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NEW ENGLAND DIV JUN 78

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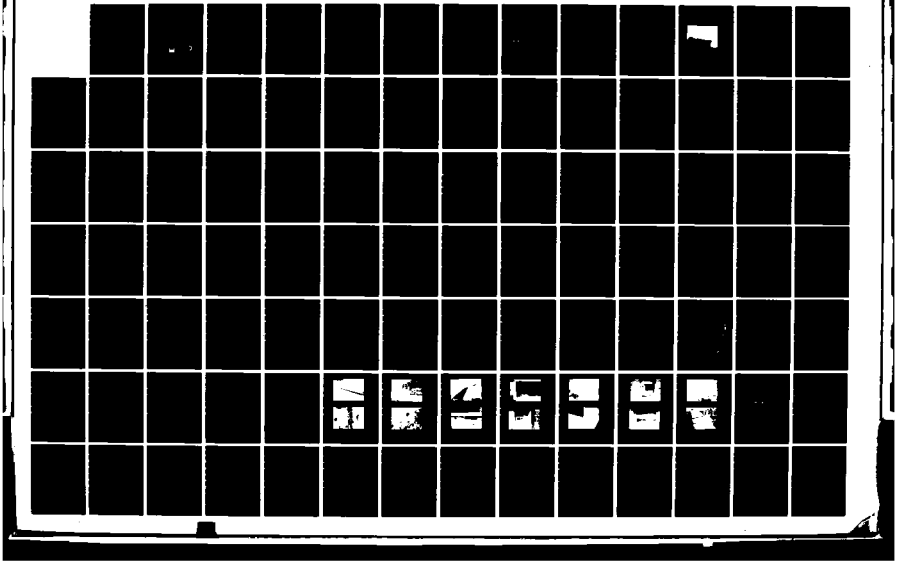

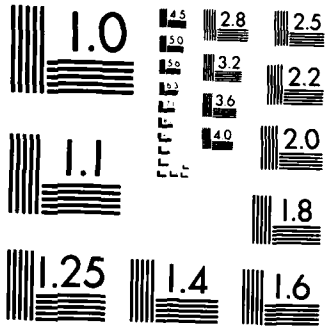

PISCATAQUA RIVER BASIN
NOTTINGHAM, NEW HAMPSHIRE

DOLLOFF DAM
NH 00134

STATE NO 184.02

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

JULY 1978

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NH 00134	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* Dolloff dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE July 1978 13. NUMBER OF PAGES 57
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

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

DAMS, INSPECTION, DAM SAFETY,

Piscataqua River Basin
Nottingham, New Hampshire
Tributary of Pawtucketway River

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

The dam is 27 ft. high and 414 ft. long. It is an earthen embankment contained between certical dry masonry (stone) wall. The dam is in fair condition. The spillway capacity of the impounding system is inadequate. The downstream berms are sluffing. The test flood would overtop the dam by 3.5 ft. at the lowest point of the crest.

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

REPLY TO

NEDED-E

SEP 8 1979

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

Dear Governor Gallen:

Inclosed is a copy of the Dolloff Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis. A brief assessment is included at the beginning of the report.

The preliminary hydrologic analysis has indicated that the spillway capacity for the Dolloff Dam would likely be exceeded by floods greater than 26 percent of the Probable Maximum Flood (PMF), the test flood for spillway adequacy. Our screening criteria specifies that a dam of this class which does not have sufficient spillway capacity to discharge fifty (50) percent of the PMF, should be adjudged as having a seriously inadequate spillway and the dam assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The term "unsafe" applied to a dam because of an inadequate spillway does not indicate the same degree of emergency as that term would if applied because of structural deficiency. It does indicate, however, that a severe storm may cause overtopping and possible failure of the dam, with significant damage and potential loss of life downstream.

It is recommended that within twelve months from the date of this report the owner of the dam engage the services of a professional or consulting engineer to determine by more sophisticated methods and procedures the magnitude of the spillway deficiency. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed. During periods of unusually heavy precipitation, round-the-clock surveillance should be provided.

NEDED-E
Honorable Hugh J. Gallen

I have approved the report and support the findings and recommendations described in section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the non-Federal Dam Inspection Program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire, and the owner of the project.

Copies of this report will be made available to the public, upon request to this office, under the Freedom of Information Act, thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for the cooperation extended in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	NH00134
Name of Dam:	Dolloff Dam
Town:	Nottingham
County and State:	Rockingham County, New Hampshire
Stream:	Tributary of Pawtuckaway River
Date of Inspection:	31 May 1978

BRIEF ASSESSMENT

Dolloff Dam is 27 feet high, 28 feet wide, and 414 feet long. It is an earthen embankment contained between vertical dry masonry (stone) walls. The downstream face has 4 levels of rock-berm buttresses, the upstream face has one berm. The upstream face and berm were refaced with concrete in 1964. Appurtenant structures include: an uncontrolled spillway, a stoplog spillway, and a low-level gated outlet with a mechanical lifting mechanism. Dolloff Dam, with Drown's Dam and Gove Dike, impound Pawtuckaway Pond. The pond now is used for recreation; it is 3 miles long, and has a 900-acre surface. Maximum storage is 11,700 acre-feet.

Dolloff Dam, at least 136 years old, is in fair condition. The spillway discharge capacity of the impounding system is inadequate. Seepages at the downstream toe discharge about 0.02 cfs, and leakage in the gate control shaft amounts to about 5 cfs. The downstream berms are sluffing. The possible existence of a concrete liner on the upstream side of the downstream wall makes stability questionable.

The stoplog and ungated spillway will pass 2,900 cfs, or about 26 percent of the test flood. The test flood would overtop the dam by 3.5 feet at the lowest point of the crest.

The owner, New Hampshire Water Resources Board (NHWRB) should, within two years, implement the results of the following recommendations: evaluate further all factors relating to overtopping and the inadequacy of the spillways of the impoundment system, design or specify remedial measures to control seepages and leakages, repair the downstream berms, and investigate the existence of the concrete liner and evaluate, if present. Within one year, NHWRB should implement the following operating and maintenance measures: monitor seepages and leakages weekly, clear trees and brush to about 50 feet downstream, and establish a round-the-clock surveillance and warning program to be exercised during floods.

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

This Phase I Inspection Report on Dolloff 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

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

Fred J. Ravens Jr.

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

Saul Cooper

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

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

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

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

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

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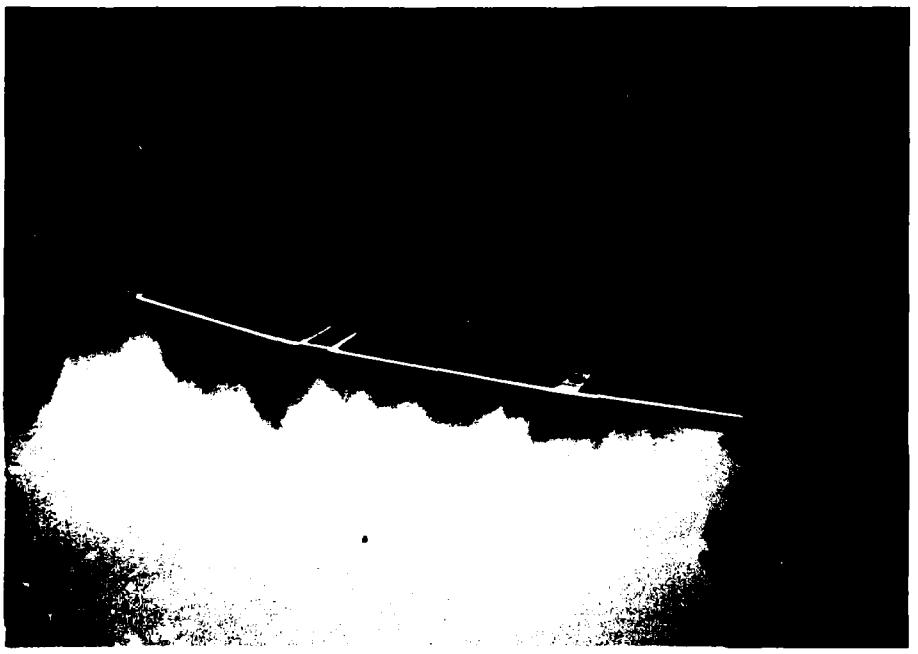
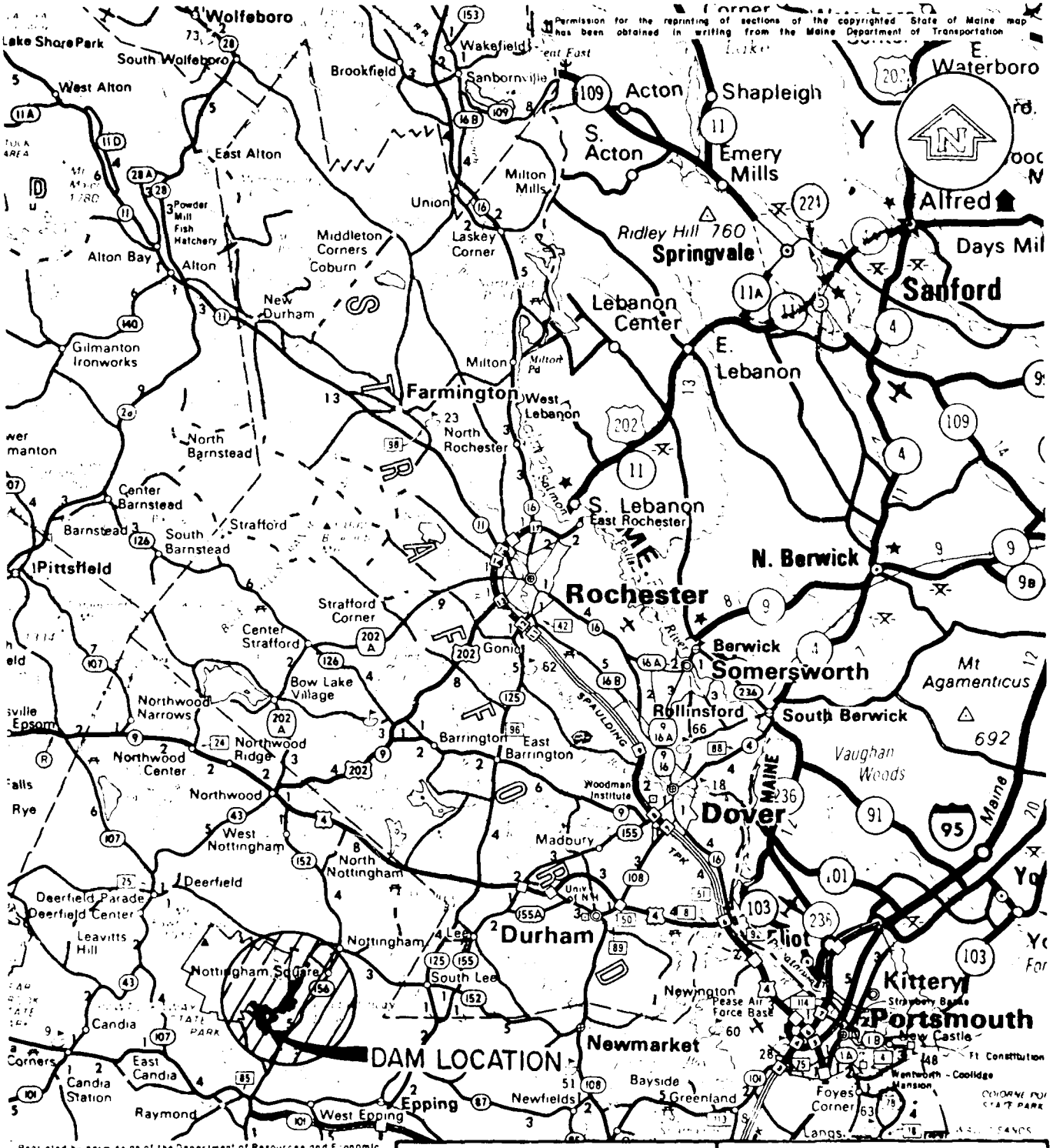


Figure 1 - Overview of upstream face of Dolloff Dam.



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

SCALE IN MILES

5 0 5

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

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

DOLLOFF DAM
LOCATION MAP

PAWTUCKAWAY POND NEW HAMPSHIRE

SCALE: 1" = 5Mi.

DATE: JULY 1978

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
DOLLOFF 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 & Company, Inc. 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. Dolloff Dam is located in the Town of Nottingham, New Hampshire. Dolloff Dam spans the Pawtuckaway River, a major tributary in the Lamprey River Basin. The dam is about 3 miles above the confluence with the Lamprey River, a major tributary in the Piscataqua River Basin. The dam is shown on U.S.G.S. Quadrangle, Mt. Pawtuckaway, New Hampshire with coordinates approximately at N 43° 04', 22", W 71° 09', 06", Rockingham County, New Hampshire. (See Location Map page iv.)

indicating that a 2-foot thick "cement wall" was constructed on the upstream side of the vertical dry masonry wall at the downstream side of the crest of the dam. The existence of such a wall could not be verified during the inspection. If the wall does exist and it is intact, it would tend to reduce the stability of the dam because the full hydrostatic head of the reservoir would act directly against the downstream vertical dry masonry wall and its reinforcing berms. No other design and construction data pertinent to the stability of the dam were available.

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

d. Post-Construction Changes. Prior to the ownership by the Lamprey River Improvement Company, a second gated outlet was built where the stoplog section is today. In 1956, ledge was removed from the spillway area, increasing its capacity; the second gated outlet was replaced with a stoplog section.

The upstream side was refaced with concrete in 1964. The concrete walkway was constructed in 1970. Dolloff Dam was again rehabilitated in 1974. Work included concrete refacing of the upstream side and the reconstruction of the stoplog section to its present day condition.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations.

(1) Embankment. Visual observations indicated that some deterioration of the rock berms has occurred on the downstream face of the dam, as evidenced by holes in the top of the uppermost berm at one location and a fallout of rock from the face of the upper berm at a second location. The extent of the deterioration is not considered serious in the present condition, but the stability of the dam would be adversely affected if the deterioration continued. A total of three holes in the berms to the right of the stoplog spillway were noted. A portion of a timber remaining in one of them indicates that they may have been a part of the original construction and that the holes contained large timbers that may have been used as bracing for the main wall. A wet spot was noted near the downstream toe of the dam at one location, and concentrated seepage was discharging at the base on the northeast sidewall of the stoplog spillway. Southwest of the low-level gated outlet, water was discharging from the lowest rock berm at the downstream face of the dam, but it could not be determined that this water was seepage under and/or through the dam or whether it was the result of lateral flow of water from the nearby low-level gated outlet channel.

(2) Appurtenant Structure Visual inspection of the overflow spillway, stoplog section, and control-shaft portions of the dam did not reveal any evidence of instability. The following conditions as previously described could cause structural instability if left uncorrected:

(a) The substantial leakage through the stone masonry at the outlet control shaft and the wooden sluice gate.

(b) The major crack in the left end of the left overflow spillway bridge deck. The crack through the deck has effectively eliminated the capacity of the deck to resist vertical shear at that support. Although this would not influence the stability of the dam it represents a safety hazard to personnel and equipment crossing the bridge.

b. Design and Construction Data. A report dated December 5, 1918, shows a cross-section sketch of the dam

SECTION 5
HYDROLOGY AND HYDRAULIC ANALYSIS

5.1 Evaluation of Features

a. Design Data. No original hydrologic and hydraulic design data (1839-1842) were found for the structures impounding Pawtuckaway Pond. However, hydrologic and hydraulic information dating from the ownership by the Lamprey River Improvement Company to the present ownership by the New Hampshire Water Resources Board, were found and assessed to determine their acceptability in evaluating the overtopping potential of Dolloff Dam.

Dolloff Dam is classified as being intermediate in size having a maximum storage of 11,700 acre-feet.

To determine the hazard classification for Dolloff 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 extending from the dam to the village of West Epping, a distance of about 3 miles. Failure of Dolloff Dam at maximum pool would probably result in an increase in stage of 12.5 feet along the reach. An increase in water depth of this magnitude would probably result in the loss of more than 10 lives and sever State Route 156, a village road, inundate several houses and cause appreciable damage to any agricultural lands in the reach.

As a result of the analysis described above, Dolloff Dam was classified - High Hazard. Using OCE Recommended Guidelines for Safety Inspection of Dams, the recommended spillway test flood is the Probable Maximum Flood. The test flood discharge for Pawtuckaway Pond, having a drainage area of 20.66 square miles, was determined to be 11,200 cfs.

b. Experience Data. No information regarding past overtopping of the structure was found.

c. Visual Observations. No visual evidence was found of damage to the structure caused by overtopping at the time of the inspection.

d. Overtopping Potential. Dolloff Dam, in conjunction with Gove Dike and Drown's Dam, is unable to pass the test flood without overtopping. The water depth over the lowest point was calculated to be 3.5 feet. The stoplog and ungated spillway will pass 26% of the test flood.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

The New Hampshire Water Resources Board has operated the pond since 1955. The level of Pawtuckaway Pond is controlled by discharge through Dolloff and Drown's Dam. Gove Dike, the third impounding structure, has no outlet facilities.

Drown's Dam usually has all its stoplogs in position, allowing for control of the water level through Dolloff Dam. The sluice gate at Dolloff Dam is normally closed. The New Hampshire Water Resources Board uses the gate only to drain the pond as required. The lake level is controlled through the stoplog spillway at Dolloff Dam. Pond elevation during the recreational season is maintained reasonably constant at 250 feet MSL. In the fall, the level is drawn down, allowing abutters to make improvements to their shoreline and providing some storage for flood runoff.

4.2 Maintenance of Dam

Dolloff 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 reported that the sluice gate at Dolloff Dam is only operated when the level of the reservoir can be sufficiently lowered to permit complete reseating of the gate. If the gate is opened when the reservoir is full it can not be closed and reseated to obtain a complete seal.

4.4 Description of Any Warning System in Effect

No written warning system was disclosed for Dolloff Dam.

4.5 Evaluation

The operation and maintenance procedures for Dolloff Dam, consisting of a weekly program of inspection, should insure that all normal 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.

problems observed during the visual inspection are:

(a) seepage at the downstream toe of the dam,

(b) one hole and one fallout of rock in the uppermost rock berm on the downstream side of the dam,

(c) seepage at the downstream toe of the sidewall on the northeast side of the stoplog-spillway channel,

(d) leakage of the low-level sluice gate,

(e) minor bulging and tilt of the vertical dry masonry wall on the downstream side of the dam,

(f) cracks, spalling and small leaks in the concrete around the stoplog spillway,

(g) major structural crack in the service bridge across the concrete overflow spillway,

(h) rusting of the I-Beam support at the center of the service bridge, and

(i) potential for overtopping.

in each downstream abutment wall was observed. Seeps in both walls were emanating from construction joints near the channel floor. Minor spalling was noted at the base of the right side wall. (See Appendix C - Figure 11.) The concrete service bridge and steel railings were observed to be in good condition.

The dam's low-level gate structure, located approximately 240 feet from the left dam abutment, is reported to contain a wooden gate approximately 3' high by 4' wide. The gate can be raised by a mechanical operating mechanism at the top of the dam. The New Hampshire Water Resources Board would not permit inspection or operation of the gate during the summer recreational season. The control shaft, which houses the gate and operating mechanism, is an integral part of the dam embankment. The support structure is stone dry wall masonry faced with reinforced concrete on the upstream side. At the time of the inspection, substantial leakage was observed around the wooden gate, and numerous large leaks were flowing with considerable velocity through cracks in the downstream control shaft sidewalls. (See Appendix C - Figure 12.) The discharge water was clear. The largest of the sidewall leaks were concentrated through several cracks between the stone masonry. Two of the granite support struts are broken.

d. Reservoir Area. The reservoir slopes are predominantly gentle and are covered with trees and brush. (See Appendix C - Figure 13.) Numerous cottages and homes have been built along the southeast portion of the perimeter of the reservoir. Little sedimentation was observed in the reservoir. About six inches of sediment covered the bottom of the sluiceway.

e. Downstream Channel. The channels downstream of both the concrete overflow spillway (see Appendix C - Figure 14.) and the stoplog spillway appear to be in bedrock. The bottom of the channel downstream of the gated low-level outlet is covered with rocks and it is not known whether the channel is immediately underlain by bedrock. (See Appendix C - Figure 15.) All three channels are clear of trees and brush for a short distance downstream of the dam, but are bordered by brush and trees further downstream. Some debris, consisting of rocks, logs, and brush was found in all three channels.

3.2 Evaluation

The observed condition of the dam is fair. The potential

About 35 feet southwest of the gated low-level outlet, a number of boulders appear to have fallen out of the face of the uppermost rock berm on the downstream side of the dam. These boulders are now lying in a pile at the bottom of the berm.

