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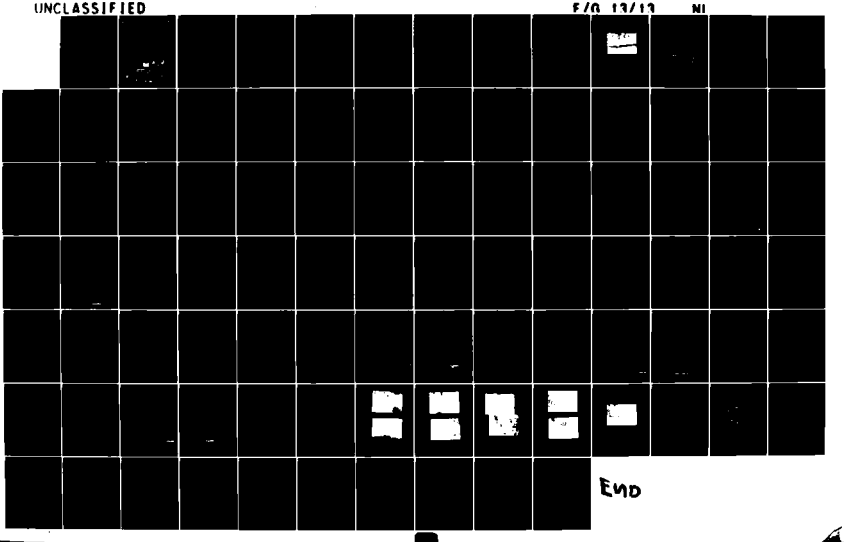

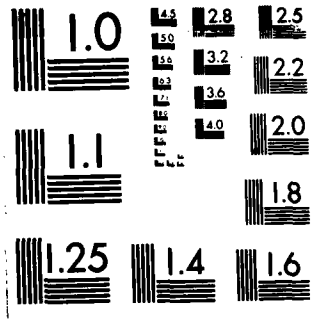

PISCATAQUA RIVER BASIN
NOTTINGHAM, NEW HAMPSHIRE

MENDUMS POND DAM
NH 00133

STATE NO 184.01

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

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

DAMS, INSPECTION, DAM SAFETY,

Piscataqua River Basin
Nottingham, New Hampshire
Little River

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

The dam is 31 ft.high and 440 ft. long. It is an earthen embnakment placed between vertical dry masonry walls, spans the upper reach of the Little River, and is located in the east central New Hampshire. The dam is in fair condition. Based on size and hazard classifiactions in accordance with Corps guidelines, the test flood is the PMF. A major breach at maximum pool would probably result in the loss of less than 10 lives and appreciable property damage.

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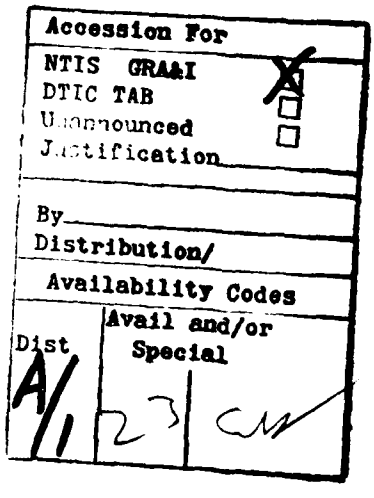
MENDUMS POND DAM

NH 00133

PISCATAQUA RIVER BASIN
NOTTINGHAM, NEW HAMPSHIRE



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION REPORT
PHASE I INSPECTION REPORT

Identification No.:	NH00133
Name of Dam:	Mendums Pond Dam
Town:	Nottingham
County and State:	Rockingham County, New Hampshire
Stream:	Little River
Date of Inspection:	6 June 1978

BRIEF ASSESSMENT

Mendums Pond Dam is 31 feet high, averages about 36 feet wide, and is 440 feet long. It is an earthen embankment placed between vertical dry masonry walls, spans the upper reach of the Little River, and is located in east central New Hampshire. It has three low-level outlet gates at two elevations and an ungated spillway. Maximum storage capacity is about 3,330 acre-feet. Mendums Pond is used for recreational purposes. The pond is 1.5 miles in length with a surface area of more than 200 acres.

The dam is in fair condition. Leakage around the gates and from the open joints of the stone masonry walls in the control shaft is estimated to be about 2 cfs. Seepages at the downstream toe of the dam on both sides of the gatehouse are discharging about 0.02 cfs of clear water. Minor settlements were noted in the earth crest and a subsidence was noted in the upstream dry masonry wall 75 feet northwest of the gatehouse.

Based on size and hazard classifications in accordance with Corps guidelines, the test flood is the Probable Maximum Flood. A PMF outflow of 3825 cfs (708 csm) would overtop the dam by 2 feet; therefore the spillway is considered inadequate. The uncontrolled spillway weir will pass 1010 cfs, or about 26 percent of the test flood outflow. A major breach at maximum pool would probably result in the loss of less than 10 lives and appreciable property damage.

The owner, New Hampshire Water Resources Board, should implement the results of the recommendations given in Section 7.2. within two years after receipt of this Phase I Report. The operating and maintenance measures recommended in Subsection 7.3.b. should be implemented within one year after receipt of this Phase I Report.

Warren A. Guinan

Warren A. Guinan
Project Manager
N.H. P.E. No. 2339

This Phase I Inspection Report on Mendums Pond 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.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL COOPER, Member
Chief, 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 (OCE), 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 test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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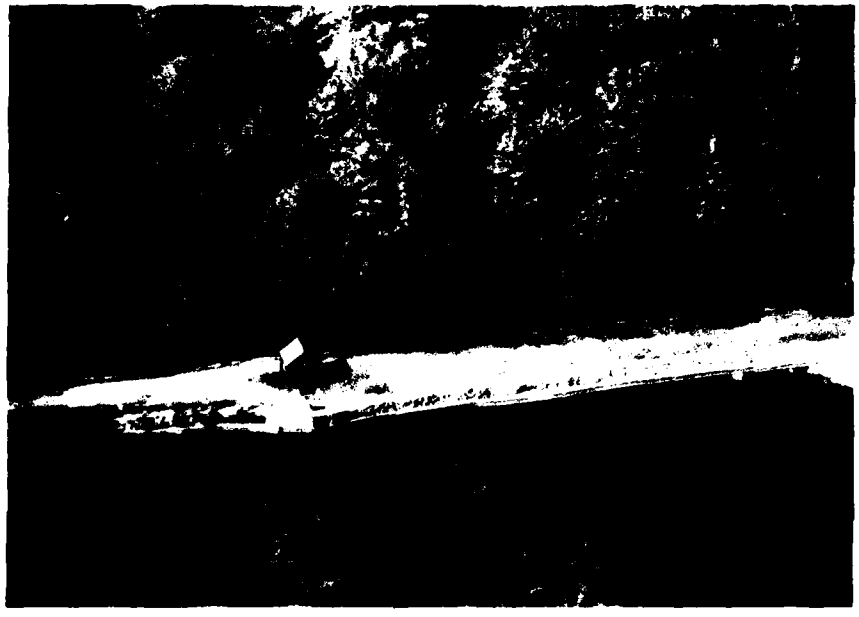
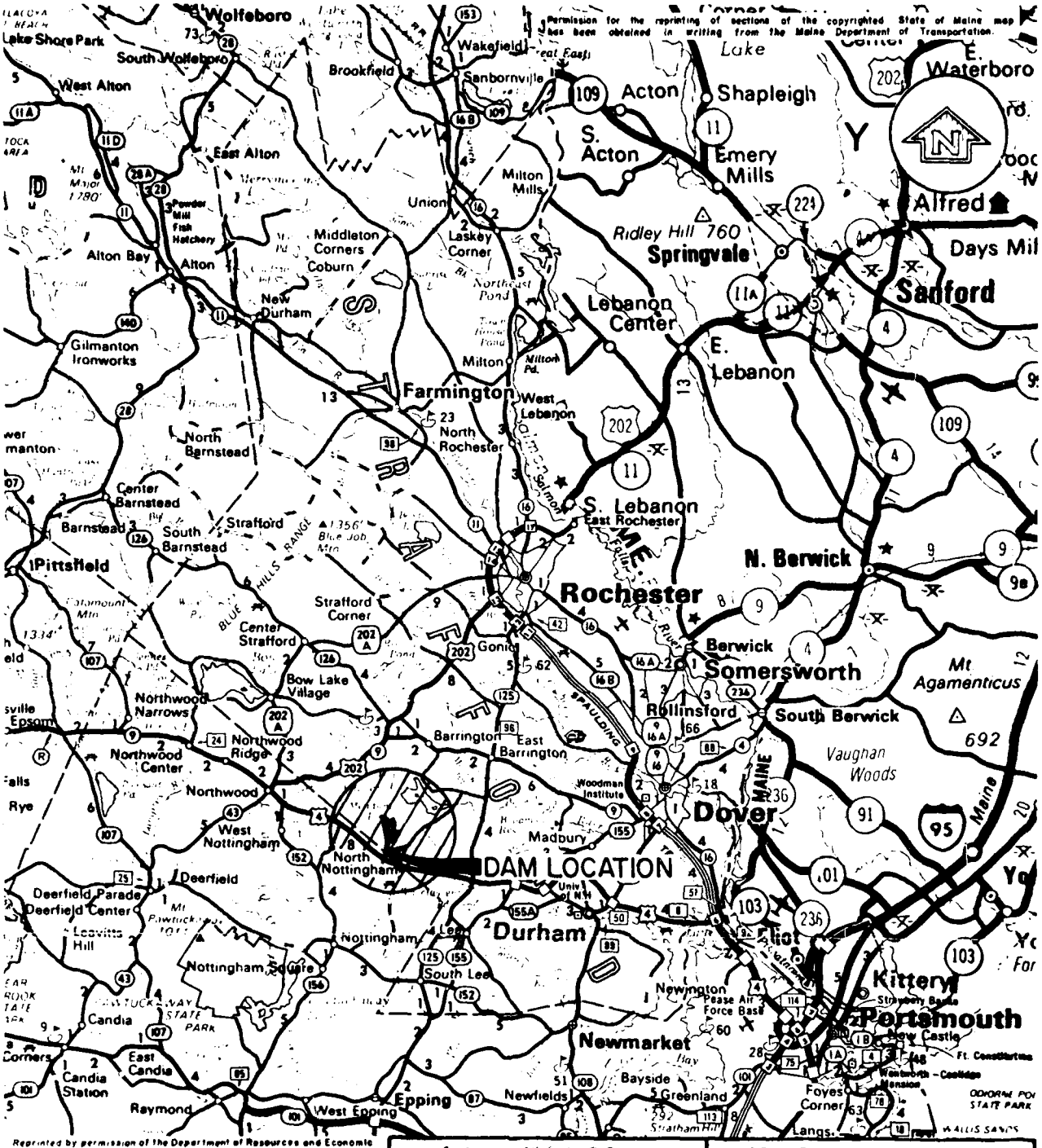


Figure 1 - Overview of Mendums Pond Dam.



SCALE IN MILES

5 0 5

MAP BASED ON STATE OF NEW HAMPSHIRE-STATE OF MAINE OFFICIAL HIGHWAY MAPS.

Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

MENDUMS POND DAM
LOCATION MAP

MENDUMS POND **NEW HAMPSHIRE**

			SCALE: 1" = 5 Mi.
			DATE: AUGUST 1978

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
MENDUMS POND 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. Anderson-Nichols & Company, 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 Anderson-Nichols under a letter of May 3, 1978 from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0329 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. Mendums Pond is located in both the Towns of Barrington and Nottingham, New Hampshire. Mendums Pond Dam spans the headwaters of Little River which flows southeasterly for a distance approximately 7 miles to its confluence with the Lamprey River. Mendums Pond Dam is shown on the U.S.G.S. Quadrangle, Mt. Pawtuckaway, New Hampshire with coordinates approximately at N 43° 08' 00", W 71° 04' 54", Nottingham, Rockingham County, New Hampshire. (See Location Map vii.)

b. Description of Dam and Appurtenances. Mendums Pond Dam is an earthen embankment placed between upstream and downstream vertical dry masonry walls. The dam is about 440 feet in length, ranges from 24 to 49 feet in width, and is 31 feet in height. It has three mechanically operated gates. The lowest level sluiceway has a wooden gate 2' H x 4' W; 14 feet above its invert are two smaller wooden gates 1.8' H x 1.5' W with the same invert elevation. Each gate has its own operating mechanism. An uncontrolled overflow spillway has been constructed near the right northwest abutment. The spillway is a reinforced concrete weir 25 feet long, 1½ feet wide at the crest, about 2 feet wide at its base and about 2 feet high.

c. Size Classification. Intermediate (Hydraulic height - 29 feet; Storage - 3,330 acre-feet) based on storage ($\geq$ 1000 to $<$ 50,000 acre-feet) as given in OCE Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant hazard. A major breach would probably result in the loss of less than 10 lives and appreciable property damage.

e. Ownership. Mendums Pond Dam was originally constructed about 1840 by the Newmarket Manufacturing Company. On March 13, 1916 the Lamprey River Improvement Company, a subsidiary of the N.H. Gas & Electric Company, acquired all titles and rights to Mendums Pond Dam. The N.H. Gas & Electric Company took over ownership October 28, 1945. The dam, land, and water rights were transferred to the State of New Hampshire for one dollar on December 28, 1955.

f. Operator. Mr. Vernon K. Knowlton, Chief Engineer, New Hampshire Water Resources Board (NHWRB), 37 Pleasant Street, Concord, New Hampshire 03301 is repsonsible for the operation of Mendums Pond Dam. Phone (603) 271-3406.

g. Purpose of Dam. Originally under the ownership of Newmarket Manufacturing, Mendums Pond Dam conserved water for a hydroelectric plant at Newmarket, New Hampshire. This remained its primary use until the State of New Hampshire purchased the dam in 1955. Since then the dam and lake have been in use for recreational purposes only.

h. Design and Construction History. Little information was revealed concerning the original design and construction of the dam. The dam was originally built at its present location about 1840. In 1919 or 1920, three tie rods were placed about eight feet below the crest, two on the northwest and one on the southeast of the low-level control works to check bulging. The southeast downstream sloping buttress was probably placed at this time by the Lamprey River Improvement

a. Evaluate further the potential for overtopping and inadequacy of the spillway discharge capacity.

b. Design remedial measures needed to eliminate the seepage downstream of the dam and leaking into the control shaft of the low-level outlet.

7.3 Remedial Measures

a. Alternatives. The NHWRB should, as a practical alternative pending implementation of the above recommendations, operate the reservoir at lower levels so as to provide more storage for extreme flood events. The NHWRB could purchase downstream land that would be adversely impacted by dam failure and restrict human occupancy.

b. Operating and Maintenance Procedures.

(1) Monitor on a weekly basis seepage and leakage at the toe of the dam and control shaft, respectively.

(2) Repair the subsided portion of upstream dry masonry wall, backfill with earth, and reseed.

(3) Fill in depression on earth crest with topsoil and reseed.

(4) Seal the cracks in the upstream concrete facing.

(5) Clear trees and brush from an area about 50 feet downstream of the dam.

(6) Clear debris from downstream channel of overflow weir.

(7) Repair or replace the outlet gates to permit operation and proper reseating and sealing under all headwater and tailwater conditions.

(8) The New Hampshire Water Resources Board should develop a written operational procedure to follow in the event of floodflow conditions or imminent dam failure. This procedure should include round-the-clock surveillance and a warning system. The warning system should also be included in the written procedure of "Project Linkup", a disaster plan involving Civil Defense (as coordinator), state agencies, and town officials. "Project Linkup", at this time, is in draft form awaiting the Governor's approval.

(9) Continue periodic inspection systems on a bi-annual frequency.

SECTION 7
ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection indicates Mendums Pond Dam is in fair condition. The major concerns that may affect the long-term integrity of the dam are:

(1) Potential for overtopping;

(2) Substantial leakage through the dry masonry walls of the low-level outlet control shaft;

(3) Seepages at two locations at the downstream toe of the dam;

(4) Settlements of numerous areas of the earth crest; and

(5) Subsidence of upstream dry masonry wall approximately 75 feet northwest of the gatehouse.

b. Adequacy of Information. The information available is such that the assessment of the dam must be based primarily on the visual inspection.

c. Urgency. The recommendations enumerated in Section 7.2 below should be implemented by the owner within 2 years after receipt of this Phase I Report. The operational and maintenance procedures enumerated in Section 7.3.b. below should be implemented by the owner within one year after receipt of this Phase I Report.

d. Need for Additional Investigation. The information available from the visual inspection is adequate to identify the potential problems which are: overtopping, seepage, and leakage into the control shaft of the gates. These problems require the attention of a competent engineer who will have to make additional engineering studies to design or specify remedial measures to rectify the problems. If left unattended, the problem could lead to instability of the structure.

7.2 Recommendations

It is recommended that the New Hampshire Water Resources Board should accomplish the remedial measures resulting from the following:

c. Operating Records. No records were disclosed pertinent to the structural stability of the dam except that of H. D. Dunham's report recommending the installation of three tie rods "....at a depth of about eight feet from the surface to check further outward movement at points where the overhang or bulging amount to 12 or 14 inches."

d. Post-Construction Changes. Known post-construction changes to the dam are as follows:

(1) Installation of 3 steel tie rods and probably the left sloping rock buttress subsequent to 1918;

(2) In 1958-59, the gate section was extensively repaired and faced with concrete, including the addition of reinforced concrete supports in the downstream face of the the low-level control shaft;

(3) In 1963, a concrete weir was built on the natural spillway at the northwest end of the dam; and

(4) In 1977, the southeast side of the dam was refaced.

e. Seismic Stability. This dam is in Seismic Zone 2 and hence does not have to be evaluated for seismic stability according to OCE Recommended Guidelines.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The visual inspection revealed the following evidence of possible stability problems:

(1) Substantial leakage through the dry masonry wall at the outlet gate control shaft;

(2) Seepage at two locations at the downstream toe of the dam;

(3) Settlement of numerous areas at the crest of the dam;

(4) Subsidence of upstream dry masonry wall approximately 75 feet northwest of the gatehouse; and

(5) Shift in the downstream vertical dry masonry wall southeast side, near the portal of the control shaft.

Items (3) and (4) in the above list may be the result of large leakage that was mentioned in reports dated 1919, 1940, and 1970. Repairs have been made to the dam at several times (including 1958, 1962, and 1963). It cannot be determined on the basis of this visual inspection and the available data whether the repairs have eliminated the conditions that led to the settlements mentioned in Items (3) and (4).

Although a definite shift (Item (5) above) of about 6 inches along a nearly vertical plane has occurred in the downstream southeast face of the vertical dry masonry wall, the reinforced concrete frame that now forms the outlet portal, placed in 1958-59, seems to have stabilized this problem. No similar shift was noted on the northwest side. One or more of the old granite struts may have broken causing this shift.

