
Spalling		Minor - at intermediate construction joints
Erosion		Random patterns on downstream face. Mortared patches up to 2 to 3 square feet eroded up to 1/2" deep. Minor at interfaces with bedrock
Cracking		None noted
Rusting or staining of concrete	AC	None noted

Webster Dam
Allenstown-Pembroke, NH

November 7, 1979
NH 00378

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Visible reinforcing	AC	None noted
Efflorescence	|	None noted
Seepage	AC	None noted
B. Gate Structure		
Condition of concrete	PR	Very poor
Spalling	|	Extensive. Downstream face spalled over one-third of its surface area up to 6" deep. Progressive spalling on downstream header. Underside of roof has progressively spalled
Erosion	|	Extensive. The interface with the spillway is eroded for depths up to 4". The left sidewall of the outlet tunnel eroded 2' high x 10' long and 12" deep. The vertical interface between the downstream end of this structure and the spillway exhibits similar erosion. Erosion on the right side of the tunnel wall is similar to the left wall but up to 15" deep
Cracking	PR	A high degree of random cracking on the upstream face and top of the structure. A crack 2" wide x 2" deep and 6' long on the upstream face of this structure. Random cracks on left vertical face and a high degree of random cracks on downstream face. Downstream header exhibits closely spaced uniform cracking. Extensive cracking on underside of tunnel roof

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
B. Gate Structure (cont.)		
Rusting or staining of concrete	PR	None noted
Visible reinforcing		None noted
Efflorescence		Upstream end, the left vertical face and the downstream face are highly effloresced. The downstream header is highly effloresced and exudated. The tunnel roof is highly effloresced and exudated and random stalactites
Seepage		Seepage through the left sidewall is approximately 10 cfs
Sluice Gate		No longer operational. Badly damaged, leaking and the lifting mechanism unoperable. Seepage through sluice gate is evident.
C. Gate House		
Condition of structure		Extremely poor. Roof has caved in and 50% of downstream bearing wall destroyed
Condition of concrete		Poor
Spalling		Concrete platform over sluiceway entrances spalled over 10% of its surface area. The right canal wall downstream of structure spalled.
Erosion	PR	Gate inlets eroded at crest level. Right side of right inlet eroded 6' to 8' long, 2' high and up to 12" deep. All other inlet walls subjected to a lesser degree of erosion.

Webster Dam
Allenstown-Pembroke, NH

November 7, 1978
NH 00378

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Cracking	PR	Downstream foundation wall has horizontal cracks up to 4" wide and random cracking. Right wall has 3 horizontal cracks supplemented with minor horizontal and vertical cracks. Left wall is similar. Upstream face has a series of horizontal cracks
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence		Minor
Sluice gates	PR	Poor condition. Operating mechanism for 2 left gates dismantled. The stems of these gates are broken and inoperable. Timber frame of third and fourth gate rotted
DOWNSTREAM CHANNEL		
Slope Conditions	NAC	Steep slope on left side and moderate slopes on right side; heavy vegetation on both sides
Rockslides or falls		None noted
Control of debris		Occasional tree limbs and branches in channel
Trees overhanging the channel		Heavy overgrowth on both sides of channel extends over channel; some trees in channel
Other obstructions		None noted
Existence of gages	NAC	None

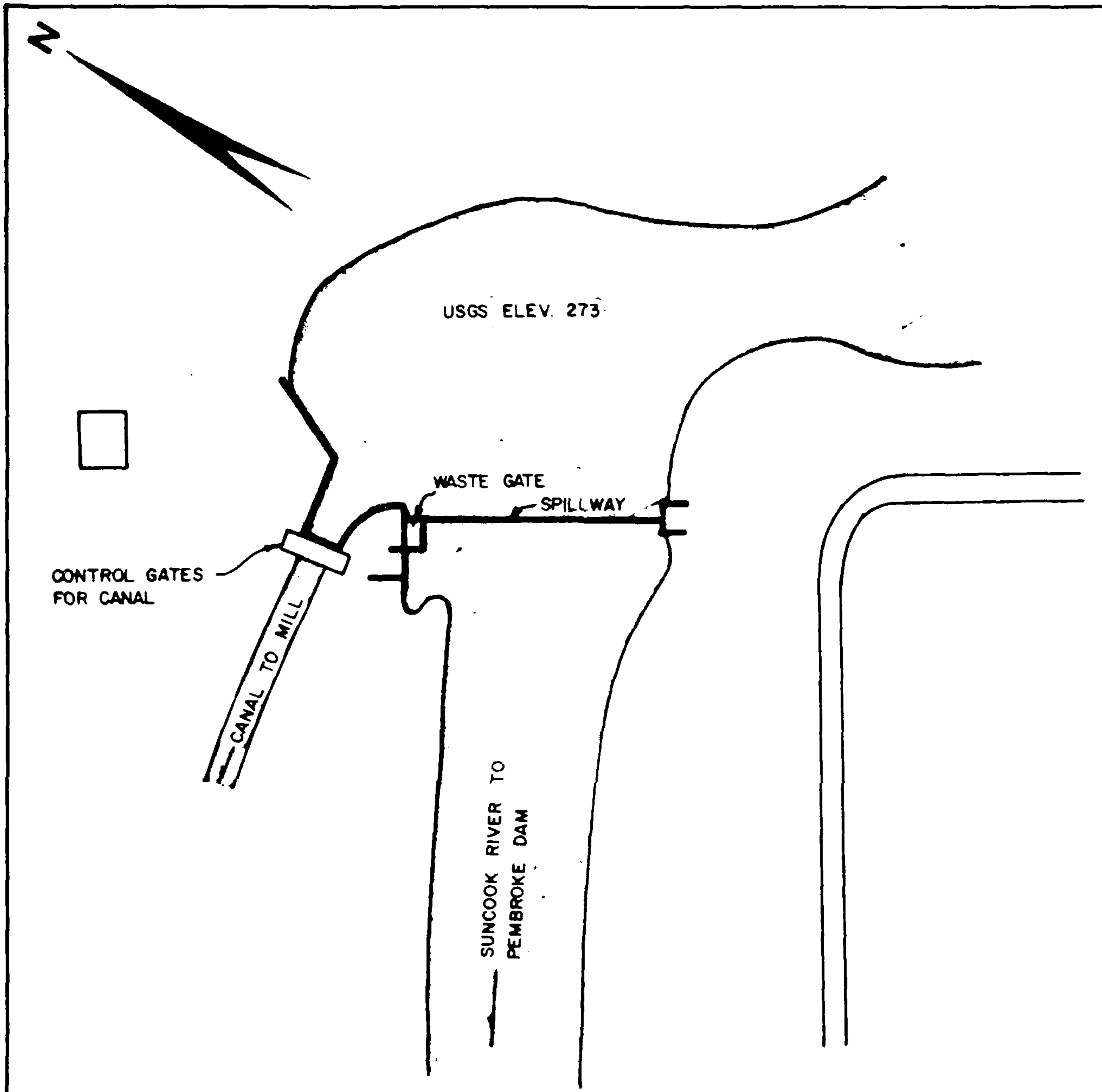
Webster Dam
Allenstown-Pembroke, NH

November 7, 1978
NH 00378

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
RESERVOIR		
Shoreline	NAC	Stable, no slides noted
Sedimentation		None noted; some silting likely behind spillway
Upstream hazard areas in event of backflooding		Numerous houses along shoreline near dam
Changes in nature of watershed (agriculture, logging, construction, etc.)		New large apartment complex under construction on upstream left side. Area generally well developed in vicinity of dam
OPERATION AND MAINTENANCE FEATURES		
Reservoir regulation		None presently exists
Maintenance	NAC	Considerable repairs and maintenance needed at dam

APPENDIX B



GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

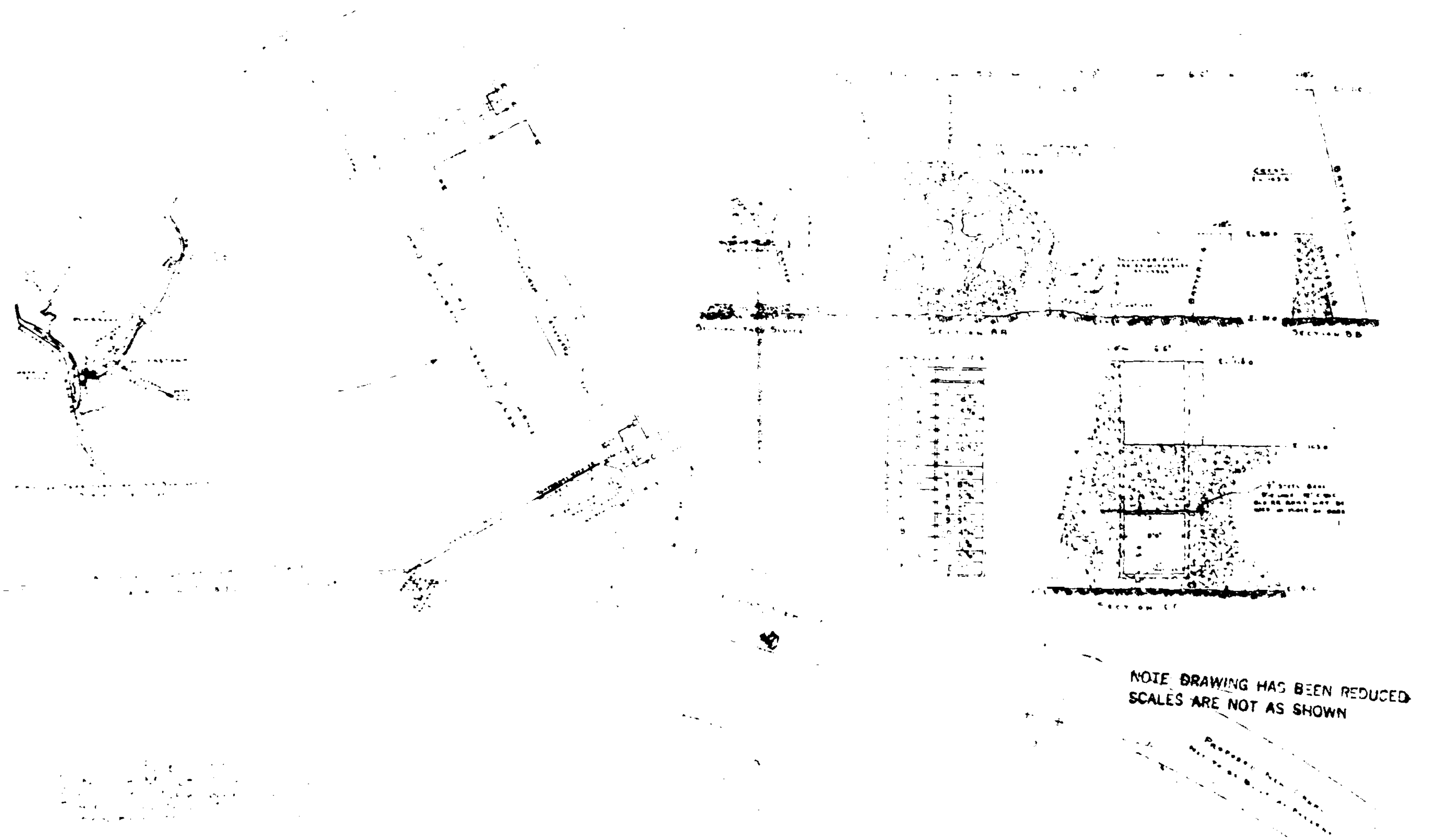
SITE PLAN

WEBSTER DAM — NEW HAMPSHIRE

FILE No. 2201

SCALE 1" ≈ 100'

DATE NOVEMBER 1978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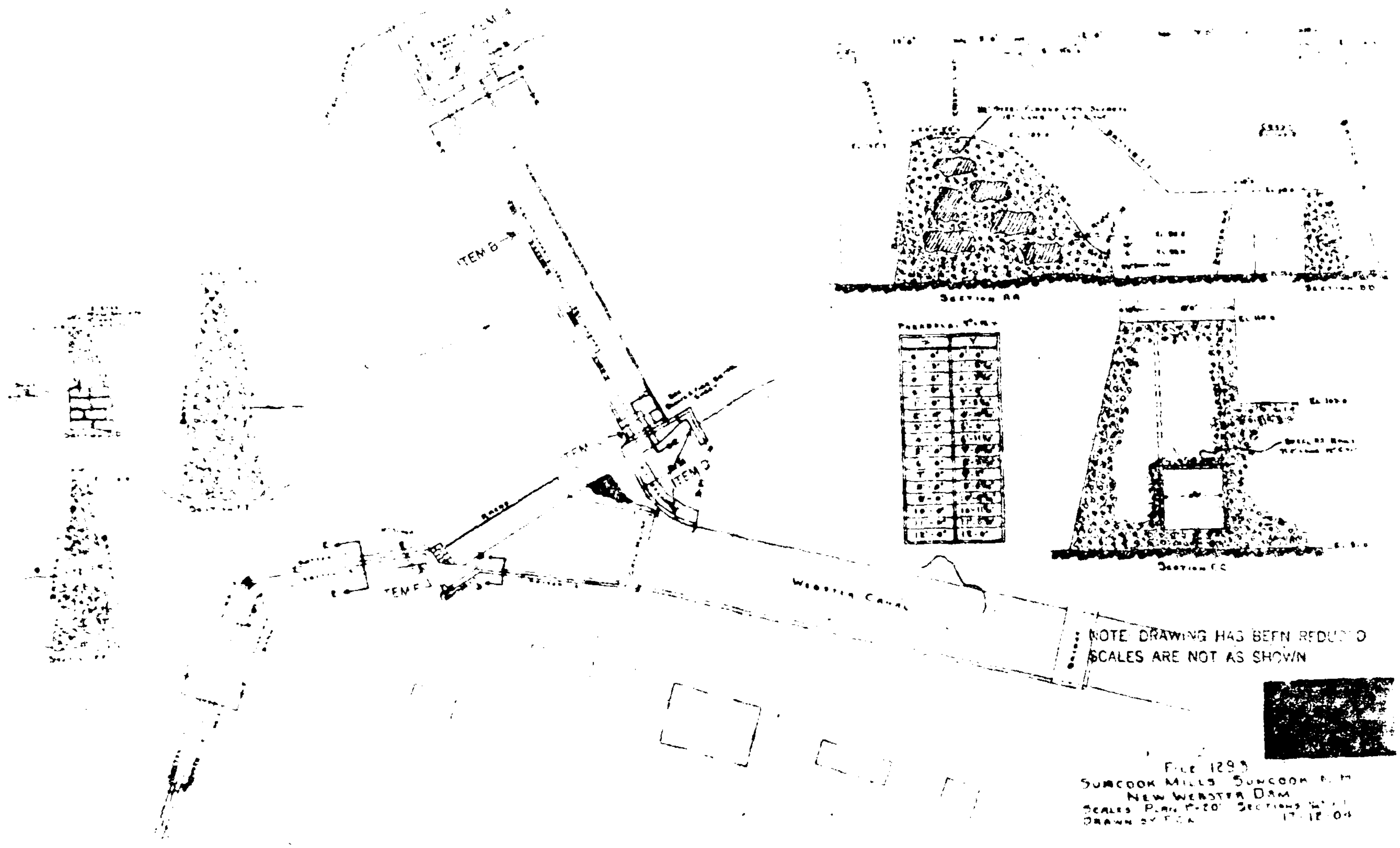
SCALES ARE NOT AS SHOWN