The rock berms on the downstream side of the dam are generally free of vegetation.

c. Appurtenant Structures. Access to the top of the dam is across a concrete service bridge over the overflow spillway. (See Appendix C - Figure 6.) The bridge consists of two simple spans. The concrete deck is supported in the center with a steel wide-flange beam spaced between the top of a concrete pier and the underside of the deck. (See Appendix C - Figure 7.) The wide-flange beam has not been painted and is rusting. There is a hairline crack through the left deck section at the left abutment. (See Appendix C - Figure 8.) The service bridge railing is painted steel with little evidence of corrosion. The expansion joint in the deck at the center pier is in fair condition and has some evidence of deterioration.

The forty-two foot section of concrete overflow spillway is in good physical condition. Surface laitance of the concrete has disappeared but no cracks in the weir or training walls were noted. A few loose stones and a small amount of debris were noted in the downstream channel. The upstream approach channel slopes gently to the spillway with a sand and gravel bottom. The capped pipes cast into the spillway crest are good condition except for surface rust. The visual inspection did not reveal the actual purpose of these pipes.

The lake level is primarily maintained by a 13'-4" wide by 11' - 7" high removable stoplog section located approximately 100 feet from the left abutment. (See Appendix C - Figure 9.) The wood stoplogs appeared in good condition, however, numerous leaks were noted. The stoplogs were leaking at the joints between the planks and at the seats between planks and vertical supports. The two center steel uprights have not been painted and are showing evidence of corrosion. Leaching and wet spots were observed at least in five concrete form tie-holes up to 3 feet above the channel bottom. A hairline crack was visible in the left channel wall located below the service bridge in the top third of the wall. The crack was dry at the time of the inspection and showed no evidence of previous leakage. Minor spalling of concrete was observed at the base of the left side wall near the downstream corner.(See Appendix C - Figure 10.) Minor seepage

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Dolloff Dam is one of three structures (the others being Drown's Dam and Gove Dike) that impound Pawtuckaway Pond. The pond level is controlled by both Dolloff and Drown's Dams; Gove Dike has no control or outlet structures.

b. Dam. The dam is about 414 feet long, 27 feet high, and 28 feet wide at the crest. (See Appendix C - Figures 2, 3, and 4.) The crest of the dam is covered with grass.

The top of the concrete facing on the upstream side ranges from 3.34 feet to 4.7 feet above pond level. Eleven vertical hairline cracks were found on the top of the facing, with a maximum width of about 1/10 inch and spaced 13 to 60 feet apart. Some efflorescence was visible at the cracks.

A wet spot and some standing water were observed at a point about 8 feet downstream of the toe of the dam, and 40 feet southwest of the overflow spillway. No visible flow of water was taking place at the time of the inspection, and no signs of sediment discharge were found at this location.

About 50 feet southwest of the channel downstream from the low-level outlet, water was flowing from the base of the lowest rock berm at the toe of the dam. It is not apparent whether this water was flowing through and/or under the dam, or whether it was flowing laterally from the low-level outlet discharge channel and exiting under the rocks at the toe of the dam.

Some minor bulging and tilt were noted in the top part of the vertical dry masonry wall that is exposed above the rock berms on the downstream face of the dam.

The downstream berms have three holes to the right of the low-level outlet. (See Appendix C - Figure 5.) A portion of an old timber remains in one of the holes. Apparently, the holes were part of the original construction and contained large timbers that may have been used as bracing for the main wall. The alignment of the holes indicates that the timbers were placed at about a 45^{o} vertical angle from the base.

SECTION 2
ENGINEERING DATA

2.1 Design

No original design data were disclosed for Dolloff 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. Dunham's report contains a sketch of a cross section copied from a report by W.M. Oliver, C.E. to Newmarket Manufacturing Co., dated 1889. (See Appendix B.)

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. Little engineering data were disclosed for Dolloff 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 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 concrete facing and spillways. 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.)

(6) Zoning - unknown

(7) Impervious core - unknown (see 6.1 b.)

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - A slot through the dam, at the right one-third point, constructed with stone masonry forms the control shaft supporting the sluice gate. A 4-foot wide by 7-foot high portal on the downstream side provides access to the sluice gate and shaft, and releases the sluice discharge water. A shaft at about the middle of the dam's cross-section, covered by a locked housing, contains the lifting mechanism for a sluice gate which is estimated to be 4 feet wide by 3 feet high.

i. Spillway

(1) Type - Ungated and stoplog

(2) Length of weir - 42' (ungated); 13' (stoplog)

(3) Crest elevation - 250' MSL (ungated); 238' MSL (all stoplogs removed)

(4) Gates - none

(5) U/S Channel - Pawtuckaway Pond

(6) D/S Channel - The channels downstream of both the concrete overflow spillway and the stoplog spillway appear to be in bedrock. The bottom of the channel downstream of the gated low-level outlet is covered with rocks and it is not known whether the channel is immediately underlain by bedrock.

(7) General - 4' wide concrete slab access bridges over each spillway.

(6) Upstream portal gated outlet - 237.2

(7) Streambed at centerline of dam - 235 (downstream toe as measured at time of inspection)

(8) Maximum tailwater - unknown

d. Reservoir (miles)

(1) Length of maximum pool - 3.0

(2) Length of recreation pool - 3.0

(3) Length of flood control pool - not applicable

e. Storage (acre-feet)

(1) Recreation pool - 11,500

(2) Flood control pool - not applicable

(3) Design surcharge - unknown

(4) Top of dam (low point of embankment) - 11,700

f. Reservoir Surface (acres)

(1) Top of dam - 985

(2) Maximum pool - 975

(3) Flood Control pool - not applicable

(4) Recreation pool - 903

(5) Spillway crest - 210

g. Dam

(1) Type - earthen embankment with both upstream and downstream sides faced by nearly vertical dry masonry walls; both faces being buttressed by terraced berms. The upstream wall and berm has been faced with concrete along the right two-thirds of the embankment.

(2) Length - 414' (field measured)
- 377' (from past inspection reports)

(3) Height - 27' (structural height)

(4) Topwidth - approximately 28'

mechanical lifting device for the gate is covered by a locked canopy. The New Hampshire Water Resources Board indicates that the mechanical lifting device is in good working condition but they would not permit its inspection or demonstrate its operation during the summer recreational season. They reported that if the gate were lifted, it would not be possible to lower and reseat the gate. Presumably, reseating is not possible because of the water pressure and condition of the gate. As such, the gate operation was not verified during the inspection.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 20.66 square miles (13,225 acres) of predominantly wooded terrain.

b. Discharge at Damsite.

(1) Outlet works (gated outlet) - 300 cfs @ maximum pool elevation (252.7' MSL).

(2) Maximum known flood at damsite is unknown.

(3) Ungated spillway capacity at maximum pool elevation - 690 cfs @ elev. 252.7' MSL.

(4) Stoplog spillway capacity at recreational pool elevation (250' MSL) is estimated to be 1630 cfs (assuming removal of all stoplogs.)

(5) Stoplog spillway capacity at maximum pool elevation - 2210 cfs @ elev 252.7' MSL

(6) Total spillway capacity at maximum pool elevation - 2900 cfs @ elev. 252.7' MSL

c. Elevation (ft. above MSL based on elevation of 250 shown on U.S.G.S. Quadrangle sheet and assumed to be spillway elevation at Dolloff Dam, Pawtuckaway Pond)

(1) Top of Dam - 252.7

(2) Maximum pool - design surcharge - unknown

(3) Full flood control pool - not applicable

(4) Recreation pool - 250

(5) Spillway crest (gated) - 238 (assuming all stoplogs removed)

g. Purpose of Dam. The dike and dams impounding Pawtuckaway Pond were originally constructed to provide greater industrial storage for the Newmarket Manufacturing Company located in Newmarket, New Hampshire. Under the ownership of the Lamprey River Improvement Company, Pawtuckaway Pond was utilized primarily as an upstream storage for generation of hydroelectricity for the region, with some recreational usage. Pawtuckaway Pond is presently being used only for recreational purposes.

h. Design and Construction History. Little information was found concerning the original design and construction of the dam. A 1918 report (see Section 2) contains a sketch copied from an 1889 report that indicates that the structure is basically an earth fill dam faced with vertical dry masonry walls, the downstream of which is separated from the earth fill by a concrete wall. The dam is buttressed along both the upstream and downstream faces.

Sometime after construction of the dam and prior to the ownership by the Lamprey River Improvement Company, a second gated outlet was built where the stoplog section is today. In 1956, ledge was removed from the spillway area, increasing its capacity; the second gated outlet was replaced with a stoplog section.

The upstream side was refaced with concrete in 1964. The concrete walkway was constructed in 1970. Dolloff Dam was again rehabilitated in 1974. Work included concrete refacing of the upstream side and the reconstruction of the stoplog section to its present day condition.

i. Normal Operational Procedures. Pawtuckaway Pond is controlled by discharge through Dolloff and Drown's Dam. Normal pool elevation is 250+ MSL. Usually, pond level is maintained through manipulation of the stoplog level at Dolloff Dam, with all the stoplogs in position at Drown's Dam. No formal operation and maintenance procedures were disclosed; however, the dams are visited on a weekly basis by the New Hampshire Water Resources Board.

j. Regulating Outlets. The stoplog section is a separate outlet section located at about the left one-third point of the dam. It consists of a concrete slab apron with three sets of stoplogs arranged with a 4'-8" center section and 4'-4" sections on either end, totaling 13'-4" in width. The stoplogs are 4" x 8". The stoplog section is spanned by a footbridge 4' x 16'. In addition to the stoplog section, a wooden-gated sluice drain is located at the right one-third point. The gate is estimated to be 4' wide by 3' high. A

b. Description of Dam and Appurtenances. Dolloff Dam is the primary controlling dam in the three structure system that impounds Pawtuckaway Pond. Drown's Dam and Gove Dike are the other two structures. Dolloff Dam consists of an earthen embankment placed between vertical dry masonry walls. The downstream wall has four levels of rock berms. The upstream wall has a single berm, and both wall and berm have been faced with concrete. The dam is about 414 feet long, 27 feet high, and 28 feet wide at the crest. (See plans and sketches in Appendix B.) The crestline from left to right looking downstream can be described as follows: (1) To the left of the left abutment is a 40-foot section of natural ground that is lower than any point in the crestline of the embankment. (2) Forty-two foot section of concrete overflow spillway is adjacent to the left abutment. The crest of this spillway contains a series of 1½-inch (I.D.) capped iron pipes, spaced about 3 feet apart. These pipes presumably were placed to support temporary stoplogs. (3) About 120 feet to the right of this spillway is a second concrete spillway about 13 feet wide fitted with three sets of stoplogs. (4) About 120 feet right of the stoplog spillway is a gated sluiceway fitted with a wooden gate estimated to be 3 feet high by 4 feet wide. It is raised and lowered by a mechanical device (shown as a rack and pinion in a sketch by the NHWRB). The portal of the sluiceway on the downstream face is about 3 feet wide and 7 feet high. (5) The crestline then continues toward the right abutment for about 132 feet meeting natural ground.

c. Size Classification. Intermediate (Hydraulic height-21 feet, Storage - 11,700 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. High hazard. A major breach in the dam would probably result in the loss of more than 10 lives and appreciable property damage.

e. Ownership. Dolloff Dam, along with Drown's Dam and Gove Dike, are reported to have been built sometime between the years 1839 and 1842 by the Newmarket Manufacturing Company for the purpose of impounding Pawtuckaway Pond for use in their milling operations. Ownership passed onto the Lamprey River Improvement Company, a subsidiary of New Hampshire Gas and Electric Company, sometime prior to 1917. The New Hampshire Water Resources Board purchased the three structures for one dollar in 1955 from the New Hampshire Gas and Electric Company.

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

SECTION 7
ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

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

(1) Overtopping potential

(2) Seepage at the toe of the dam and at the downstream toe of the northeast wall of the stoplog spillway.

(3) Deterioration of the rock berms on the downstream face of the dam where three timber braces have rotted out and the holes have partially collapsed.

(4) Bulging and tilt of the vertical dry masonry wall that projects above the uppermost rock berm on the downstream face of the dam.

(5) Leakage into the control shaft of the gated low-level outlet.

(6) Cracks in the upstream concrete facing.

(7) The possible existence and unknown condition of a concrete wall just inside of the downstream dry masonry wall.

(8) Major crack in the left end of the overflow spillway concrete service bridge.

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 recommended remedial measures enumerated in 7.2 and 7.3 below should be implemented within one year.

d. Need for Additional Investigation. The information available from the visual inspection indicates that the potential problems are overtopping, seepage, deterioration of the downstream rock berms, and leakage into the control shaft of the gated low-level outlet. These problems require the attention of a competent engineer to design or specify

remedial measures to rectify the problems. If left unattended, the problems could lead to instability of the structure. Visual inspection could not verify or disprove the existence of the concrete liner on the interior of the downstream face. Therefore, additional investigations are needed to determine the presence and condition of the liner. These data are necessary to evaluate the structural stability of the dam.

7.2 Recommendations

The New Hampshire Water Resources Board should accomplish the remedial measures resulting from the following:

(a) Evaluate further the potential for overtopping and the inadequacy of the spillway for the total impoundment system of Pawtuckaway Pond.

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

(c) Design and reconstruct the deck of the service bridge. The steel wide flange beam at the center support should be reinforced with web and flange stiffeners.

(d) Determine the existence and condition of the concrete liner wall within the dam, and if it exists, evaluate further the stability of the dam.

(e) Specify the repairs to seal the cracks in the concrete facings.

7.3 Remedial Measures

a. Alternatives. The New Hampshire Water Resources Board should consider as an alternative pending implementation and results of the recommendations above that the reservoir be operated at a lower level during the year so as to provide more storage for extreme flood events.

b. Operation and Maintenance Procedures.

(1) Seepage and leakage at the toe of the dam and at the toe of the stoplog spillway should be monitored on a weekly basis.

(2) Trees and brush should be cleared from an area about 50 feet downstream of the dam.

(3) Deterioration of the rock berms should be remedied by periodic maintenance.

(4) The New Hampshire Water Resources Board should develop a written operational procedure to follow in the event of flood flow conditions or imminent dam failure that should include round-the-clock surveillance and a warning system. The warning system should be included also in the written procedures 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.

(5) The minor bulging and tilt of the vertical downstream dry masonry wall should be monitored and remedial action taken, if needed.

(6) Cracks and spalling in the concrete of the stoplog section should be repaired.

(7) The sluice gate should be repaired or replaced to permit operation at all times and proper reseating and sealing under full head of water.

APPENDIX A

CHECK LIST - VISUAL INSPECTION

VISUAL INSPECTION CHECK LIST

PARTY ORGANIZATION

PROJECT Dolloff Dam, New Hampshire

DATE May 31, 1978

TIME 10:00 A.M.

WEATHER Sunny, warm

W.S. ELEV. 250.1 U.S. 231.5 DN.S.

PARTY:

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

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydraulic/Hydrologic	R.C. 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 Dolloff Dam, New Hampshire DATE May 31, 1978

PROJECT FEATURE Dam Embankment NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	253.
Current Pool Elevation	Gage reading 25.1 (250.1 MSL) (assumed)
Maximum Impoundment to Date	Unknown
Surface Cracks	None visible, crest is grass-covered
Pavement Condition	Not paved
Movement or Settlement of Crest	None
Lateral Movement	None for upstream concrete wall. Local minor bulging and tilt of downstream dry masonry wall.
Vertical Alignment	Good
Horizontal Alignment	Good. See "Lateral Movement" above.
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	None
Trespassing on Slopes	None
Sloughing or Erosion of Slopes or Abutments	Some rocks in downstream berm appear to have been moved to downstream toe about 280' east of overflow spillway.
Rock Slope Protection - Riprap Failures	One hole in top of upper downstream berm about 270' east of overflow spillway.
Unusual Movement or Cracking at or near Toes	See "Sloughing..." above.
Unusual Embankment or Downstream Seepage	None
Piping or Boils	Standing water about 8 ft. from downstream toe 40 ft. east of overflow spillway. Possible seepage at downstream toe east of low-level outlet.
Foundation Drainage Features	None known
Toe Drains	None known
Instrumentation System	None known

PERIODIC INSPECTION CHECK LIST

PROJECT Dolloff Dam, New Hampshire DATE May 31, 1978

PROJECT FEATURE Intake Structure NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	N.A. Low-level outlet and stoplog spillway are incorporated into face of dam.
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	Good
Stop Logs and Slots	Leaking between planks

PERIODIC INSPECTION CHECK LIST

PROJECT Dolloff Dam, New Hampshire DATE May 31, 1978

PROJECT FEATURE Outlet Works NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good
Spalling	None
Visible Reinforcing	None
Rusting or Staining of Concrete	None
Any Seepage or Efflorescence	Substantial leakage through stone masonry around tower and gate works.
Joint Alignment	No visible movement
Unusual Seepage or Leaks in Gate Chamber	Gate chamber not visible.
Cracks	Between stone masonry
Rusting or Corrosion of Steel	None
b. Mechanical and Electrical	Canopy locked. NHWRB would not open at time of inspection. Mechanical system not visible.
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 Dolloff Dam, New Hampshire DATE May 31, 1978

PROJECT FEATURE Outlet Works NAME

DISCIPLINE NAME

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

PERIODIC INSPECTION CHECK LIST

PROJECT Dolloff Dam, New Hampshire DATE May 31, 1978

PROJECT FEATURE Sluice Gate Outlet NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	LOW-LEVEL OUTLET
General Condition of Concrete	Constructed of stone masonry.
Rust or Staining	None
Spalling	None
Erosion or Cavitation	None
Visible Reinforcing	None
Any Seepage or Efflorescence	Substantial leakage through stone masonry around outlet.
Condition at Joints	No visible movement
Drain holes	None
Channel	
Loose Rock or Trees Overhanging Channel	Some trees and brush overhanging channel.
Condition of Discharge Channel	Some brush, stone and debris in channel downstream.

PERIODIC INSPECTION CHECK LIST

PROJECT Dolloff Dam, New Hampshire DATE May 31, 1978

PROJECT FEATURE Stoplog Spillway NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Good
Rust or Staining	Little-2 small areas on left abutment.
Spalling	Little
Erosion or Cavitation	Little-surface laitance eroded
Visible Reinforcing	None visible
Any Seepage or Efflorescence	Minor at left and right abutments
Condition at Joints	No visible movement
Drain holes	None
Channel	Bedrock
Loose Rock or Trees Overhanging Channel	Some trees and brush overhanging channel.
Condition of Discharge Channel	Good, channel bottom appears to be bedrock.

PERIODIC INSPECTION CHECK LIST

PROJECT Dolloff Dam, New Hampshire DATE May 31, 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	None
Floor of Approach Channel	Sand and gravel
b. Weir and Training Walls	
General Condition of Concrete	Good - surface laitance gone
Rust or Staining	None
Spalling	None
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None
Drain Holes	N.A.
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None close to dam, many further downstream.
Floor of Channel	Apparently bedrock
Other Obstructions	Stones and other debris

PERIODIC INSPECTION CHECK LIST

PROJECT Dolloff Dam, New Hampshire DATE May 31, 1978

PROJECT FEATURE Overflow Spillway Bridge NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	
Bearings	Concrete to concrete ends
Anchor Bolts	4½" rusted
Bridge Seat	Center I beam-rusted, no paint
Longitudinal Members	N.A.
Under Side of Deck	Good
Secondary Bracing	None
Deck	1 thru crack at intersection with abutment. Possible shear crack.
Drainage System	No differential movement.
Railings	None One side, good condition.
Expansion Joints	Sealed with caulking-fair condition.
Paint	Railings painted, good condition.
b. Abutment & Piers	
General Condition of Concrete	Good
Alignment of Abutment	Good
Approach to Bridge	Good
Condition of Seat & Backwall	Fair

PROJECT Dolloff Dam, New Hampshire DATE May 31, 1978

PROJECT FEATURE Reservoir NAME R. Langen

Pawtuckaway Pond

AREA EVALUATED	REMARKS
Stability of Shoreline	Good
Sedimentation	Minor, no visual problems
Changes in Watershed Runoff Potential	Minor
Upstream Hazards	Several homes, most are at least 6' above lake.
Downstream Hazards	Two cottages, State Highway 156, a village road, and several homes in West Epping about 3 miles downstream.
Alert Facilities	None observed
Hydrometeorological Gages	Lake level gage on upstream face
Operational & Maintenance Regulations	None observed

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

F. DUNNHAM
SINGER BUILDING
BROADWAY, NEW YORK
PHONE, 3197 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

PAUCTUCKAWAY AND MENDUM PONDS

REPORT FROM H. F. DUNHAM

to

D. A. BELDEN, PRESIDENT

LAMPREY RIVER IMPROVEMENT COMPANY

December 5, 1918

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Ocean NO. 2 — 100 — E-4561
RIVER Pawtuckaway River MILES FROM MOUTH D.A.SQ.MI. 20.66
TOWN Nottingham OWNER Lamprey River Wp Co. Newmarket
LOCAL NAME OF DAM At Pond Outlet
BUILT DESCRIPTION Gravity — Split Stone Facing
Concrete on Ledge

POND AREA-ACRES DRAWDOWN FT. POND CAPACITY-ACRE FT.
HEIGHT-TOP TO BED OF STREAM-FT. 27 MAX. MIN.
OVERALL LENGTH OF DAM-FT. 376.6 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. 45 FREEBOARD-FT. 4
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST None
WASTE GATES-NO. WIDTH MAX. OPENING DEPTH BELOW CREST

REMARKS Condition Good

TL into Lamprey

POWER DEVELOPMENT

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

USE Consecvation

REMARKS Menace

DATE 8/6/35

FORM E8

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD

TOWN	Nottingham	TOWN NO.	STATE NO. 184.02
RIVER STREAM	Pawtuckaway River at Pond Outlet		
DRAINAGE AREA	20.66 Sq. Mi.	POND AREA	
DAM TYPE	Gravity	FOUNDATION NATURE OF	Ledge
MATERIALS OF CONSTRUCTION	Split Stone, Earth, Concrete		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM	27'	TOP OF DAM TO SPILLWAY CRESTS	4'
SPILL WAYS, LENGTHS DEPTHS BELOW TOP OF DAM	45'	LENGTH OF DAM	376.6'
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	None		
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.— c/o E. H. Burroves, Supt. Newmarket

CONTRACTOR

NO.