Minor cracking in the upstream concrete facing does not pose an immediate stability problem, but could lead to future problems if it is not repaired.

b. Design and Construction Data. No design and construction data were disclosed for the original dam. Some drawings relating to various repairs to the dam are available, but the visual inspection indicates that the repairs were not made in strict conformance with these drawings.

SECTION 5
HYDROLOGY AND HYDRAULIC ANALYSIS

5.1 Evaluation of Features

a. Design Data. No hydrologic or hydraulic design data were disclosed for Mendums Pond Dam.

b. Experience Data. No information regarding past overtopping was disclosed.

c. Visual Observations. At the time of inspection, no visual evidence was noted of damage to the structure caused by overtopping.

d. Overtopping Potential. Mendums Pond Dam is classified as being intermediate in size having a maximum storage of 3,330 acre-feet. The normal recreation level has a surface area of 209 acres, which is equivalent to 6 percent of the watershed.

To determine the hazard classification for Mendums Pond Dam, the impact of failure of the dam at maximum pool was assessed using Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers. The analysis covered the reach from the dam to U.S. Route 4, a distance of about 0.35 mile. Failure of Mendums Pond Dam at maximum pool would probably result in an increase in stage of approximately 15 feet along the reach. An increase in water depth of this magnitude would probably sever U.S. Route 4 and result in the loss of less than 10 lives and appreciable property damage. Immediately upstream and downstream of U.S. Route 4 is a large wetland area that would serve to attenuate considerably the effects of the flooding.

As a result of the analysis described above, Mendums Pond Dam was classified - Significant Hazard. Using OCE Recommended Guidelines for Safety Inspection of Dams, the recommended test flood is the Probable Maximum Flood. The test flood inflow for Mendums Pond Dam, having a drainage area of 5.4 square miles, was determined to be 4345 cfs (805 csm). The test flood discharge after routing was determined to be 3825 cfs (708 csm).

Mendums Pond Dam is unable to pass the test flood without overtopping. The water depth over the dam embankment was calculated to be 2 feet. Neither will the dam pass one-half the test flood without overtopping. The water depth over the dam during one-half the test flood was calculated to be 1.1 feet. The spillway capacity is only about 26 percent of the test flood discharge.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

The New Hampshire Water Resources Board (NHWRB) has operated Mendums Pond Dam since 1955. The lake level is maintained by the uncontrolled overflow spillway located at the northwest end of the dam. In the fall, drawdown is accomplished by the opening of the three gates to provide spring freshet storage.

4.2 Maintenance of Dam

Mendums Pond Dam is maintained by the NHWRB.

4.3 Maintenance of Operating Facilities

Throughout the year, the dam is visited on a weekly basis by the NHWRB. The NHWRB would not permit inspection of gate operating mechanisms, nor operate the gates at this season of the year. They reported that if the gates were lifted, it would not be possible to lower and reseat and achieve a complete seal. Presumably, reseating is not possible because of water pressure and condition of the timber gates. Therefore, the gate condition and operation was not verified during the inspection. The control shaft has been improved by the extensive concrete work done over a period of years by the NHWRB. The gatehouse appeared to be well maintained.

4.4 Description of Any Warning System in Effect

No written warning system was disclosed for Mendums Pond Dam.

4.5 Evaluation

The operation and maintenance procedures for Mendums Pond Dam, consisting of a weekly program of inspection, should insure that all minor problems encountered can be remedied within a reasonable period of time. The NHWRB should also establish a warning system to follow in event of any emergencies.

(southeast) training wall is considered good with only the loss of surface laitance. The visual inspection of the weir indicates that it was constructed on bedrock.

d. Reservoir Area. The watershed above the pond is steeply to gently sloping and is heavily wooded. (See Appendix C - Figure 8.) The area downstream of the dam is gently sloping and heavily wooded. Cottages are located around the perimeter of the lake.

e. Downstream Channel. The bottom of the channel downstream of the low-level outlet is covered with boulders, gravel, and sand. (See Appendix C - Figure 9.) It is generally unobstructed; some trees are growing adjacent to the channel. The channel downstream of the overflow spillway is cut in bedrock and there is a shallow depth of sand, gravel, and boulders on the bottom. (See Appendix C - Figure 7.) One clump of brush is growing in the center of the channel downstream of the overflow weir, and there is brush growing next to the northwest bank of the channel. A few logs were noted in the channel farther downstream. Both the low-level outlet channel and the overflow weir channel merge into a sizeable deep marsh about 700 feet downstream of the dam that extends on downstream about 1,000 feet, nearly to U.S. Route 4.

3.2 Evaluation

The observed condition of the dam is fair. The potential problems observed during the visual inspection are:

(a) Substantial leakage through the dry masonry wall at the outlet gate control shaft (2 cfs);

(b) Seepage at two locations at the downstream toe of the dam (0.02 cfs or 10 gpm);

(c) Settlement of numerous areas of the earth crest;

(d) Potential for overtopping;

(e) Minor cracks in upstream reinforced concrete wall; and

(f) Subsidence of upstream dry masonry wall approximately 75 feet northwest of the gatehouse.

Two areas of seepage were noted near the downstream toe of the dam, one between the southeast abutment and the gatehouse, and the other between the gatehouse and the northwest abutment. The seepage water was clear at the time of the inspection and there was no evidence of piping, boiling, or other instability at either seepage.

Four hairline cracks were noted in the concrete facing on the upstream side of the dam.

A subsidence of the dry masonry wall approximately 12 feet long was noted on the upstream face approximately 75 feet northwest of the gatehouse, creating the lowest point along the length of the upstream face.

c. Appurtenant Structures

(1) Low-level gates. The visual inspection of the low-level gates revealed that substantial leakage is occurring through the stone masonry of the control shaft. Leakage was observed around the perimeter of the gates; however, there was no visible leakage through the gates.

The control shaft has been faced with reinforced concrete wall on the upstream side. A reinforced concrete frame has been added in the downstream face of the control shaft. (See Appendix C - Figure 6.) The gates are located approximately midpoint between the upstream and downstream faces.

The observed leakage was exiting between the open joints in the stone masonry. The majority of the leakage was through the side wall joints near the bottom of the dam and discharging with considerable velocity. The discharge water was clear. The estimated discharge was 2 cfs.

The gates can be raised by mechanical operating mechanisms at the top of the dam. The New Hampshire Water Resources Board would not permit inspection or operation of the gates during the summer recreational season. The control shaft which houses the gates and operating mechanisms are constructed integrally with the dam embankment.

The exterior of the gatehouse was observed to be in fair condition.

(2) Emergency Overflow Spillway. An overflow spillway has been constructed adjacent to the northwest abutment of the dam. The weir is reinforced concrete, 2 feet high, with a 1.5 foot wide crest and is 25 feet long. (See Appendix C - Figure 7.) The condition of the concrete weir and left

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Mendums Pond Dam is a low dam which impounds an intermediate size reservoir. The watershed above the pond is gently to steeply sloping. The downstream area is gently sloping. Cottages are located around the perimeter of the reservoir.

b. Dam. Mendums Pond Dam is an earth embankment with upstream and downstream vertical dry masonry walls. (See Appendix C - Figures 2, 3, and 4.) A concrete facing has been constructed to within about 4 feet of the top of the upstream dry masonry wall. Between the southeast abutment and the gatehouse, which is near the center of the dam, a sloping rock buttress has been placed against the downstream dry masonry wall. This sloping buttress may have been placed subsequent to original construction. From the gatehouse part way to the northeast abutment, a rectangular rock berm has been placed against the downstream dry masonry wall. It has two smaller rectangular buttresses, one at the northwest end, the other near the middle of the berm. The rectangular berm and buttresses appear to be part of the original construction. The crest of the dam is covered with grass.

Located near the center of the dam is a low-level gated shaft with two gates at a higher level. A concrete uncontrolled spillway is located near the northwest abutment.

The dam is 440 feet long, 31 feet high, and 24 to 49 feet wide at the crest. At the time of the inspection the water level in the pond was 7.3 feet below the crest of the dam.

Four grass-covered depressions several feet wide and up to 12 inches deep that may be caused by settlement were noted on the crest of the dam next to the downstream dry masonry wall. Similar depressions were noted in a 1935 inspection report, but it is not known whether the depressions that now exist are the same ones that were observed in 1935.

The top of the downstream dry masonry wall bow 4½ feet downstream from a straight line between the southeast abutment and the gatehouse. Three tie rods through the upstream and downstream faces of the dam, about 8 feet below the crest, were noted. (See Appendix C - Figure 5.) The installation of these tie rods was recommended in a report by H. F. Dunham dated December 5, 1918, but it is not known when the tie rods were actually installed.

SECTION 2
ENGINEERING DATA

2.1 Design

No original design data were disclosed for Mendums Pond Dam.

2.2 Construction

A report prepared by H.F. Dunham for the Lamprey River Improvement Company, dated December 5, 1918, was the earliest investigation found regarding Mendums Pond Dam. Dunham's report contains a sketch of a cross section copied from a report by W. M. Oliver, C.E. to Newmarket Manufacturing Company dated 1889. (See Appendix B.) After ownership was transferred to the State, the New Hampshire Water Resources Board (NHWRB) made repairs in 1958-59, 1963, and 1977. Copies of plans of these repairs are included in Appendix B.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. Little engineering data were disclosed for Mendums Pond Dam. A search of the files of the NHWRB revealed only a limited amount of recorded information. The report by W. M. Oliver, C.E., 1889, referenced in the Dunham Report, was not disclosed.

b. Adequacy. Because of the limited amount of detailed data available, the final assessments and recommendations of this investigation are based on the visual inspection and hydrologic and hydraulic calculations.

c. Validity. The visual inspection is generally consistent with the 1889 sketch for the exposed portions of the dam, except as modified by the addition of the tie rods, as recommended by H. C. Dunham in 1918, and the concrete facing, overflow spillway, and refacing of the gate section accomplished by the NHWRB. The plans found for the NHWRB rehabilitation are in general conformity with the structure as seen in the visual inspection. (For details, see Sections 3 & 6 and Appendix B.)

the dam. A gatehouse covers the operating mechanisms. The control shaft is open on the downstream face of the dam. Originally granite struts spaced about 6 feet apart vertically maintained the integrity of the shaft. These struts are now replaced by a reinforced concrete frame.

(3) Height - 31' (structural height)

(4) Top Width - ranges from 24' to 49'

(5) Side Slopes - Vertical

(6) Zoning - unknown

(7) Impervious core - unknown

(8) Cutoff - unknown

(9) Grout curtain - unknown

(10) Other - Downstream face of dam partially buttressed with rock berms.

h. Diversion and Regulating Tunnel. - not applicable (See j. below.)

i. Spillway

(1) Type - Overflow concrete weir, 2 feet high, with a crest width of 1½ feet.

(2) Length of weir - 25'

(3) Crest elevation - 219' MSL

(4) Gates - None

(5) U/S Channel - Mendums Pond

(6) D/S Channel - The downstream channel is cut in bedrock with a shallow depth of sand, gravel, and boulders on the bottom. The channel has a gentle slope away from the spillway but at about 50 feet it steepens sharply, twists, and turns for about 250 feet where it empties into several small marshy ponds before joining a large deep marsh that extends downstream about 1,700 feet from the dam.

j. Regulating Outlets. Three wooden gates are located over ports in the upstream face of the wall of the control shaft. The lowest port (gate 2' H x 4' W) is at the base of the shaft; the upper smaller ports (gates 1.8' H x 1.5' W) have their inverts 14 feet above the invert of the lower port. Each gate has its own gate lifting mechanism that is hand operated. The control shaft is built integrally with the dry masonry walls at about the middle of the dam, and the wall containing the ports is at about the midsection of

(4) Full flood control pool - not applicable

(5) Recreation pool - 219

(6) Spillway crest - 219 (obtained from U.S.G.S. Quadrangle sheet and assumed to be spillway elevation)

(7) Upstream invert low-level port - 195

(8) Streambed at centerline of main dam - 195 (at downstream toe measured 6/13/78)

(9) Maximum tailwater - unknown

d. Reservoir (miles)

(1) Length of maximum pool - 1.5

(2) Length of recreational pool - 1.5

(3) Length of flood control pool - not applicable

e. Storage (acre-feet)

(1) Recreational pool - 1,960 (spillway crest)

(2) Flood control pool - not applicable

(3) Test flood pool - 3,890

(4) Top of dam - 3,330

f. Reservoir Surface (acres)

(1) Top of dam (embankment) - 310

(2) Test flood pool - 330

(3) Flood control pool - not applicable

(4) Recreation pool - 209

(5) Spillway crest - 209

g. Dam

(1) Type - earthen embankment placed between upstream and downstream vertical dry masonry walls.

(2) Length - 440'

Company. In 1958-59 the gate section was extensively repaired and faced with concrete that included the addition of reinforced concrete supports in the downstream face of the low-level control shaft. In 1963, a concrete weir was built at the overflow spillway near the northwest abutment. In 1977, the southeast side of the dam was refaced. The 1958-1977 construction improvements were accomplished by the NHWRB.

i. Normal Operating Procedures. The dam is visited on a weekly basis by the NHWRB. During the winter, spring, and summer seasons the gates are generally kept closed, and the outflow is over the overflow spillway. The lake level fluctuates depending upon the amount of inflow. In the fall, and at other times if necessary, the lake is drawn down by opening the gates. The fall drawdown provides additional storage for the spring freshets.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 5.4 square miles (3,456 acres) of gently to steeply sloping wooded terrain. The normal recreation level has a surface area of 209 acres, which is equivalent to 6 percent of the watershed.

b. Discharge at Damsite

(1) Outlet works (ports) - One lower gate, 2' H x 4' W and Invert Elevation 195' MSL; 2 upper gates, 1.8' H x 1.5' W and Invert Elevation 209' MSL. Total gate capacity at spillway crest - 300 cfs @ 219' MSL.

(2) The maximum discharge at damsite is unknown. No records of past overtopping were disclosed.

(3) Spillway capacity at maximum pool elevation - 1010 cfs @ 224.3' MSL

(4) Total project discharge (gates closed) - 3825 cfs @ 226.3' MSL

c. Elevation. (ft. above MSL) (Elevations are relative to assumed spillway elevation; see (5) below.)

(1) Top of dam - the crest varies from 224.3 to 226.4

(2) Test flood pool - 226.3

(3) Design surcharge (original design) - unknown

APPENDIX A

CHECK LIST - VISUAL INSPECTION

VISUAL INSPECTION CHECK LIST

PARTY ORGANIZATION

PROJECT Mendums Pond Dam, N.H. DATE June 6, 1978

TIME 5:30 P.M.

WEATHER Sunny

W.S. ELEV. 215.7 U.S. 195 DN.S.

PARTY:

1. Warren Guinan
2. Robert Langen
3. Stephen Gilman
4. Ronald Hirschfeld
5. John Falcione
6.
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrology/hydraulics	R. Langen	
2.	Structural Stability	S. Gilman	
3.	Soils and Geology	R. Hirschfeld	
4.	Mechanical	J. Falcione	
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT Mendums Pond Dam, N.H. DATE June 6, 1978

PROJECT FEATURE Dam Embankment NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	224.3
Current Pool Elevation	215.7
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	Not paved
Movement or Settlement of Crest	Four grass-covered depressions several feet wide and up to 12" deep on crest of dam next to downstream dry-masonry wall. Downstream dry masonry wall deviates 4½ ft. horizontally from a straight line between gate house and east abutment.
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	See "Lateral Movement" above. Good
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	None observed
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection - Riprap Failures	None observed
Unusual Movement or Cracking at or near Toes	None observed
Unusual Embankment or Downstream Seepage	Two seepages near downstream toe of dam
Piping or Boils	None observed
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	None observed

PERIODIC INSPECTION CHECK LIST

PROJECT Mendums Pond Dam, N.H. DATE June 6, 1978

PROJECT FEATURE Intake Channel and Structure NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	Mendums Pond - low-level outlet is near center of dam.
a. Approach Channel	Clear
Slope Conditions	Clean
Bottom Conditions	Gravel and cobbles
Rock Slides or Falls	None visible
Log Boom	None
Debris	None
Condition of Concrete Lining	Good - erosion limited to loss of surface laitance
Drains or Weep Holes	None visible
b. Intake Structure	Not visible
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT Mendums Pond Dam, N.H. DATE June 6, 1978

PROJECT FEATURE Control Tower NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good
Spalling	None observed
Visible Reinforcing	None observed
Rusting or Staining of Concrete	None observed
Any Seepage or Efflorescence	None observed
Joint Alignment	Not applicable
Unusual Seepage or Leaks in Gate Chamber	Leaks observed on d/s face around gate
Cracks	None observed
Rusting or Corrosion of Steel	
b. Mechanical Lifting Mechanism	Gatehouse locked. NHWRB would not permit inspection during recreational season
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System in Gate Chamber	

PERIODIC INSPECTION CHECK LIST

PROJECT Mendums Pond Dam, N.H. DATE June 6, 1978

PROJECT FEATURE Outlet Works NAME

DISCIPLINE NAME

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

PERIODIC INSPECTION CHECK LIST

PROJECT Mendums Pond Dam, N.H. DATE June 6, 1978

PROJECT FEATURE Outlet Works NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Good
Rust or Staining	None
Spalling	None visible
Erosion or Cavitation	None visible
Visible Reinforcing	None
Any Seepage or Efflorescence	Substantial leakage through stone masonry (sidewalls) d/s of gate structure
Condition at Joints	Open
Drain holes	None visible
Channel	
Loose Rock or Trees Overhanging Channel	Some trees downstream
Condition of Discharge Channel	Good, consists of rocks, sand, and gravel

PERIODIC INSPECTION CHECK LIST

PROJECT Mendums Pond Dam, N.H. DATE June 6, 1978

PROJECT FEATURE Spillway Weir NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Some on west abutment
Floor of Approach Channel	Sand, gravel, and boulders
b. Weir and Training Walls	Stone masonry - open joints
General Condition of Concrete	Good
Rust or Staining	None
Spalling	Minor spalling and loss of surface laitance
Any Visible Reinforcing	No
Any Seepage or Efflorescence	None
Drain Holes	None
c. Discharge Channel	
General Condition	Fair
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Some trees overhanging downstream
Floor of Channel	Bedrock, some boulders
Other Obstructions	Brush growing in and next to channel

PERIODIC INSPECTION CHECK LIST

PROJECT Mendums Pond Dam, N.H. DATE June 6, 1978

PROJECT FEATURE Service Bridge NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	None - Gatehouse over spillway - locked - house in good condition
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

PROJECT Mendums Pond Dam, N.H. DATE June 6, 1978

PROJECT FEATURE Reservoir NAME R. Langen

AREA EVALUATED	REMARKS
Stability of Shoreline	Good
Sedimentation	Not visible
Changes in Watershed Runoff Potential	Minor
Upstream Hazards	Few homes; lowest is 6' above lake
Downstream Hazards	U.S. Route 4 downstream about 2000 yds. - deep marsh 300 feet below dam to U.S. Route 4.
Alert Facilities	None observed
Hydrometeorological Gages	None
Operational & Maintenance Regulations	None observed