ITEM B
ITEM D
ITEM E
Webster Canal
Section AA
Section BB
Section CC
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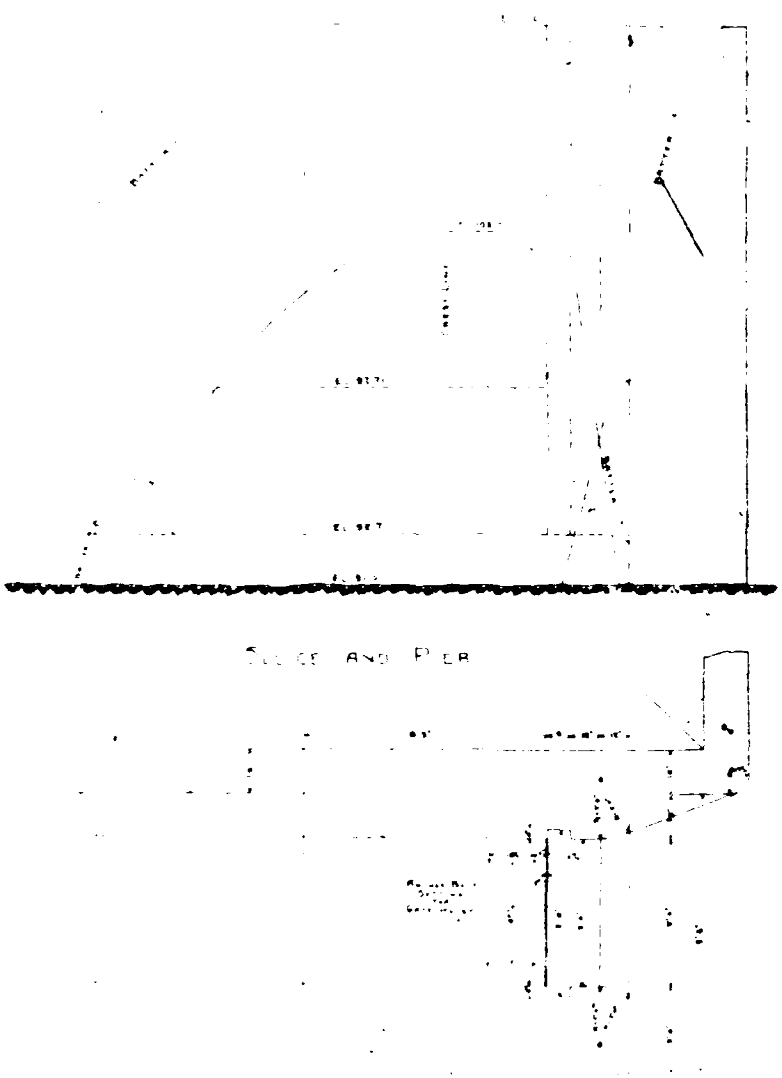
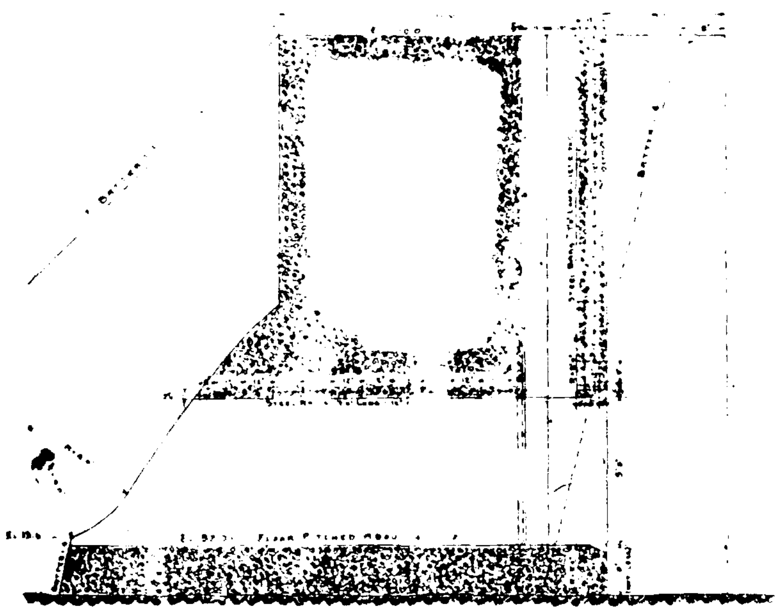
New Webster Dam
Scales Plan 1"=20' Sections
Drawn by
12-12-04



Sluice and Pier

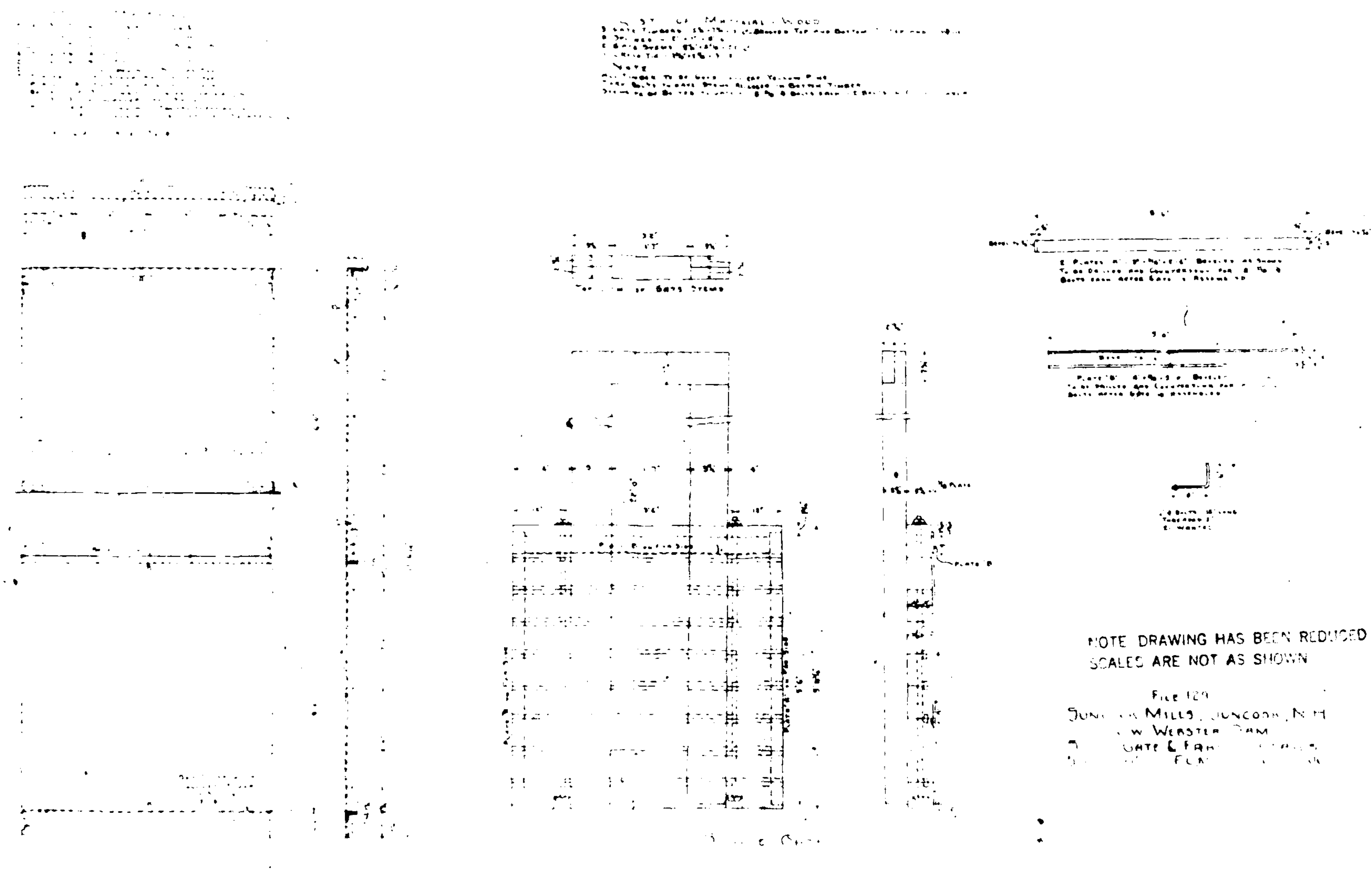


Section Along ℄ of Sluice

NOTE DRAWING HAS BEEN REDUCED
SCALES ARE NOT AS SHOWN

File 129.5
Suncook Mills, Suncook, N.H.
New Webster Dam
Sluice and Pier Detail
Scale [illegible]

B-5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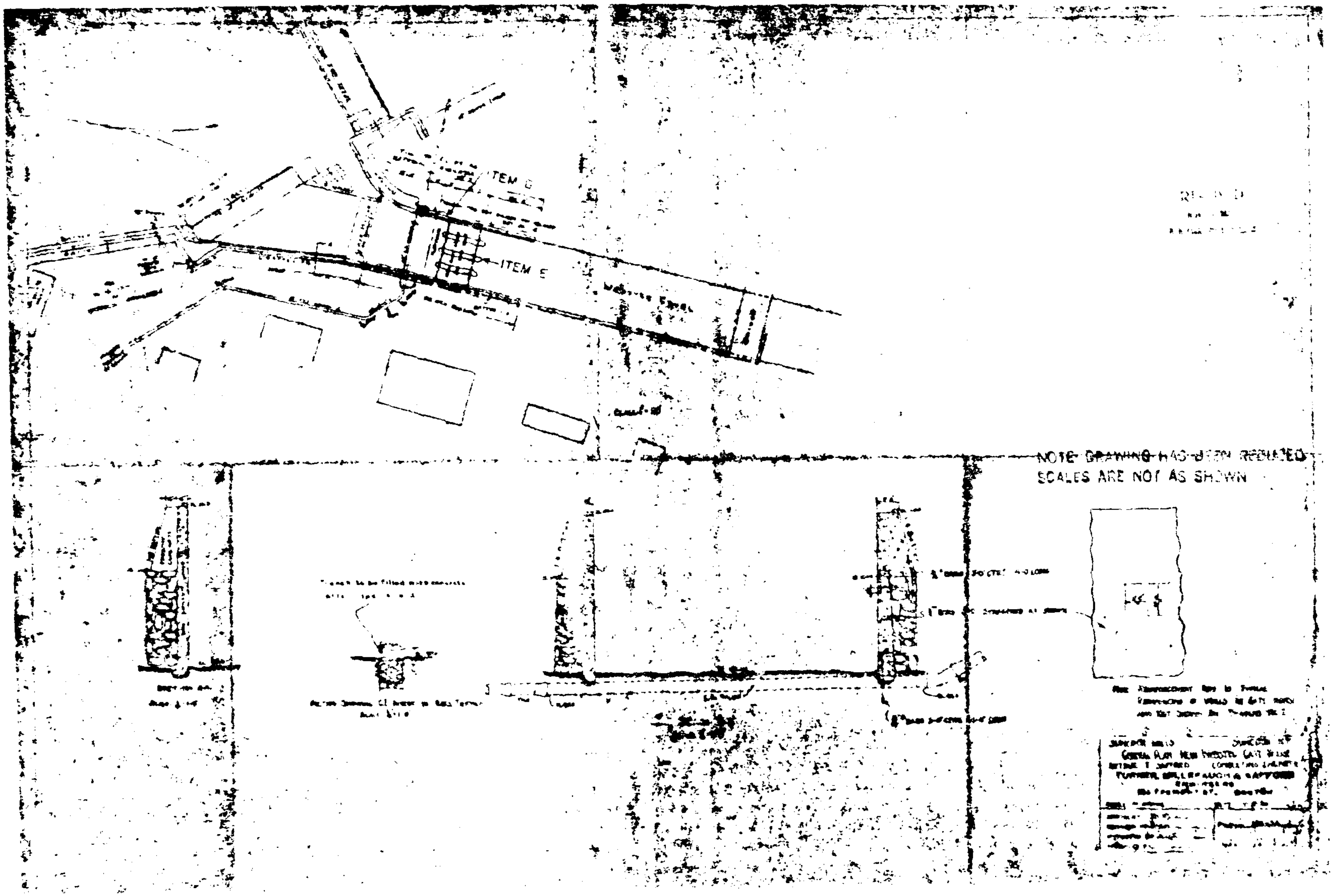
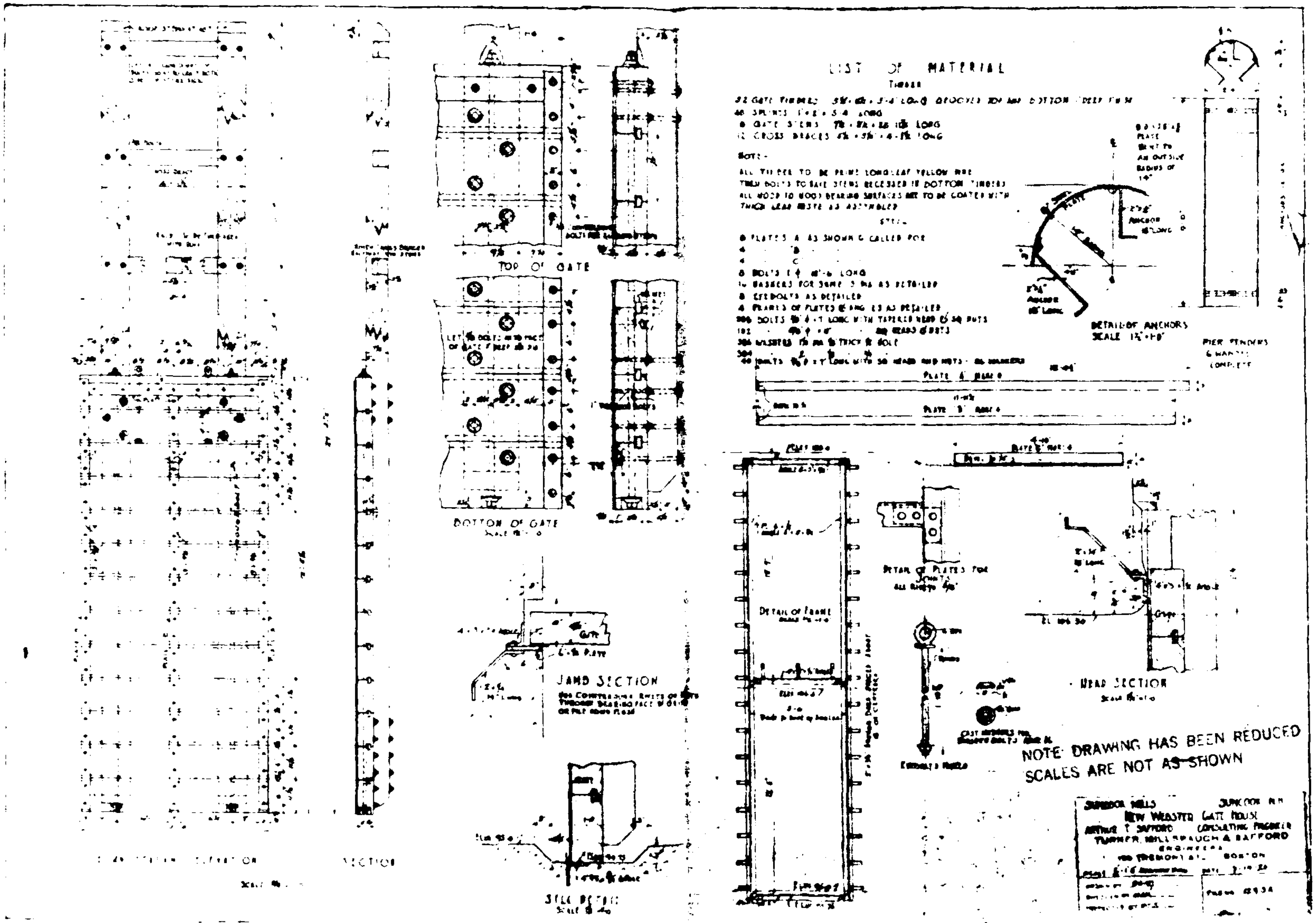