	RECEIVED	INVESTIGATED BY	DATE
APPLICATION			

IF DAM IMPROPERLY CONSTRUCTED IT Would BE A MENACE TO THE PUBLIC SAFETY

IS DAM SUBJECT TO PROVISIONS OF P. L. CHAP. 218, SECTS 15-28? Yes

	RECEIVED	CHECKED BY	DATE
PLANS & SPECIFICATIONS			
	APPROVED BY COMMISSION	COMMISSION CONSTRUCTION INSPECTOR	

FINAL CONSTRUCTION APPROVAL CHARGES PAID

IS DAM SUBJECT TO PERIODIC INSPECTION? Yes

DAM INSPECTION RECORD

DATE	INSPECTOR	REPORT	CHARGES	PAID	DATE	INSPECTOR	REPORT	CHARGES	PAID
6/35	L.C.Blake	9/18/35	38.00	10/14/35					
Condition--Good									

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-456l

TOWN	Nottingham	TOWN NO. 2	STATE NO. 184.02
RIVER STREAM	Pawtuckaway River at Pond Outlet		
DRAINAGE AREA	20.00 Sq. Mi.	POND AREA	927 acres
DAM TYPE	Gravity	FOUNDATION NATURE OF	Ledge
MATERIALS OF CONSTRUCTION	Split Stone, Earth, Concrete		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTION—PUBLIC UTILITY		
HEIGHTS TOP OF DAM TO BED OF STREAM	27'	TOP OF DAM TO SPILLWAY CRESTS	4'
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	45'	LENGTH OF DAM	376.6'
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	None		
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- Good (Clear Spillway)

MENACE- Yes. Will be subject to periodic inspection.

Head = 23'

(1.5 x 23 x 0.6) = 1750 H.P.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made August 8, 1935, according to notification to owner dated July 31, 1935, and bill for same is enclosed.

Sept. 18, 1935
Copy to Owner

Samuel J. Lord
Hyd. Eng.

PUBLIC SER E COMMISSION OF NEW HAMPSHIRE—DAM RECC I-4361

TOWN	NOTTINGHAM	TOWN NO. 2	STATE NO. ~~109~~ 184
RIVER STREAM	Pawtuckaway River at Pond Outlet		
DRAINAGE AREA	20.66 Sq. Mi.	POND AREA	
DAM TYPE	Gravity	FOUNDATION NATURE OF	Ledge
MATERIALS OF CONSTRUCTION	Split Stone, Earth, Concrete		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM	27'	TOP OF DAM TO SPILLWAY CRESTS	4'
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	45'	LENGTH OF DAM	376.6'
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	None		
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. CONTRACTOR NO.
c/o P. H. Burrowes, Supt. Newmarket

	RECEIVED	INVESTIGATED BY	DATE
APPLICATION			

IF DAM IMPROPERLY CONSTRUCTED IT would BE A MENACE TO THE PUBLIC SAFETY

IS DAM SUBJECT TO PROVISIONS OF P. L. CHAP. 218, SECTS 19-26?

	RECEIVED	CHECKED BY	DATE
PLANS & SPECIFICATIONS			
	APPROVED BY COMMISSION	COMMISSION CONSTRUCTION INSPECTOR	

FINAL CONSTRUCTION APPROVAL CHARGES PAID

IS DAM SUBJECT TO PERIODIC INSPECTION? Yes

DAM INSPECTION RECORD

DATE	INSPECTOR	REPORT	CHARGES	PAID	DATE	INSPECTOR	REPORT	CHARGES	PAID
9/15/3[illegible]	C.D.C.								

OK

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE DOLLOFF DAM SOUTH OUTLET

LOCATION STATE NO. 154.02

Town Nottingham : County Strafford

Stream Pantuckaway R. At Pond Outlet

Basin-Primary Ocean ✓ : Secondary Lamprey R.

Local Name

Coordinates—Lat. 43° 5' - 3800 : Long. 71° 10' - 4200

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 20.66 Sq. Mi.

Overall length of dam 376.6 ft.: Date of Construction

Height: Stream bed to highest elev. 27' ft.: Max. Structure 23' ✓ ft.

Cost—Dam : Reservoir

DESCRIPTION Gravity split stone earth and concrete ✓

Waste Gates

Type

Number : Size 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 45 ± ft.: Net ft.

Height of permanent section—Max. 23 (LEDGE) ft.: Min. ft.

Flashboards—Type None : Height ft.

Elevation—Permanent Crest : Top of Flashboard

Flood Capacity 1955 cfs.: 46 cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. ft.: Min. ft.

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

OWNER Lamprey River Improvment Co. % P.H. Burroughs Newmarket NH

REMARKS Condition good Clear Spillway subject to inspection

Tabulation By " Date April 24

NEW HAMPSHIRE WATER CONTROL COMMISSION

REPORT ON DAM INSPECTION

TOWN Nottingham DAM NO. 184.02 STREAM Pawtuckaway River

OWNER Lamprey River Improvement Co. ADDRESS % N.H.G&E Co. Portsmouth, N.H.

In accordance with Section 20 of Chapter 133, Laws of 1937, the above dam was inspected by me on 12/21/49 ~~accompanied~~ by _____

NOTES ON PHYSICAL CONDITION

Abutments Good

Spillway Fair - natural ledge

Gates Operable

Embankment Other Fair - stone facings not tight.

CHANGES SINCE LAST INSPECTION Some concrete work around gate in 1948.

FUTURE INSPECTIONS Yes

This dam (is) (~~is not~~) a menace because of pond area & property down stream.

REMARKS Pawtuckaway Pond (also 184.03 & 184.04)
Pond 6" below BM #1.

Copy to Owner	Date

Francis C. Moore
INSPECTOR

(Additional Notes Over)

DOLLOFF DAM

MEMO

TO: Vernon A. Knowlton
Chief Engineer

DATE: November 7, 1977

FROM: Donald M. Rapoza
Civil Engineer

SUBJECT: Leakage at Dollof Dam, Pautuckway Lake

As the result of a memo dated September 23, 1977 regarding leakage at the Dollof Dam at Pautuckaway Lake, I inspected the site on October 25, 1977 and found the following:

The lake was 1.96 feet below the permanent concrete crest. Lake gage approximately 23.20. The gage should be relocated away from the stoplog section. Gage does not reflect actural lake elevation when discharging any appreciable water through the section.

The upstream concrete facing of the structure has several vertical cracks throughout the length of the structure. The cracks are due to contraction or shrinkage and show signs of efflouscence approximately 3 feet below the top of wall.

Leakage was observed at three locations along the downstream face of the granite stone. Facing upstream approximately 50 feet right of the gate section, a small amount of seepage was observed. This seepage can be expected and has no adverse effect on the structure.

The second location is the stonework forming the sluiceway below the gate section. Several leaks were found throughout both sides of the sluiceway and at the gate section. This flow was coming from either the cut stones, the cracked concrete, and/or the seal mechanism at the gate. This area should be monitored periodically with an attempt to seal the leakage by dropping some cinders in the upstream sluiceway. Should the flow increase substantially from these areas, the pond should be drained and the necessary repairs made to the sluiceway.

The third seepage area is located approximately 20 feet left of the gate section. Water from the gate section was going into the stonework at the base of the dam at 10 feet from the gate section. Dye was placed in the water at this spot and exited the base of the dam, 20 feet left of gate section. It could not be determined if the leaked was totally attributed to the inflow.

There is a definate vertical line on the downstream side of the dam when the stonework was dislodged. This same line is located above a seepage area at the base of the dam.

Recommend that we monitor the leakage on a set schedule and make necessary repairs if required.

DMR/kn

APPENDIX B

INSPECTION REPORTS/SKETCHES

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.

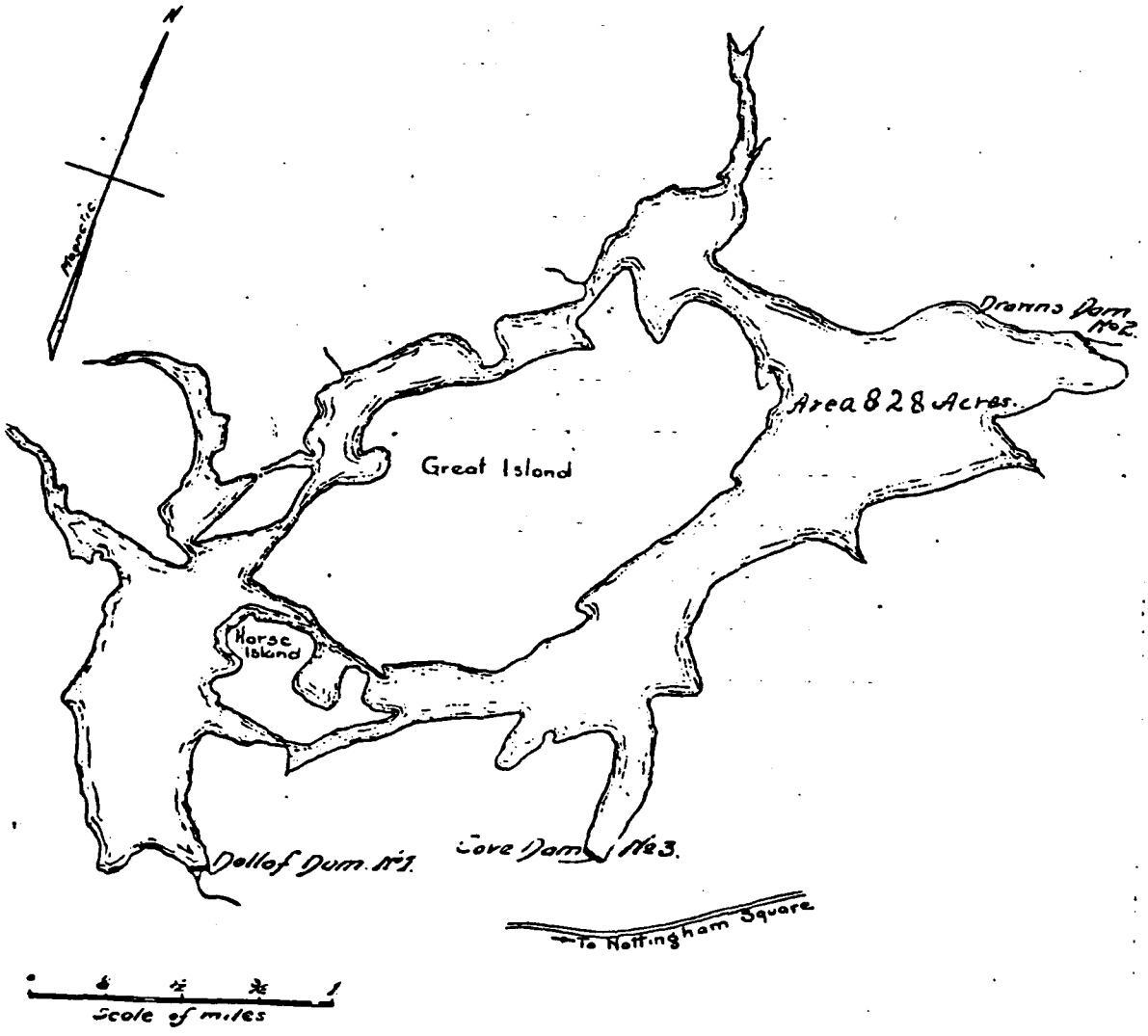
At the Drown Dam (No.2) there are stop planks retained by timber braces more or less decayed. Renewals should be made as time may require. But all of the Pawtuckaway spillways real and imaginery, taken together, are insufficient for a drainage area of twenty (20) square miles. This can be shown conclusively 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.

Mendum's.

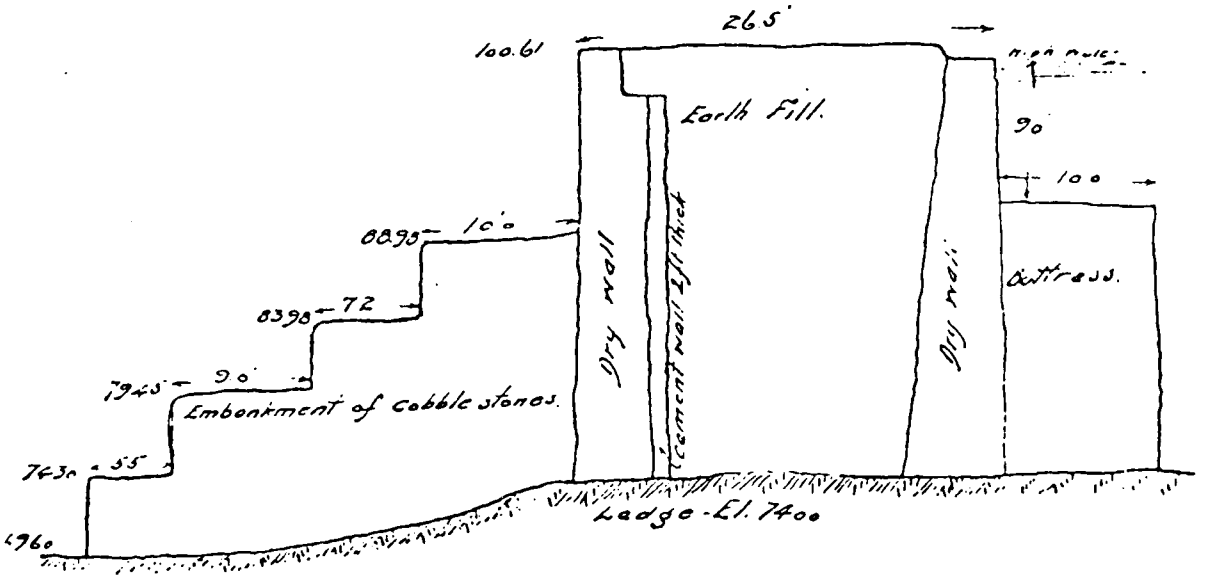
At the Mendum reservoir there is less need to make changes. The bottom of the present spillway should be brought to a uniform level and all growth of small trees and obstacles of all descriptions, driftwood, old stumps, etc. should be removed and the entire space kept clear. One further recommendation 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 removal, 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,

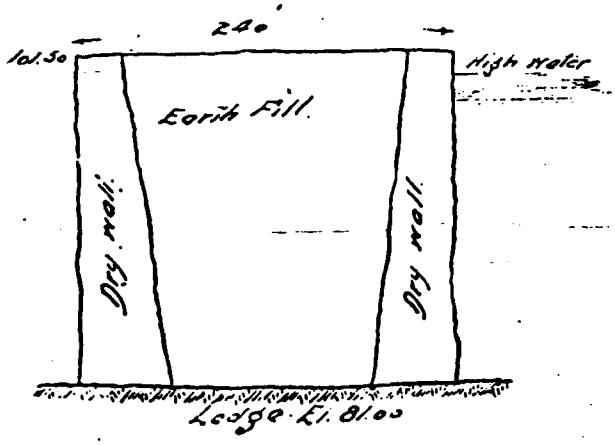
H.F.D./R.



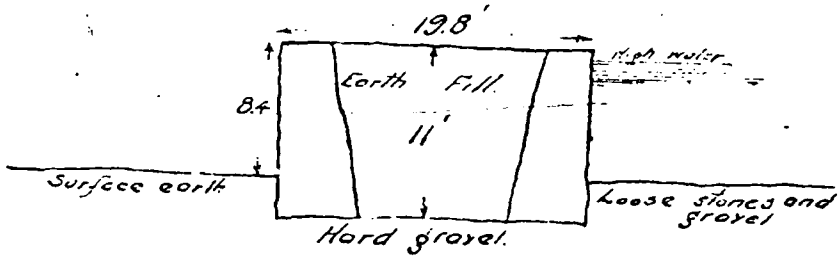
Plan of
P.A.W.T.U.C.K.A.W.A.Y RESERVOIR
Nottingham NH
Traced from a plan made by
Jon Stetson and dated 1839
Reduced by J.H. Lickfield 1918
Scale ½ mile to the inch.



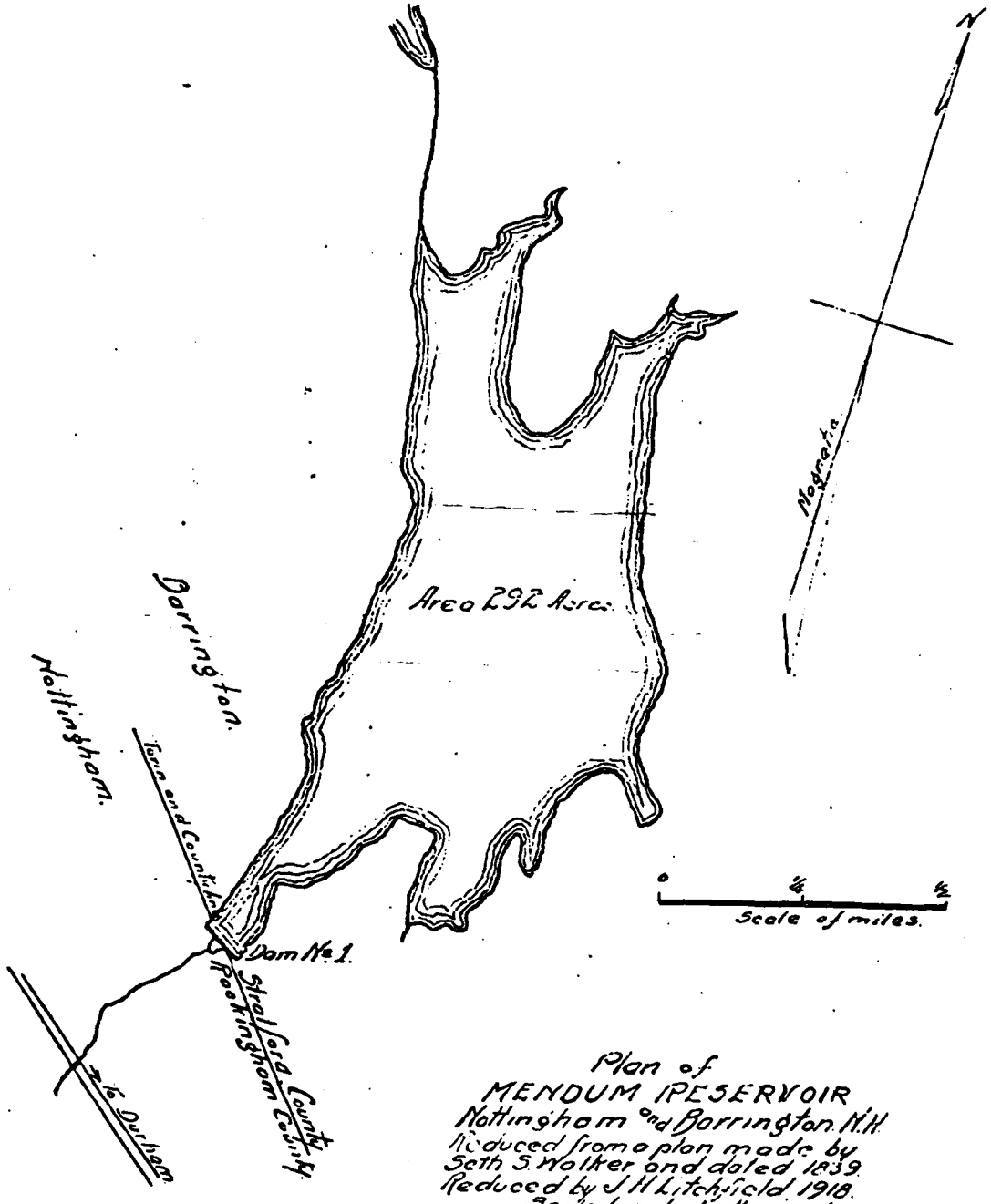
Cross Section
of
DOLLOF DAM. (No 1)
Nottingham NH
Scale 10' to the inch.
Copied Nov. 1918. by J.H. Litchfield
from drawings in a report by
J.W.M. Oliver C.E. to the Nemmartet
Manufacturing Co. dated 1869



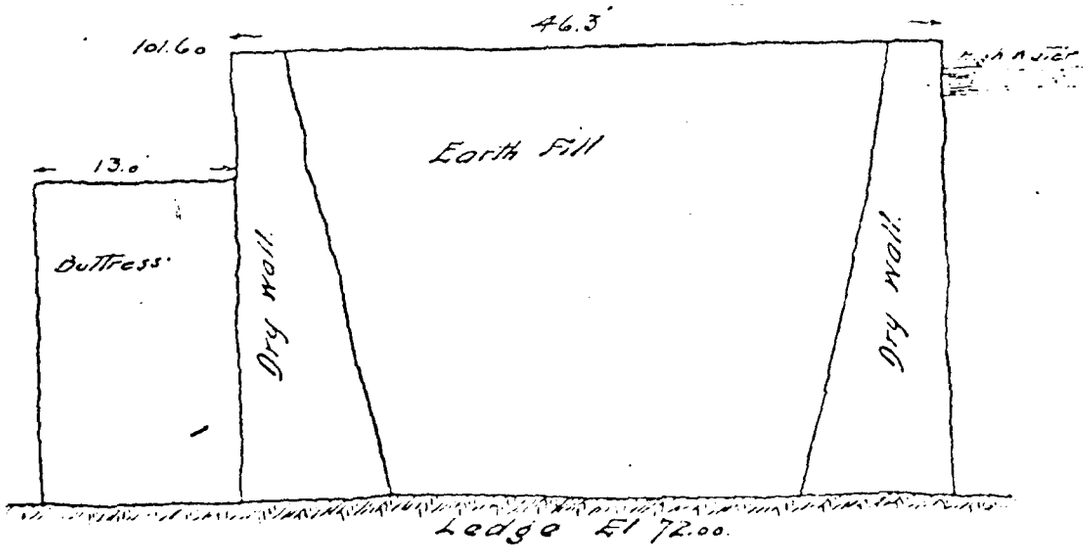
Cross Section
of
DROWN'S DAM (No. 2)
Nottingham N.H.
Scale 10' to the inch
Copied Nov. 1918. by J.H. Litchfield.
from drawings in a report by
W.M. Oliver C.E. to the Normarket
Manufacturing Co. dated 1869.