APPENDIX B

INSPECTION REPORTS/SKETCHES

NEW HAMPSHIRE WATER CONTROL COMMISSION

REPORT ON DAM INSPECTION

TOWN *Nottingham* DAM NO. *184.01* STREAM *Lamprey River*

OWNER *N.H. Gas & Elec. Co.* ADDRESS *Newmarket, N.H.*

In accordance with Section 20 of Chapter 133, Laws of 1937, the above dam was inspected by me on [redacted] accompanied by *Supt. Waldron*

NOTES ON PHYSICAL CONDITION

Abutments *Left abutment has been bulldozed down [illegible] and should be [illegible] to grade at top of dam. Otherwise good.*

Spillway *Fair – in earth*
Discharge [illegible] directs flow [illegible] in [illegible]

Gates *Good*

[illegible] ~~OTHER~~ *Earth Dam: Fair – [illegible] rock facing caved in 15' wide, 10' deep, this summer. This has been repaired, without application, by relaying [illegible] upstream slope from 10' below top of dam, right of gates, with rock and fairly pervious earth.*

CHANGES SINCE LAST INSPECTION *Repaired cave-in as noted above.*

FUTURE INSPECTIONS *Yes*

This dam (is) ~~(is not)~~ a menace because *of [illegible], height of dam and property downstream.*

REMARKS *Should be required to fill the excavated left abutment to [illegible] with [illegible]. [illegible] should be informed that [illegible] require [illegible] [illegible] upstream [illegible] left [illegible] similar to that on right side.*

Copy to Owner	Date

[signature]
INSPECTOR

(Additional Notes Over)

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Lamprey No. 184.01
RIVER Little River MILES FROM MOUTH D.A.SQ.MI 5.5
TOWN Northwood OWNER [redacted] Electric Co Lamprey R. Sup. 6
LOCAL NAME OF DAM
BUILT _____ DESCRIPTION STONE-EARTH

POND AREA-ACRES [redacted] DRAWDOWN FT. [redacted] POND CAPACITY-ACRE FT. 3800
HEIGHT-TOP TO BED OF STREAM-FT. [redacted] MAX. [redacted] MIN. [redacted]
OVERALL LENGTH OF DAM-FT. [redacted] MAX.FLOOD HEIGHT ABOVE CREST-FT. _____
PERMANENT CREST ELEV.U.S.G.S. _____ LOCAL GAGE _____
TAILWATER ELEV.U.S.G.S. _____ LOCAL GAGE _____
SPILLWAY LENGTHS-FT. [redacted] FREEBOARD-FT. [redacted]
FLASHBOARDS-TYPE,HEIGHT ABOVE CREST None
WASTE GATES-NO. WIDTH MAX.OPENING DEPTH SILL BELOW CREST
[redacted] [redacted] 27'

REMARKS [redacted]

POWER DEVELOPMENT

UNITS NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE

USE STORAGE

REMARKS _____

DATE [redacted]

See C36-L

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD

I-4560

TOWN	Nottingham	TOWN NO. 1	STATE NO
RIVER STREAM	Mendums Pond		
DRAINAGE AREA	[redacted]	POND AREA	[redacted]
DAM TYPE	Gravity	FOUNDATION NATURE OF	Ledge
MATERIALS OF CONSTRUCTION	Split Stone, Earth		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTION—PUBLIC UTILITY		
HEIGHTS TOP OF DAM TO BED OF STREAM	[redacted]	TOP OF DAM TO SPILLWAY CRESTS	[redacted]
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	[redacted]		LENGTH OF DAM [redacted]
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	Non-		
OPERATING HEAD CREST TO N. T. W.		TOP OF FLASHBOARDS TO N. T. W.	
WHEELS, NUMBER KINDS & H. P.			
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- Lamprey River Improvement Co.

CONDITION- Fair (Spillway should be cleared and Depressions in dike filled.)

DANGER- Yes. Will be subject to periodic inspection.

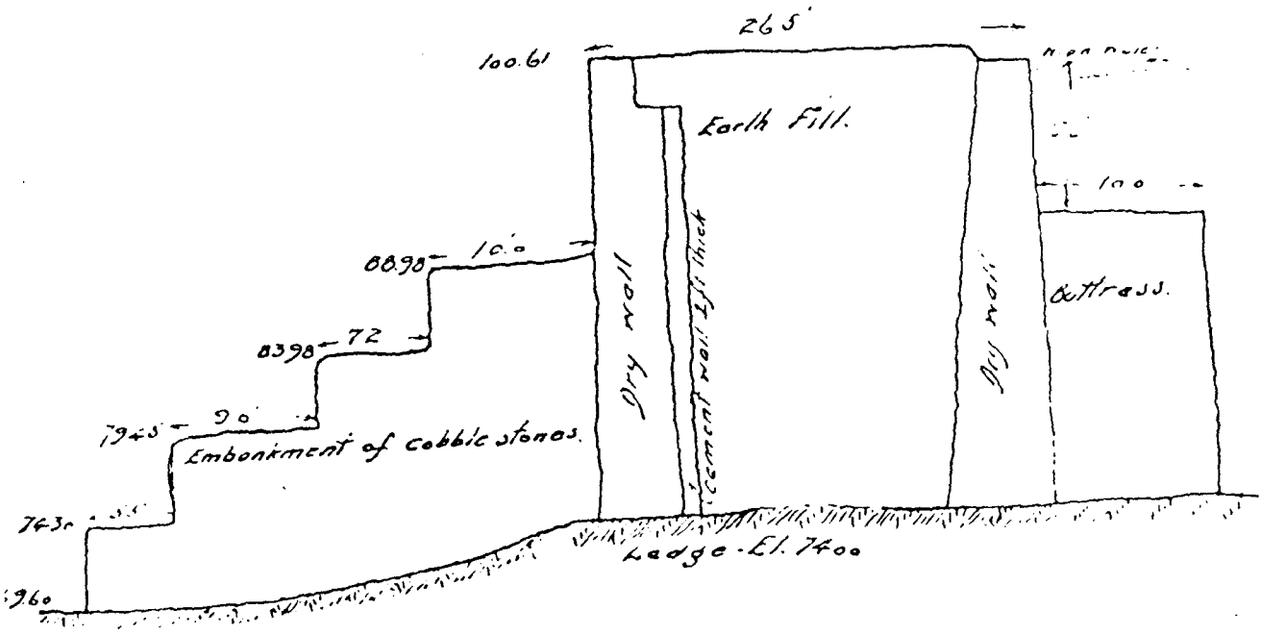
To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made [redacted] according to notification to owner dated July 31, 19[redacted], and bill for same is enclosed.

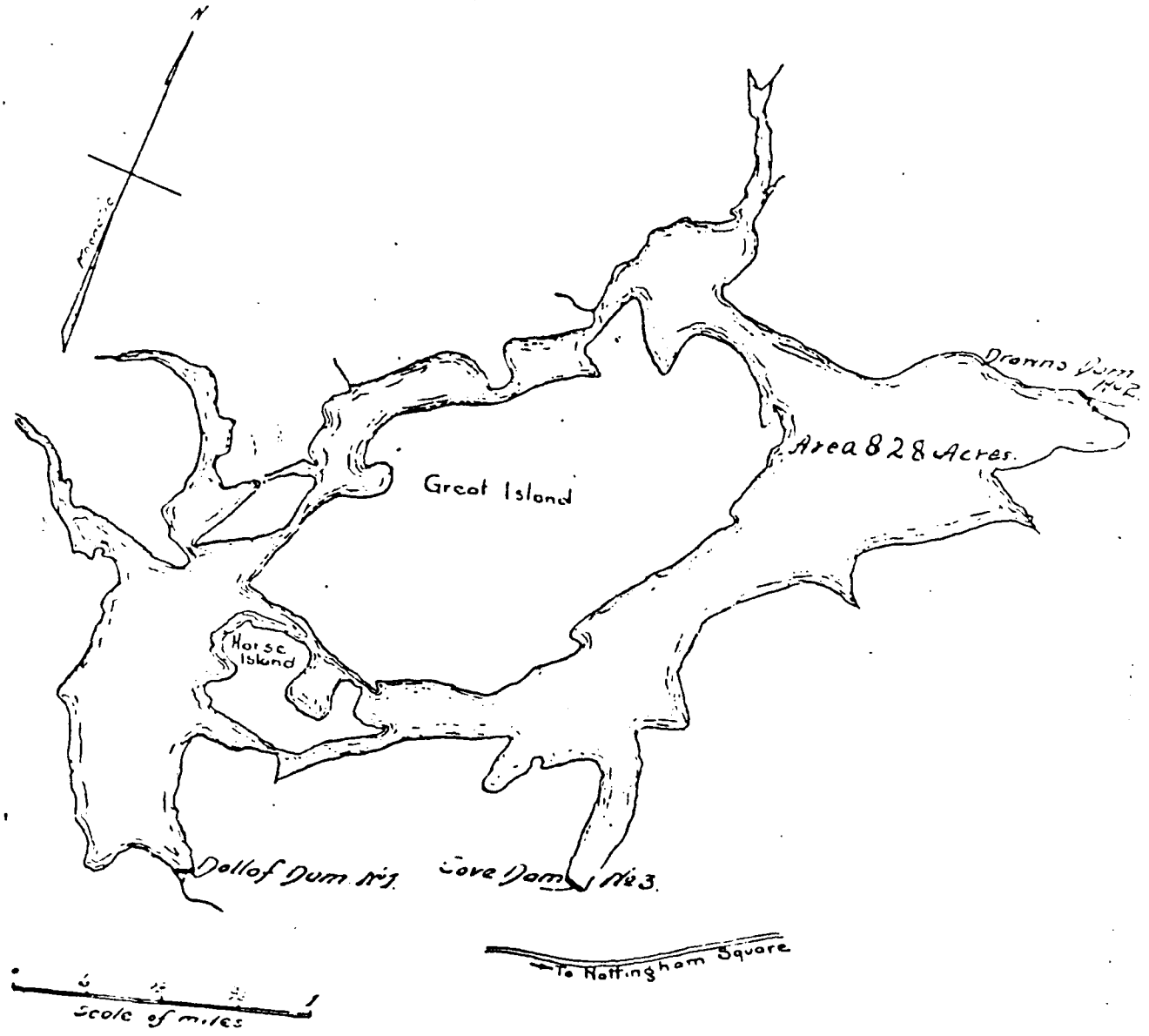
[redacted]

Copy to Owner

Ernest J. Lord
Hyd. Eng.



Cross Section
of
DOLLOF DAM. (No 1)
Nottingham NH.
Scale 10' to the inch.
Copied Nov. 1918. by J.H. Litchfield
from drawings in a report by
H.M. Oliver C.E. to the Hemmarket
Manufacturing Co. dated 1889



Plan of
PAWTUCKAWAY RESERVOIR
Nottingham NH
Reduced from a plan made by
Wm Stather and dated 1839
Reduced by J.H. Litchfield 1918
Scale 2 mile to the inch.

Mendum's.

At the Mendum reservoir there is less need to make changes. The bottom of the present spillway should be brought to a uniform level and all growth of small trees and obstacles of all descriptions, driftwood, old stumps, etc. should be removed and the entire space kept clear. One further recommendation needs attention at your convenience. The upstream wall at Mendum's is of very large rough stone, boulders for the most part, and at two or three places these have cracked under the pressure which has been concentrated at various points by the remo al, through frost action in nearly a hundred years, of many of the smaller stones used in construction to level up and give added bearing surface. Last month many restorations to early conditions were made by replacement without mortar, but with much work and careful attention to strengthening the wall. There are however three places where steel tie-rods should be introduced at a depth of about eight feet from the surface to check further outward movement at points where the overhang or bulging amount to 12 or 14 inches. The tie-rods should be not less than 2¼ inches in diameter with upset ends and provided with washers or crabs 3 or 4 feet in diameter. The location of the rods and a section is shown in Fig. 2 on the last sheet attached to this report. The rods should be free from rust bedded and packed in fine gravel concrete in proportions 1, 2, 3. Very little need be used. The exposed parts should be painted. Then with general supervision and economic control the reservoirs should continue for a long time to give good service without causing you any anxiety or disquiet.

Yours truly,

H.F.D/R.

with stems of wood and ratchet connections. These gates are evidently of later construction and are backed up by brick work and two or three braces of wood extending to the solid ledge below the dam where the ends are bolted down. It would be simple and good construction to spring a brick arch between the vertical stone walls to hold the gate frames in place. It is within reason to think that the brick work and braces were placed asthey are so that under certain pressures due to flood conditions, and perhaps with a little help, the whole construction, brick work, gates and timbers would be swept out of the way, much increasing spillway capacity. But whether that inference be correct or not, there can be no apparent harm in leaving the structure in its present condition or in replacing the wood braces when that becomes necessary.

At the Drown Dam (No.2) there are stop planks retained by timber braces more or less decayed. Renewals should be made as time may require. But all of the Pawtuckaway spillways real and imaginery, taken together, are insufficient for a drainage area of twenty (20) square miles. This can be shown conclusively by precipitation records personally witnessed where the annual totals are below those of southern New Hampshire. To provide more ample spillway capacity the Gove Dam (No.3) should be lowered or reduced in elevation about three feet over a length of two hundred and fifty feet in two sections of one hundred and twenty-five feet each as shown in Fig. 1 in the last sheet hereto attached. This will afford in addition to the other spillways a free flow for a great volume of water whenever the necessity arises. That may not be once in a century.

Their records were virtually barometer readings.)

Gate Repairs.

4. The main gates at the Mendum reservoir set in a wood from had suffered from decay making it difficult to fix upon a satisfactory estimate of leakage. Rocky creek-bed conditions below the dam interposed further difficulties. But nothing serious was observed. The gates and gate frames have just been renewed as you directed, necessary pointing in their vicinity attended to and the reservoir is now filling.

Report by Mr. W. M. Oliver, C. E.

5. In the year 1889 Mr. Oliver made a very comprehensive and valuable report upon all of these dams for the Newmarket Manufacturing Company, and this report with maps, sketches and figures is now in your possession. The maps and cross sections have been checked up carefully and found to be surprisingly accurate. This includes restored base-line measurements and distances to faces of walls. Also deep excavations were made at Mendum's to show that his cross sections were reliable. The more essential sections have been copied freely and are shown in the ink prints attached hereto with well deserved credit to Mr. Oliver in each case.

Recommendations.

6. At Pawtuckaway Dam No. 1 the main gate is at the original level of the stream and is about twenty inches by fifty inches (20" x 50"). It is raised by a wood stem with nut and screw. The stem and timber support within the gate house should be renewed at no distant date. Between this gate and the spillway there are two waste gates each three feet by three feet (3' x 3')

some through the dam itself--but all that comes through the core wall is always perfectly clear, and a recent measurement,- November 18,- when the surface of the water in the reservoir was two and eight tenths feet below the spillway,gives a good idea of present conditions. The total volume discharged was four and eight tenths second feet, of which it was estimated one half leaked through the gates, or reached the stream in the quarter of a mile between the dam and the measuring channel. The leakage is nearly the same in volume from each half of the dam as may be observed where it flows laterally along the buttressed lower slopes of the dam to the main gateway, the sides of which are walled up vertically from the creek bed. The volume discharged is not large considering the extent of the core wall and the pressure to which it is subjected. A recently examined earth and core wall dam, built over forty years ago in another State, could well be cited here. The dam was more than a fourth of a mile long and about thirty-five feet high. From the first there was leakage. More material was added at the foot of the water slope. Able engineers were called and accurate gaging kept for many years and recorded in annual reports. Following one of these is the comment,-

> "The only variation in the discharge from the weirs appears to be due to changes in the weather."

The same statement would doubtless hold good at the Pawtuckaway and Mendum reservoirs were they accurately gaged. The early water supply for London, England, was from springs that were carefully gaged as the demand increased. Then it was observed that the discharge was greater before than it was after a rain storm.

possess permanent features, in the broad puddled clay-and-gravel cores and heavy retaining walls, superior to any of those described by Mr. Schuyler. More information about the design, the designer and the degree of originality in the construction of these dams would be very interesting. It is quite possible that the "type" had its origin in those structures. The dams have caused some anxiety at different dates and changes have been recommended and some have been made at dates that show the existance of faulty work elsewhere rather than in the dams themselves. Soon after the Mill river disaster in Massachusetts, in 1874, and again after the Johnstown flood in 1889, studies were made and the core walls in some places reinforced. In the writer's opinion there has not been a moment since the dams were built that they were unsafe--except from overtopping in some deluge too severe for the spillways to accomodate. It is of eye witness record that the water has been within an estimated "two feet" of the top of the Mendum dam and sand bags have been used on the Pawtuckaway dam No 1 on the water face wall to divert the flood to the spillway. This should not have been necessary.

Pawtuckaway - Dams No. 1, 2 and 3.

3. The dams leak a little. It may be said that all core wall dams do leak. Personal observations for more than two years, and at many different stages of water in the Pawtuckaway reservoir have been recorded, and the leaks in the main Dam (No. 1) measured in a channel constructed for that purpose. The main and waste gates do not close perfectly, but well enough for all reservoir purposes. Some water escapes at the gates--

Dam", "Drown's Dam", and the "Gove Dam" indicated on the map respectively as Dams No. 1, 2 and 3. At Mendum's Pond there is but one dam, located at the main outlet and lying partly in the town of Barrington and partly in the town of Nottingham, hereinafter referred to as the"Mendum Dam". The dams were designed and built very nearly as they are at the present time in or between the years 1839 and 1842.

Type of Dams.

2. In a comprehensive work on "Reservoirs for Irrigation Water Power and Water Supply", published in 1900, Mr. James D. Schuyler, M. Am. Soc. C. E., devotes some seventy-five pages to rock-fill dams. His discussion in part follows:

> "Rock-fill dams may be said to have originated forty or fifty years ago in the mining districts of California.....in difficult and almost inaccessible locations.....and were considered to be of a temporary nature.....They began with timber or log cribs filled with loose stone. Their next stage was an embankment of loose stone, a portion of which was laid up as a dry wall with a facing of two or more thicknesses of plank to secure water tightness. The latter type has proven so serviceable that it is still regardedas one of the most desirable classes of dam that can be built where economy is of prime importance."

Then follows an outline description of six types of rock-fill dams--including these two.

> "2. Rock-fill dams with a central core of steel plates and without hand-laid facing walls."

> "4. Rock-fill dams with facing of masonry built vertically backed with earth and covered on the lower side with blocks of stone laid in mortar."

Now all of these reservoir dams under consideration on the Lamprey water shed are rock-fill dams and not only were they built long before the mining days in California but they

H. F. DUNHAM
[illegible] BUILDING
[illegible] BROADWAY, NEW YORK
TELEPHONE, 3107 CORTLANDT

M. Am. Soc. C. E.
M. Cleveland Engineering Society
M. American Water Works Association

December 5, 1918.