ITEM G
ITEM E
NOTE: DRAWING HAS BEEN REDUCED
SCALES ARE NOT AS SHOWN



LIST OF MATERIAL
TOP OF GATE
BOTTOM OF GATE
JAMB SECTION
SILL DETAIL
DETAIL OF FRAME
DETAIL OF PLATES FOR
HEAD SECTION
DETAIL OF ANCHORS
SCALE 1 1/2"=1'0"
PIER FENDERS
SECTION
NOTE: DRAWING HAS BEEN REDUCED
SCALES ARE NOT AS SHOWN
SUNCOOK MILLS
SUNCOOK N.H.
NEW WEBSTER GATE HOUSE
ARTHUR T. SAFFORD CONSULTING ENGINEER
TURNER, MILLSPAUGH & SAFFORD
ENGINEERS
BOSTON

The New Hampshire Water Resources Board (NHWRB), located at 37 Pleasant Street, Concord, N.H., 03301, maintains an extensive correspondence file on this dam. Included in this file are the following items:

1) The specifications for the proposed construction of the dam dated August 27, 1917.

2) A proposal dated August 27, 1917 by the H.P. Cummings Construction Company for the construction of the dam.

3) A 1917 report by John W. Storrs on his inspection of the foundation of the dam. The report is dated September 26, 1917.

4) A NHWRB "Inventory of Dams and Water Power Developments" dated August 2, 1934.

5) The New Hampshire Water Control Commission's (NHWCC) "Data on Water Power Developments in New Hampshire" and "Data on Dams in New Hampshire" both dated April 26, 1939.

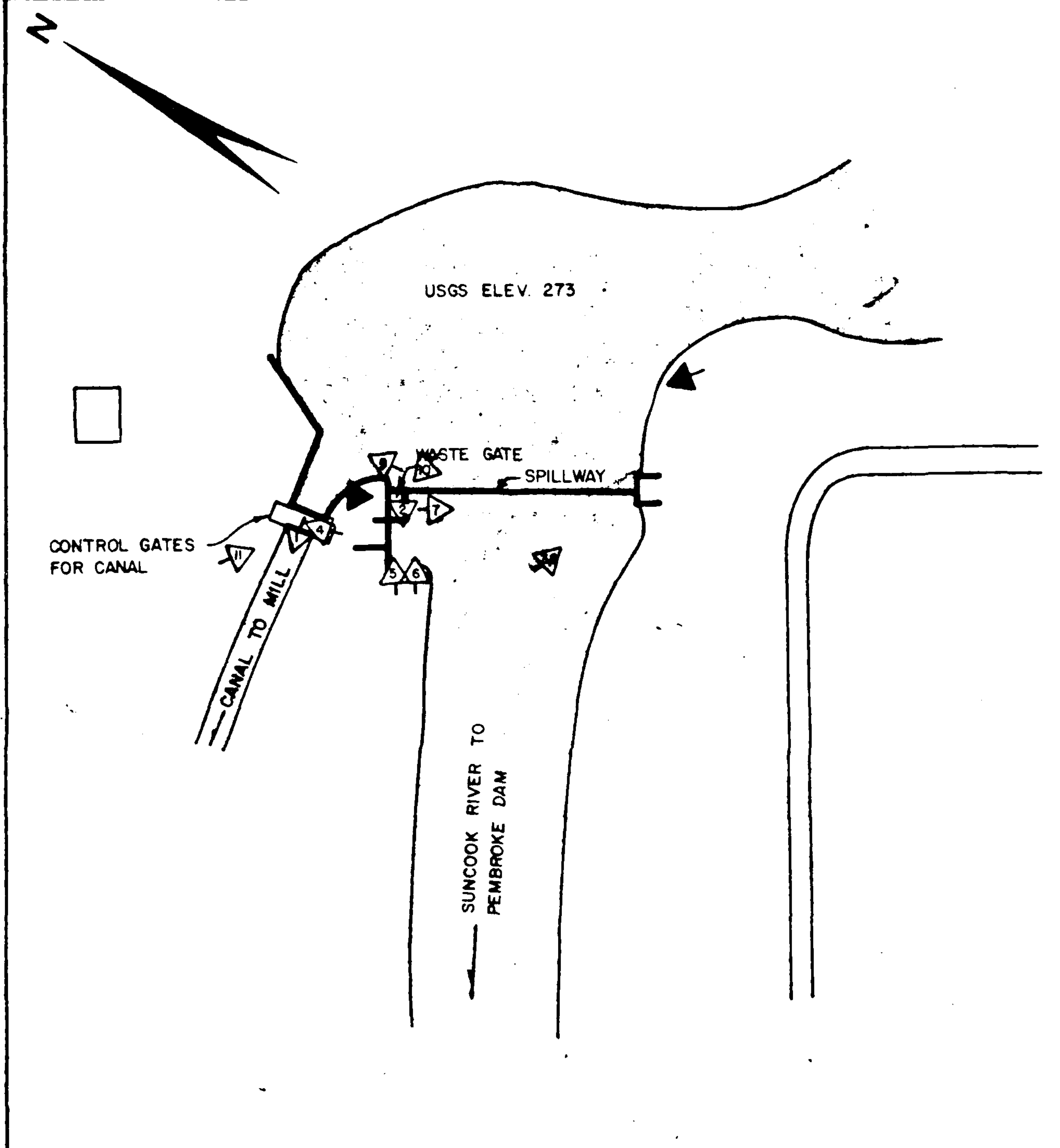
6) Two NHWRB questionnaires dated July 10, 1942 and January 28, 1948 regarding power generation from the dam.

7) A NHWCC inspection report dated June 14, 1950.

8) December 1977 and September 1978 inspection reports by the NHWRB.

APPENDIX C

SELECTED PHOTOGRAPHS



OVERVIEW

APPENDIX C

FILE No. 2201

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

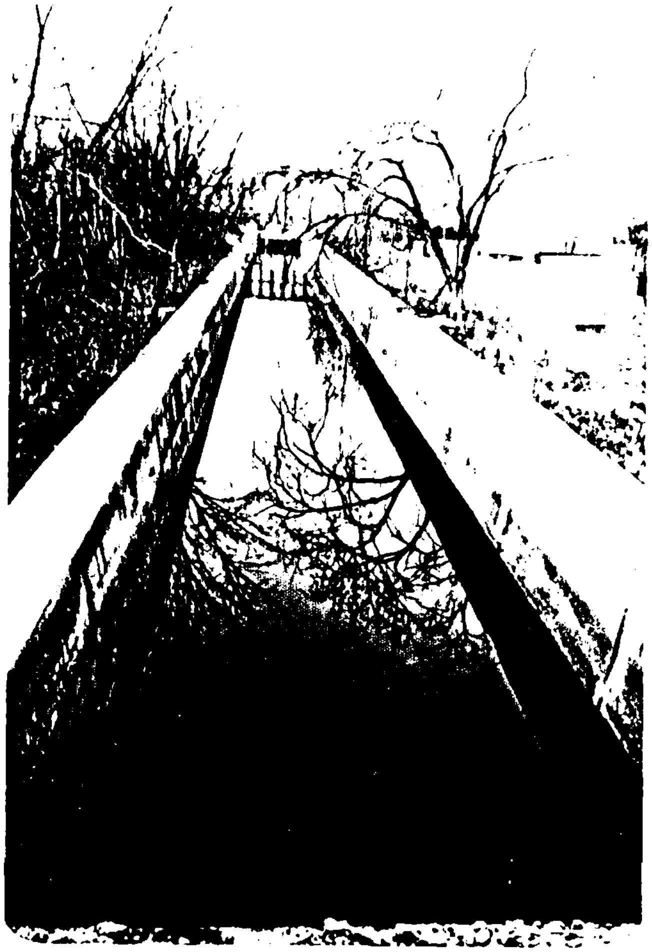
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION AND ORIENTATION OF PHOTOS

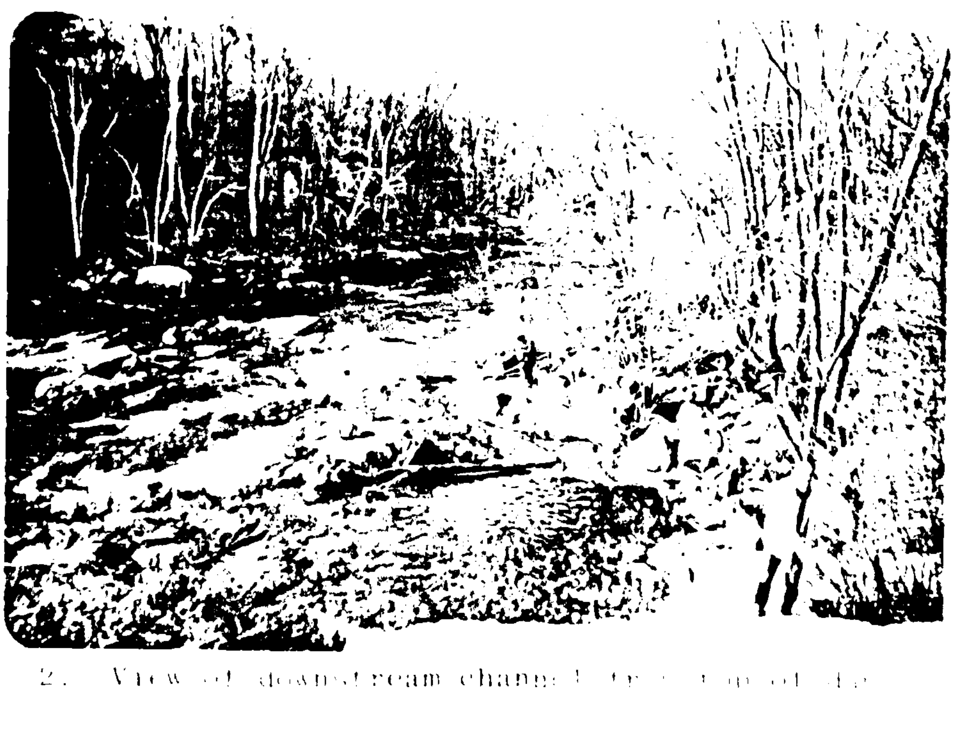
WEBSTER DAM — NEW HAMPSHIRE

SCALE 1" ≈ 200'