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
W.M. Oliver C.E. to the Newmarket
Manufacturing Co. dated 1889



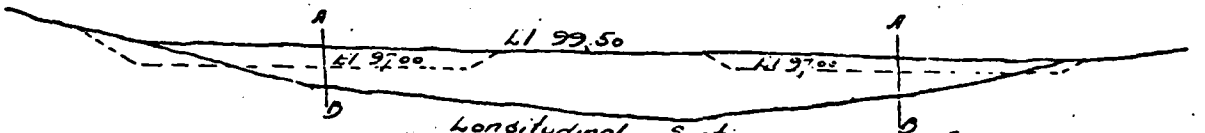
Plan of
MENDUM RESERVOIR
Nottingham and Barrington N.H.
Reduced from a plan made by
Seth S. Walker and dated 1859.
Reduced by J.H. Litchfield 1918.
Scale ¼ mile to the inch.



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

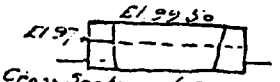
Changes to be made of Gove Dam (No 3)

Fig 1.



Longitudinal Section

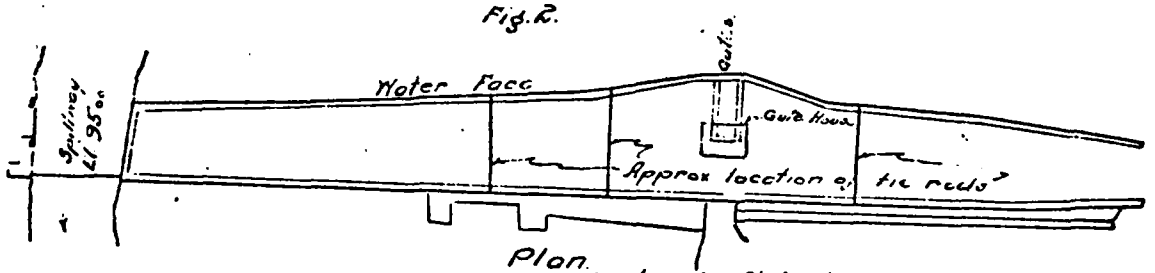
Scales:
Hor 60 ft to the inch
Vert 20 ft to the inch



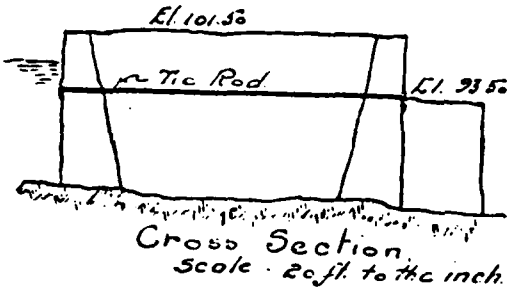
Cross Section of proposed spillway at N.B.
Scale: 20 ft to the inch.

Changes to be made at Mendum Dam.

Fig 2.



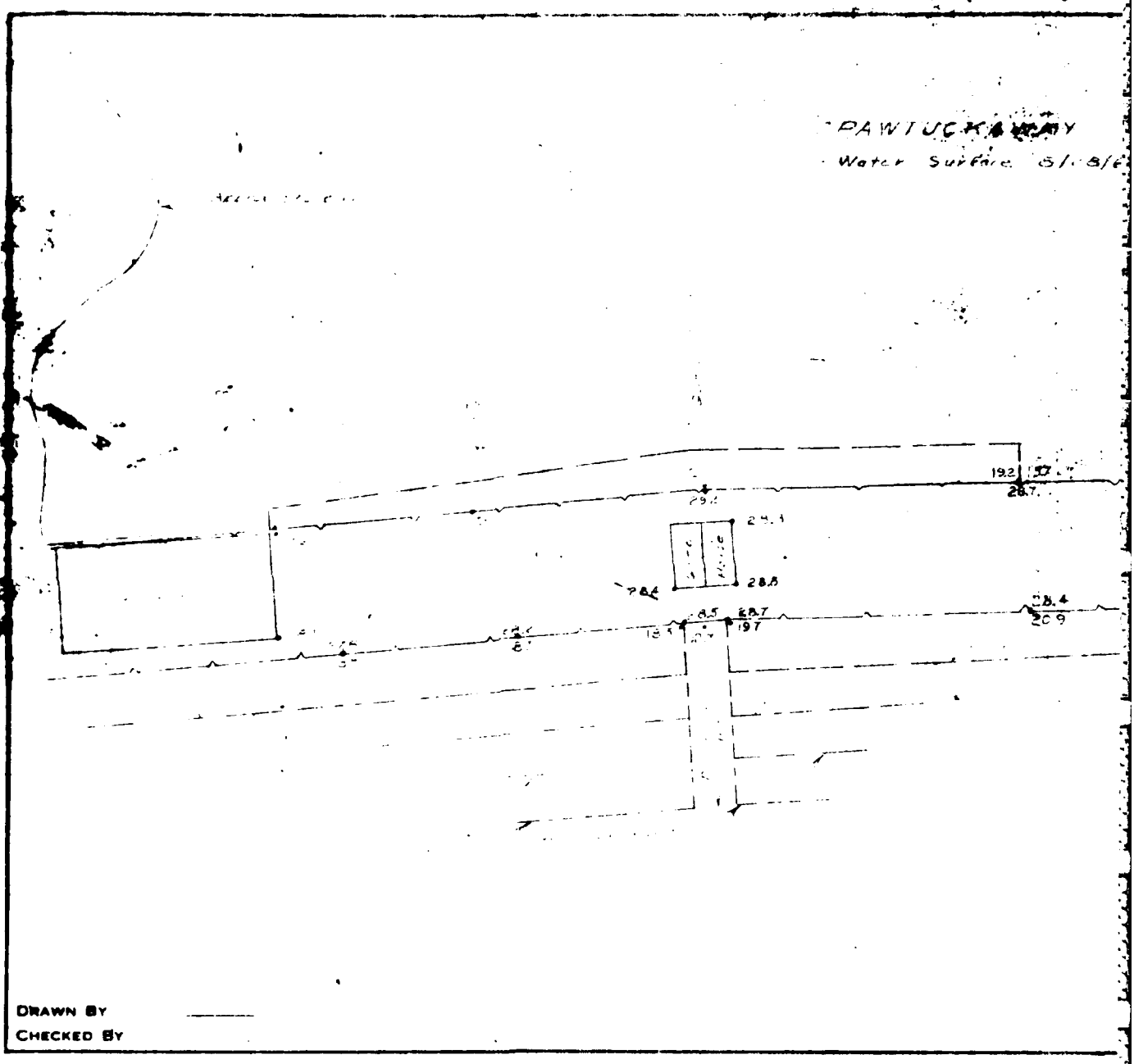
Plan
Scale:- 60 ft to the inch.

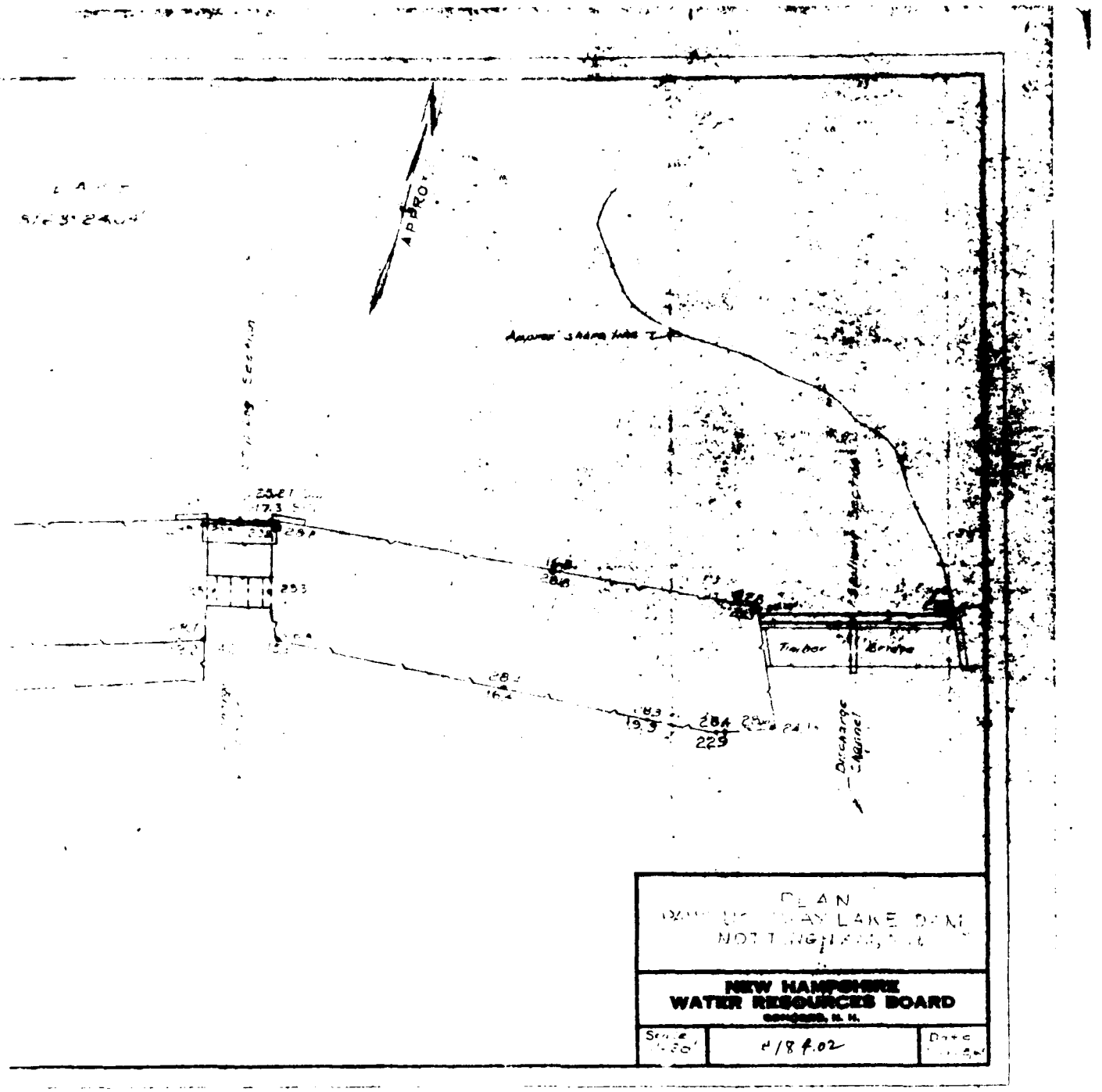


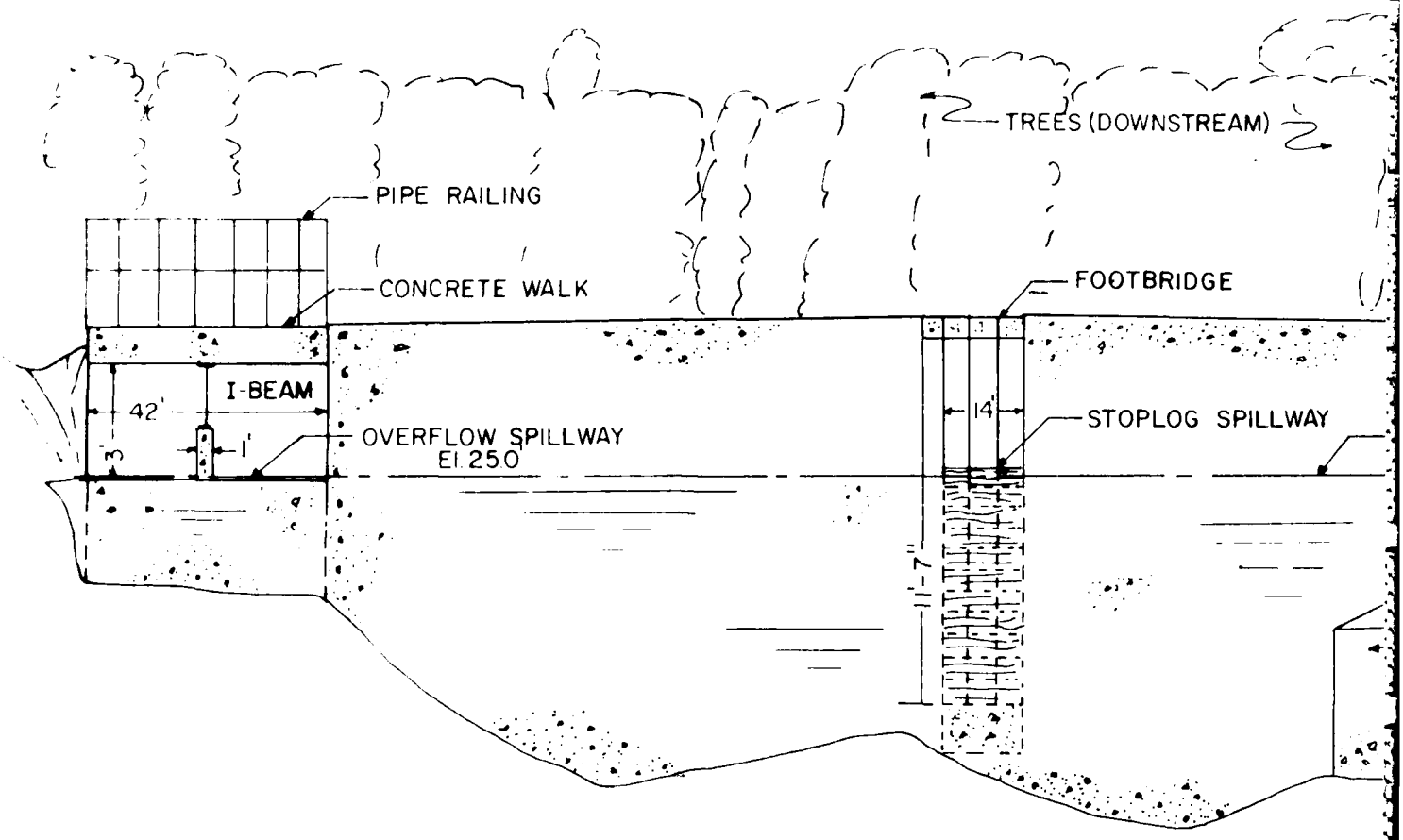
Cross Section
Scale - 20 ft. to the inch.

APPENDIX D

HYDROLOGY/HYDRAULICS







ELEVATION

H/H
DOLLOFF DAM 1 of 8

HYDROLOGY 6/29/78
PD

PAWTUCKAWAY LAKE

EP 1: PROBABLE MAXIMUM FLOOD DETERMINATION (PMF

RE: PRELIMINARY GUIDANCE FOR ESTIMATING MAXIMUM PROBABLE DISCHARGES IN PHASE I DAM SAFETY INVESTIGATIONS, NED - COE, MARCH 1978

USING FLAT & COASTAL CURVE TO DETERMINE PMF PEAK INFLOW

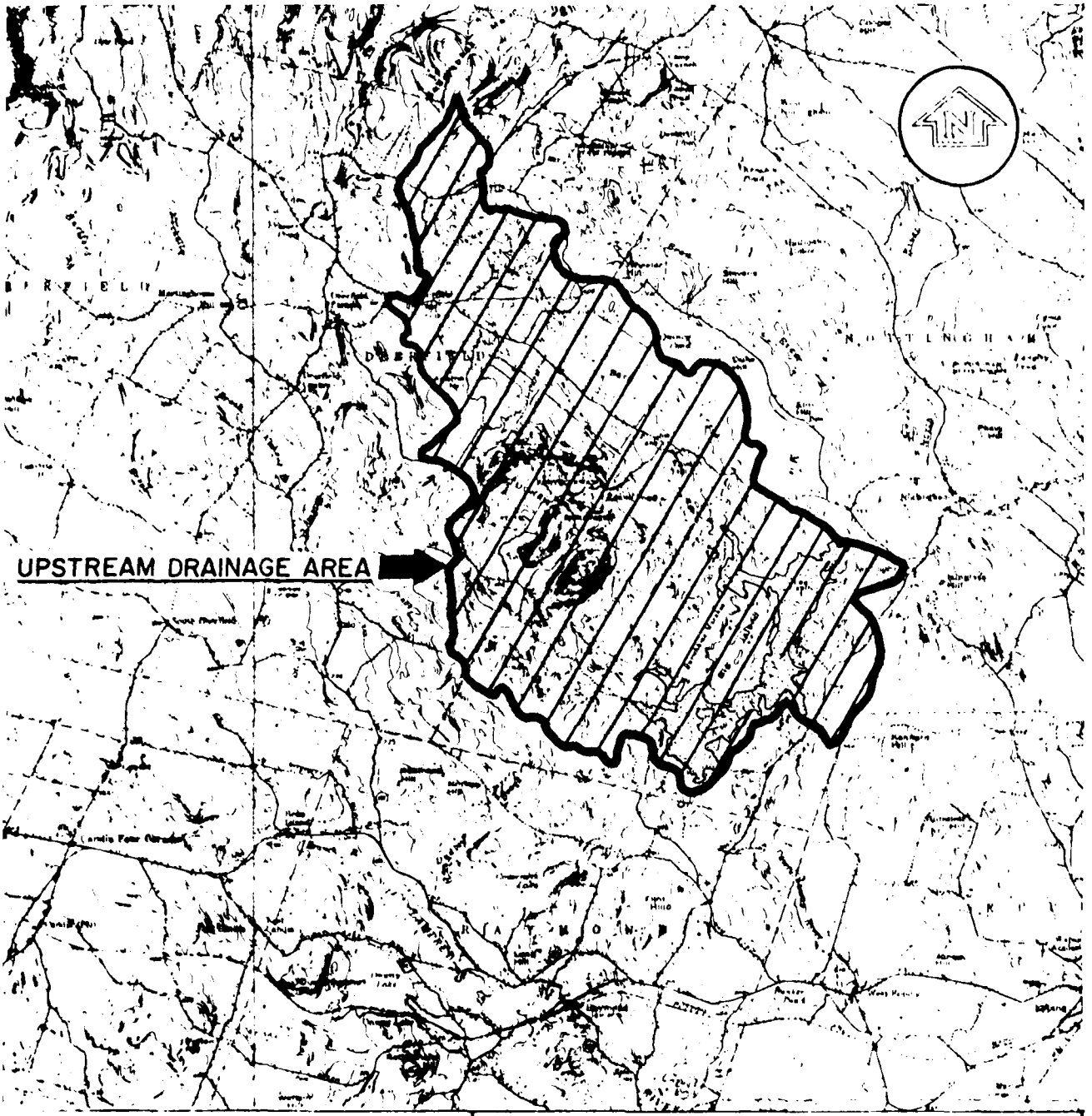
DA = 19.9 square miles (ANG)
DA = 20.66 " " (WRB)
DA = 18.0± " " (Public Service Commission)
DA = 21 " " (COE 74)