Mr. D. A. Belden, President,
Lamprey River Improvement Company,
Haverhill, Mass.

Dear Sir:-

Agreeably to your request, I have made a study of conditions pertaining to the two artificial reservoirs owned by your company, known as Pawtuckaway Lake and Mendum Pond, both of which are in the towns of Nottingham and Barrington, New Hampshire. I have kept in view your desire to be informed concerning the type of construction and present condition of the various dams, spillways and controlling apparatus, and particularly as to any defects which should be remedied in the interest of public safety to life and property.

1. The reservoirs are within the drainage area tributary to the Lamprey River ten to fifteen miles westerly from Newmarket, N. H. The area tributary to each reservoir is not definitely known but has been estimated at about six square miles for the Mendum Reservoir and twenty square miles for the Pawtuckaway. More exact determination would have been made but for the fact that the U. S. Geological Survey is now plotting the notes of a quadrangle covering the reservoirs and their drainage districts. Both of the reservoirs are formed by dams built at the outlets of these small lakes and at overflow points where the higher elevation of water would cause a discharge into a depression or ravine at a distant point. There are three dams at Pawtuckaway as attached map shows, known locally as "Dollof

PAWTUCKAWAY AND MENDUM PONDS

REPORT FROM H. F. DUNHAM

to

D. A. BELDEN, PRESIDENT

LAMPREY RIVER IMPROVEMENT COMPANY

December 5, 1918

B-8

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON RESERVOIRS & PONDS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 18:07 1

Town Nottingham : County Strafford

Stream Menduns Pond

Basin—Primary Ocean : Secondary Lamprey R.

Local Name

DRAINAGE AREA

Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 5.56 5.56 Sq. M

ELEVATION vs. WATER SURFACE AREA vs. VOLUME

Point	Head Feet	Surface Area Acres	Volume Acre Ft.
(1) Max. Flood Height			
(2) Top of Flashboards			
(3) Permanent Crest			
(4) Normal Drawdown		240	
(5) Max. Drawdown			
(6) Original Pond			

Base Used ..... : Coef. to change to U.S.G.S. Base .....

RESERVOIR CAPACITY

	Total Volume	Useable Volume
Drawdown	..... ft.	..... ft.
Volume	..... ac. ft.	..... ac. ft.
Acre ft. per sq. mi.	.....	.....
Inches per sq. mi.	.....	.....

USE OF WATER Conservation

OWNER Lamprey River Improvement Co.

REMARKS

condition fair

Tabulation By ..... Date .....

Town No. 1 Town Nottingham No.

Data by U.S.G.S. File

Owner Lamprey River Improvement Company

River or Stream Lendums Pond

Public Utility No Drainage area 6.6 sq. mi.

Wheel Capacity H. P. { Primary H. P. / 90% time }

Type of Construction Stone

Height 15 ft. Operating Head Storage ft.

Length 395 ft. Spillway Length (No. 1) 40 ft. (No. 2) ft.

Would Failure of Dam do Harm? Yes

Present Condition Good Date 1922

LWB Good 1925

1922
update 1925

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 184.01

Town Nottingham : County Strafford

Stream Landers Pond

Basin-Primary Coast : Secondary Lamprey River

Local Name

Coordinates—Lat. 43°10' - 1300 : Long. 71°5' - 4000

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 5.56 Sq. Mi.

Overall length of dam 416 ft.: Date of Construction

Height: Stream bed to highest elev. 32 ft.: Max. Structure 25.5 ft.

Cost—Dam : Reservoir

DESCRIPTION Stone and earth foundation ledge

Waste Gates

Type

Number 1 : Size 24" ft. high x ft. wide

Elevation Invert : Total Area sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on : Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction

Length—Total 33 ft.: Net ft.

Height of permanent section—Max. ft.: Min. ft.

Flashboards—Type None : Height ft.

Elevation—Permanent Crest : Top of Flashboard

Flood Capacity 1820 cfs.: cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 8'2" ft.: Min. ft.

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

OWNER [redacted] Improvement Co. [redacted] Exeter

REMARKS Reservoir mainly in Barrington [illegible] at time of inspection

Tabulation By JS B-5 Date [redacted]

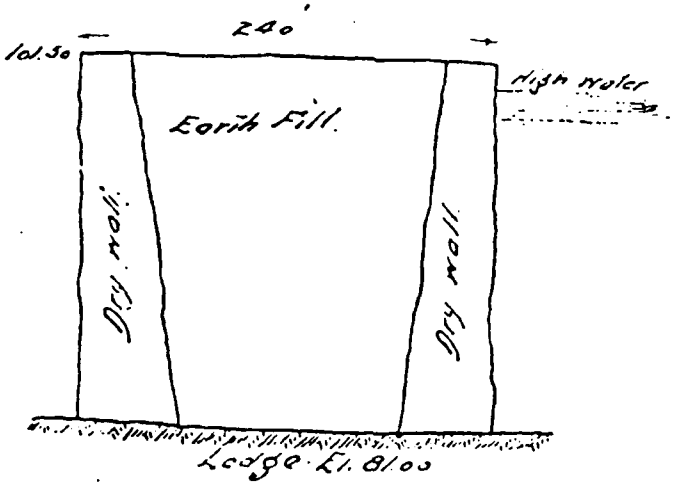
SAS21284

- NOTTINGHAM -

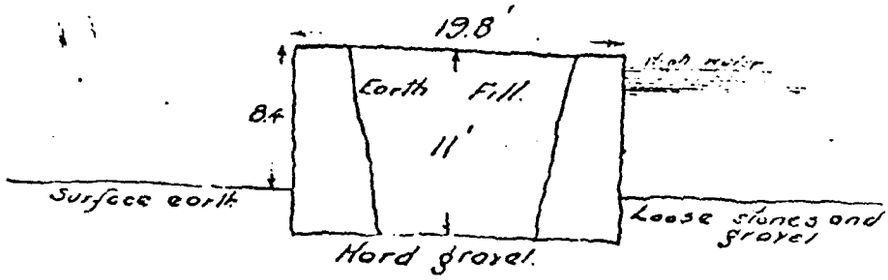
TYPE OF DAM	L'	W'	H'	CONDITION	HOLD WATER	MENACE	INSPECTION DATE	OWNER INTERVIEWED	
GRAVITY	1/10'	33'	33'	FAIR	YES	YES	8-[illegible]-35	[illegible]	Refers to Mr. [illegible] & MENDUMS
GRAVITY	330'	23'	27'	FAIR	YES	YES	[illegible]	"	
GRAVITY	230'	23'	5'	FAIR	YES	YES	[illegible]	"	
GRAVITY	232'	23'	10'	FAIR	YES	YES	[illegible]	"	
GRAVITY	225'	13'	6½'	FAIR	YES	YES	7-30-35	YES	
GRAVITY	77'		13'	POOR	NO	YES	7-30-35	YES	
GRAVITY	146'	12'		POOR	YES	YES	[illegible]	NO	
"A" FRAME	75'	10'	12½'	FAIR	YES	YES	7-30-35	YES	
LOG CRIB	50'		4'	RUINS	NO	NO	8-6-35	NO	

Made By .....

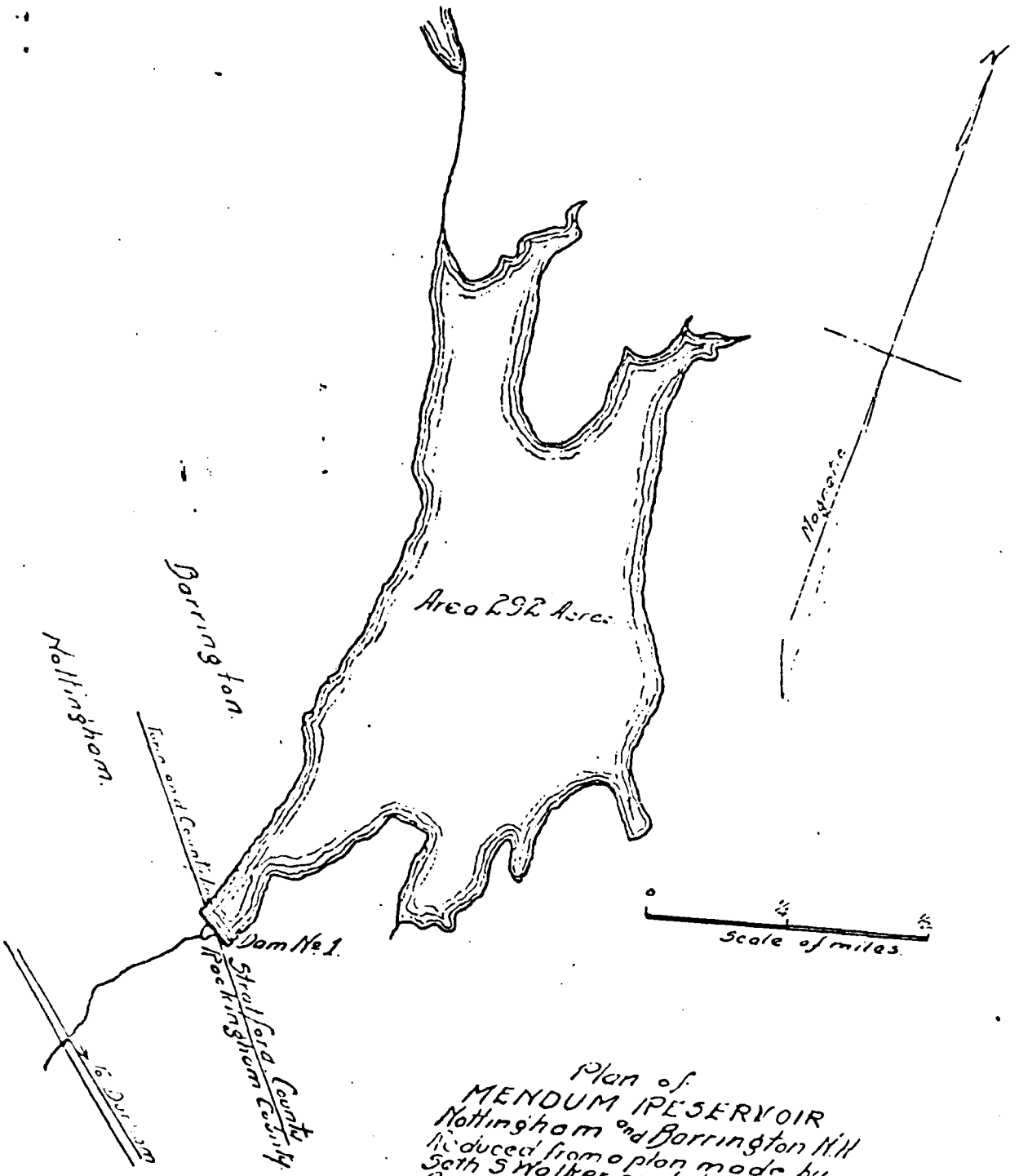
B-4



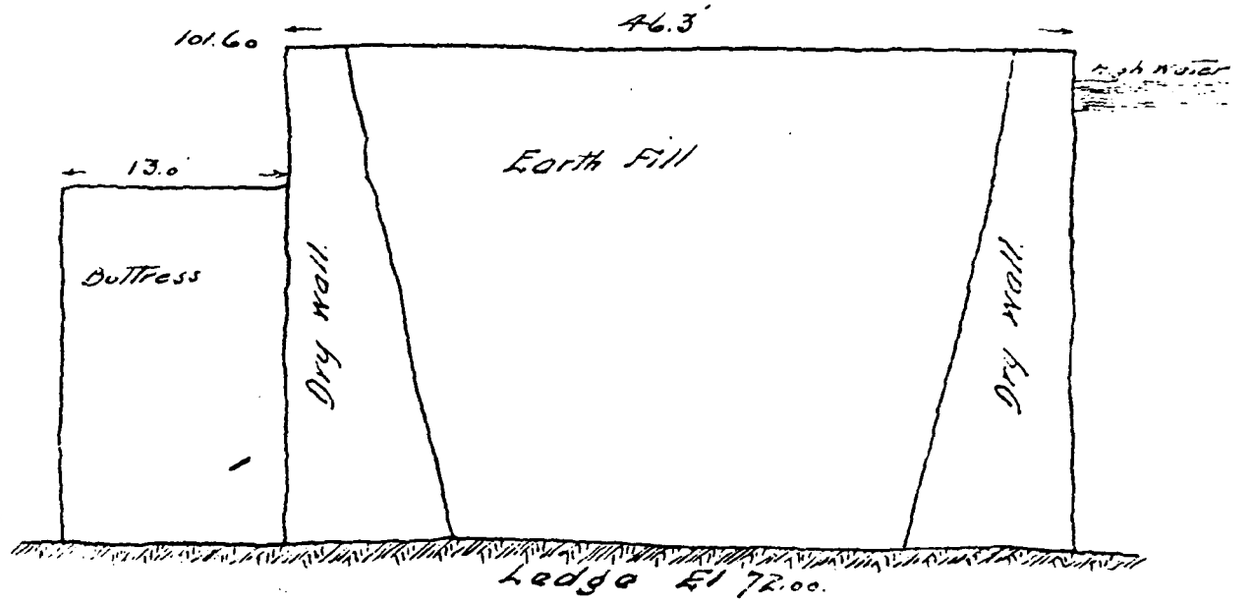
Cross Section
of
DROWN'S DAM (No. 2)
Nottingham NH
Scale 10' to the inch
Copied Nov. 1918. by J.H. Litchfield.
from drawings in a report by
W. M. Oliver C.E. to the Northwestern
Manufacturing Co. dated 1869.



Cross Section
of
GOVE DAM (No 3)
Nottingham N.H.
Scale 10' to the inch
Copied Nov. 1918. by J.H. Litchfield
from drawings in a report by
H.M. Oliver C.E. to the Newmarket
Manufacturing Co. dated 1889



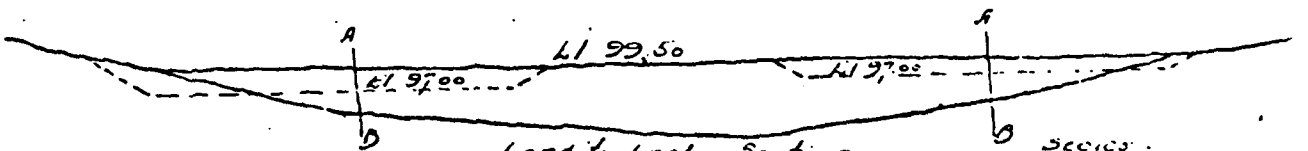
Plan of
MENDUM RESERVOIR
Nottingham and Barrington N.H.
Reduced from a plan made by
Seth S Walker and dated 1859
Reduced by J H Litchfield 1918.
Scale 1 mile to the inch

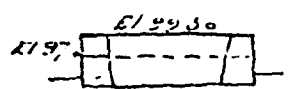


Cross Section
of
MENDUM DAM
Nottingham & Barrington N.H.
Scale 10 ft to the inch
Copied Nov 1918 by J.H. Litchfield
from drawings in a report by
W.M. Oliver CE to the Newmarket
Manufacturing Co. dated 1889

Changes to be made at Gove Dam (No 3)

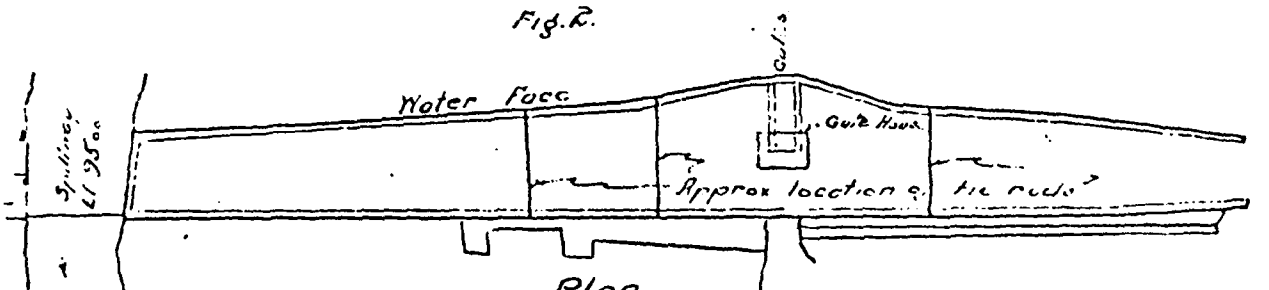
Fig 1.

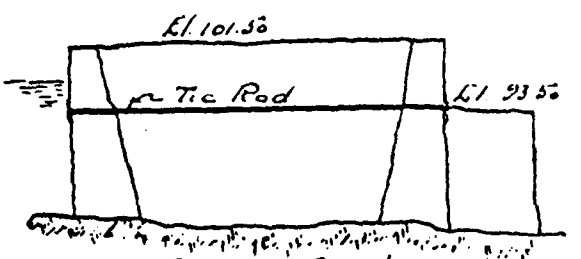




Changes to be made at Nienstum Dam.

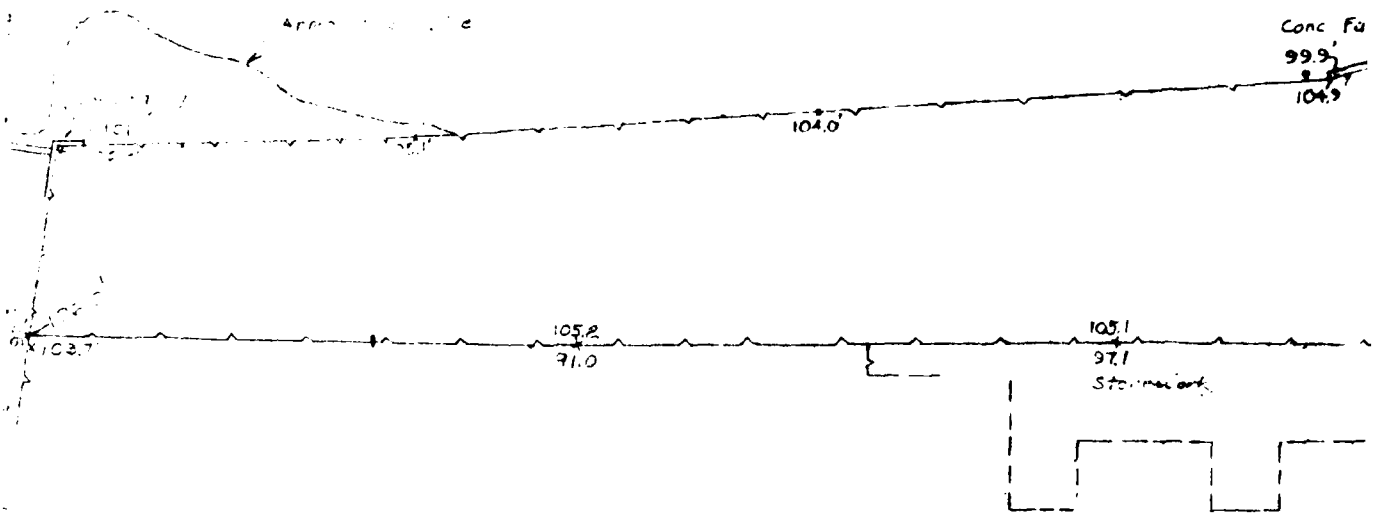
Fig 2.