DATE NOVEMBER 1978

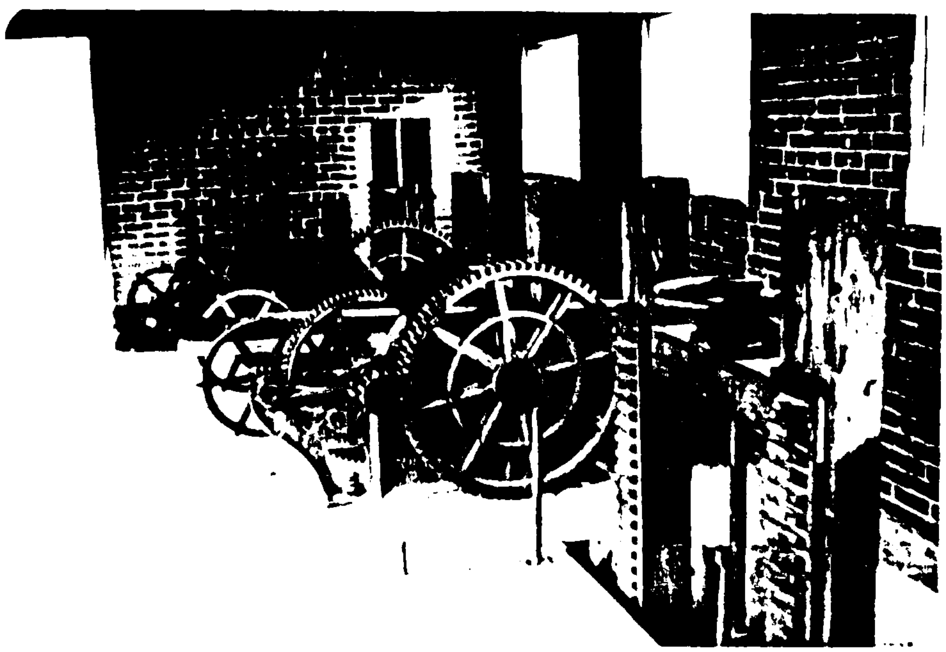


1. View of old diversion channel from gatehouse



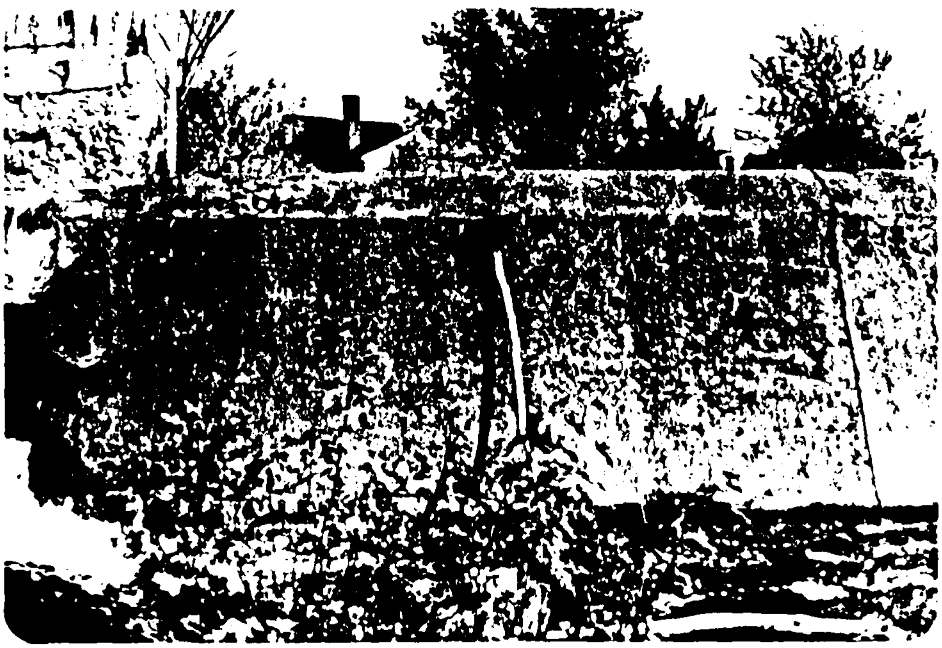
2. View of downstream channel from top of dam

3. View from downstream channel of erosion and uncontrolled dumping at left abutment

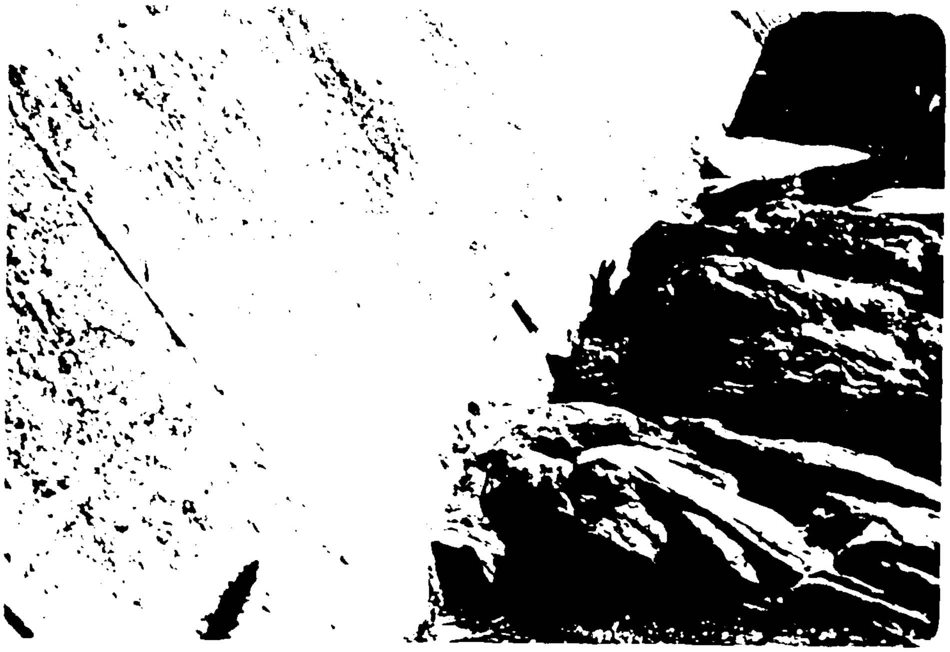


4. View of deteriorated gate operating mechanisms

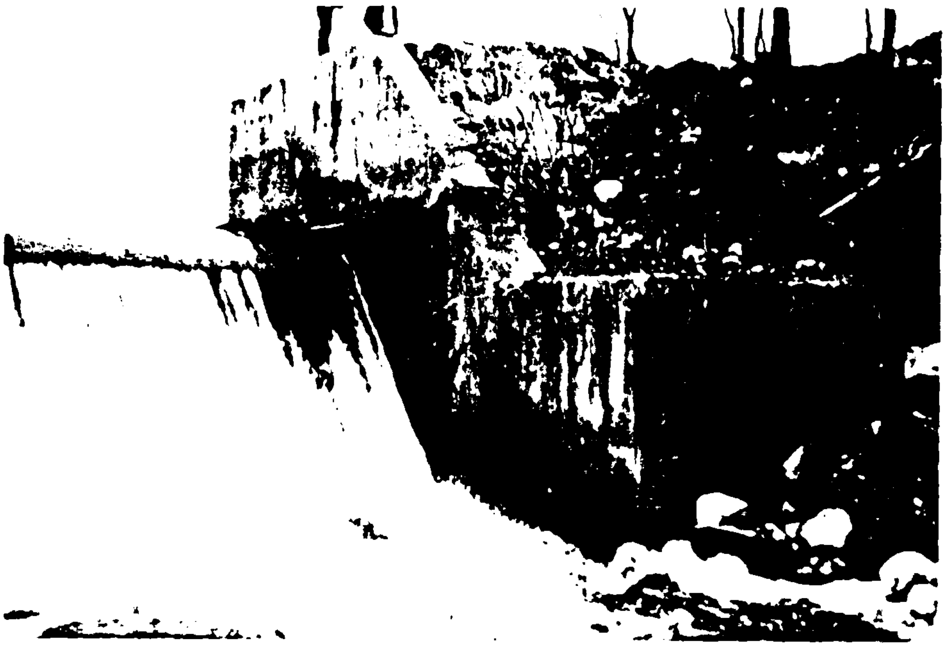
5. View from downstream of deteriorated concrete on sluice gate structure at right end of spillway and serious leakage around gate in closed position



6. View of right end of spillway showing vertical construction joint and pressure relief drain



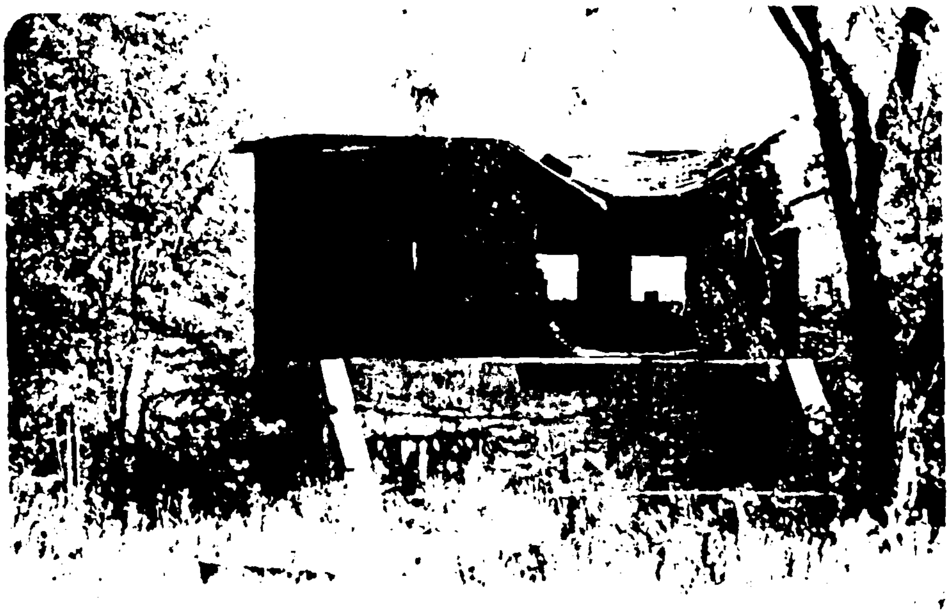
7. View from sluice gate structure showing bedrock foundation conditions and surface deterioration of concrete



8. View of left abutment showing erosion of construction joint and of base of concrete wall

9. View from sluice gate structure showing deterioration of right upstream training wall

10. View from upstream showing gate operating mechanism and deterioration of sluice gate structure



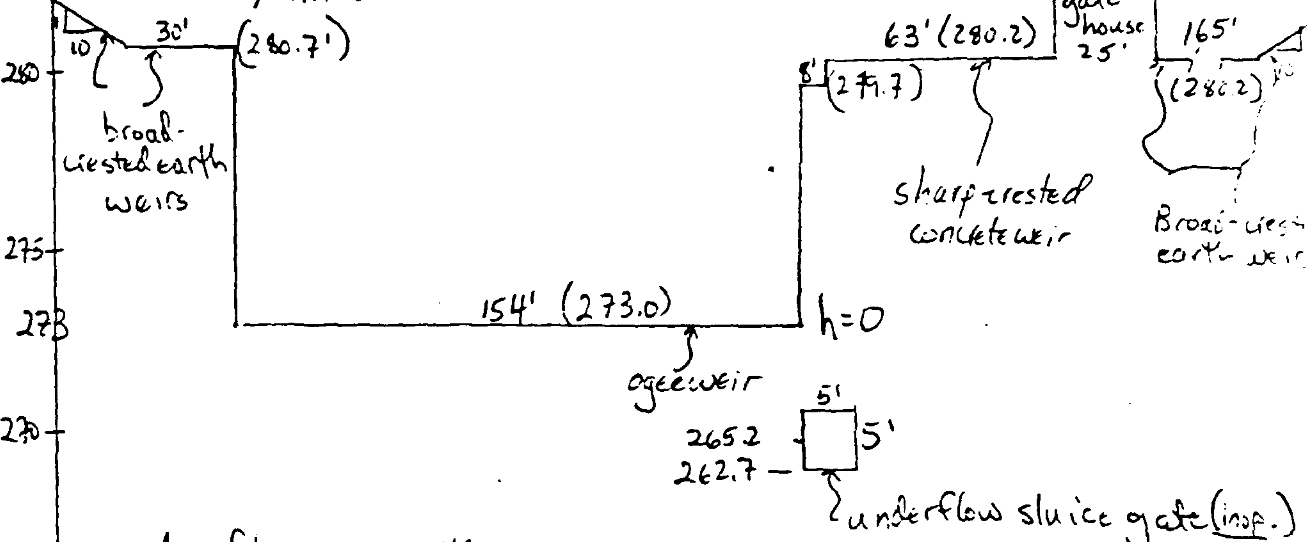
11. View from diversion channel showing deterioration of gatehouse

APPENDIX D

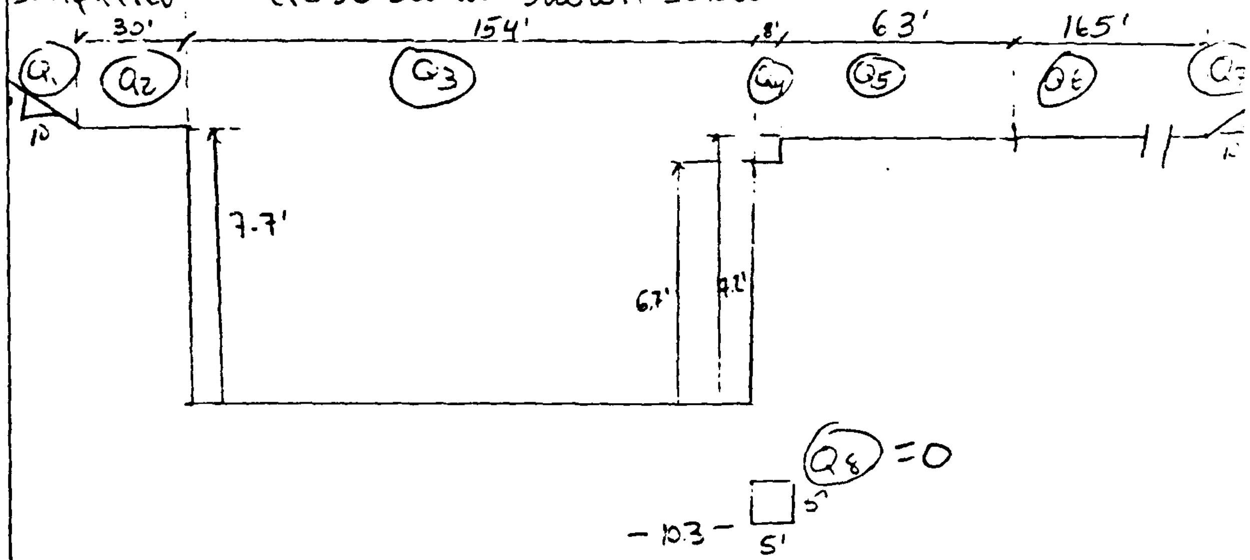
HYDROLOGIC/HYDRAULIC COMPUTATIONS

Stage - Discharge Curve.

The information used to establish the cross-section at Webster Dam was determined from field notes, old plans, and FIS survey notes.



The flow over this cross-section is equivalent to that over the simplified cross-section shown below.