@ DA = 20.66 square miles

PMF = 590 cfs/sq mile

$$PMF = \frac{590 \text{ cfs}}{\text{sq mile}} \times 20.66 \text{ sq miles}$$

PMF = 12,200 cfs (Q_{PI})



ATIONAL PROGRAM OF INSPECTION OF
NON-FED. DAMS
PAWTUCKAWAY POND
DOLLOFF DAM
NOTTINGHAM, NEW HAMPSHIRE

REGIONAL VICINITY MAP

JULY 1978

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

ERSON NICHOLS & CO., INC. CONCORD, NH

SCALE IN MILES

1 ½ 0 1 2 3

MAP BASED ON USGS 15 MINUTE QUADRANGLE
SHEET SUNCOOK, N.H. 1957 and
Mt. PAWTUCKAWAY, N.H. 1957

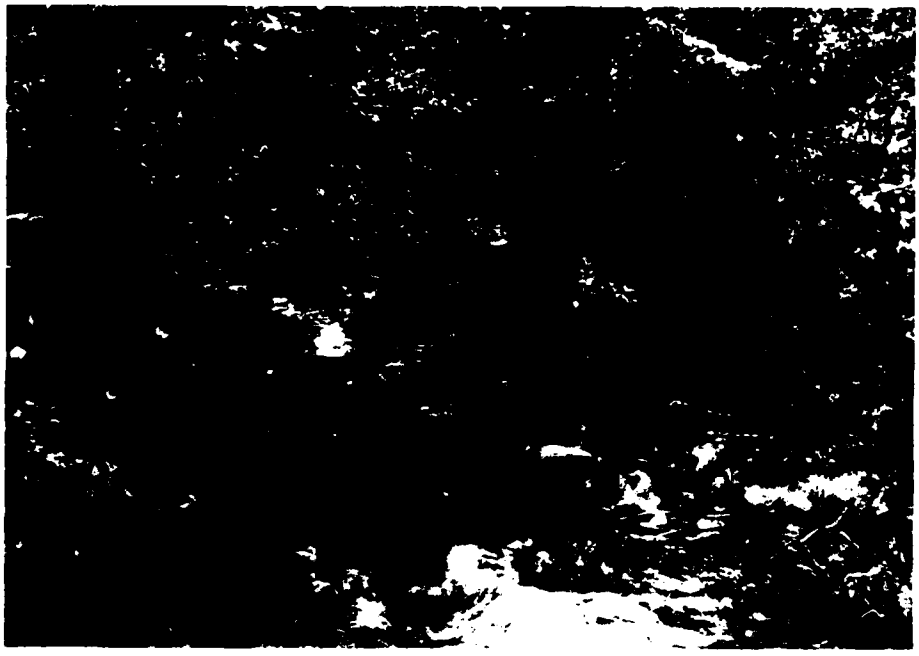


Figure 14 - Looking at the channel downstream of the overflow spillway.

Figure 15 - Looking at the channel downstream of the gated outlet from the top of Dolloff Dam.

Figure 12 - Looking upstream at the gated outlet of Dolloff Dam. Note the seepage from the sidewalls within the portal.

Figure 13 - Looking upstream at Pawtuckaway Pond from the top of Dolloff Dam near the southwest abutment.

Figure 10 - View of northeast sidewall of stoplog spillway. Note the condition and seepage along the bottom of the wall.

Figure 11 - View of seepage and spalling along toe of southwest sidewall of the stoplog spillway.

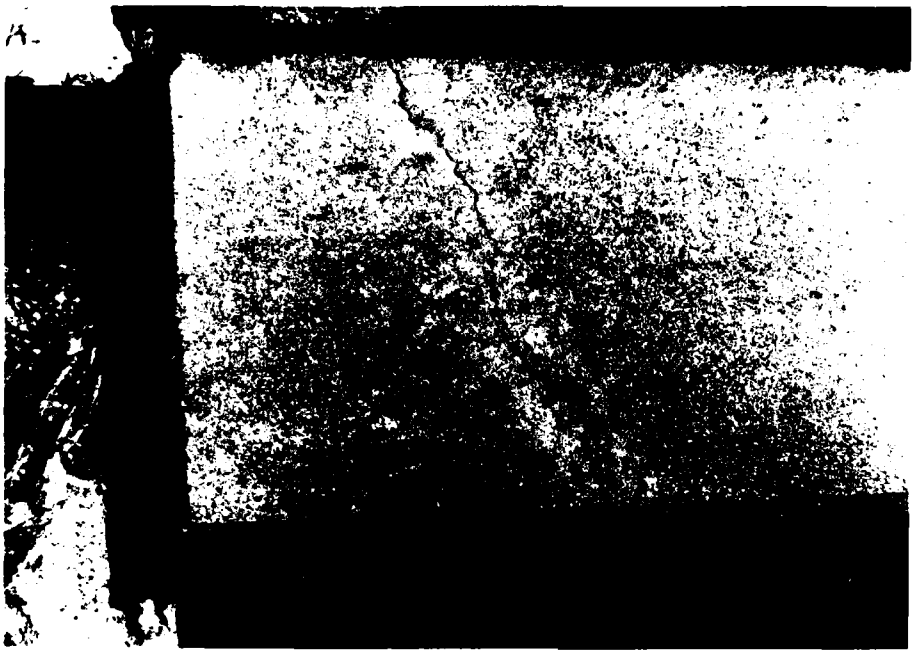


Figure 8 - Looking downstream at a crack in the bridge slab spanning the overflow spillway, adjacent to the northeast abutment.

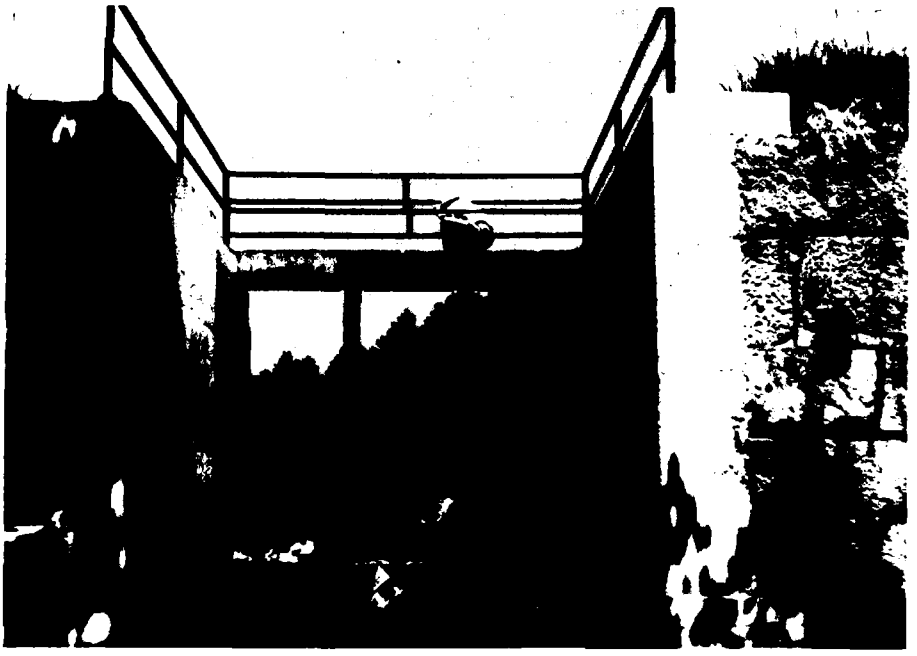


Figure 9 - Looking upstream at the stoplog spillway at Dolloff Dam.

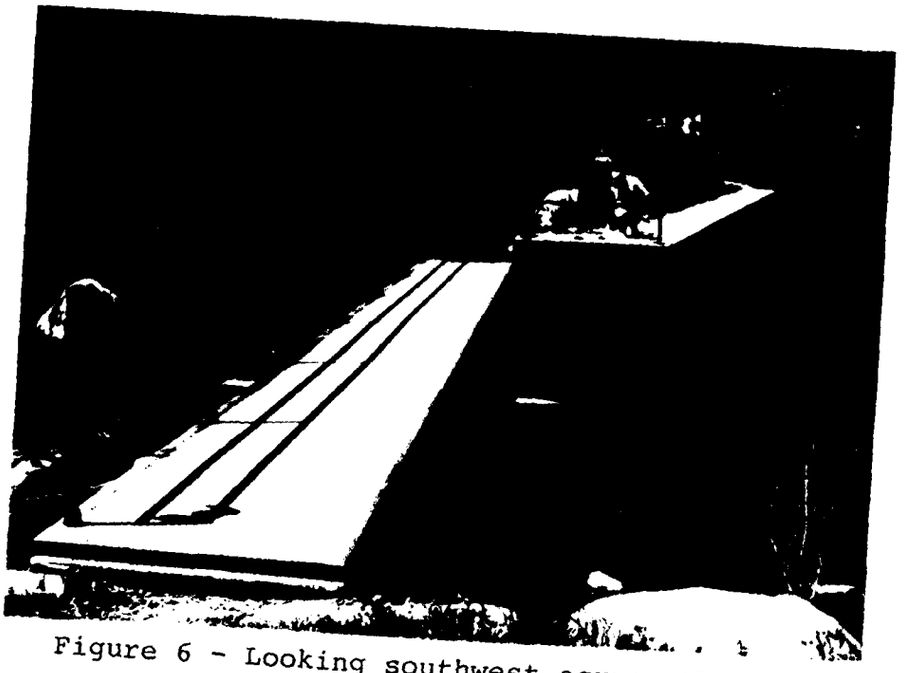


Figure 6 - Looking southwest across the overflow spillway from the northeast abutment.

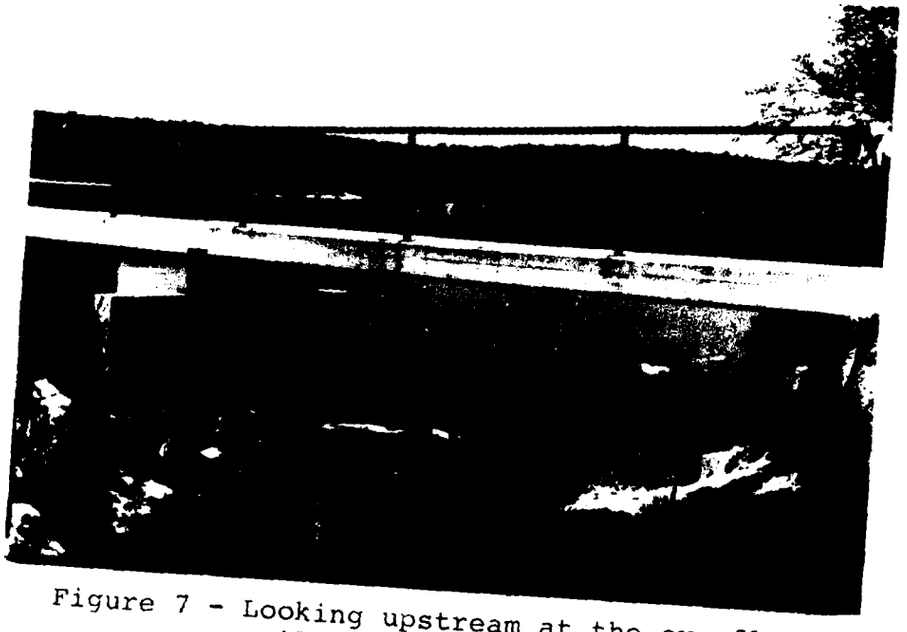


Figure 7 - Looking upstream at the overflow spillway and service bridge.

Figure 4 - Looking southwest at the downstream face between gated outlet and southwest abutment, showing the top two berms and the vertical wall.

Figure 5 - Looking down at the fill placed in the hole, located on the highest berm along the downstream face, just southwest of the gated outlet.

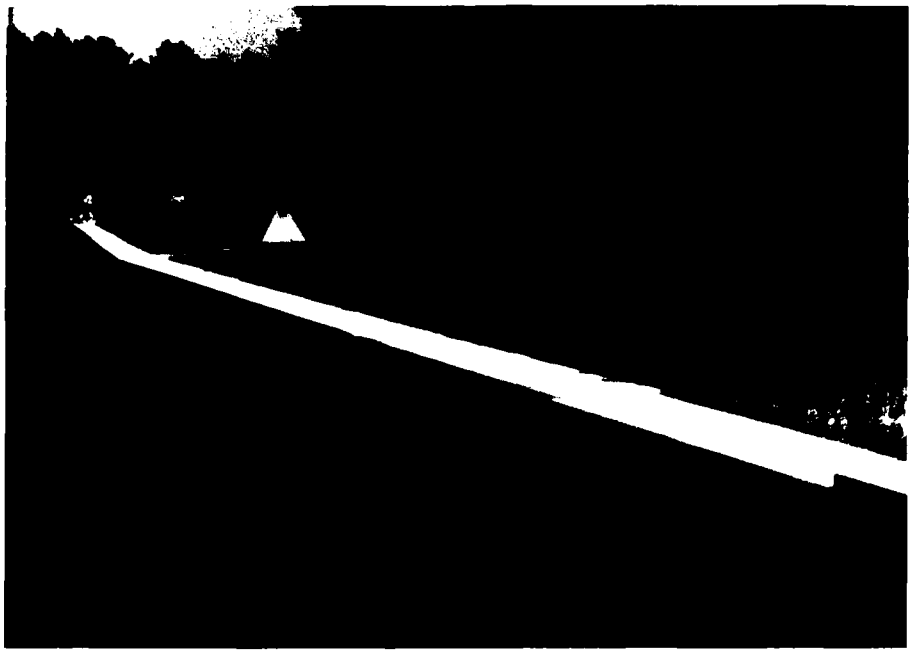
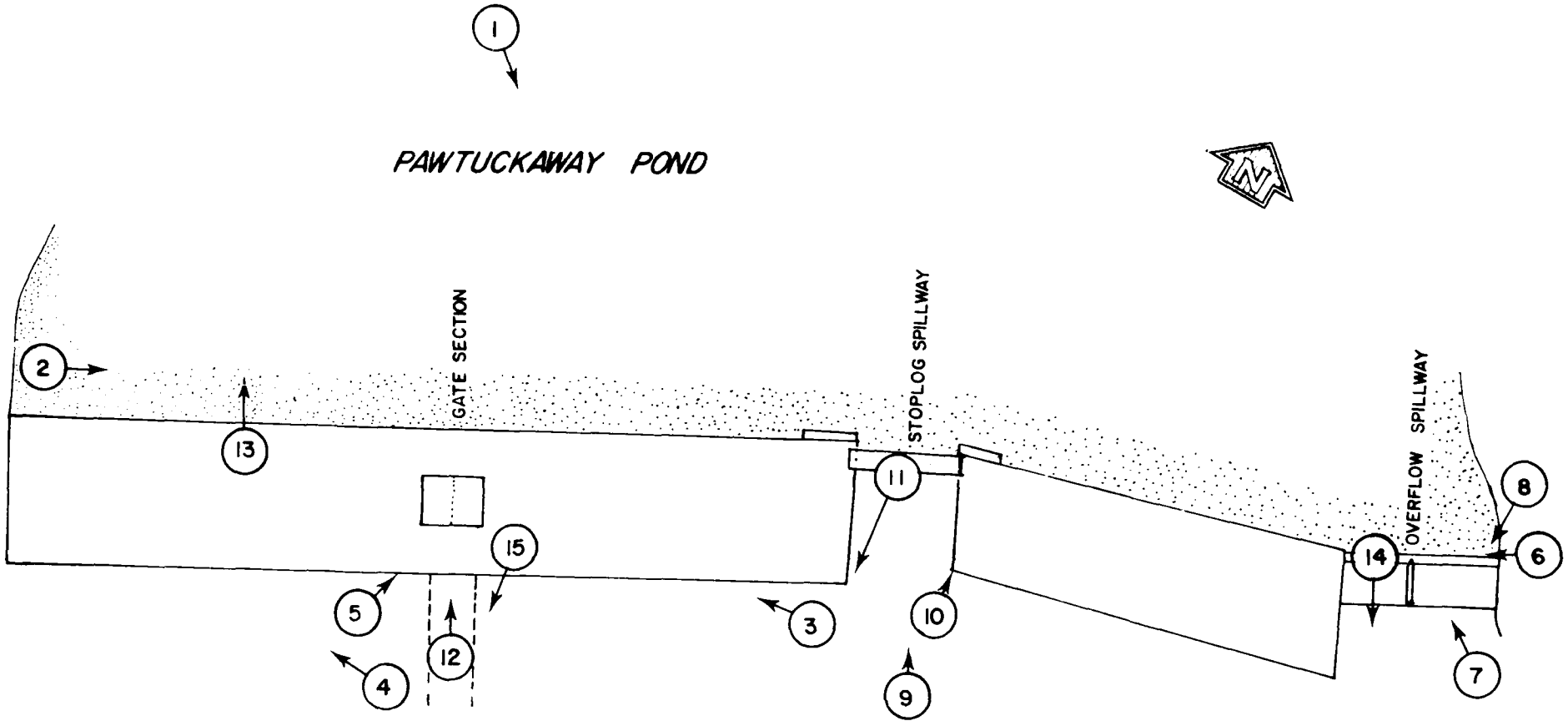


Figure 2 - View looking at the upstream face of Dolloff Dam from the southwest abutment.

Figure 3 - Looking southwest at the vertical downstream face between the stoplog spillway and gated outlet.