MENDUMS POND

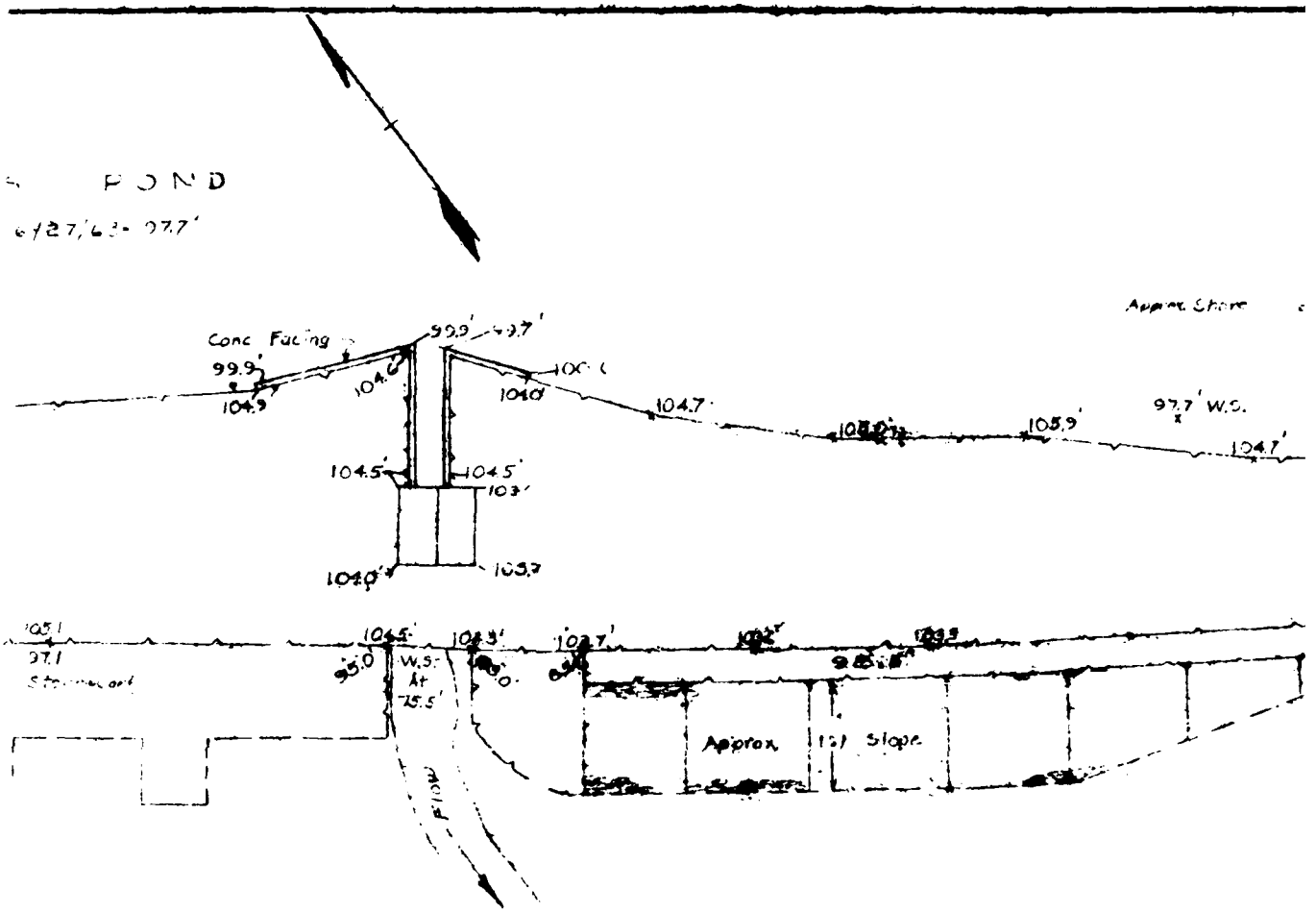
Water Surface 6/27/63- 97.7'



DRAWN BY Vernon A. Snow Jr.

CHECKED BY

193

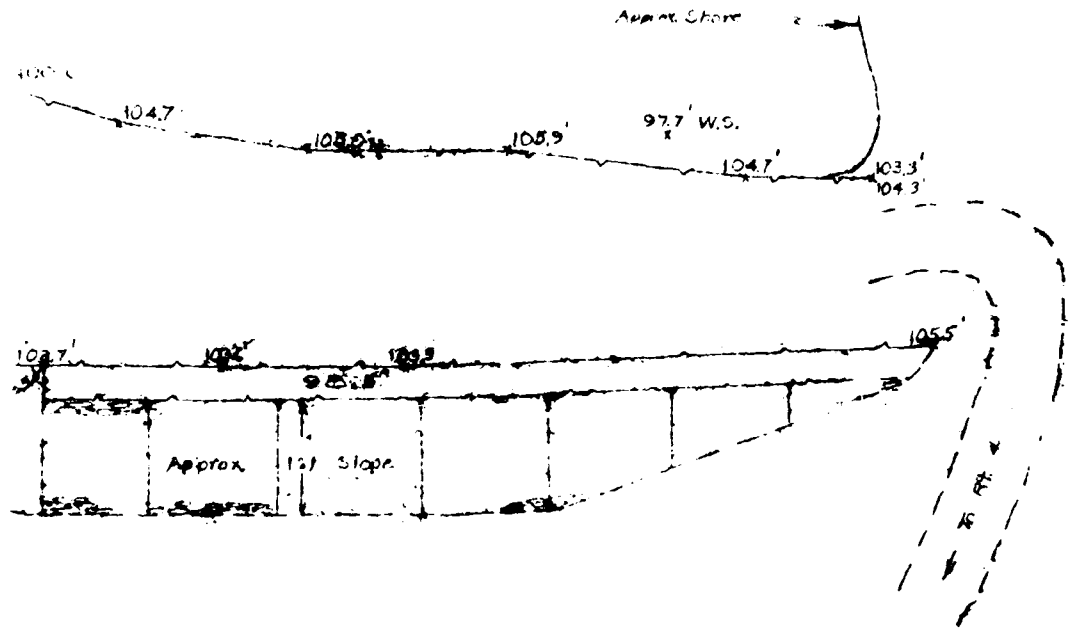


MEND-U
107

WATER

SCALE
1"=20

293

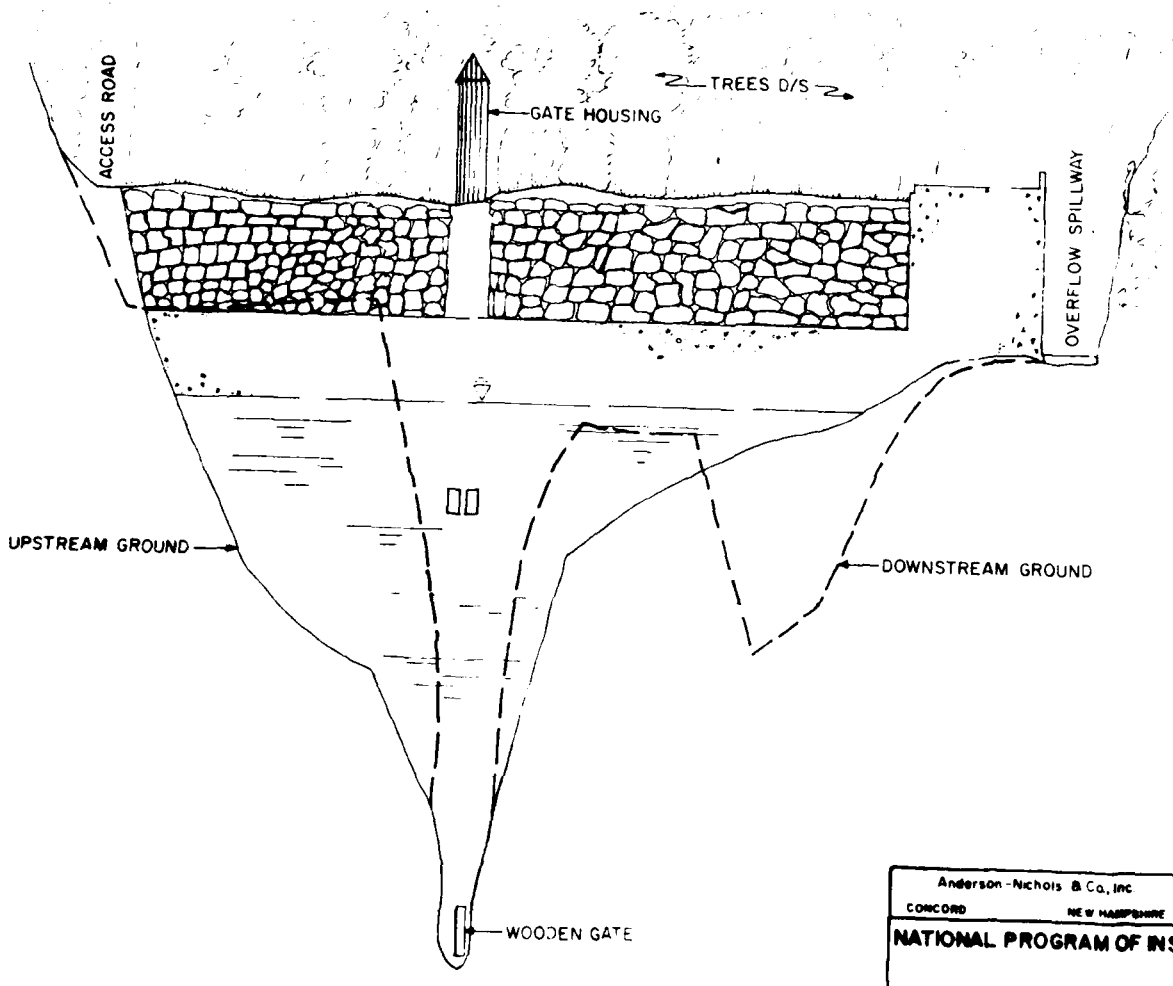


PLAN
MENDUMS POND DAM
[illegible] N.H.

NEW HAMPSHIRE
WATER RESOURCES BOARD
[illegible], N. H.

Scale 1"=20'	[illegible]	Date June 29

303



ELEVATION

Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

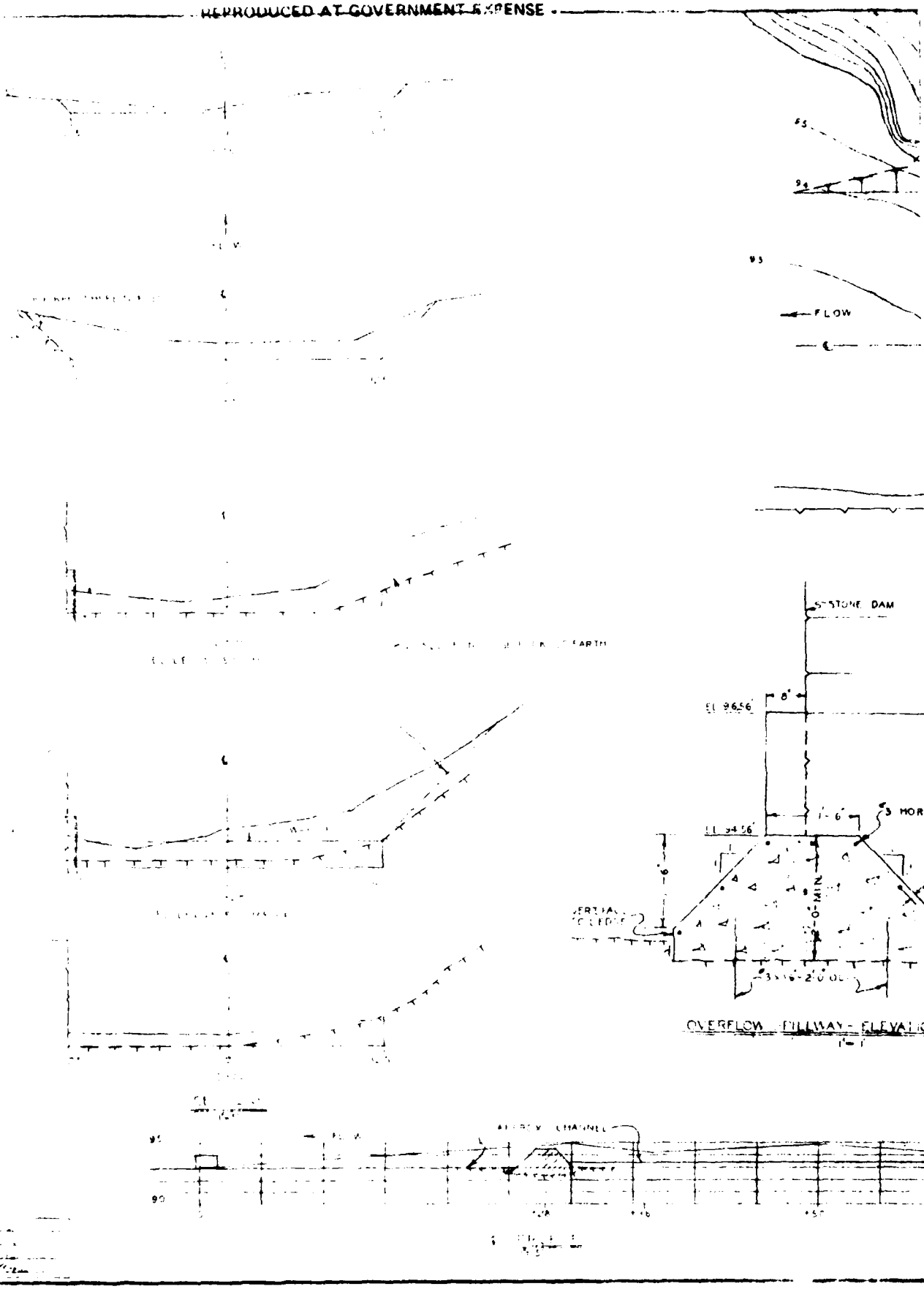
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

MENDUMS POND DAM

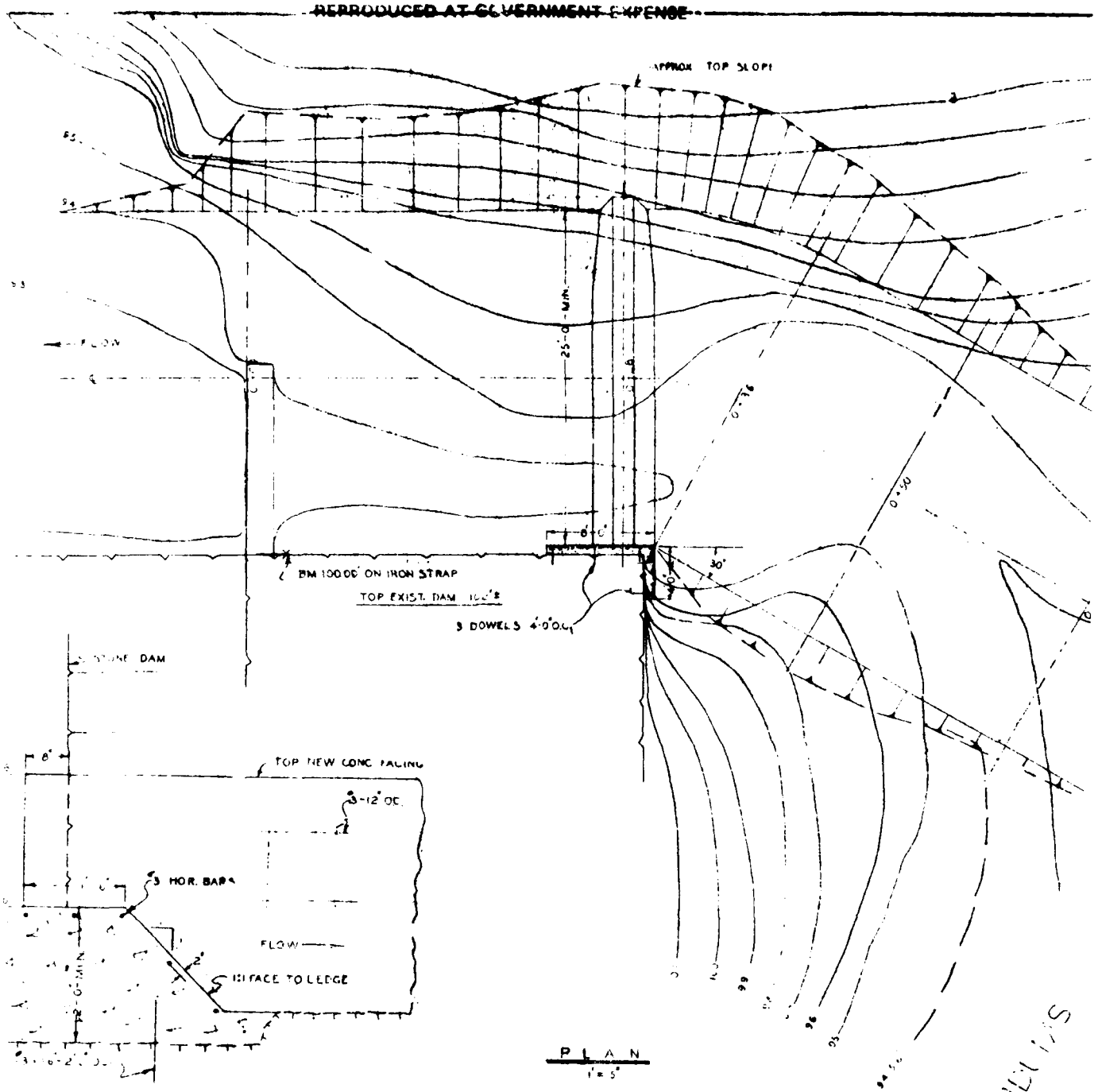
MENDUMS POND NEW HAMPSHIRE

SCALE NOT TO SCALE

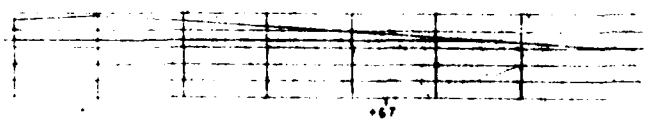
DATE AUGUST 1978



1673



A SPILLWAY ELEVATION & DETAILS
1"=1'