The canal gates controlled by the gate house to the right of the dam are inoperable. The 5' x 5' sluiceway under the dam is inoperable, and assumed to be close for h = 0 to 6.7

$$Q_3 = 3.7\,(154)\,h^{3/2}$$

> Over an ogee spillway, $Q = CLH^{3/2}$, $C = 3.7$

$$Q_1 = Q_2 = Q_4 = Q_5 = Q_6 = Q_7 = 0$$

for h = 6.7 to 7.2

$$Q_4 = 3.0\,(8)\,(h - 6.7)^{3/2}$$

all others unchanged

> For a broadcrested concrete weir, $C = 3.0$

for h = 7.2 to 7.7

$$Q_5 = 3.3\,(63)\,(h - 7.2)^{3/2}$$

$$Q_6 = 2.8\,(165)\,(h - 7.2)^{3/2}$$

$$Q_7 = 2.8\,(10)(h - 7.2)\,(.5(h - 7.2))^{3/2}$$

> For Q_5 sharp-crested concrete weir $\rightarrow C = 3.3$. Q_6, Q_7: broad crested earth $\rightarrow C = 2.8$

for h > 7.7

$$Q_1 = 2.8\,(10)(h - 7.7)\,(.5(h - 7.7))^{3/2}$$

$$Q_2 = 2.8(30)\,(h - 7.7)^{3/2}$$

> Broadcrested earth weirs $\rightarrow C = 2.8$

The BASIC program which follows calculates the stage-discharge curve at the dam.

+ Rouse, Engineering Hydraulics, p. 52

```
LIST
100 REM: STAGE DISCHARGE PROGRAM FOR PEMBROKE WEBSTER DAM, JOB 165
110 REM: ON TAPE 10, FILE 58
120 PAGE
130 PRI "DISCHARGE FROM WEBSTER DAM AS FUNCTION OF HEAD ABOVE SPILLWAY"
140 PRINT USING 150:
150 IMAGE // 2T"HEAD"30T"DISCHARGE"
160 PRINT USING 170:
170 IMAGE 1T"(FEET)"32T"(CFS)"
180 PRINT USING 190:
190 IMAGE 15T"TOTAL"       8X"LEFT"8X"RIGHT"8X"MAIN"8X"SPILLWAY"
200 PRINT USING 210:
210 IMAGE 28T"BANK"9X"BANK"9X"ST."
220 FOR H=0 TO 13 STEP 0.5
230 Q1=0
240 Q2=0
250 Q4=0
260 Q5=0
270 Q6=0
280 Q7=0
290 Q3=3.7*154*H↑1.5
300 IF H<=6.7 THEN 390
310 Q4=3*8*(H-6.7)↑1.5
320 IF H<=7.2 THEN 390
330 Q5=3.3*63*(H-7.2)↑1.5
340 Q6=2.8*165*(H-7.2)↑1.5
350 Q7=2.8*10*(H-7.2)*(0.5*(H-7.2))↑1.5
360 IF H<=7.7 THEN 390
370 Q1=2.8*10*(H-7.7)*(0.5*(H-7.7))↑1.5
380 Q2=2.8*30*(H-7.7)↑1.5
390 T1=Q1+Q2
400 T2=Q5+Q4
410 T3=Q6+Q7
420 T4=T1+T2+T3+Q3
430 PRINT USING 440:H,T4,T1,T2,T3,Q3
```

P.3

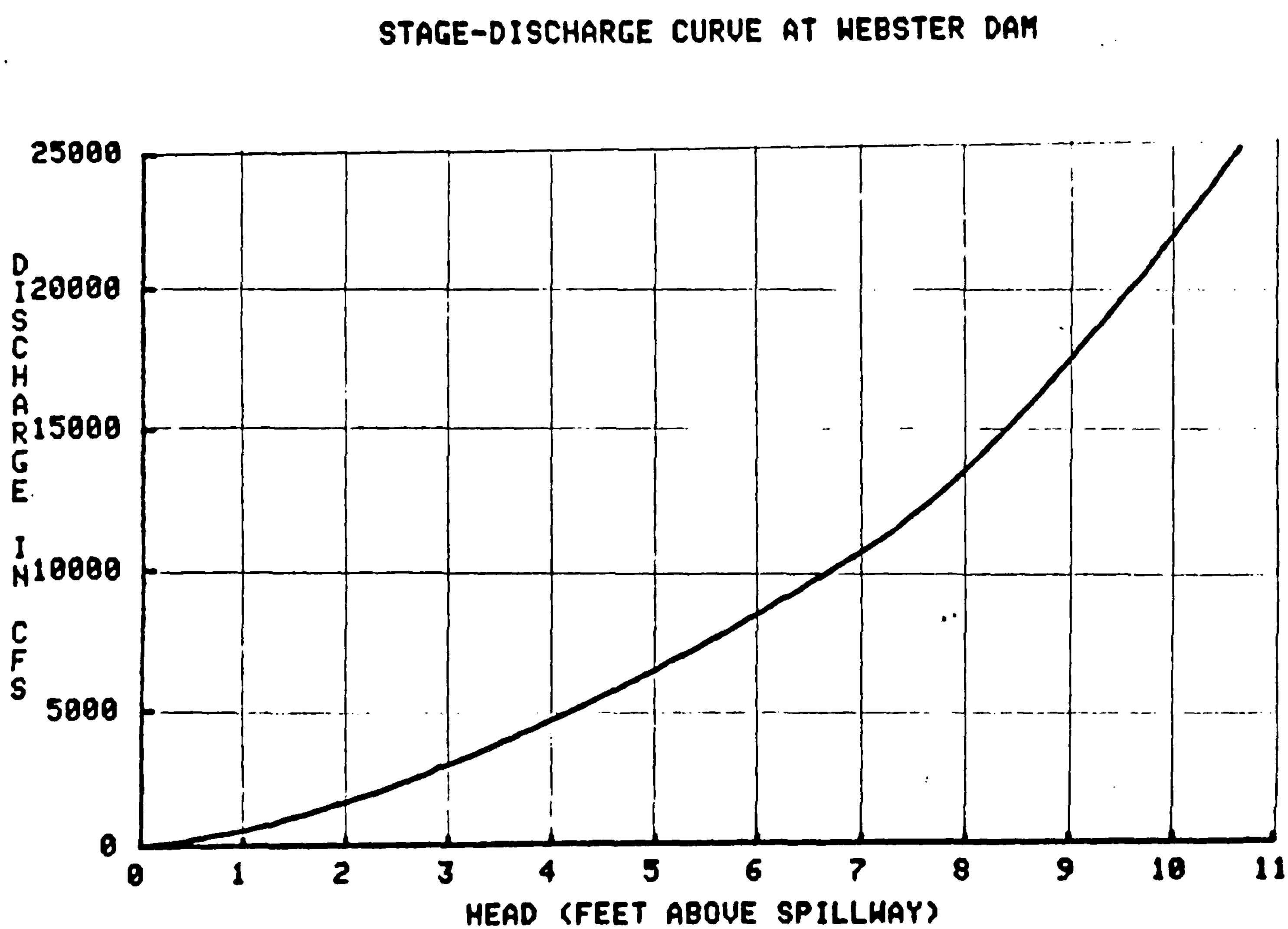
```
440 IMAGE 2T,2D.1D,14D,12D,13D,12D.16D
450 NEXT H
460 END
```

P 4

P.5

DISCHARGE FROM WEBSTER DAM AS A FUNCTION OF HEAD ABOVE SPILLWAY

HEAD (FEET)	DISCHARGE (CFS) TOTAL	LEFT BANK	RIGHT BANK	MAIN ST.	SPILLWAY
0.0	0	0	0	0	0
0.5	201	0	0	0	201
1.0	570	0	0	0	570
1.5	1047	0	0	0	1047
2.0	1612	0	0	0	1612
2.5	2252	0	0	0	2252
3.0	2961	0	0	0	2961
3.5	3731	0	0	0	3731
4.0	4558	0	0	0	4558
4.5	5439	0	0	0	5439
5.0	6371	0	0	0	6371
5.5	7350	0	0	0	7350
6.0	8374	0	0	0	8374
6.5	9443	0	0	0	9443
7.0	10557	0	4	0	10553
7.5	11831	0	51	76	11703
8.0	13428	14	184	336	12893
8.5	15256	66	366	704	14121
9.0	17273	144	586	1159	15385
9.5	19459	246	838	1691	16684
10.0	21804	372	1118	2294	18019
10.5	24300	523	1424	2965	19387
11.0	26942	699	1754	3701	20788
11.5	29727	901	2106	4499	22221
12.0	32652	1129	2479	5358	23686
12.5	35714	1383	2872	6277	25182
13.0	38912	1665	3284	7255	26708


STAGE-DISCHARGE CURVE AT WEBSTER DAM
25000
20000
15000
10000
5000
0
DISCHARGE IN CFS
0
1
2
3
4
5
6
7
8
9
10
11
HEAD (FEET ABOVE SPILLWAY)

P.6

Storage-Elevation Curve

The surface area of the pond created by Webster Dam is about 15 acres. The Storage elevation curve on p. 8 assumes no spreading as the pond rises.

1" of runoff over 259 sq. mi

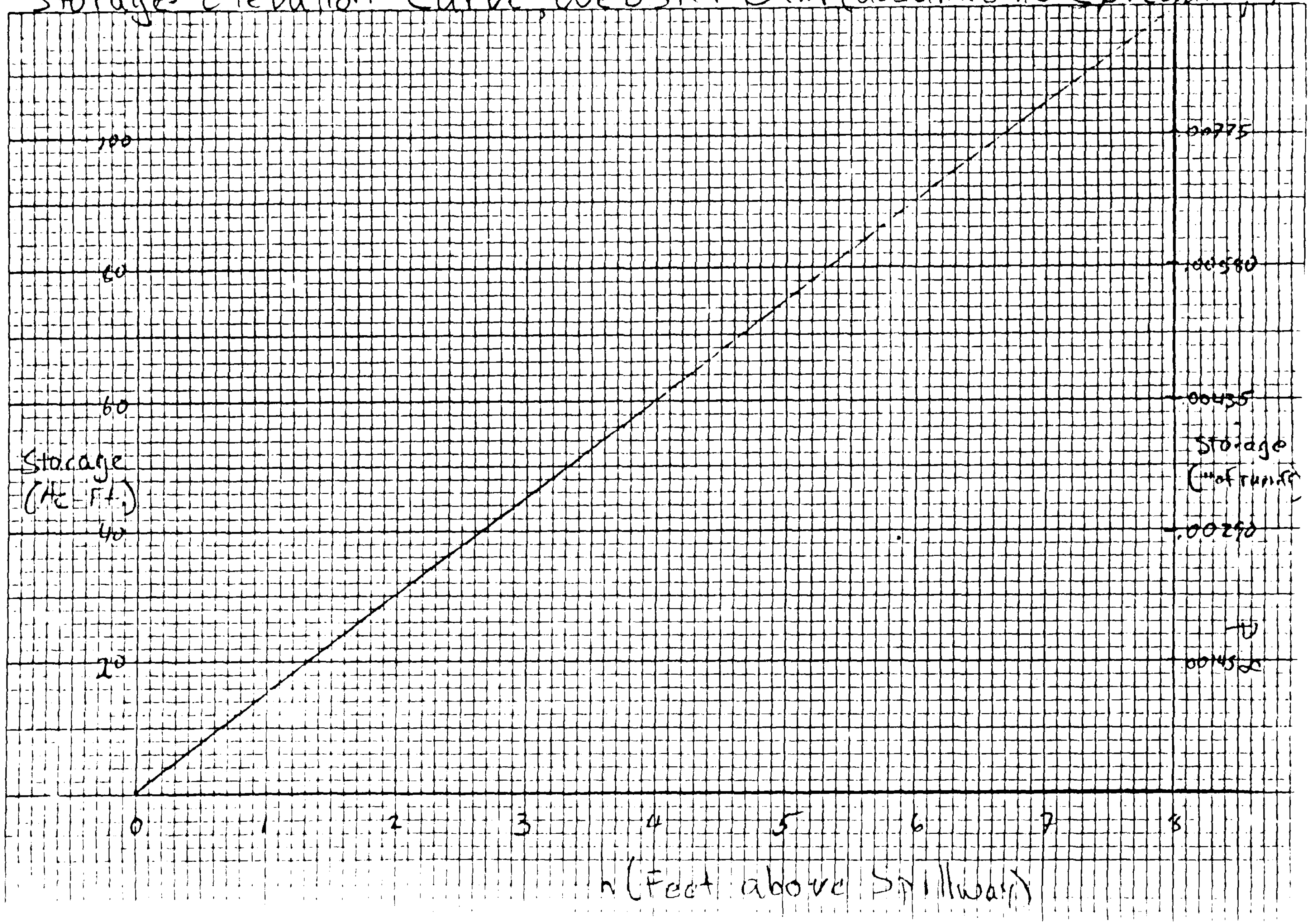
$$\rightarrow 1'' \, (259 \text{ sq. mi}) \left(\frac{640 \text{ acres}}{\text{sq. mi.}}\right) \left(\frac{1 \text{ ft}}{12''}\right)$$

$= 13813$ Ac-ft.

So 1 Ac ft of storage $= \frac{1}{13813} = .000072''$.

1' of rise in the pond stores .00108 inches of rain

Storage- Elevation Curve, Webster Dam (assumes no spreading)



DAM FAILURE ANALYSIS

Assume that the dam fails when the water surface elevation reaches the crest on the right side, at h=7.2 (elevation 280.2). From the stage-discharge curve, this would require a discharge of about 11,500 cfs.

Peak failure outflow = normal outflow + breach outflow

Normal outflow = 11,100 cfs.

$$\text{Breach outflow} = Q_{p1} = \frac{8}{27} W_b \sqrt{g} (y_o)^{3/2}$$

y_o = height of water surface above tailwater. A plot of Discharge vs. elevation of the tailwater (from ANCO FIS HEC-2 runs) is given on p. 10.