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

DOLLOFF DAM
PHOTO INDEX

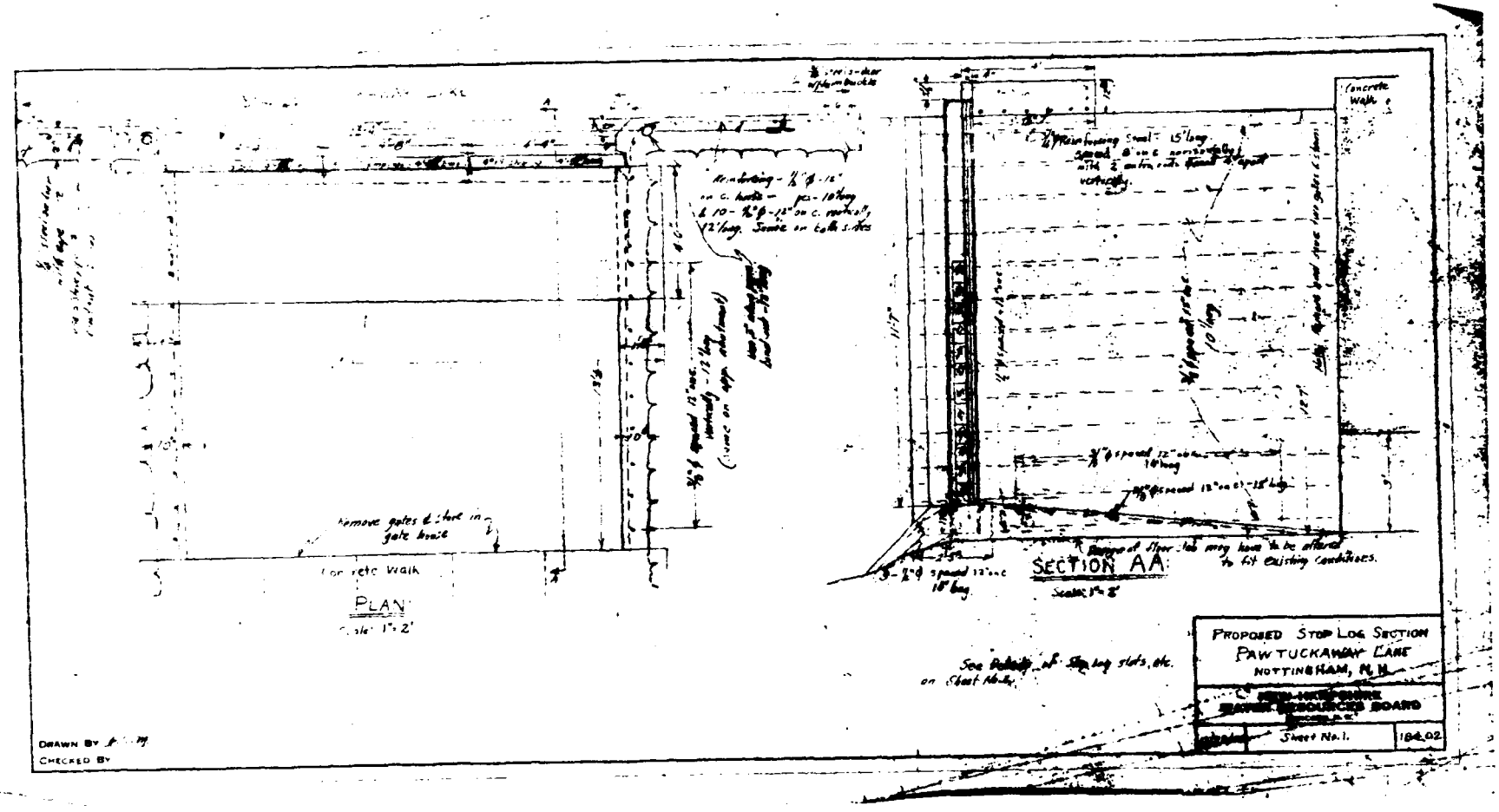
PAWTUCKAWAY POND NEW HAMPSHIRE

SCALE: NOT TO SCALE

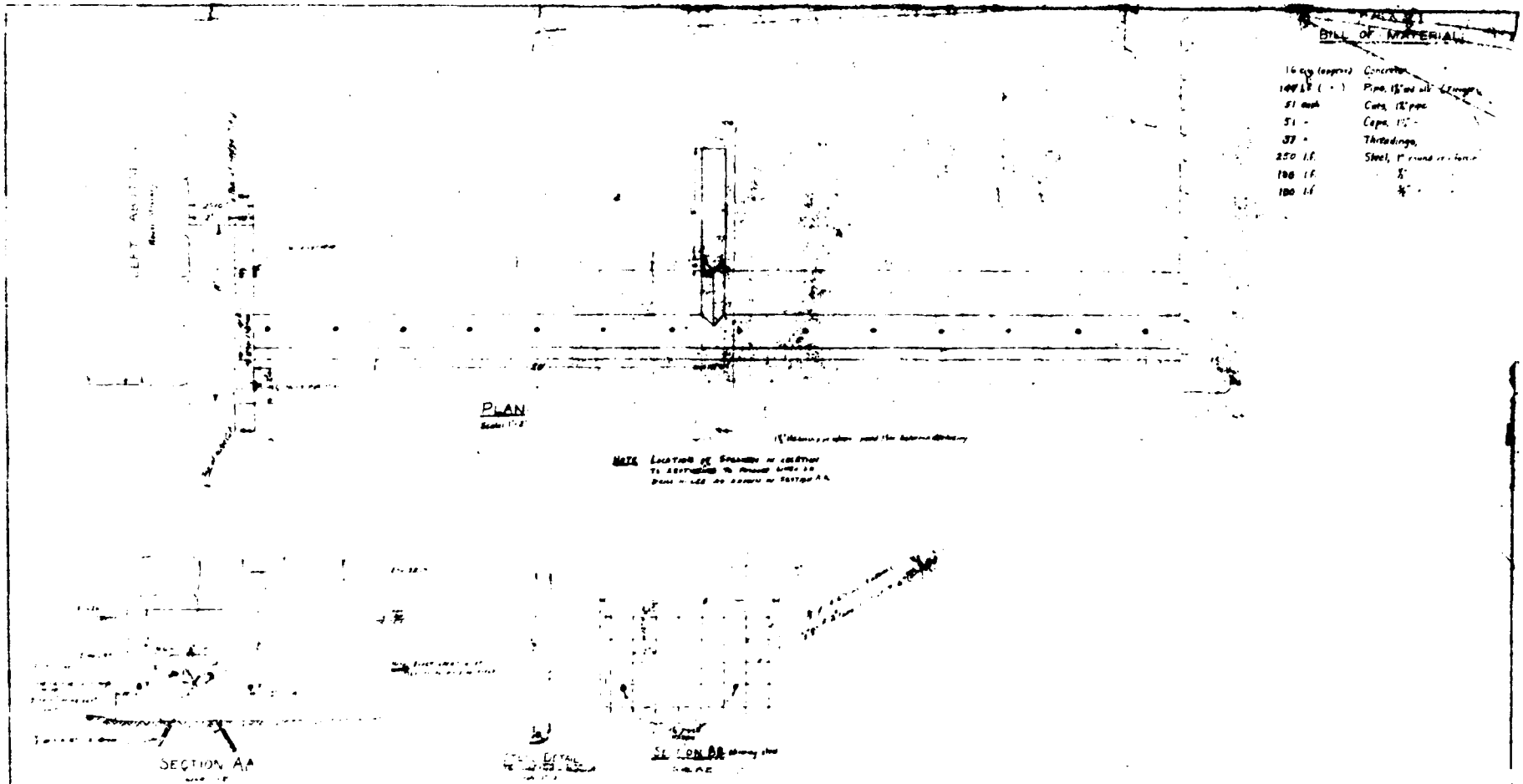
DATE: JULY 1978

APPENDIX C

PHOTOGRAPHS



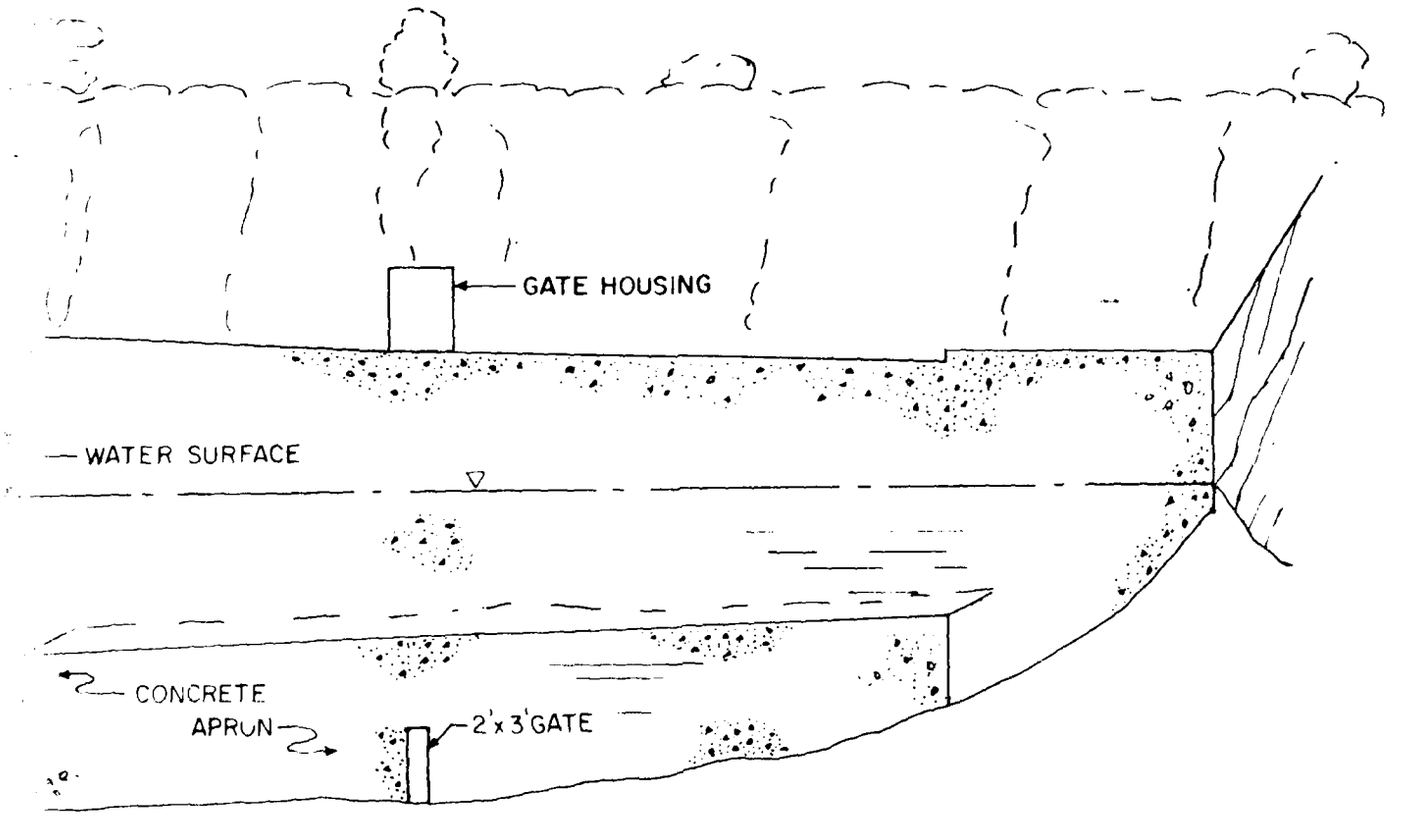
APPROVED AT GOVERNMENT EXPENSE



BILL OF MATERIAL

16 cu (approx)	Concrete
140 LF (-)	Pipe, 1½" std silv [illegible]
51 each	Cons, 1½" pipe
51 -	Caps, 1½" -
51 -	Threadings,
250 LF	Steel, [illegible]
196 LF	⅝"
180 LF	½"

NEW HAMPSHIRE WATER RESOURCES BOARD
CONCORD, N. H.



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

DOLLOFF DAM

PAWTUCKAWAY POND NEW HAMPSHIRE

SCALE: NOT TO SCALE

DATE: JULY 1978

7/7/78
BO

HYDROLOGY

FAIRTUCKAWAY LAKE

STEP 2: @ Q_{P_1} = PMF = 12,200 cfs

SURCHARGE HEIGHT TO PASS Q_{P_1}

RE: HYDRAULIC BACKUP FOR EACH INDIVIDUAL STRUCTURE; IE: RATING CURVES

TRIAL 1 — elev = 28.6

GOVE DIKE	=	0
DROWN'S DAM	=	823 cfs
DOLLOFF DAM	=	1096 cfs
		1919 cfs

TRIAL 2 — elev = 30.0

GOVE DIKE	=	617 cfs
DROWN'S DAM	=	1636
DOLLOFF DAM	=	2243
		4496 cfs

TRIAL 3 — elev = 31.0

GOVE DIKE	=	1455
DROWN'S DAM	=	2787
DOLLOFF DAM	=	3842
		8084 cfs

TRIAL 4 — elev @ 32.0

GOVE DIKE	=	3382
DROWN'S DAM	=	5062
DOLLOFF DAM	=	6427

7/7/78
BO

HYDROLOGY
DAWTUCKAWAY LAKE

FROM THE ABOVE TRIALS A RATING CURVE FOR THE LAKE CAN BE DRAWN. READING THE ELEVATION AT THE PMF

@ PMF = 12,200 cfs
elev = 31.65

GOVE DIKE	= 2596 cfs
DOLLOFF DAM	= 5430
DROWN'S DAM	= 4127
	12153 cfs

SINCE THIS IS LESS THAN PMF
ROUND ELEVATION UP TO 31.7

∴ SURCHARGE HEIGHT = 31.7 - 25.0 = 6.7'
(ABOVE SPILLWAY)

VOLUME OF SURCHARGE HEIGHT

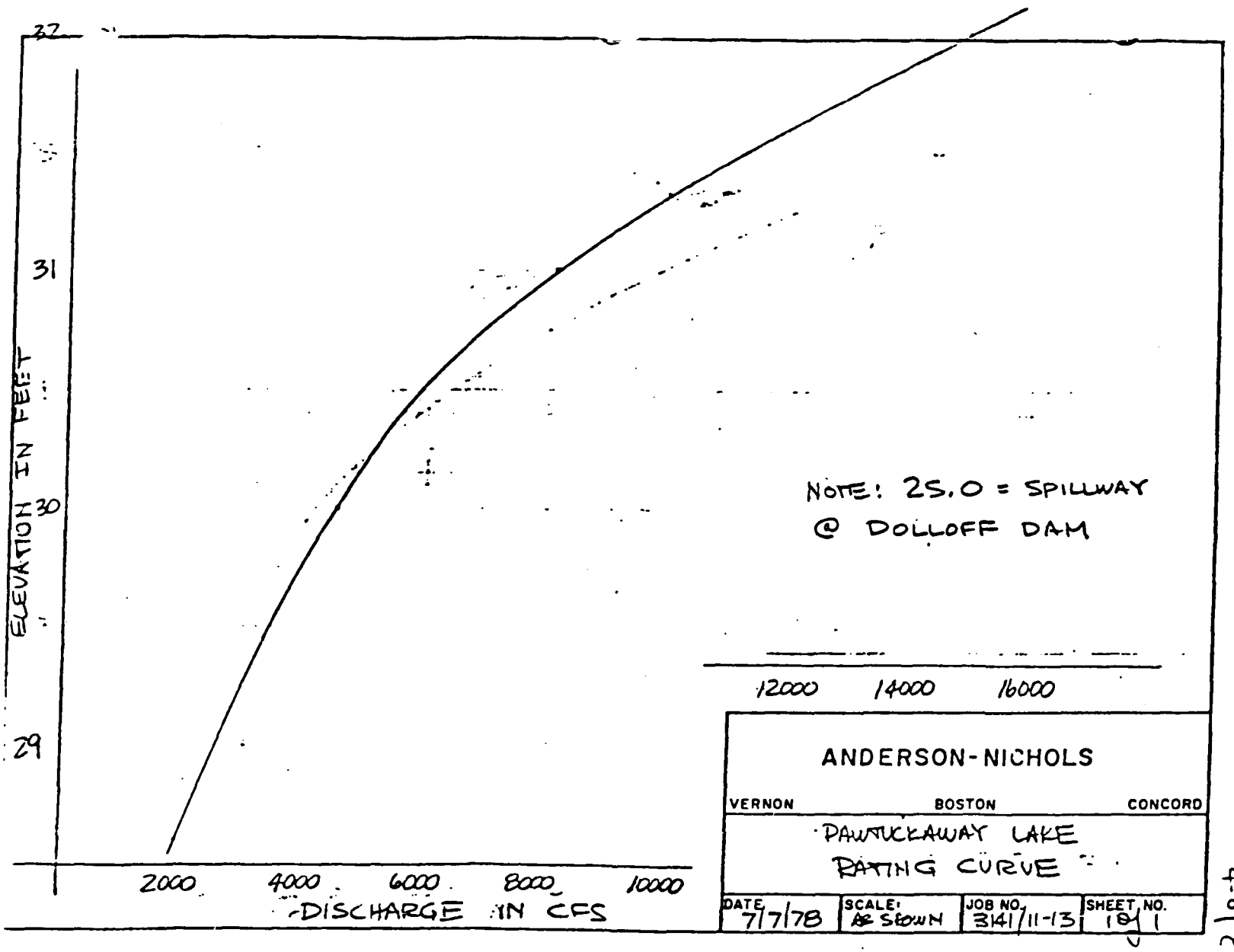
INVENTORY –

DAM	MAX	NORMAL
Dolloff Dam	14700	11500
Gove Dike	14700	11500
Drown's Dam	14700	11500

normal lake level = 903 A @ elev 25.0 (SPILLWAY)
elevation 260 (QUAD) = 1482 A @ elev 25+10 = 35.0

STOR @ 31.7 = 13700 AF
@ 25.0 = 11500 AF
} see STOR-ELEV

• STOR (SURCHARGE) = [illegible] AF



ANDERSON-NICHOLS

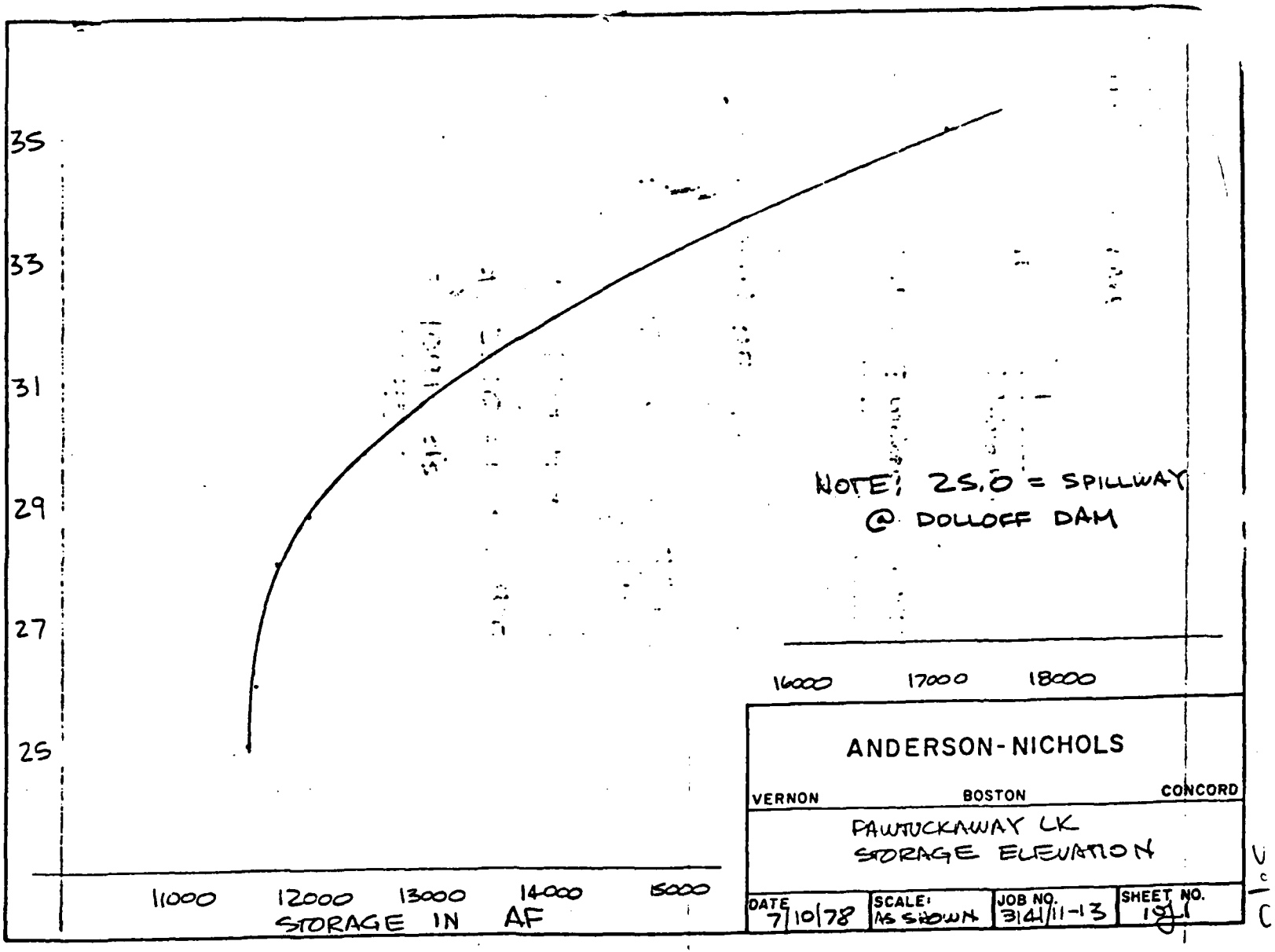
VERNON BOSTON CONCORD

PAWTUCKAWAY LAKE
RATING CURVE

DATE	SCALE:	JOB NO.	SHEET NO.
7/7/78	AS SHOWN	3141/11-13	19

D-5

4-9c


35
33
31
29
27
25
11000
12000
13000
14000
15000
STORAGE IN AF
16000
17000
18000
NOTE: 25.0 = SPILLWAY
@ DOLLOFF DAM
ANDERSON-NICHOLS
VERNON
BOSTON
CONCORD
PAWTUCKAWAY LK
STORAGE ELEVATION
DATE 7/10/78
SCALE: AS SHOWN
JOB NO. 3141/11-13
SHEET NO. 19

6.6.8

7/10/78
BS

HYDROLOGY
FAUNTLEROY LAKE

$$2200\ AF \times \frac{1}{20.66\ mi^2} \times \frac{mi^2}{640\ A} = 0.17\ A$$

0.17 A = 2 inches of RUNOFF OVER BASIN

C. DETERMINATION OF Q_{P2}

$$Q_{P_2} = Q_{P_1} \times \left(1 - \frac{STOR_1}{19}\right)$$

$$= 12200\ cfs \times (1 - 2/19)$$

$$= 12200\ cfs \times 0.895$$

$$= 10916\ cfs$$

YDROLOGY
PAWTUCKAWAY LAKE

7/10/78
BO

STEP 3 a) SURCHARGE HEIGHT TO PASS Q_{P2}

Q_{P2} = 10916 cfs

FROM RATING CURVE : elev = 31.46

SURCHARGE HEIGHT = 31.46 - 25.0 = 6.46'

FROM STORAGE - ELEVATION CURVE

STOR @ 31.46 = 13500 AF
STOR @ 25.0 = 11500 AF

∴ VOL OF SURCHARGE = 2000 AF

$$2000\,AF \times \frac{1}{20.66\,mi^2} \times \frac{mi^2}{640\,A} = 0.151\,ft$$

0.151 ft = 1.82 inches over BASIN

b. AVERAGE SURCHARGE & PEAK OUTFLOW (Q_{P3})

$STOR_1$ = 2.0" } AVE = 1.9"
$STOR_2$ = 1.8" }

$$1.9'' \times 20.66\,mi^2 \times \frac{1\,ft}{12''} \times \frac{640\,A}{1\,mi^2} = 2094\,AF$$

2094 AF + 11500 AF = 13594 AF

8 of 8

HYDROLOGY
PAWTUCKAWAY LAKE

7/10/78
PBo

FROM STOR-ELEV CURVE:

@ 13594 AF → elev = 31.5

FROM RATING CURVE:

31.5 = 11200 cfs = Q_{P3}

CHECK of 1/2 PEAK OUTFLOW

1/2 PEAK OUTFLOW = 5600 cfs

FROM RATING CURVE —

5600 cfs → 30.41 ft

7/7/78
(30

DOLLOFF DAM
RATING CURVE COMPS

$Q = CLH^{3/2}$

ASSUME STOPLOGS IN
MAX ELEV = SPILL = 25.0
GATES CLOSED!!!

C = 2.8 FOR SPILLWAY SECTIONS
C = 2.7 FOR OVERLAND FLOW

1. @ elev = 25.0 $Q = 0$ SPILLWAY

2. @ elev = 25.5

$Q = CLH^{3/2}$
$= (2.8)(41 + 14)(0.5)^{3/2} = 54.4$ cfs

3. @ elev = 26.0

$Q = (2.8)(55)(1.0)^{3/2} = 154$ cfs

4. @ elev = 26.5

$Q = (2.8)(55)(1.5)^{3/2} = 282.9$ cfs

5. @ elev = 27.0

$Q = (2.8)(55)(2.0)^{3/2} = 435.6$ cfs

6. @ elev = 27.5

$Q = (2.8)(55)(2.5)^{3/2} = 608.7$ cfs

7. @ elev = 27.7

$Q = (2.8)(55)(2.7)^{3/2} = 683.2$ cfs

8. @ elevation 27.7+ the area left of the STRUCTURE now handles a portion of the flow

@ elev 28.0

SPILLWAYS → $Q = (2.8)(55)(3.0)^{3/2} =$ 800.2 cfs
OVERLAND → $Q = (2.7)(14)(0.3)^{3/2} =$ 6.2 cfs
806.4 cfs

9. @ elev 28.4 — low chord @ footbridge over emer. spillway

SPILLWAY → $Q = (2.8)(55)(3.4)^{3/2} =$ 965.5 cfs
OVERLAND → $Q = (2.7)(29)(0.4)^{3/2} + 6.2 =$ 26.0 cfs
991.5 cfs

10. @ elev 28.6

ASSUME LOSSES CAUSED BY FOOTBRIDGE OVER EMERGENCY SPILLWAY AS NEGLIGIBLE. CONTINUE USING WEIR FORMULA.

$Q = CLH^{3/2}$

SPILLWAY → $Q = (2.8)(55)(3.6)^{3/2} =$ 1051.9 cfs
OVERLAND → $Q = (2.7)(30)(0.6)^{3/2} + 6.2 =$ 43.8
1095.7 cfs

11. @ elev 28.6+ the area right of the structure handles a portion of the flow

2. @ elev 28.8 – LOW CHORD @ STOPLOG OUTLET

SPILLWAY ⇒ $Q = (2.8)(55)(3.8)^{3/2} = 1140.8$ cfs
L OVERLAND → $Q = (2.7)(32)(0.8)^{3/2} + 6.2 = 68.0$
R OVERLAND → $Q = (2.7)(50)(0.2)^{3/2} = 12.1$

1220.9 cfs

3. @ elev 29.0

Spillway $Q = (2.8)(55)(4.0)^{3/2} = 1232.0$ cfs
L OVER $Q = (2.7)(33)(1.0)^{3/2} + 6.2 = 95.3$
R OVER $Q = (2.7)(110)(0.2)^{3/2} + 12.1 = 38.7$

1366.0 cfs

4. @ elev 29.4 – TOP LEFT ABUTMENT

SPILLWAY $Q = (2.8)(55)(4.4)^{3/2} = 1421.3$
L OVER $Q = (2.7)(34)(1.4)^{3/2} + 6.2 = 158.3$
R OVER $Q = (2.7)(143)(0.6)^{3/2} + 12.1 = 191.5$

1771.1 cfs

5. @ elev 29.8 – TOP DAM

SPILL + L.OVER $Q = 1421.3 + 158.3 = 1579.6$
L. OVERLAND $Q = (2.7)(79+14)(0.4)^{3/2} = 63.5$
R OVERLAND $Q = (2.7)(175)(1.0)^{3/2} + 12.1 = 484.6$

2127.7 cfs

16. @ elev 30.0

BELOW TOP OF DAM = 2127.7 cfs
ABOVE DAM $Q = (2.7)(479)(0.2)^{3/2}$ = 115.7
2243.4 cfs

17. @ elev 31.0

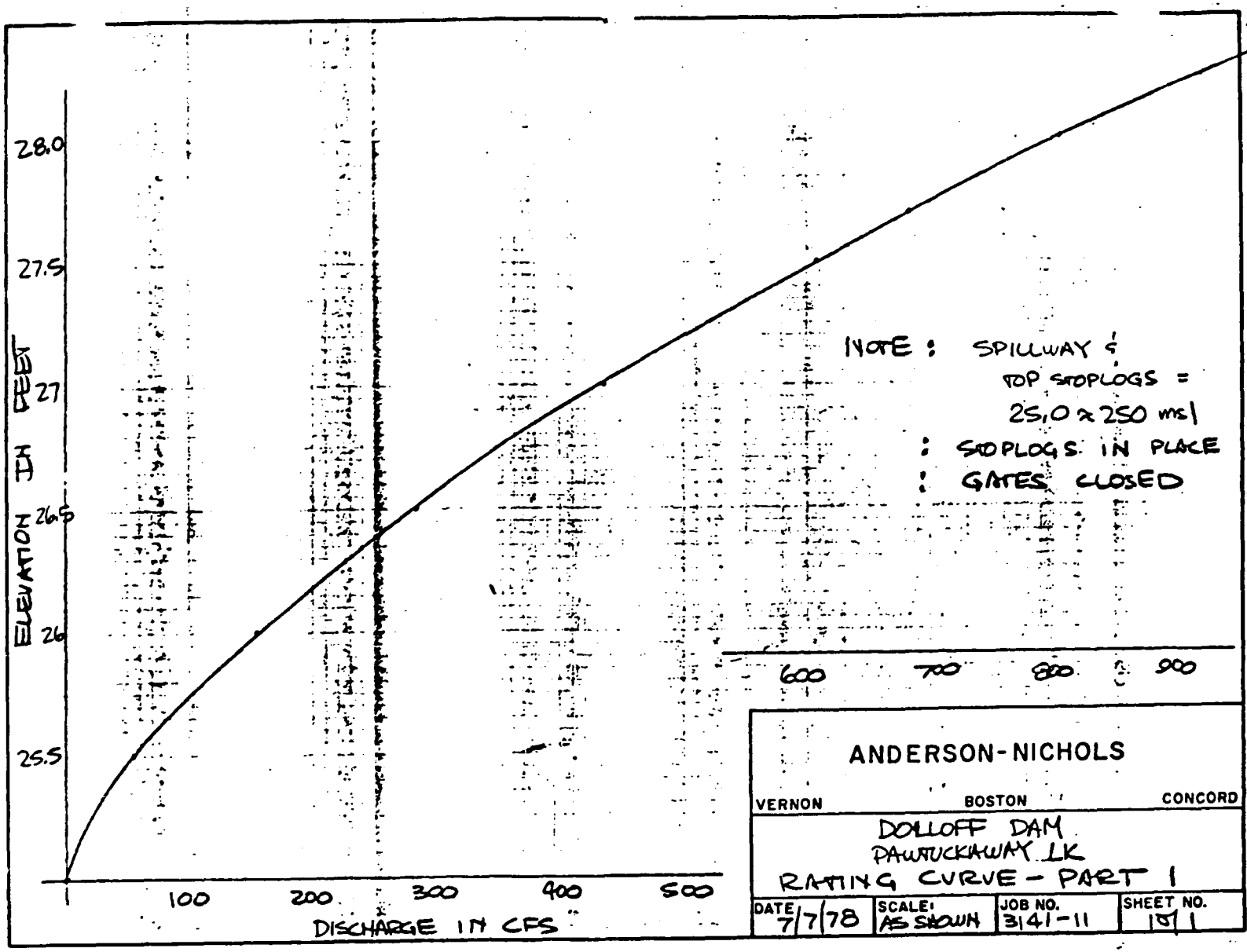
BELOW TOP OF DAM = 2127.7
ABOVE DAM $Q = (2.7)(483)(1.2)^{3/2}$ = 1714.3
3842.0

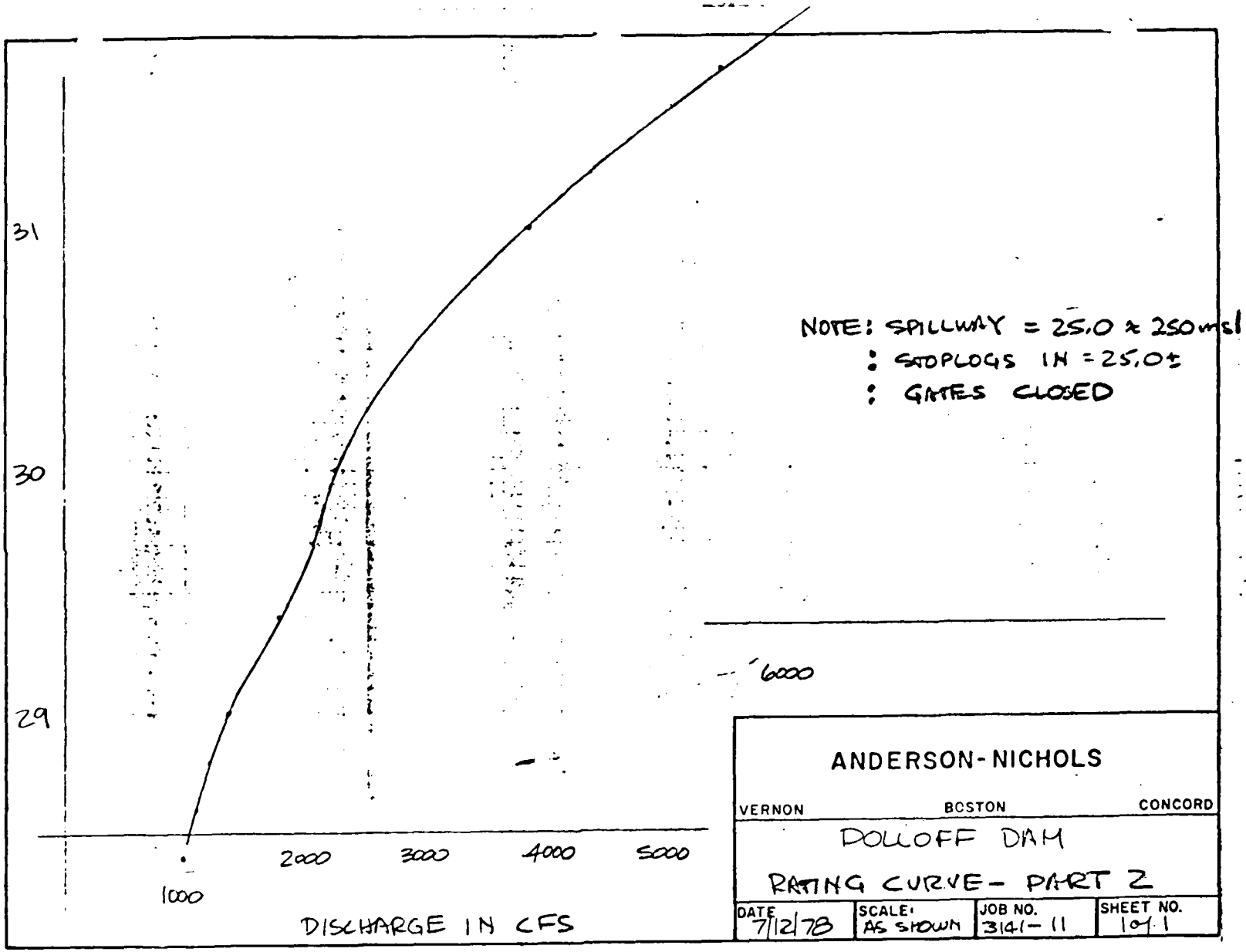
18. @ elev 32.0

BELOW TOP OF DAM = 2127.7
ABOVE DAM $Q = (2.7)(488)(2.2)^{3/2}$ = 4299.5
6427.2

19. @ elev 31.65

BELOW TOP OF DAM 2127.7
ABOVE DAM $Q = (2.7)(486)(1.85)^{3/2}$ = 3301.9
5429.6


28.0
27.5
27
26.5
26
25.5
ELEVATION IN FEET
100
200
300
400
500
DISCHARGE IN CFS
600
700
800
900
NOTE: SPILLWAY ¢
TOP STOPLOGS =
25.0 x 250 msl
: STOPLOGS IN PLACE
: GATES CLOSED
ANDERSON-NICHOLS
VERNON BOSTON CONCORD
DOLLOFF DAM
PAWTUCKAWAY LK
RATING CURVE - PART 1
DATE 7/7/78
SCALE: AS SHOWN
JOB NO. 3141-11
SHEET NO. 1



D-15

ANDERSON-NICHOLS

VERNON BOSTON CONCORD

DOLLOFF DAM

RATING CURVE - PART 2

DATE	SCALE:	JOB NO.	SHEET NO.
7/12/78	AS SHOWN	3141-11	10 of 1

OLOFF DAM
IATE CAPACITY

7/15/78
[illegible]

TA: SIZE OF OPENING = 3' HIGH BY 4' wide (estimated)
pool elevations to be Tested:
PMF = 31.5
MAX pool = 27.7
REC pool = 25.0
TOP DAM = 28.0
INVERT of GATE = 29.0 − 16.8 = 12.2

$Q = CA\sqrt{2gh}$ ORIFICE EQUATION

$K = \frac{1}{C^2}$ $K_f = \frac{29.1\ n^2\ L}{R^{4/3}}$

$n = 0.02$
$L = 28'$
$R = \frac{A}{P} = \frac{12}{14}$
$R = 0.857$

$K_f = 0.40$

entrance & exit = 1.10

$K_{ex} = 1.1 + 0.4 = 1.5$

$1.5 = \frac{1}{C^2}$

$1.5C^2 = 1$

$C^2 = 0.67$

$C = 0.82$

$Q_{CAPACITY}$ @ PMF $h = 31.5 - (12.2 + 1) = 18.3$

$Q = (0.82)(12)(64.4 \cdot 18.3)^{1/2} = 340$ cfs

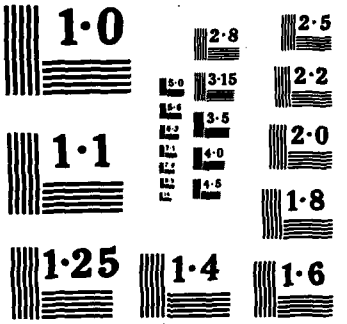
$Q_{CAPACITY}$ @ MAX pool $h = 27.7 - (13.2) = 14.5$

$Q = (0.82)(12)(64.4 \cdot 14.5)^{1/2} = 300$ cfs

AD-A155 995 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
DOLLOFF DAM NH 00134..(U) CORPS OF ENGINEERS WALTHAM MA
NEW ENGLAND DIV JUN 78

UNCLASSIFIED F/G 13/13 NL

END



③ $Q_{CAPACITY}$ @ Recreational Pool $h = 25 - 13.2 = 11.8$

$Q = (0.82)(12)(64.4 \cdot 11.8)^{.5} = 270$ cfs

④ $Q_{CAPACITY}$ @ TOP OF DAM $h = 28.0 - 13.2 = 14.8$

$Q = (0.82)(12)(64.4 \cdot 14.8)^{.5} = 305$ cfs.

PAWTUCKAWAY LAKE
DOLLOFF DAM
BO 8/16/78
DOWNSTREAM HAZARD

ASSUME FAILURE AT FULL POOL CONDITIONS. FULL POOL IS DEFINED AS MAXIMUM POOL

DOLLOFF DAM
MAX POOL = 252.7 MSL

PEAK FAILURE OUTFLOW (BREACH):

$$\Phi_B = \frac{8}{27} w_b \sqrt{g}\ y^{3/2}$$

w_b = BREACH WIDTH
g = 32.2 ft/sec^2
y_o = POOL LEVEL → RIVER BED

ASSUMING OTHER STRUCTURES HOLD & BREACH WIDTH FROM GATED OUTLET TO STOPLOG OUTLET. = 112'

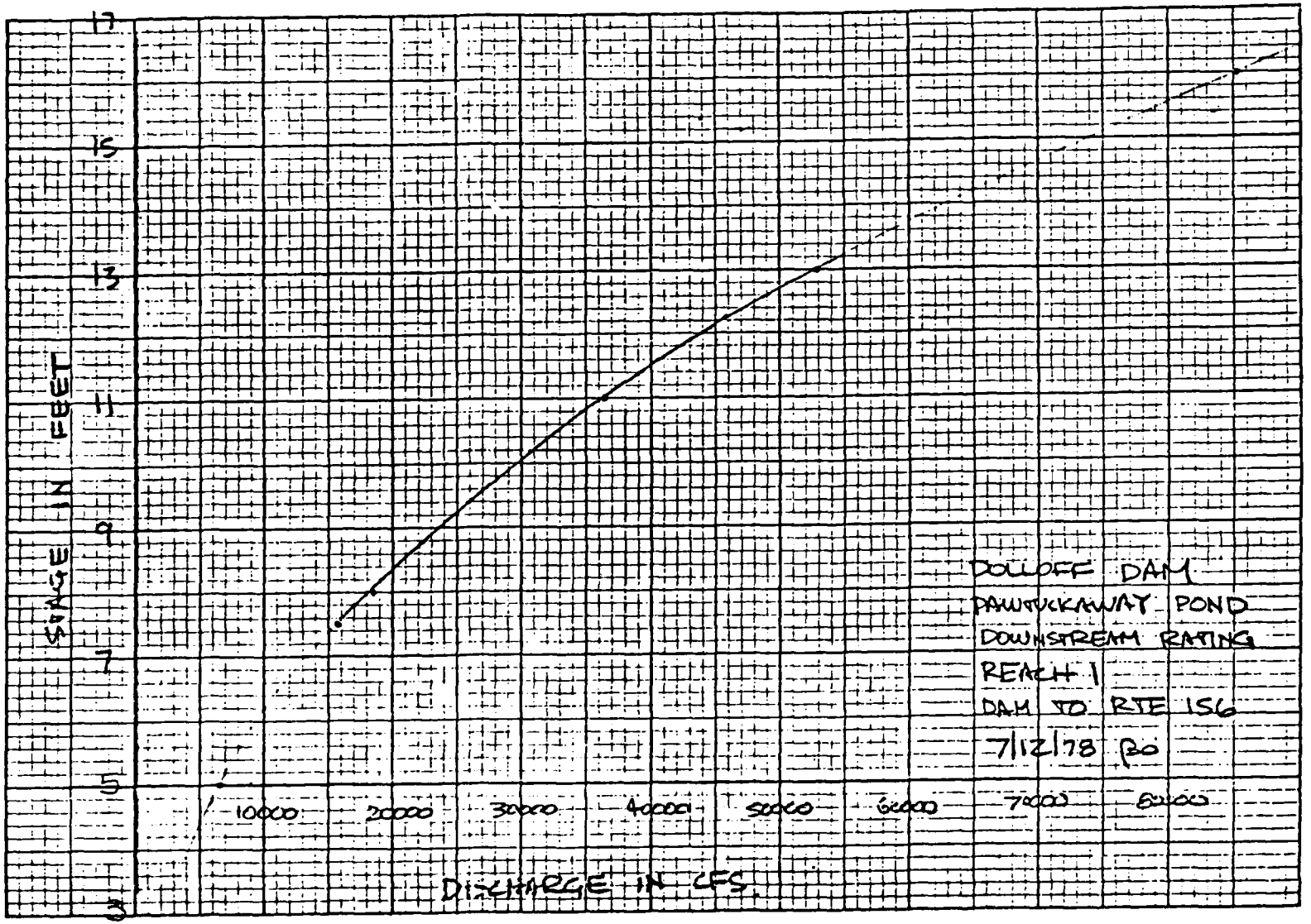
① REACH 1

$$\Phi = \frac{8}{27}(112)(\sqrt{32.2})(252.7-240)^{3/2}$$
$$= 8523 \text{ cfs}$$

DISCHARGE IN REACH OTHER THAN BREACH.

FROM DOLLOFF DAM RATING CURVE:

$\Phi = 683$ cfs


STAGE IN FEET
17
15
13
11
9
7
5
3
10000
20000
30000
40000
50000
60000
70000
80000
DISCHARGE IN CFS
DOLLOFF DAM
PAWTUCKAWAY POND
DOWNSTREAM RATING
REACH 1
DAM TO RTE 156
7/12/78 BO

2/2

7/12/78

BO

REACH 1

DAM → ROAD

– @ 16900 cfs

ROAD DATA: OPENING 18' × 9.0'

L = 26'

HW AVAIL = 1'

$Q = \left(\frac{1.49}{n}\right)(A)(R^{2/3})(S^{1/2})$

S = 0.021

n = 0.03

A = 18 × 9 = 162

P = (2×9) + 18 = 36

R = 162/36 = 4.5

Q = 3180 cfs

← flow thru opening just before pressure flow.

Since bridge can handle such a large flow, along with consideration of the minimal headwater depth available (1.0'); assume bridge provides little head loss and storage.

TOTAL Q FOR REACH = 8523 + 683 = 9206 cfs

FROM D/S HAZARD REACH 1 RATING CURVE:
← FROM DAM TO RTE 156
STAGE @ 9206 cfs ≈ 6 FEET

REACH 1'S LENGTH = 3000'±
X-SECTION AREA @ STAGE = 6 FEET :

$$\tfrac{1}{2}(1)(200) + \tfrac{1}{2}(5)(200 + 417) = 1643\ ft^2$$

VOLUME WITHIN REACH = 3000 × 1643 = 113 AF

STORAGE @ MAX POOL = 11700 AF

$$Q_2 = Q_1\left(1 - \frac{V}{S}\right) \quad \{\text{since } V < \tfrac{1}{2}S \text{ Reach ok}\}$$

$$= 9206\left(1 - 113/11700\right) = 9117 \text{ cfs}$$

FOR ALL PRACTICAL PURPOSES $Q_2 = Q_1$

∴ Q in REACH = (9206 + 9117)/2 = 9160 cfs

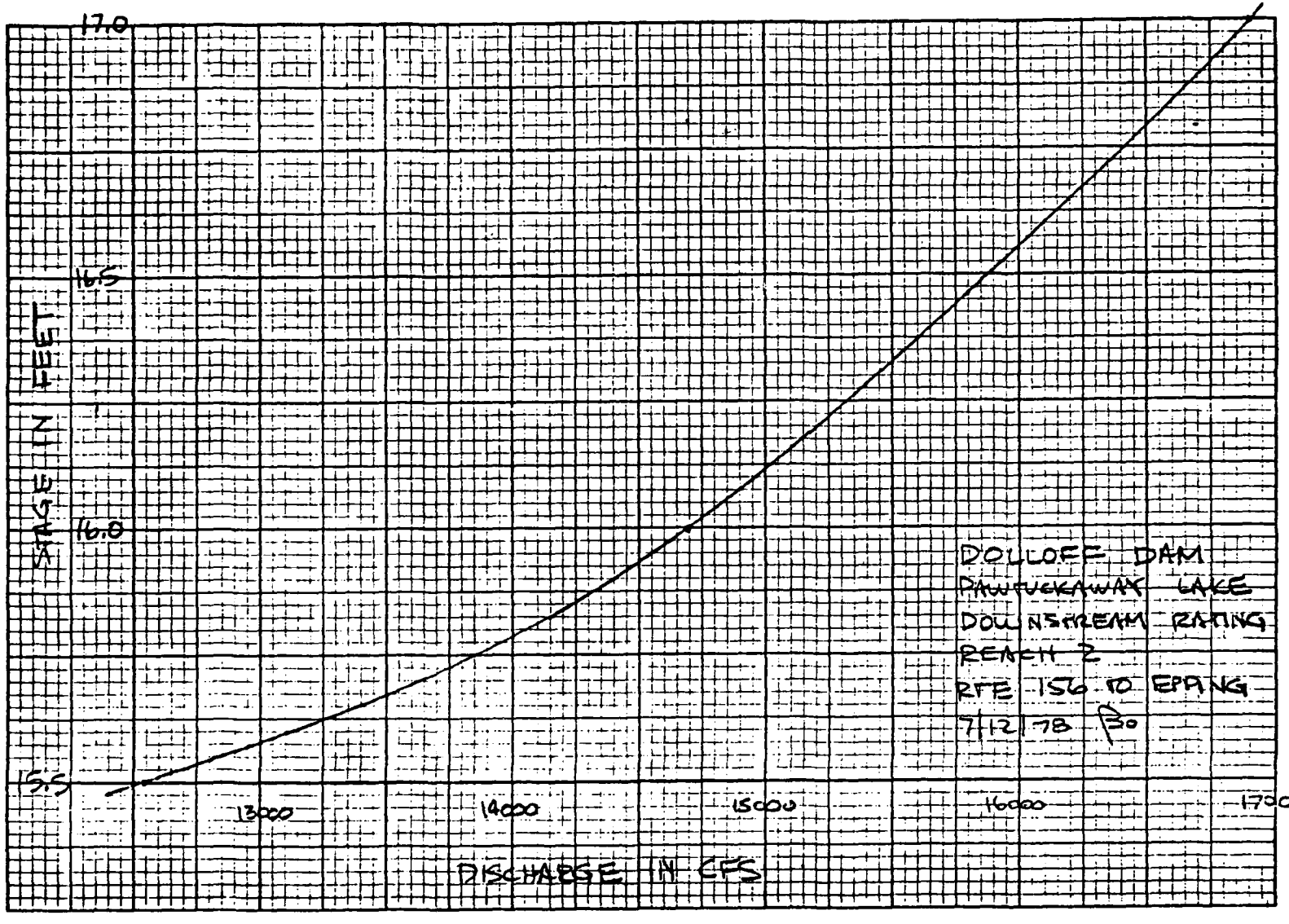
@ Q = 9160 cfs
STAGE FOR REACH 1 = 6 FEET
STORAGE WITHIN REACH = 113 AF

REACH 2

INFLOW INTO REACH = 9160 cfs

FROM D/S HAZARD REACH 2 RATING CURVE ← FROM RTE 156 TO EPPING
(FOR BOTH DOLLOFF & GOVE DIKE):

STAGE @ 9160 cfs = 13 FEET


17.0
16.5
16.0
15.5
FEET IN STAGE
13000
14000
15000
16000
17000
DISCHARGE IN CFS
DOLLOFF DAM
PAWTUCKAWAY LAKE
DOWNSTREAM RATING
REACH 2
RFE 156 TO EPPING
7/12/78

REACH 2's LENGTH = 14000'
AREA @ 13 FOOT STAGE = 2700 ft^2

VOLUME WITHIN REACH = 14000' × 2700 ft^2 = 868 AF

since 868 AF < ½ (11700 AF) REACH ok ✓

$$Q_3 = Q_2 (1 - V/S)$$
$$= 9160 (1 - 868/11700) = 8480 \text{ cfs}$$

∴ STAGE = 12.5 FEET.

VOLUME WITHIN REACH = 14000 × 2505 = 806 AF

AVE VOLUME = (868 + 806)/2 = 837 AF

$$Q_{FINAL} = Q_{INFLOW} (1 - V/S)$$
$$= 9160 (1 - 837/11700) = 8500 \text{ cfs}$$

@ Q = 8500 cfs
STAGE = 12.5 FEET
STOR ≈ 840 AF

WAVE INTO EPPING

Determine height @ West Epping (Reach 2) @ test flood elevation of 31.5 - no breaching

Reach 1

Refer to Dolloff Rating Curve - Reach 1
Discharge @ 31.5 - 5000 cfs
Q of 5000 cfs - stage 4.4'
Reach length = 3000±'
X-section area ≈ 1100 ft² ≈ 76 AC-FT
Total Storage @ 31.5' = 13600 AF
V_1 does not exceed ½S → REACH OKAY

$$Q_{p2(TRIAL)} = Q_{p1}(1 - V_1/S)$$
$$= 4972 \text{ cfs}$$

For practical purposes assume $Q_{p2(TRIAL)} = Q_{p1}$
$Q_{p2} = (5000 + 4972)/2 = 4990$ cfs

Q = 4990 cfs
Stage = 4.4'
V_1 = 76 AC-FT
] Reach 1

Assume Rte 156 bridge provides little storage

Reach 2

Q = 4990 cfs
Refer to rating curve - Reach 2 - Cove Dike & Pawtuckaway Pond - Stage = 10.4'
Reach length = 14000'
Area @ 10.4' ≈ 1900 ft² ≈ 610 AC-FT
S TOTAL = 13600 AC-FT REACH OKAY

$$Q_{p2(TRIAL)} = 4990\left(1 - \frac{610}{13600}\right)$$
$$= 4767 \text{ cfs}$$

Stage @ 4767 cfs = 10.2'
Area @ 10.2' ≈ 1750 ft² ≈ 562 AC-FT

$$Q_{p2} = Q_{p1}\left(1 - \frac{V_{ave}}{S}\right)$$
$$= 4990\left(1 - \frac{586}{13600}\right)$$
$$= 4775 \text{ cfs}$$

Q = 4775 cfs
STAGE = 10.2'
Storage = 586 AC-FT
] Reach 2

Assume 10.2' flood stage into West Epping during test flood conditions without breaching.

Determine height @ West Epping (Reach 2) @ test flood elevation of 31.5' with breaching taking into account tailwater.

Dolloff – Assume breach from gated outlet to stoplog outlet = 112'

$$Q_{p1} = \frac{8}{27} W_b \sqrt{g}\, y_o^{3/2}$$

W_b = breach width
$g = 32.2 \text{ ft/sec}^2$
y_o = pool elev. → river bed (31.5 − 19.4 = 12.1)

$$Q_{p1} = \frac{8}{27} 112 \sqrt{32.2}\, 12.1^{3/2}$$
$$= 7926 \text{ cfs}$$

$Q_{p1} = 7926 \text{ cfs} + 4000 \text{ cfs}$ (Q over nonbreached area)
$Q_{p1} = 11926$ Stage = 6.6'
Area = 1870 ft² = 129 AC-FT
Reach length = 3000±'

$$Q_{p2(trial)} = 11926\left(1 - \frac{129}{13600}\right)$$
$$= 11812 \text{ cfs}$$

For practical purposes assume $Q_{p2(trial)} = Q_{p1}$
$Q_{p2} = (11926 + 11812)/2 = 11869$ cfs

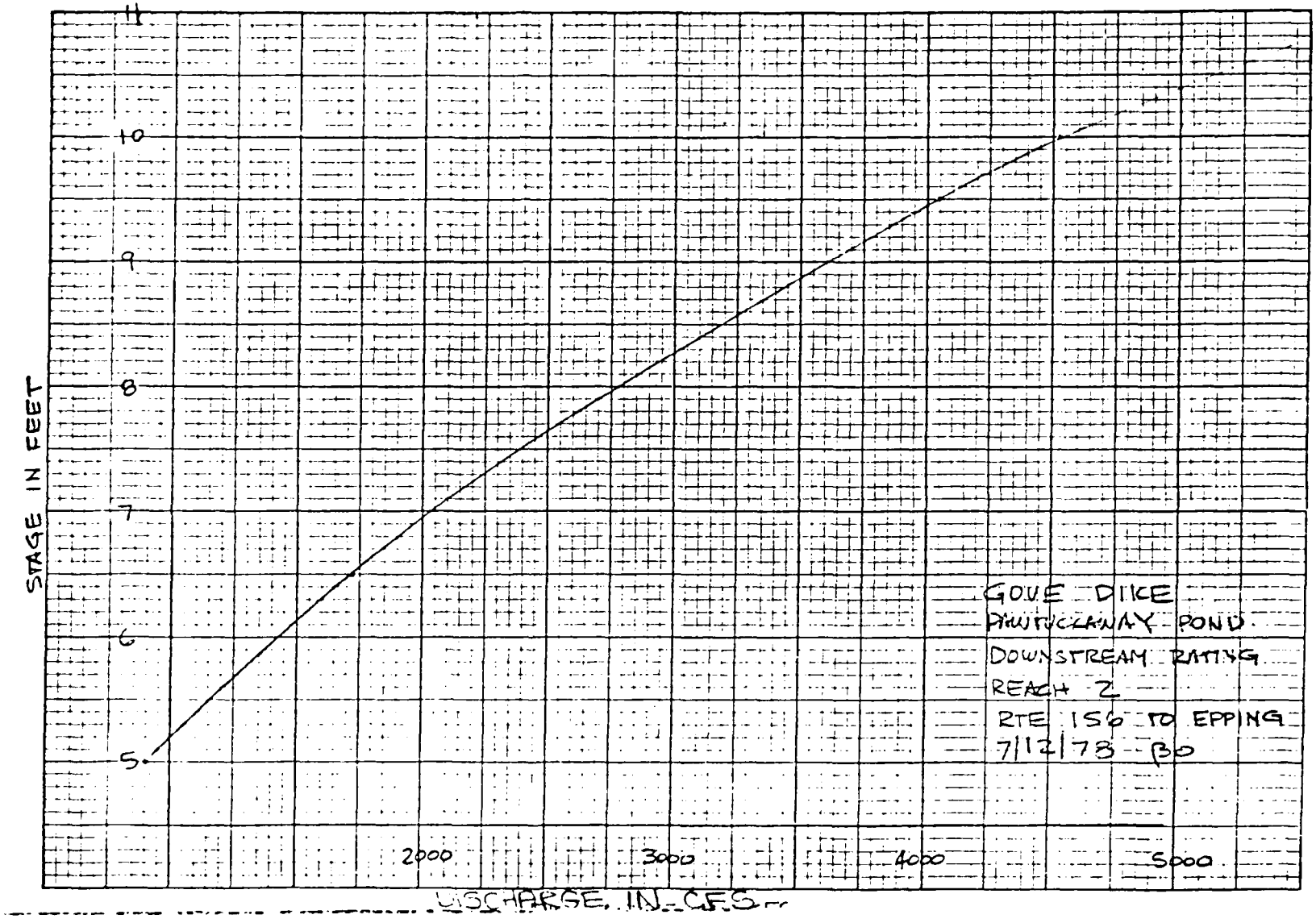
Q = 11869 cfs
Stage = 6.5'
V, O = 1.14 AC-FT] Reach 1
Assume Rte 156 bridge provides little storage

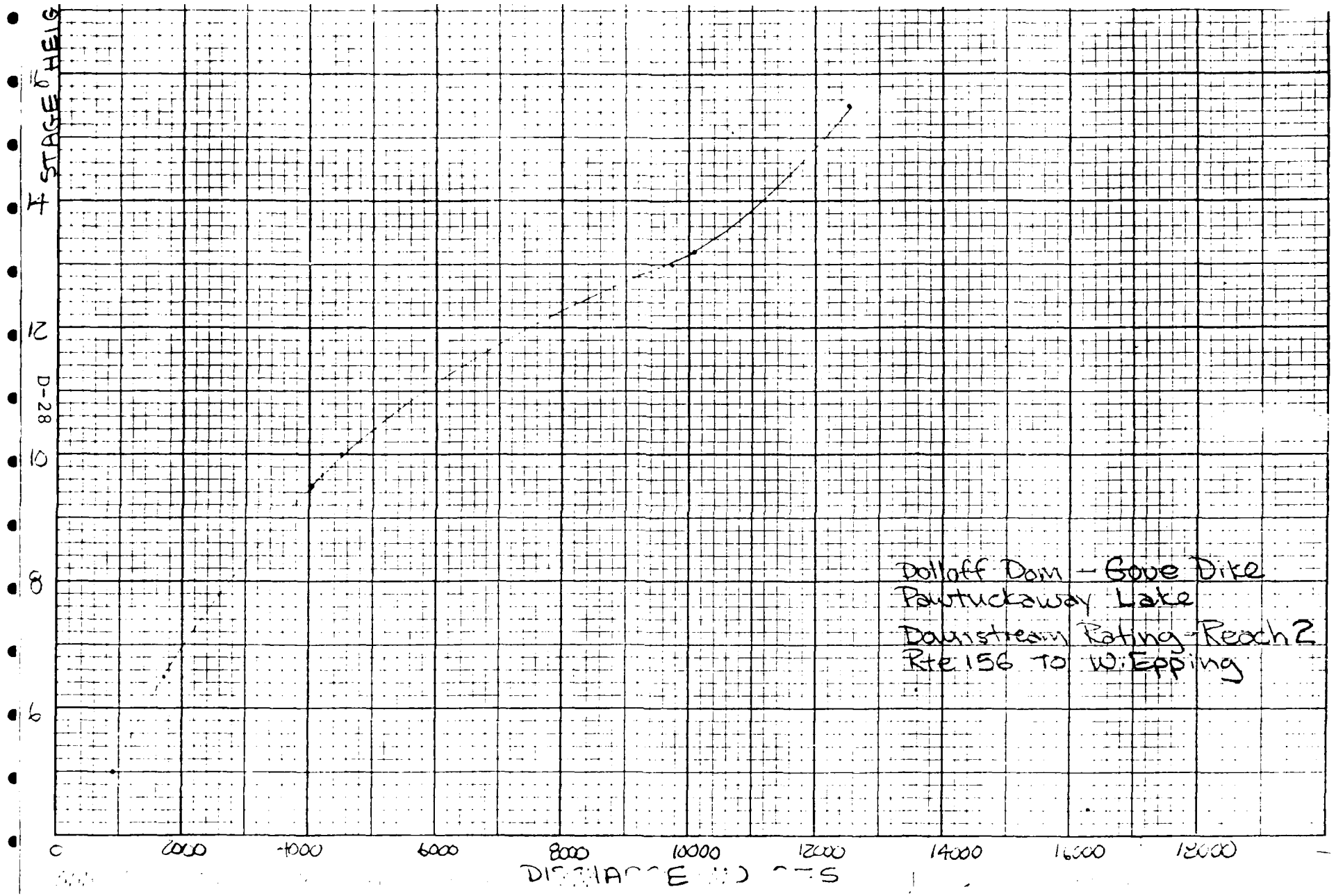
Reach 2

Q = 11869 cfs
Refer to rating curve - Reach 2
Stage = 14.5'
Reach length = 14000
Area = 3320 ft² = 1067 AC-FT

$Q_{p2(trial)} = 11869 \left(1 - \frac{1067}{13600}\right)$
$= 10938$ cfs
Stage = 13.8
Assume $Q_{p2(trial)} = Q_{p_1}$
$Q_{p2} = (11869 + 10938)/2 = 11403$

Stage 14.2' @ West Epping (Reach 2) @ test flood elevation of 31.5 with breaching.


GRAPH PAPER
STAGE IN FEET
11
10
9
8
7
6
5
2000
3000
4000
5000
DISCHARGE IN C.F.S.
GOUE DIKE
PINNACLE MAY POND
DOWNSTREAM RATING
REACH 2
RTE 156 TO EPPING
7/12/78 - BO


STAGE HEIG
14
12
10
8
6
D-28
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Dolloff Dam - Gove Dike
Pawtuckaway Lake
Downstream Rating - Reach 2
Rte 156 TO W. Epping

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY	MO	YR
NH	174	NED	NH	015	01				DOLLOFF DAM	4304.8	7109.0	17	JUL	78

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
	PAWTUCKAWAY POND

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	04	PAWATUCKAWAY RIVER	EPPING	3	2356

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.)	NORMAL (ACRE–FT.)	(27) DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
REGHCTPG	1942	R	27	21	11700	11500	NED	N	N	N	N	15JAN79

(28) REMARKS

(29) D/S HAS	(30) SPILLWAY CREST LENGTH	(31) TYPE	(32) WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) PROPOSED (MW)	(37) NAVIGATION LOCKS NO.	(38) LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
1	414	U	55	2900												

(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
NH WATER RESOURCES BD		

(49) REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

(50) INSPECTION BY	(51) INSPECTION DATE DAY | MO | YR	(52) AUTHORITY FOR INSPECTION
ANDERSON-NICHOLS & COMPANY, INC.	31MAY78	PL92-367

(53) REMARKS

END

FILMED

8-85

DTIC