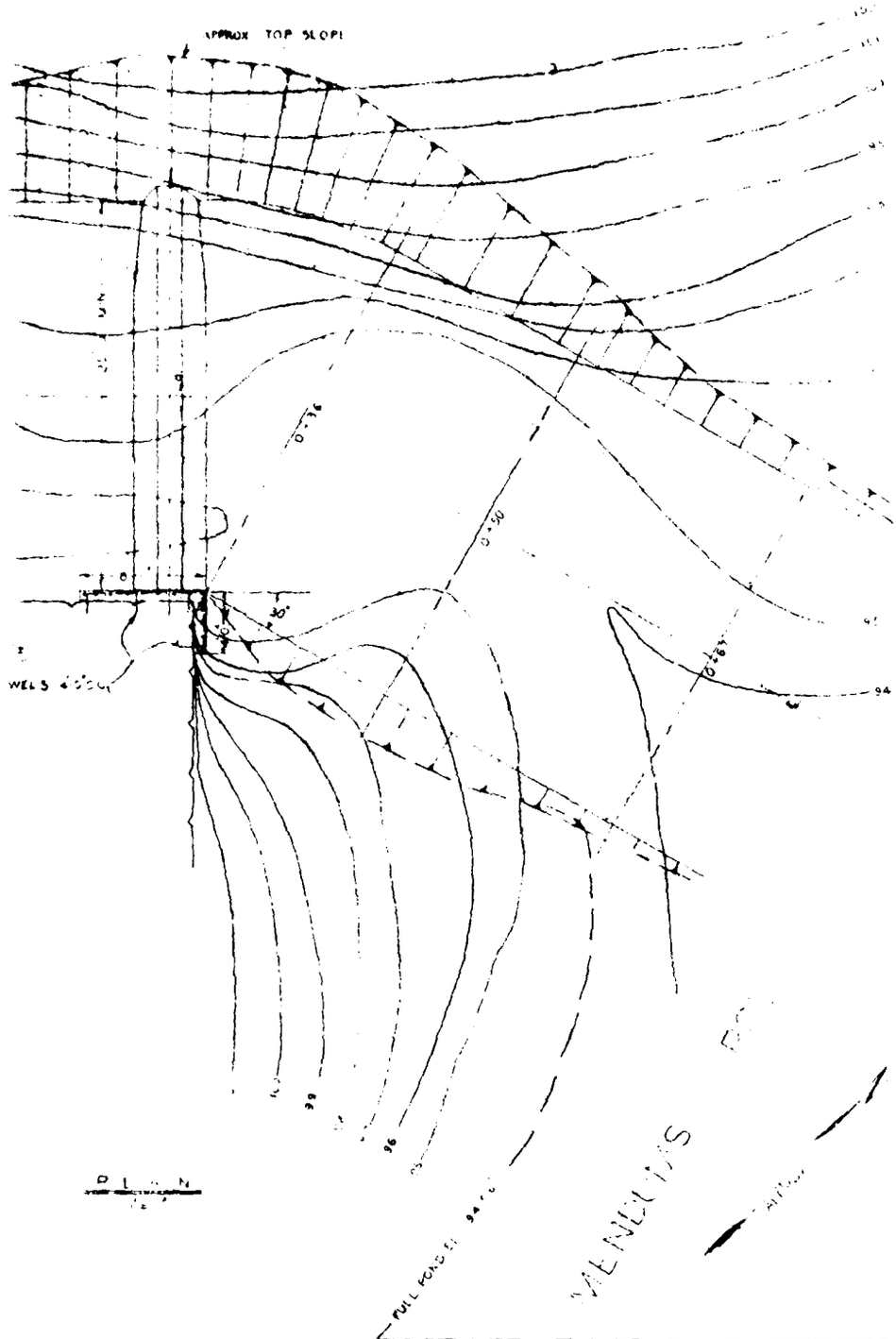
MENDUMS POND
OVERFLOW SPILLWAY

NEW HAMPSHIRE WATER RES
- CONCORD, N.

SCALE
AS SHOWN

184.01

293



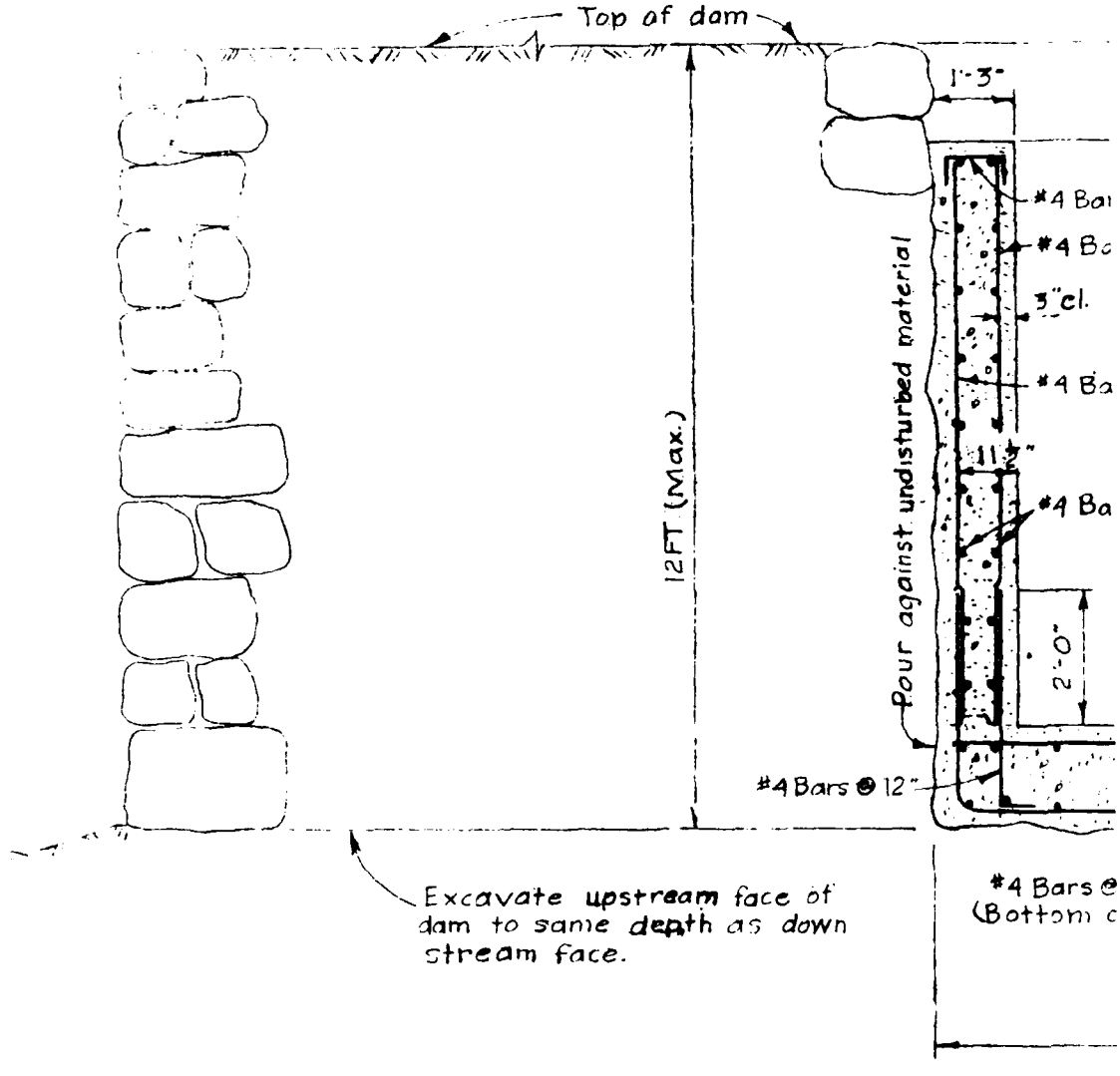
HENDUMS POND

OVERFLOW SPILLWAY

NEW HAMPSHIRE WATER RESOURCES BOARD
- CONCORD, N. H. -

SCALE		DATE
AS SHOWN	18401	

393

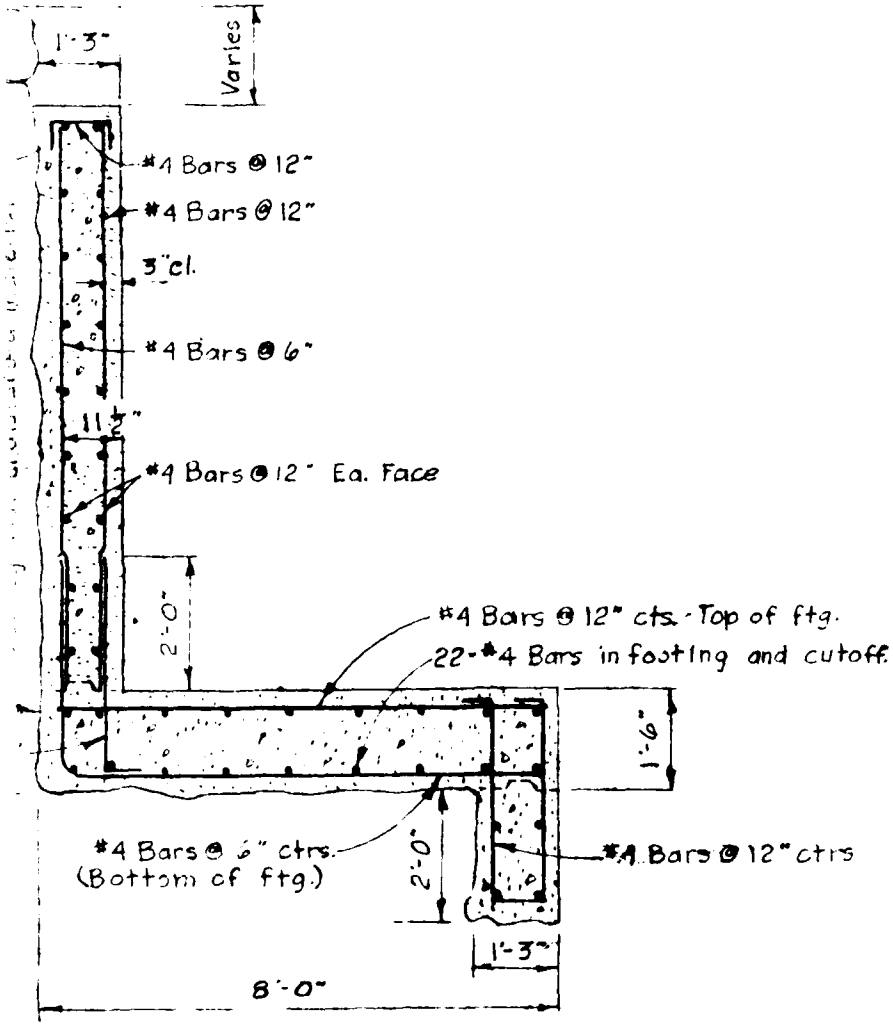


REVISED

Sc

ED BY

193



REVISED WALL AT SPILLWAY

Scale: ½" = 1'-0"

REVISED FACI
MENDUMS POND D
NOTTINGHAM, N

NEW HAMPSHIR
WATER RESOURCES
CONCORD, N. H.

Scale as shown

DAM No. 184

293

derson-Nichols & Company, Inc. Subject _____ Sheet No. 1 of 10

JOB NO. 3141-10 MENDUMS POND Date 8/4/76 Computed JJW Checked _____

SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

DA = 5.43 mi^2
Size Classification = INTERMEDIATE
Hazard Classification = SIGNIFICANT
Inspection Flood = ½ PMF to PMF

Step #1
Calculate PMF using "Preliminary Guidance For Estimating Maximum Probable Discharges in Phase I Dam Safety Investigations, March 1978"

Use Flat & Coastal

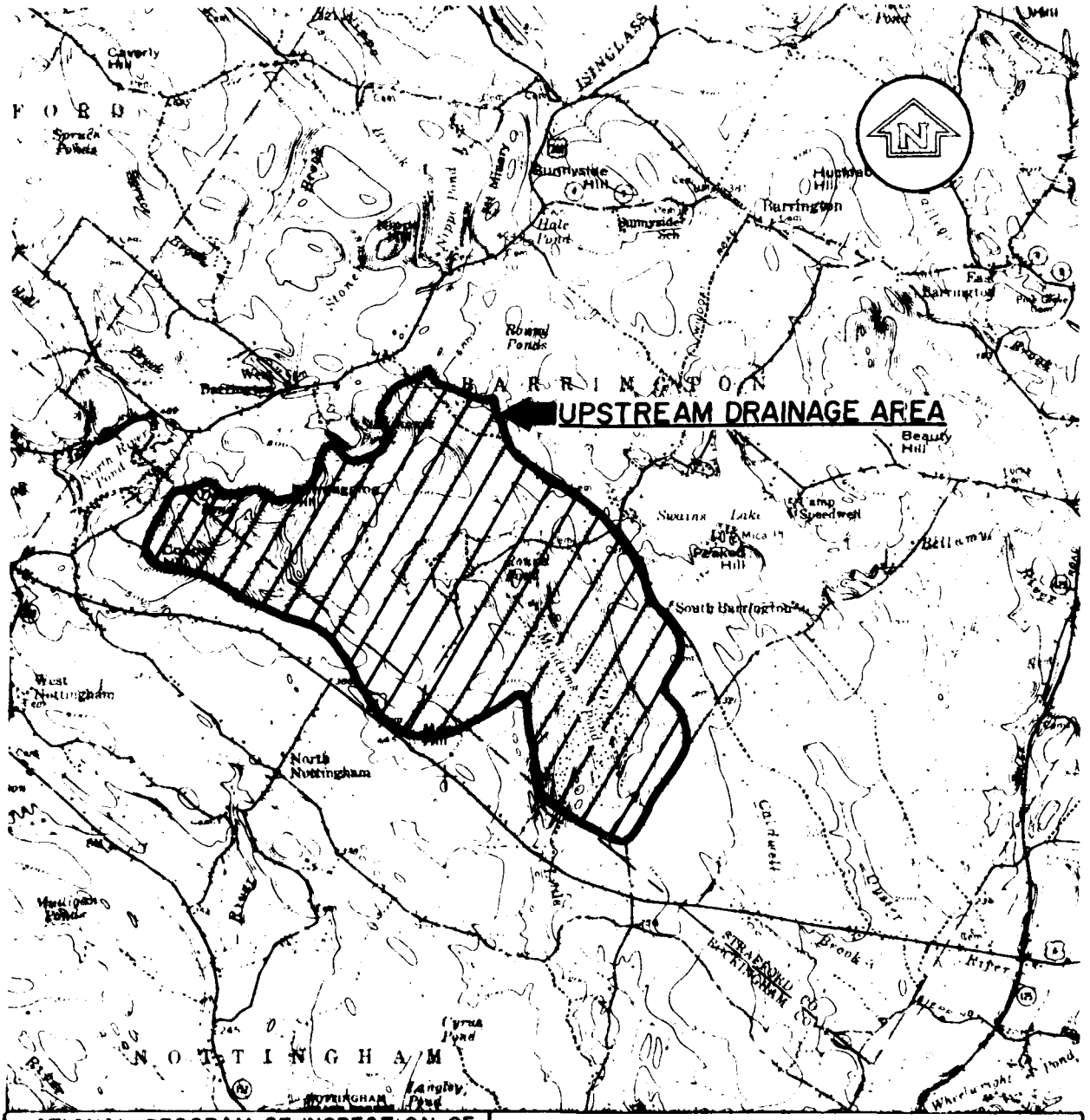
@5.43 mi^2 P.M.F. in cfs/mi^2 = 800

P.M.F. for MENDUMS Pond is:

800 $cfs/\cancel{mi^2}$ × 5.43 $\cancel{mi^2}$ = 4344 cfs

PEAK INFLOW = 4345 cfs

Assume:
Gates closed
'c' value of 2.7 over embankment flows
'c' value of 3.0 spillway (from King & Brater)



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

MENDUMS POND DAM

NOTTINGHAM, NEW HAMPSHIRE

REGIONAL VICINITY MAP

AUGUST 1978

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

ANDERSON-NICHOLS & CO., INC. CONCORD, NH

SCALE IN MILES

½ 0 1 2

MAP BASED ON U.S.G.S 15 MINUTE QUADRANGLE SHEET **Mt. PAWTUCKAWAY, N.H. 1957.**

APPENDIX D

HYDROLOGY/HYDRAULICS

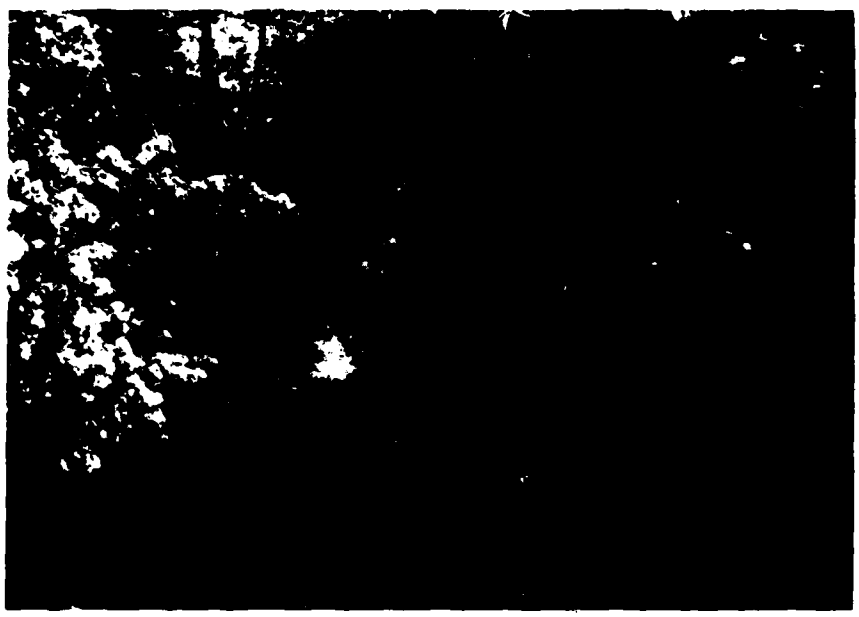


Figure 9 - Looking at the downstream channel from the top of the dam near the gate house.

Figure 7 - Looking downstream at the overflow spillway and the outlet channel forming the northwest abutment of the dam.

Figure 8 - Looking upstream at the reservoir from the gate house.

Figure 6 - Looking upstream at the outlet to the gate structure.

Figure 4 - Looking southeast along the downstream face of the dam near the overflow spillway.