The tailwater at a flow of 11,100 cfs is = 270.9

So, y_o = 280.2 - 270.9 = 9.3'

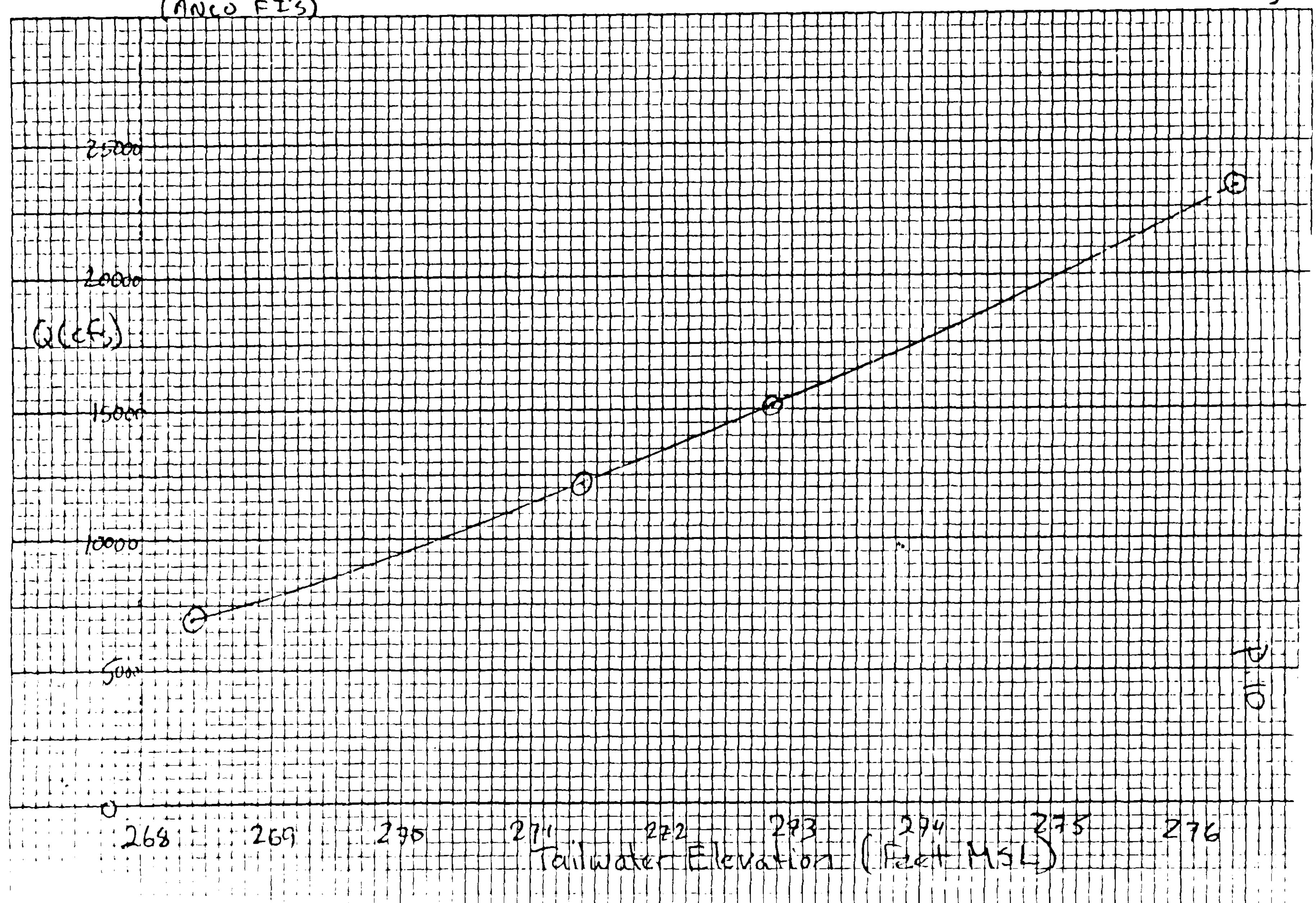
$W_b \le .4(154) = 60$

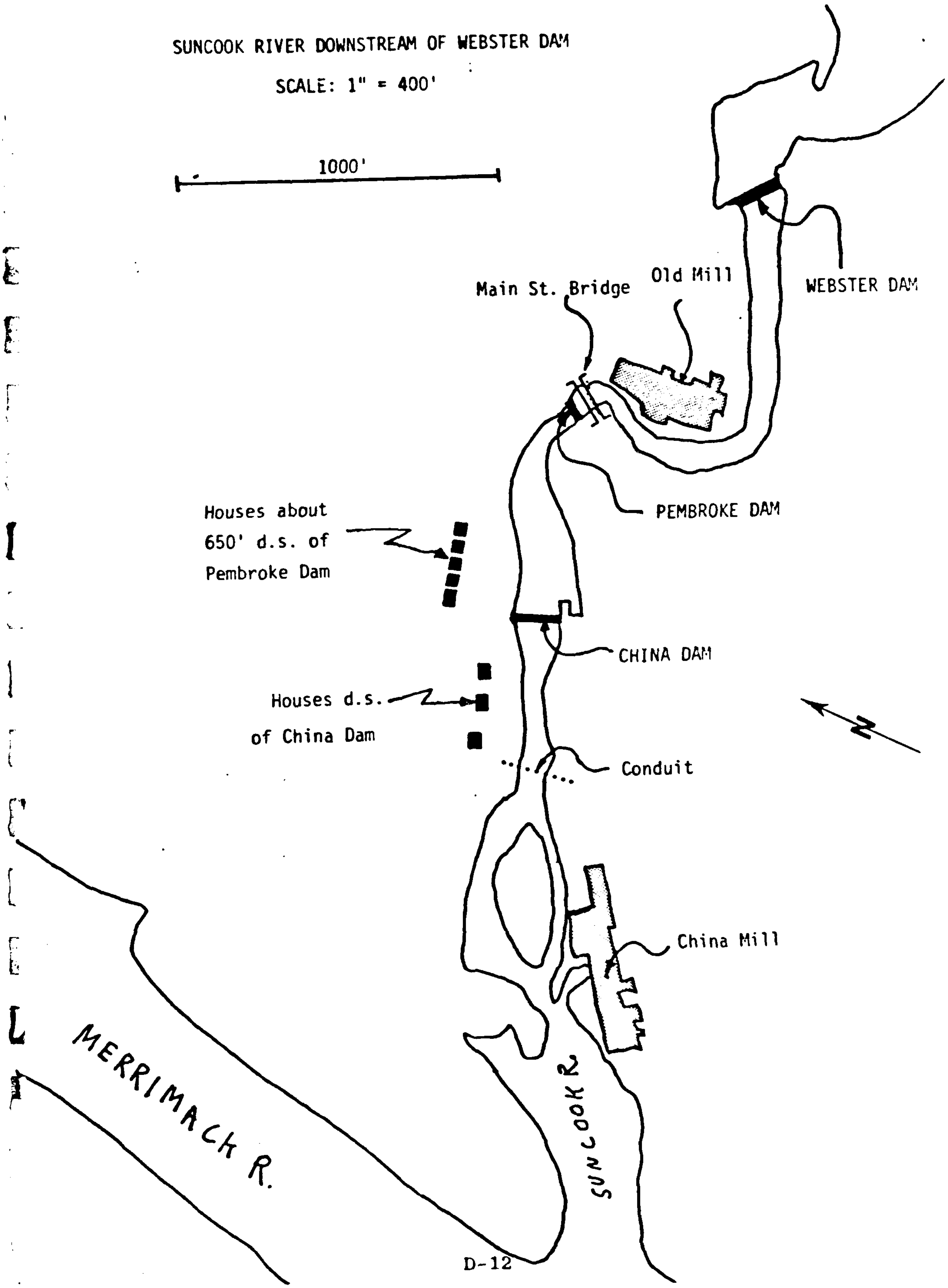
$$Q_{p1} = \frac{8}{27}(60)\sqrt{32.2}\,(9.3)^{3/2} \cong 2900 \text{ cfs}$$

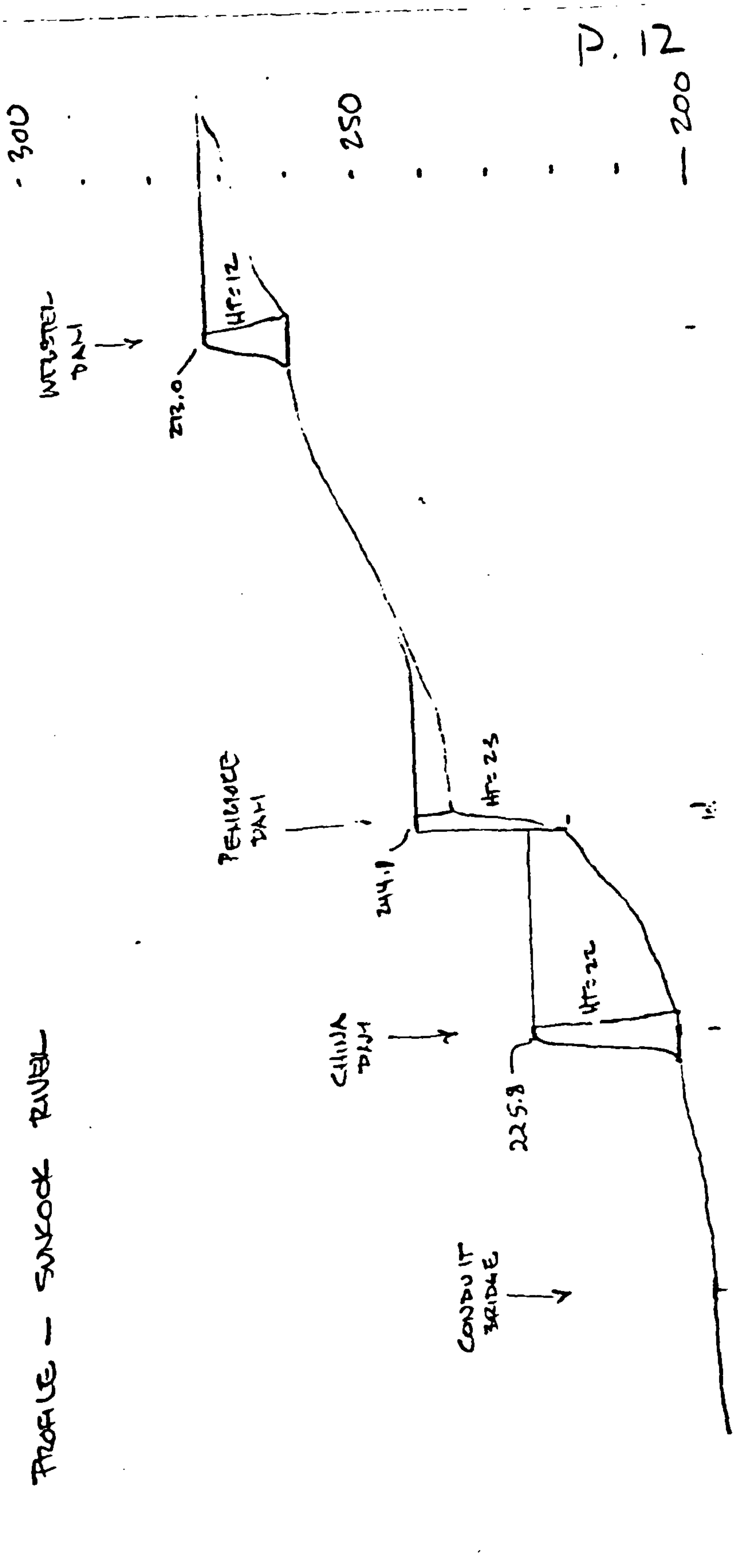
→ Peak failure outflow = 14000 cfs.

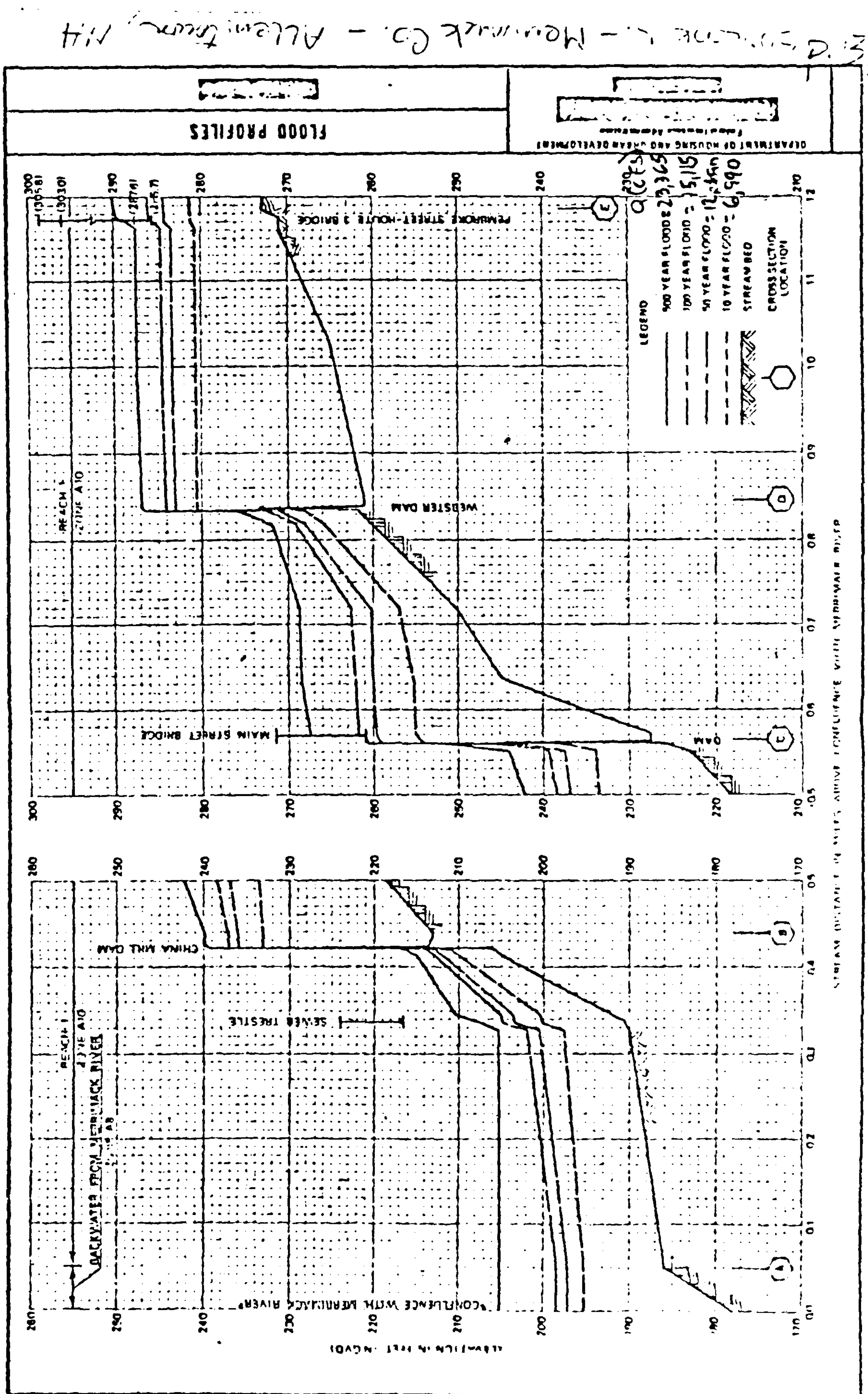
The path of the Suncook River below Webster Dam is shown on p. 11. The river runs through a heavily developed area in Suncook, New Hampshire. Page 12 is a schematic profile, and p. 13 is ANCO FIS work, showing 10, 50, 100, & 500 year water surface elevations. Due to limited downst. storage, we will assume negligible attenuation of this peak discharge.

Discharge Vs. tailwater elevation, Webster Dam (1 Foot downstream of dam)
(ANCO FIS)




SUNCOOK RIVER DOWNSTREAM OF WEBSTER DAM
SCALE: 1" = 400'
1000'
Old Mill
Main St. Bridge
WEBSTER DAM
PEMBROKE DAM
Houses about
650' d.s. of
Pembroke Dam
CHINA DAM
Houses d.s.
of China Dam
Conduit
N
China Mill
MERRIMACK R.
SUNCOOK R.


P. 12
300
250
200
WEBSTER DAM
HT=12
273.0
PEMBROKE DAM
HT=23
244.1
CHINA DAM
HT=22
225.8
CONDUIT BRIDGE
PROFILE — SUNCOOK RIVER



FLOOD PROFILES
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration
PEMBROKE STREET-ROUTE 3 BRIDGE
WEBSTER DAM
MAIN STREET BRIDGE
DAM
CHINA MILL DAM
SEWER TRESTLE
"CONFLUENCE WITH MERRIMACK RIVER"
BACKWATER FROM MERRIMACK RIVER
REACH 1
ZONE A10
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
Q (cfs)
23,365
15,115
12,35n
6,990
ELEVATION IN FEET (NGVD)
STREAM DISTANCE IN MILES ABOVE CONFLUENCE WITH MERRIMACK RIVER

The sudden increase in outflow at failure would raise the tailwater 1.4', from 270.9 to 272.3'. There is no damage potential immediately downstream of the dam due to high banks and lack of development.

There is an old mill building about 1000' downstream of Webster Dam and about 400' upstream of the Main St. bridge. The Discharge-Elevation curve for the Suncook at this (from ANCO) factory is on p.15. The factory is at elevation 255 (approximately).

Prior to failure, the flow of 11,100 cfs generates a water surface elevation of 259.1 → 4.1' of flooding.

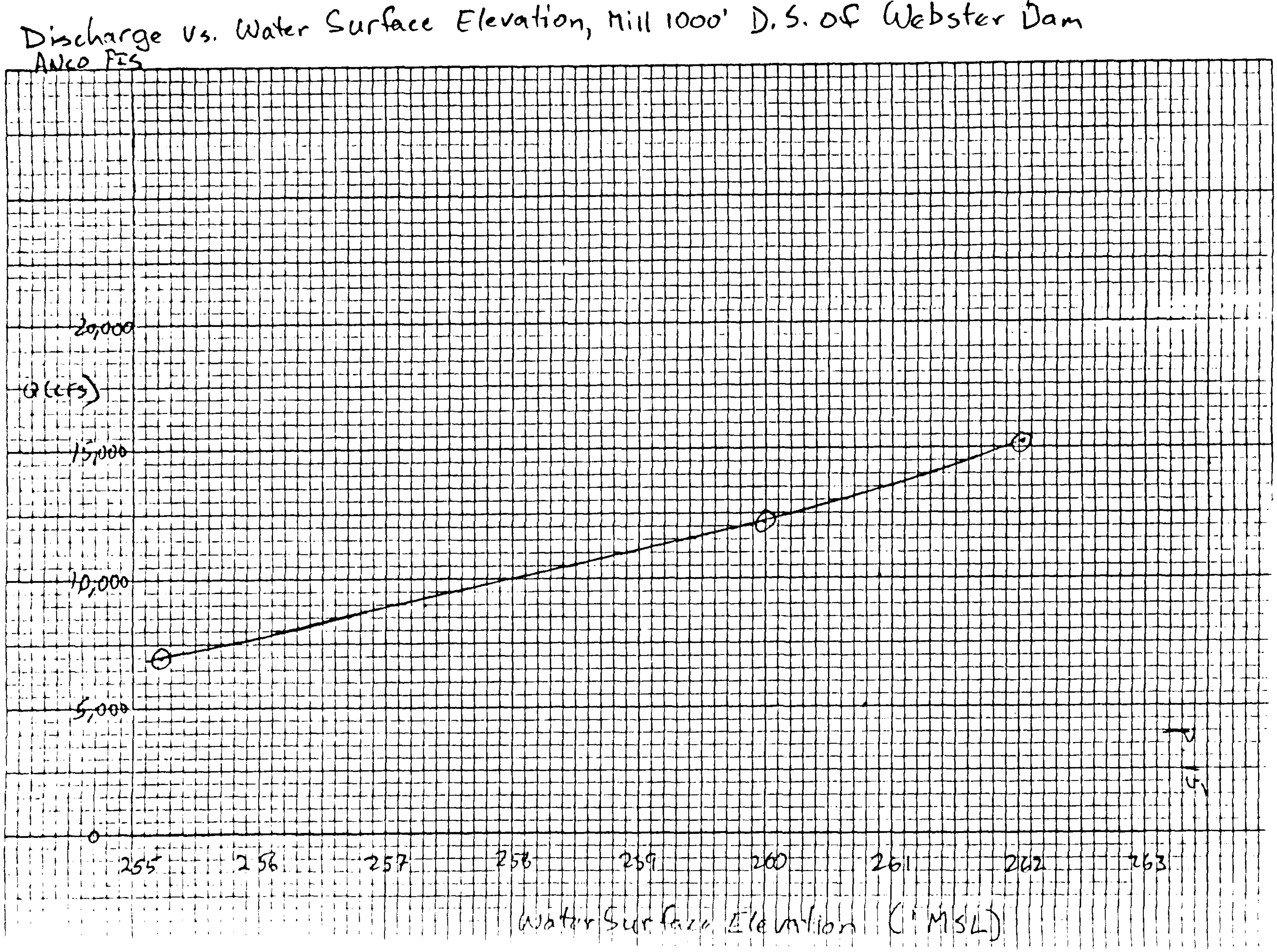
After failure, flow of 14,000 cfs generates w.s.e. of 261.3 → 6.3' of flooding → a rise of 2.2'. This rise is sufficient to increase the damage at the factory, perhaps significantly.

The next location which might be affected by dam failure is the Main Street bridge. The Discharge-Elevation curve for the bridge is on p.16 (from Anco FIS Data).

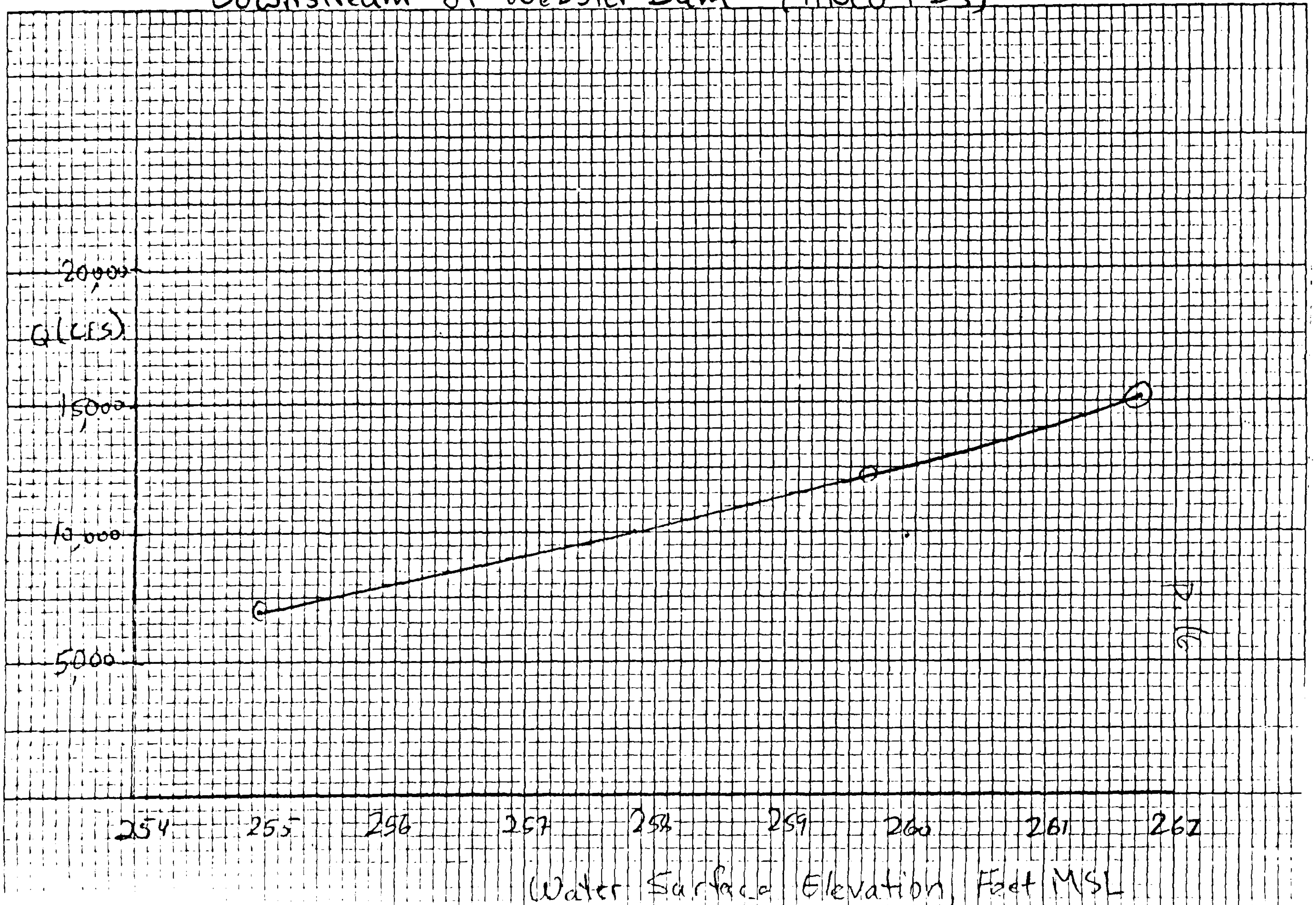
Before failure: 11,100 cfs → 258.8'

After failure: 14,000 cfs → 261.0', 1' above the low chord, a rise of 2.1'. This rise might increase damage to the bridge.

The next center of potential Damage is the Pembroke Dam. A BASIC program to calculate the Stage-Discharge curve at Pembroke Dam is given on pp. 17-19. This program is documented in the Pembroke Dam Report.


Discharge Vs. Water Surface Elevation, Mill 1000' D.S. of Webster Dam
Anco FIS
Q (cfs)
20,000
15,000
10,000
5,000
0
255
256
257
258
259
260
261
262
263
Water Surface Elevation (' MSL)

Discharge Versus Water Surface Elevation at the Main Street Bridge, 1400' Downstream of Webster Dam (ANCO FIS)



```
LIST
100 REM: STAGE DISCHARGE PROGRAM FOR PEMBROKE DAM, JOB 165
110 REM: ON TAPE 10, FILE 59
120 C1=1
130 PAGE
140 PRINT "DISCHARGE FROM PEMBROKE DAM AS A FUNCTION OF HEAD"
150 PRINT USING 160:
160 IMAGE /  2T"HEAD"30T"DISCHARGE"
170 PRINT USING 180:
180 IMAGE 1T"(FEET)"32T"(CFS)"
190 PRINT USING 200:
200 IMAGE 15T"C1"5X"TOTAL"5X"LEFT BANK"5X"RIGHT BANK"5X "SPILLWAY"
210 FOR H=0 TO 14.5 STEP 0.5
220 Q1=0
230 Q2=0
240 Q4=0
250 Q5=0
260 Q3=3*77*H↑1.5
270 IF H<=4 THEN 350
290 Q2=3*5*(H-4)↑1.5
300 Q4=3*6*(H-4)↑1.5
310 IF H<=7.5 THEN 350
320 Q1=2.8*5*(H-7.5)↑1.5
```

```
460 C2=C1
470 T3=T1+T2+Q3
480 I1=I1+1
490 H1=1/1250*T3+234.44-244.1
500 IF H1>246.53-244.1 THEN 520
510 H1=1/1091*T3+232.68-244.1
520 IF H1<=0 THEN 590
530 H2=H-H1
540 IF H2/H>0.7 THEN 600
550 C1=1.063-0.04096*H/H2
560 Q3=Q3*C1/C2
570 IF I1<15 THEN 450
580 T3=T1+T2+Q3
590 RETURN
600 C1=1
610 RETURN
```

P.19

DISCHARGE FROM PEMBROKE DAM AS A FUNCTION OF HEAD ABOVE SPILLWAY

HEAD (FEET)	C1	DISCHARGE (CFS) TOTAL	LEFT BANK	RIGHT BANK	SPILLWAY
0.00	1.00	0	0	0	0
0.50	1.00	82	0	0	82
1.00	1.00	231	0	0	231
1.50	1.00	424	0	0	424
2.00	1.00	653	0	0	653
2.50	1.00	913	0	0	913
3.00	1.00	1200	0	0	1200
3.50	1.00	1513	0	0	1513
4.00	1.00	1848	0	0	1848
4.50	1.00	2217	5	6	2205
5.00	1.00	2616	15	18	2583
5.50	1.00	3040	28	33	2980
6.00	1.00	3438	42	51	3395
6.50	1.00	3959	59	71	3828
7.00	1.00	4450	78	94	4278
7.50	1.00	4961	98	118	4745
8.00	1.00	5505	125	153	5227
8.50	1.00	6079	157	197	5725
9.00	1.00	6678	193	248	6237
9.50	1.00	7300	233	303	6764
10.00	1.00	7945	276	364	7305
10.50	1.00	8610	321	429	7860
11.00	1.00	9295	369	498	8428
11.50	1.00	10000	420	571	9009
12.00	1.00	10723	473	648	9602
12.50	1.00	11465	528	728	10209
13.00	1.00	12224	586	811	10827
13.50	1.00	13000	645	897	11458
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

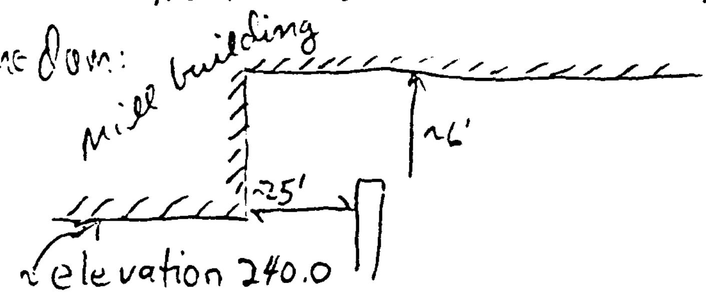
At Pembroke Dam:

Before Webster failure, flow = 11,100 cfs → stage of 12.3' (elevation 256.4, 8.3' over the dam crest)

After Webster failure flow = 14000 cfs → stage of 14.1 (elevation 258.2, 10.1' over the dam crest).

This would increase the danger of failure and the level of flooding at the mill at Pembroke Dam.

The mill at Pembroke runs along the North bank at the Dam:



The section below the dam is not likely to be flooded at our flows of interest.

About 600' downstream of Pembroke Dam there are a number of homes on the north bank of the Suncook, at about elevation 239' above MSL. The discharge-elevation curve at this site is shown on p. 21

The pre-failure outflow of 11,100 cfs would create a water surface elevation of 235.7'. This would increase to 236.8' after failure with the flow of 14,000 cfs. Thus the flow would remain below the houses.

Discharge-Elevation Curve 650' downstream of Pembroke Dam
(ANCO FIS)
P-2
25,000
20,000
15,000
10,000
5,000
0
233
234
235
236
237
238
239
240
241
Elevation above MSL
DIETZGEN GRAPH PAPER
DIETZGEN CORPORATION
MADE IN U.S.A.

China Mill Dam, which is about 750' downstream of Pembroke Dam (2200' downstream of Webster Dam) would also be affected by the failure. The Stage-Discharge curve is calculated & shown on pp. 23-24.

Before failure: 11,100 cfs → 7.6' (.6' above dam crest)

After failure: 14,000 cfs → 8.7 (1.7' above dam crest)

Below China Mill are several houses on the north bank (@ elevation 216 MSL) and a mill on the south bank. These structures are at a high enough elevation to escape significant damage from flooding. About 2250' below China Mill Dam the Suncook enters the Merrimack River.

One other hazard-creating possibility is that failure of Webster Dam could cause failure at Pembroke Dam. This event would not seriously threaten the houses 650' downstream of Pembroke Dam. The joint failure flow of ~16,500 cfs would generate a water surface of 237.7', more than a foot below the houses.

P.23

```
LIST
100 REM: STAGE DISCHARGE PROGRAM FOR PEMBROKE CHINA DAM, JOB 165
110 REM: ON TAPE 10, FILE 60
120 PAGE
130 PRINT "DISCHARGE FROM CHINA DAM AS A FUNCTION OF HEAD"
140 PRINT USING 150:
150 IMAGE // 2T"HEAD"30T"DISCHARGE"
160 PRINT USING 170:
170 IMAGE 1T"(FEET)"32T"(CFS)"
180 PRINT USING 190:
190 IMAGE 15T"TOTAL"8X"LEFT BANK"8X"RIGHT BANK"8X "SPILLWAY"
200 FOR H=0 TO 13 STEP 0.5
210 Q1=0
220 Q2=0
230 Q4=0
240 Q5=0
250 Q3=3.7*143*H↑1.5
260 IF H<=7 THEN 320
270 Q2=2.5*37*(H-7)↑1.5
280 Q4=3.3*30*(H-7)↑1.5
290 Q5=2.8*20*(H-7)*(0.5*(H-7))↑1.5
300 IF H<=9 THEN 320
310 Q1=2.8*10*(H-9)*(0.5*(H-9))↑1.5
320 T1=Q1+Q2
330 T2=Q5+Q4
340 T3=T1+T2+Q3
350 PRINT USING 360:H,T3,T1,T2,Q3
360 IMAGE 2T,2D.1D,14D,15D,18D,17D
370 NEXT H
380 END
```

P.24

DISCHARGE FROM CHINA DAM AS A FUNCTION OF HEAD

HEAD (FEET)	DISCHARGE (CFS) TOTAL	LEFT BANK	RIGHT BANK	SPILLWAY
0.0	0	0	0	0
0.5	187	0	0	187
1.0	529	0	0	529
1.5	972	0	0	972
2.0	1497	0	0	1497
2.5	2091	0	0	2091
3.0	2749	0	0	2749
3.5	3464	0	0	3464
4.0	4233	0	0	4233
4.5	5051	0	0	5051
5.0	5916	0	0	5916
5.5	6825	0	0	6825
6.0	7776	0	0	7776
6.5	8768	0	0	8768
7.0	9799	0	0	9799
7.5	10939	33	39	10868
8.0	12183	93	119	11972
8.5	13518	170	236	13112
9.0	14939	262	392	14286
9.5	16447	367	587	15493
10.0	18045	491	823	16732
10.5	19737	633	1102	18002
11.0	21525	796	1426	19303
11.5	23410	981	1796	29634
12.0	25396	1188	2214	21994
12.5	27485	1420	2682	23383
13.0	29677	1676	3201	24800

Test Flood Analysis

SIZE CLASSIFICATION = SMALL

HAZARD CLASSIFICATION = Significant.

The hazard classification is significant because of the potential for heavy damage to the mill 650' downstream of Webster Dam, to Pembroke Dam, and to the mill at Pembroke Dam. Although the potential for loss of life due to dam failure is small, heavy economic losses could result.

Test Flood:

100 year to 1/2 PMF.

The 1/2 PMF flood is often considered to be equivalent to the 500 year flood. Anco's FIS work produced 100 & 500 year flows of 15,115 cfs and 23,365 cfs respectively.

Since the hazard is on the low side of significant, we will use 15,115 cfs.

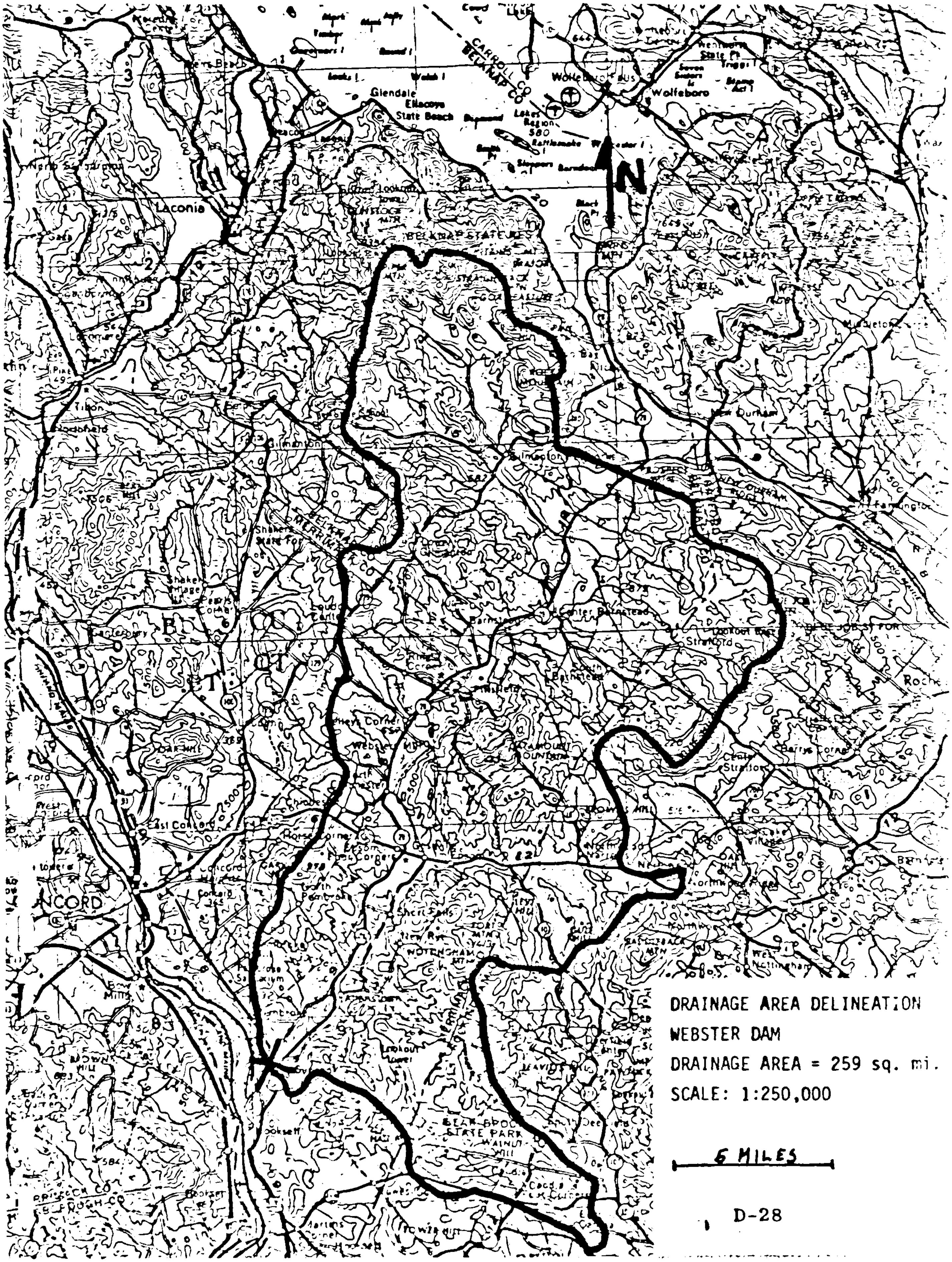
Due to the large drainage area and small available storage, this flow would not be significantly attenuated by the pond behind Webster Dam (D.A. map p. 26, storage curve

The flow of 15,115 cfs would produce a stage of about 8.5 feet (elevation 281.5). This is 1.3 above the right abutment and .8' above the left.

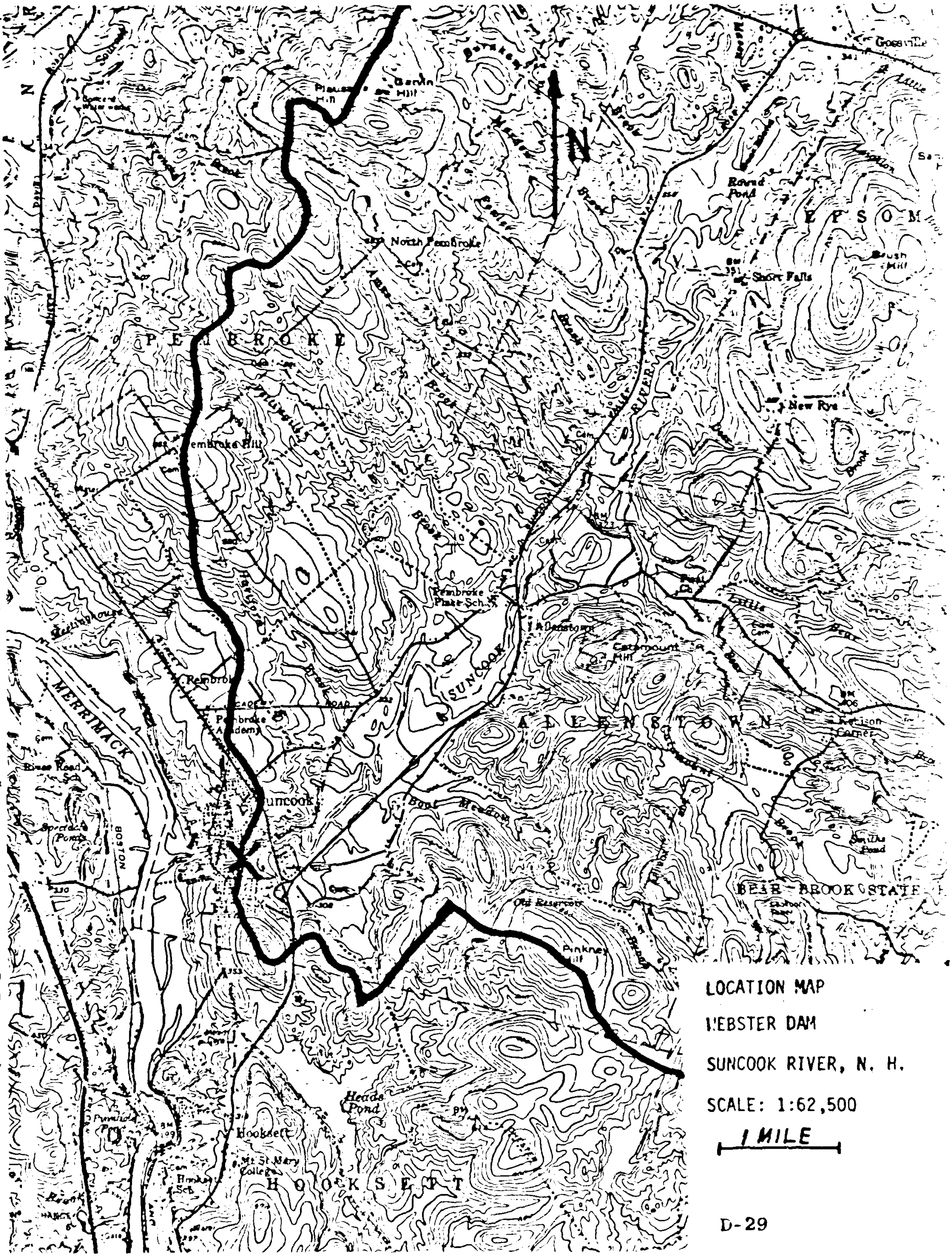
failure flow at low flows:

$h = 12'$ $\quad W_b = .4(154) = 60$

$Q_{p_1} = 8/27\,(60)\sqrt{32.2}\,(12)^{3/2} = 4200$ cfs



DRAINAGE AREA DELINEATION
WEBSTER DAM
DRAINAGE AREA = 259 sq. mi.
SCALE: 1:250,000



LOCATION MAP

WEBSTER DAM

SUNCOOK RIVER, N. H.

SCALE: 1:62,500

1 MILE

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
NH	378	NED	NH	013	02				WEBSTER DAM	4307.7	7127.1	13MAR79

POPULAR NAME	NAME OF IMPOUNDMENT

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	05	SUNCOOK RIVER	PEMBROKE	0	

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
PGRECT	1917	0	18	18	165	60	NED	N	N	N	N	13MAR79

REMARKS
22-GATEHOUSE 1923 23-NONE

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	250	U	154	11100												

OWNER	ENGINEERING BY	CONSTRUCTION BY
THOMAS HODGSON AND SONS	ARTHUR T SAFFORD	H P CUMMINGS CONST CO

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

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
GOLDBERG ZOINO DUNNICLIFF ASSOC	07NOV78	PUBLIC LAW 92-367

REMARKS

END