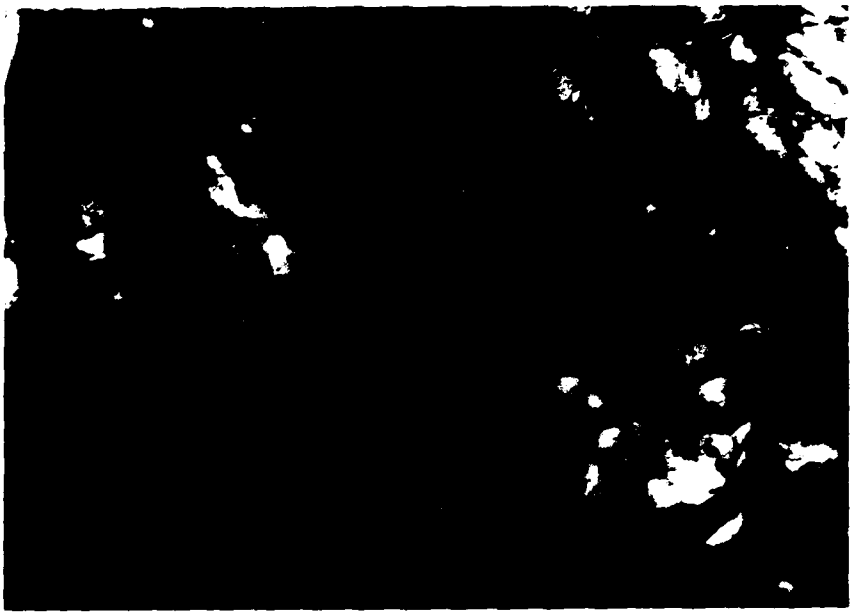
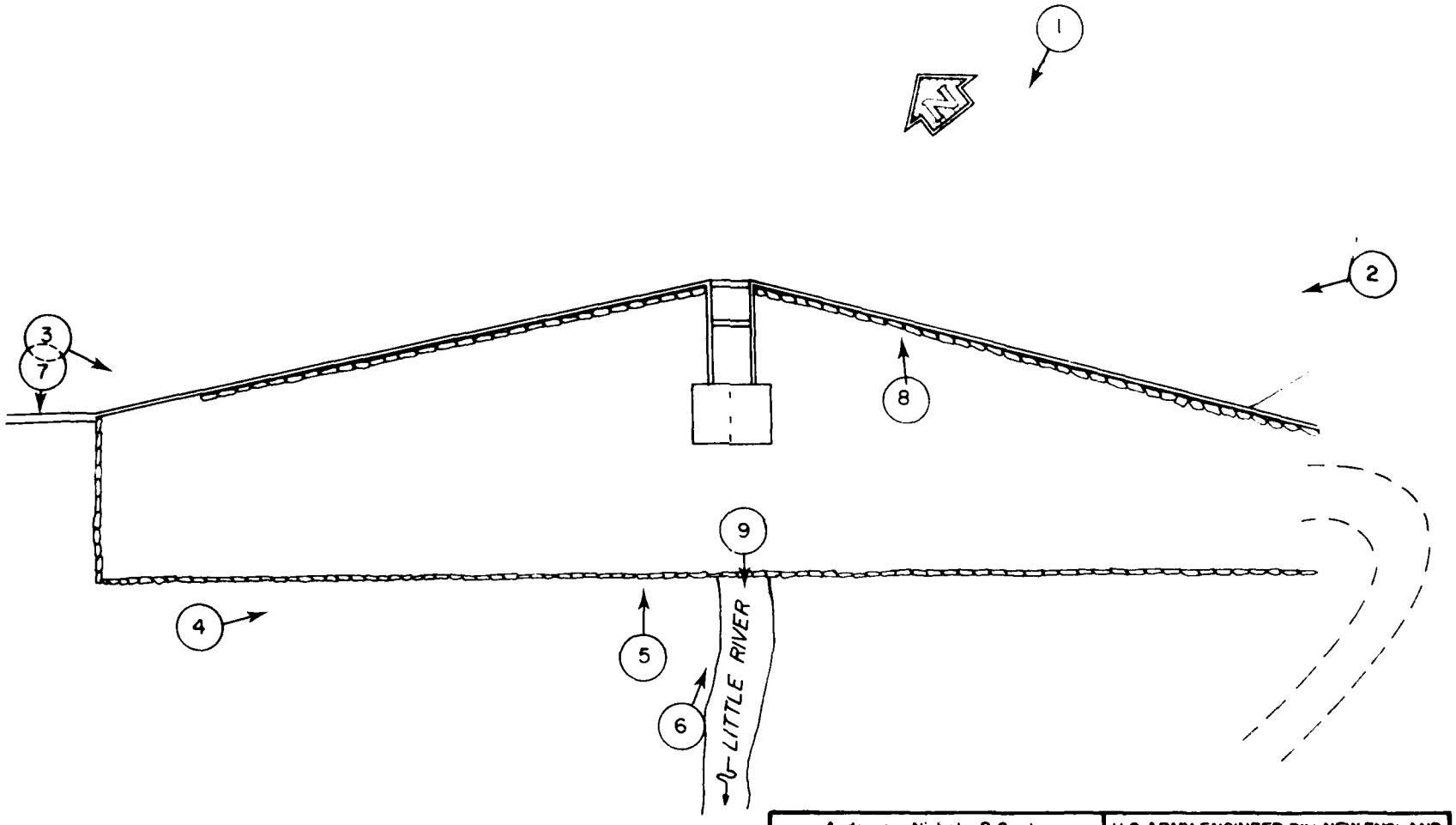


Figure 5 - View of the tie rod in the downstream face located 50 feet northwest of the gate house.

Figure 2 - Looking northwest along the upstream face of the dam from the southeast abutment.

Figure 3 - Looking southeast along the upstream face of the dam from the northwest abutment, near the overflow spillway.



Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

MENDUMS POND DAM
PHOTO INDEX

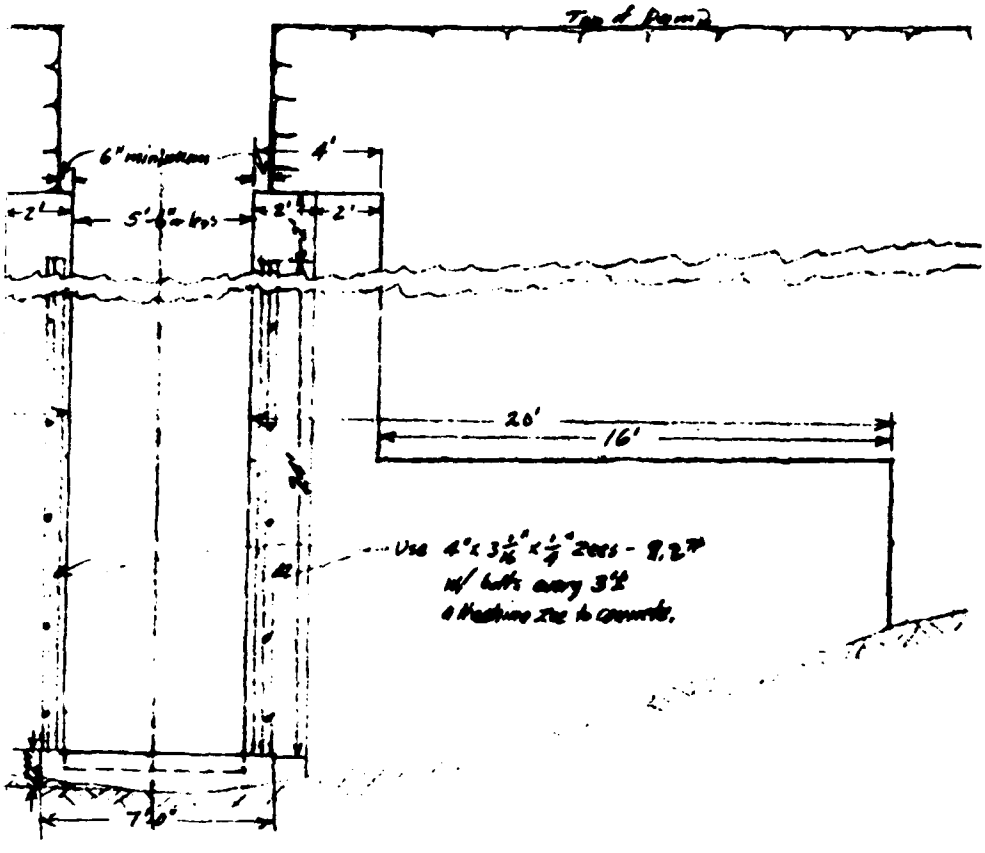
MENDUMS POND NEW HAMPSHIRE

SCALE: NOT TO SCALE

DATE: AUGUST 1978

APPENDIX C

PHOTOGRAPHS



NOTE: Granite block spreaders hold walls apart at various points in intake channel to gates.
Distances shown are approximate as are variables between walls.
Front masonry walls are not truly plumb.

Concrete volume 49 c.y. ± 5% Allow.

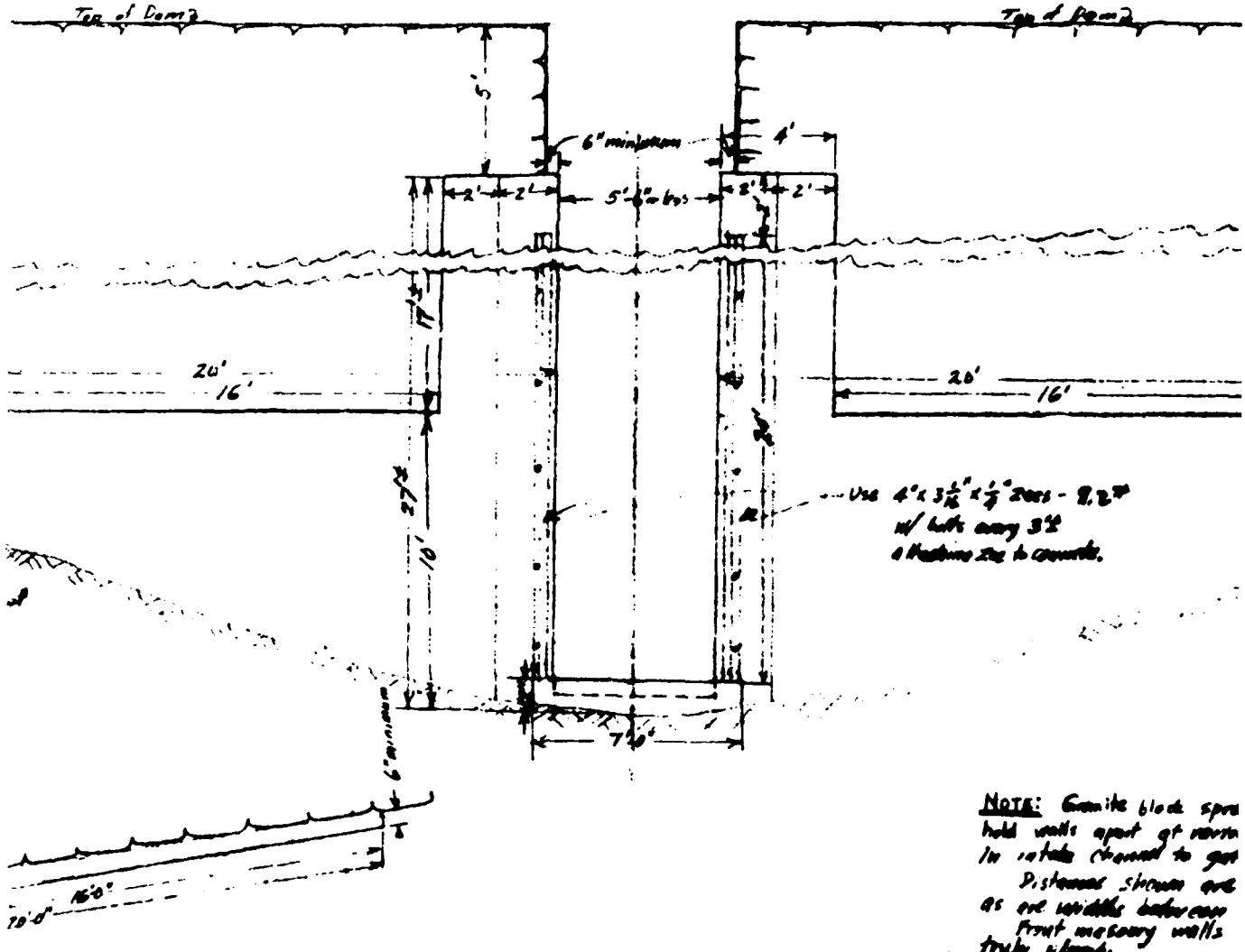
MENDUM'S POND DAM
REPAIRS TO
GATE INLET

NEW HAMPSHIRE
WATER RESOURCES BOARD
CONCORD, N. H.

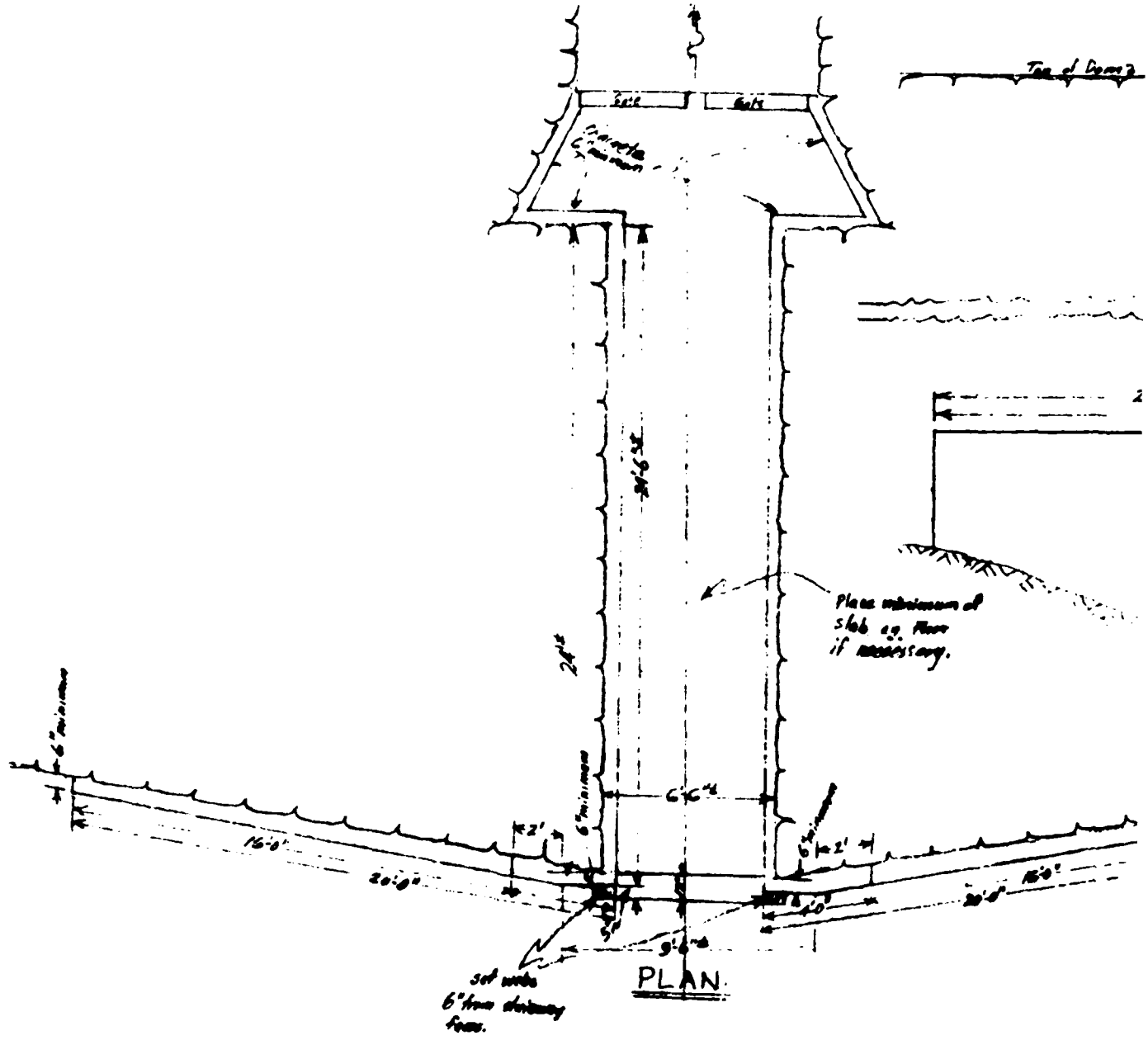
SCALE: 1" = 4'

NOTTINGHAM, N.H.

[illegible]



293

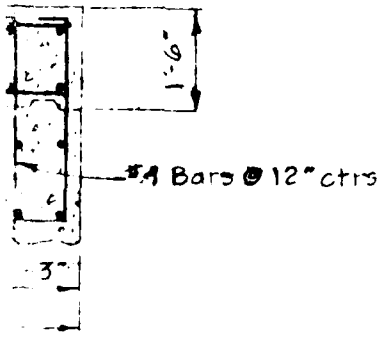


N BY F.C.M

ED BY

193

Bars @ 12" cts. - Top of ftg.
#4 Bars in footing and cutoff.



WAY

REVISED FACING
MENDUMS POND DAM
NOTTINGHAM, N.H.

NEW HAMPSHIRE
WATER RESOURCES BOARD
CONCORD, N. H.

Scale as Shown	DAM No. 184.01	2-16-71

393

Step 2a:
Determine Surcharge Height to pass Qp1 of 4345 cfs.

Trial #1 Assume elevation of 224 MSL

$Q_{\text{OVERFLOW SPILLWAY}} = CLH^{3/2}$
$= 3.0(1.0)(3)^{3/2} + 3.0(25)(5.0)^{3/2} + 3.0(\tfrac{1}{2}7)(5.0)^{3/2}$
$= 16 + 839 + 117$
$= 972$ cfs

Trial #2 Assume elevation of 226.4 MSL

$Q_{\text{OVERFLOW SPILLWAY}} = CLH^{3/2}$
$= 3.0(1)(5.4)^{3/2} + 3.0(25)(7.4)^{3/2} + 3.0(\tfrac{1}{2}11)(7.4)^{3/2}$
$= 38 + 1510 + 332$
$= 1880$ cfs

$Q_{\text{embankment}} = CLH^{3/2}$
$= 2.7(50)(1)^{3/2} + 2.7(170)(1.4)^{3/2} + 2.7(\tfrac{1}{2}20)(1.9)^{3/2} + 2.7(20)(1.7)^{3/2} + 2.7(130)(2.0)^{3/2} + 2.7(15)(1.7)^{3/2}$
$= 135 + 895 + 11 + 120 + 998 + 90$
$= 2309$

$Q_{TOT} = 1880 + 2309 = 4189$

Trial #3 Assume elevation of 225 MSL

$Q_{\text{auxiliary spillway}} = CLH^{3/2}$
$= 3.0(1.0)(4)^{3/2} + 3.0(25)(6)^{3/2} + 3.0(\tfrac{1}{2}8.5)(6)^{3/2}$
$= 24 + 1102 + 187$
$= 1313$ cfs

$Q_{\text{embankment}} = CLH^{3/2}$
$= 2.7(50)(0.4)^{3/2} + 2.7(170)(1.0)^{3/2} + 2.7(90)(0.7)^{3/2} + 2.7(20)(0.2)^{3/2}$
$= 31 + 16 + 113 + 5 = 191$

Trial #4 Assume elevation of 227

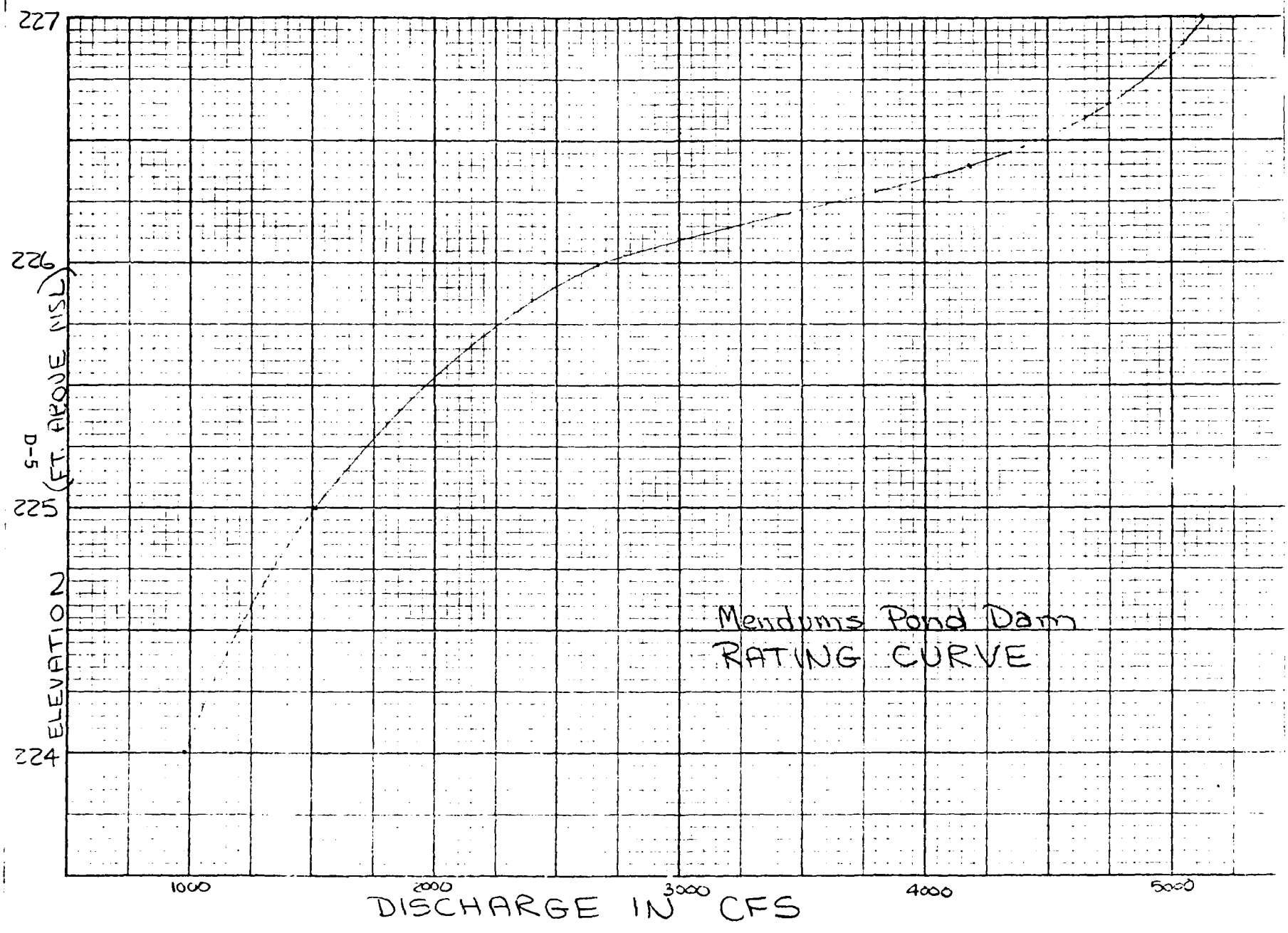
$$Q = 3.0(1)(6)^{3/2} + 3.0(25)(8)^{3/2} + 3.0(\tfrac{1}{2}12)(8)^{3/2}$$
$$= 44 + 1697 + 407$$
$$= 2148 \text{ cfs}$$
$$Q = 2.7(50)(1.5)^{3/2} + 2.7(170)(2.0)^{3/2} +$$
$$2.7(460)(2.0)^{3/2} + 2.7(\tfrac{1}{2}20)(2.5)^{3/2} +$$
$$2.7(150)(0.4)^{3/2}$$
$$= 248 + 1298 + 1222 + 107 + 102$$
$$= 2977$$
$$Q_{TOT} = 5125$$

Trial #5 Assume elevation of 226

$$Q = 3.0(1)(5)^{3/2} + 3.0(25)(7)^{3/2} + 3.0(\tfrac{1}{2}10)(7)^{3/2}$$
$$= 34 + 1389 + 278$$
$$= 1701$$
$$Q = 2.7(50)(0.5)^{3/2} + 2.7(170)(1.0)^{3/2} +$$
$$2.7(150)(1.5)^{3/2} + 2.7(60)(1.2)^{3/2}$$
$$= 48 + 459 + 744 + 213$$
$$= 1464$$
$$Q_{TOT} = 3165$$

Use the above trials to establish a rating curve for Mendenhall Pond.

Surcharge height (elevation) to pass Q_{PI} of 4345 cfs is 226.45


227
226
225
224
ELEVATION (FT. ABOVE MSL)
1000
2000
3000
4000
5000
DISCHARGE IN CFS
Mendums Pond Dam
RATING CURVE

Step #2b.

Determine Volume of Surcharge in Inches of Runoff.

Normal Ac-Ft Storage = 1960 AC-FT
Surface Area = 209 acres (@ 219 MSL)

'Frustum of Pyramid'

$$V = \frac{1}{3} h \left(b_1 + b_2 + \sqrt{b_1 b_2}\right)$$

(h = elev. above normal pool; b_1 = normal pool surface area (acres); b_2 = enlarged surface area (acres))

@ Elev. 220

Surface area = 290 acres

$V = \frac{1}{3} 1 (209 + 290 + \sqrt{209 \times 290})$

$V = 248$ AC-FT

Storage = 2208 AC-FT @ 220 MSL

@ Elev. 240

Surface Area = 423 acres

$V = \frac{1}{3} 21 (209 + 423 + \sqrt{209 \times 423})$

$= 6505$ AC-FT

Storage = 8465 AC-FT @ 240 MSL

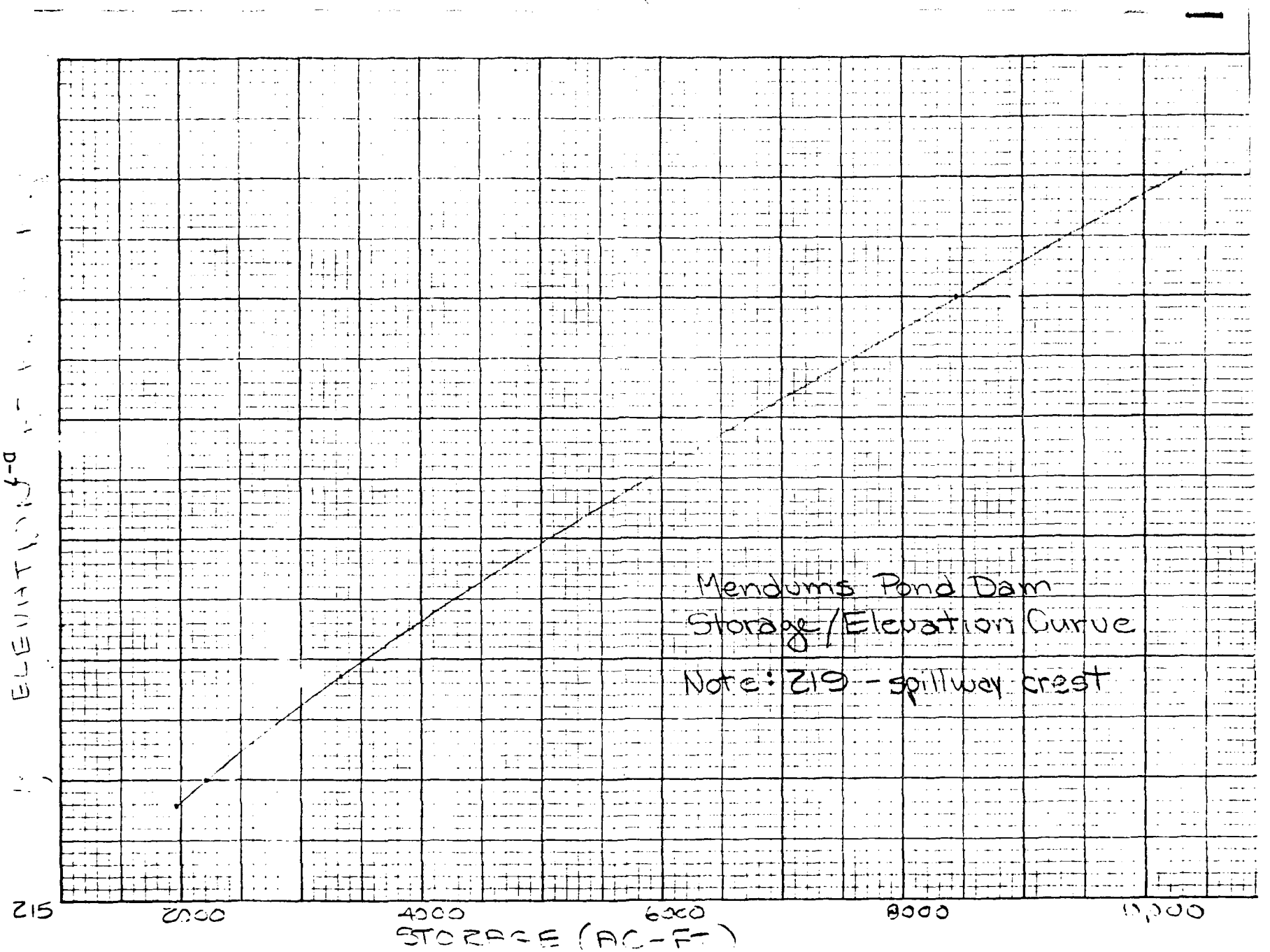
Maximum Storage - Inventory Sheet
@ 224.3 (low point) - 2500 AC-FT
5.3' freeboard - acres 310 ≈ Storage

$V = \frac{1}{3} 5.3 (209 + 310 + \sqrt{209 \times 310})$

$V = 1367$ AC-FT

@ 224.3 Storage = 1960 + 1370 = 3330

Use above data to develop storage vs elevation curve.


Mendums Pond Dam
Storage/Elevation Curve
Note: 219 - spillway crest
ELEVATION (ft)
215
2000
4000
6000
8000
11,200
STORAGE (AC-FT)

@ elev. 226.45 - Volume = 3950 AF
Normal - 1960 ∴ 1990

$1990 \text{ AC-FT} \times \frac{1}{5.43 \text{ mi}^2} \times \frac{1 \text{ mi}^2}{640 \text{ acres}} = 0.57'$
$0.57' \times 12''/\text{ft} = 6.87''$

$Q_{p2} = Q_{p1}\left(1 - \frac{\text{STOR}_1}{19''}\right)$

$= 4345 \text{ cfs}\left(1 - \frac{6.87''}{19''}\right)$
$= 2774 \text{ cfs}$

3a Determine rainfall height to produce Q_p^2 of 2774 cfs
Refer to Rating Curve:
@ 2774 cfs ⇒ elev. 226
Refer to Storage - Elevation Curve:
@ elev. 226 ⇒ storage 3830 AF

$1870 \text{ AC-FT} \times \frac{1}{5.43 \text{ mi}^2} \times \frac{1 \text{ mi}^2}{640 \text{ acres}} = 0.54'$
$0.54' \times 12''/\text{ft} = 6.46''$

3b $\text{STOR}_1 = 6.87''$
$\text{STOR}_2 = 6.46''$
Average = 6.67" or 0.56'

$0.56' \times \frac{5.43 \text{ mi}^2}{1} \times \frac{640 \text{ AC}}{1} = 1930 \text{ AC-FT}$

1930 + 1960 = 3890 AC-FT
Elevation - 226.3' MSL
Discharge - 3825 cfs - Q_p^3

Normal Storage - 1960 ac-ft
Maximum Storage - 3330 ac-ft

Mendums Pond Dam - D/S Hazard Analysis
BREACH @ maximum pool - 224.3' MSL
Storage @ time of failure - 3,330 AF

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

W_b = breach width
g = 32.2 ft/sec^2
y_o = pool elev. - u/s river bed

@ Mendums Pond Dam
W_b = 120'
g = 32.2 ft/sec^2
y_o = 224.3 - 195.5 = 28.8'
From above equation: Q = 31,183

Using typical section for reach establish rating curve.

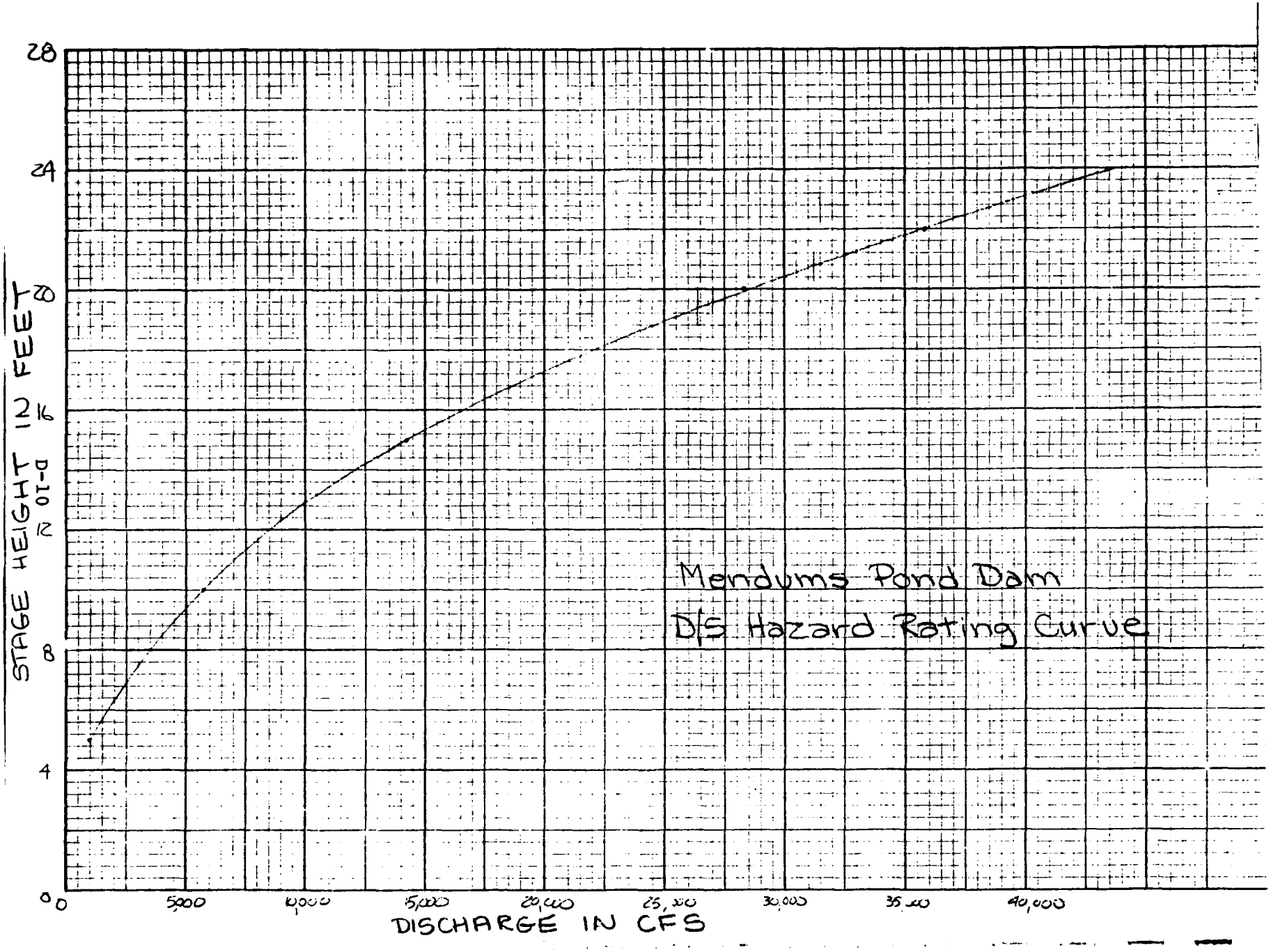
Q @ 31,183 cfs - Stage 20.8'
Reach length - 1843' (dam → Rte. 4)
Area = 8950 ft^2 = 330 AC-FT

$Q_{P_2} = 31,183\left(1 - \frac{330}{3330}\right)$
Q_{P_2} = 27,625 Stage 19.8
Area = 7565 ft^2 = 321 AC-FT

$Q_{P_3} = 31,183\left(1 - \frac{350}{3330}\right)$
= 27,905 cfs
Stage = 19.8'

Antecedent discharge - 1010 cfs - Stage 5.1'

∴ Increase in stage 19.8' - 5.1' = 14.7'
Use 15'


Mendums Pond Dam
D/S Hazard Rating Curve
STAGE HEIGHT IN FEET
DISCHARGE IN CFS
0
4
8
12
16
20
24
28
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000

D-10

Mendums Pond Dam - Gate Capacity
Find total gate capacity with pool @ spillway crest - 219' MSL

Data:
2 gates 1.8'H x 1.5'W ; Invert 209' MSL
1 gate 2'H x 4'W ; Invert 195' MSL
Length - 48'

Lower gate $Q = CA\sqrt{2gh}$

$K_f = \frac{29.1(n^2)L}{R^{4/3}}$ $n = 0.02$, $L = 48'$, $R = A/P = 8/12 = 0.67$

$K_f = 0.95$

Entrance & exit losses = 1.10 ∴ Tot K = 2.05

$2.05 = \frac{1}{C^2}$ $2.05C^2 = 1$ $C^2 = 0.49$ $C = 0.70$

Q capacity @ 219' MSL:

$Q = (0.70)(8)(\sqrt{2(32.2 \times 23)}$
$= 216$ cfs

Upper Gates

$K_f = \frac{29.1(n^2)L}{R^{4/3}}$ $n = 0.02$, $L = 48'$, $R = A/P = 2.7/5.6 = 0.48$

$K_f = 1.49$

Entrance & exit losses = 1.10 ∴ Tot K = 2.59

$2.59 = \frac{1}{C^2}$ $2.59C^2 = 1$ $C = 0.62$

Q capacity @ 219' MSL:

$Q = (0.62)(2.7)(\sqrt{2(32.2 \times 9.1)}$
$= 41$ cfs

Two gates = 41 x 2 = 82 cfs

Total gate capacity = 298 ≈ 300 cfs

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS