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NEW ENGLAND DIV JUL 78

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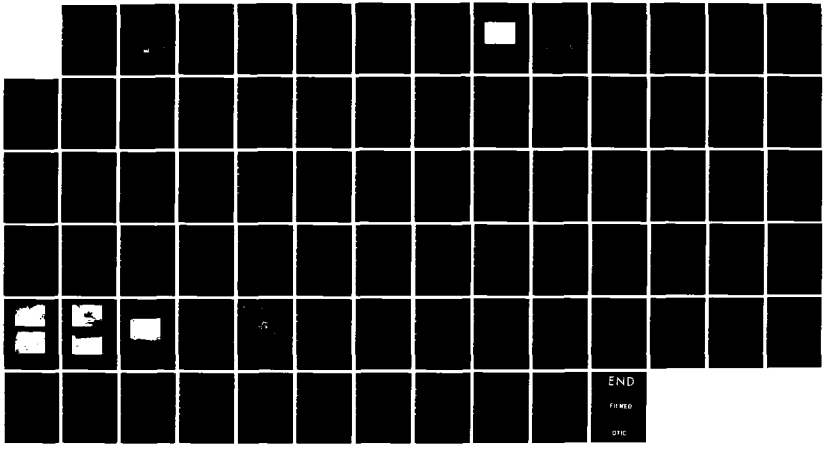

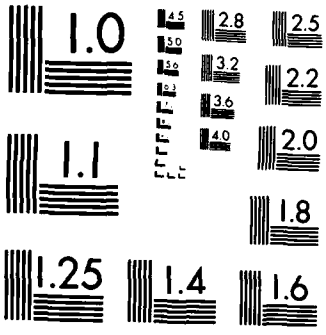

PISCATAQUA RIVER BASIN
NOTTINGHAM , NEW HAMPSHIRE

GOVE DIKE
NH 00135

STATE NO 184.03

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

JULY 1978

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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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 dike is about 9 ft. high and 270 ft. long. It is an earthen embankment contained between a nearly vertical wall of rounded boulders upstream and a vertical dry masonry wall downstream. The dike is in fair condition. The owner should monitor seepage weekly as well as clear brush on the access road and downstream of the dike.

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NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	NH00135
Name of Dam:	Gove Dike
Town:	Nottingham
County and State:	Rockingham County, New Hampshire
Stream:	Tributary of Pawtuckaway River
Date of Inspection:	30 May 1978

BRIEF ASSESSMENT

Gove Dike is about 9 feet high, 20 feet wide at the crest, and 270 feet long (as measured in the field). It is a 136-year old earthen embankment contained between a nearly vertical wall of rounded boulders upstream and a vertical dry masonry (stone) wall downstream. An unpaved road occupies the crest of the dike. This dike and Dolloff and Drown's Dams form the impoundment system of Pawtuckaway Pond. The pond is used now for recreational purposes. It is 3 miles long, has a surface of about 900 acres, and maximum storage is 11,700 acre-feet.

The dike is in fair condition. Major concerns with regard to its long-term integrity are: the overtopping potential caused by the inadequate spillway discharge capacity at Dolloff and Drown's Dams, seepage at the downstream toe (less than 0.01 cfs), and a 6-inch bulge in the downstream vertical dry masonry wall.

The dike has no outlets. The test flood would overtop the dike at its lowest point by 2.9 feet.

The owner, New Hampshire Water Resources Board (NHWRB), should within two years implement the results, after evaluation of the following: assess further all factors relating to overtopping and to the inadequacy of the spillways of the system and design remedial measures for the seepages at the downstream toe of the dike and the bulge in the downstream vertical dry masonry wall. Within one year, NHWRB should implement the following operation and maintenance measures: monitor seepage weekly, clear brush on the access road and downstream of the dike, and establish a surveillance and warning program to be exercised during floods.

Warren A. Guinan

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

PREFACE

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

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

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

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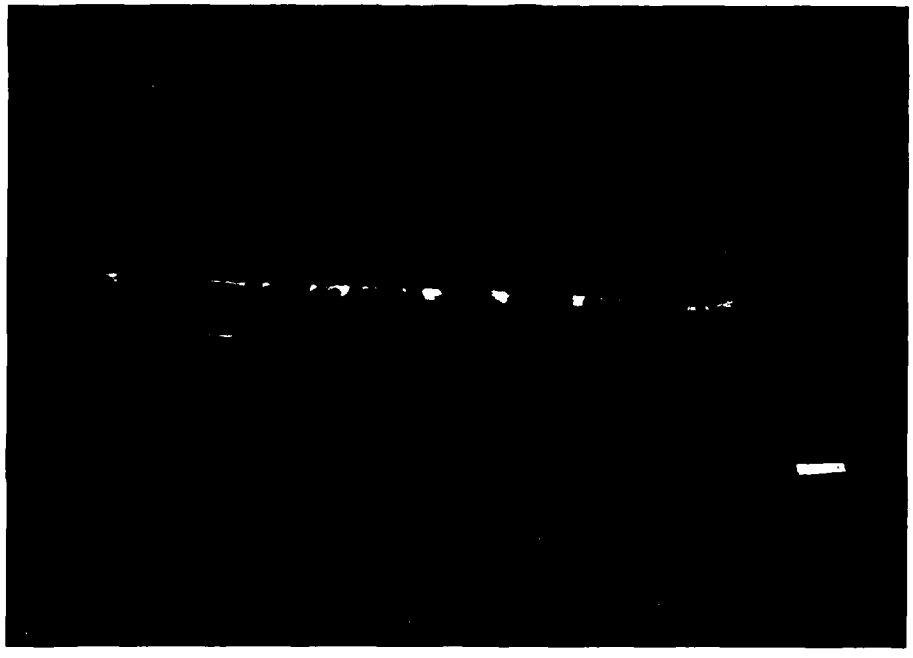
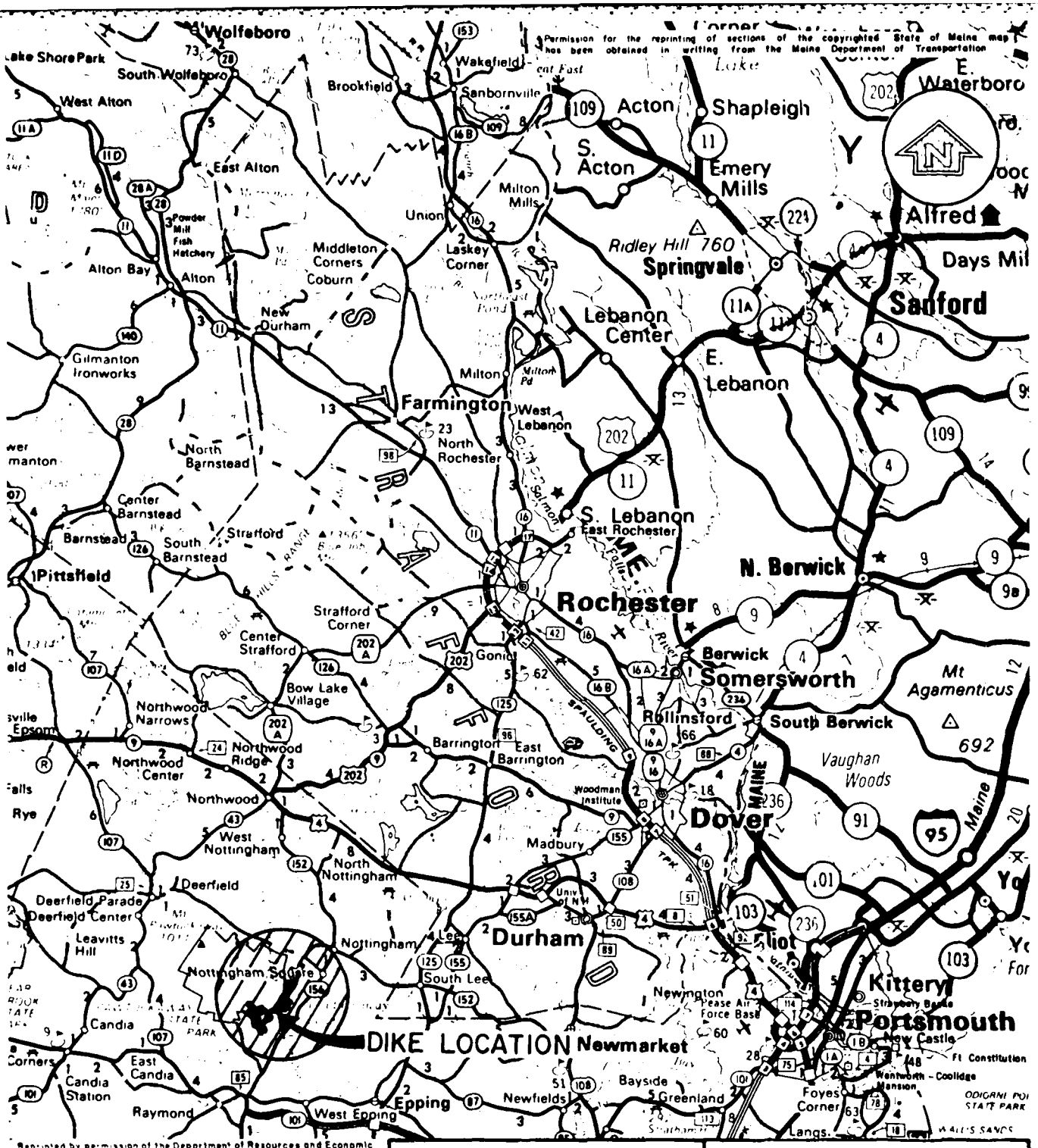


Figure 1 - Overview of upstream face of Gove Dike.



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SCALE IN MILES

5 0 5

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

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

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

GOVE DIKE
LOCATION MAP

PAWTUCKAWAY POND NEW HAMPSHIRE

			SCALE 1" = 5 Mi.
			DATE JULY 1978

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
GOVE DIKE

SECTION I
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. Gove Dike is located in the Town of Nottingham, New Hampshire. Gove Dike, together with Dolloff and Drown's Dams, form the structural barrier system that impounds Pawtuckaway Pond. Gove Dike dams an unnamed tributary of the Pawtuckaway River approximately 0.7 mile upstream of their confluence. The Pawtuckaway then flows for about 2.5 miles to its confluence with the Lamprey River, a major tributary in the Piscataqua River Basin. The dike is shown on U.S.G.S. Quadrangle, Mt. Pawtuckaway, New Hampshire, with coordinates approximately at N 43° 04' 54", W 71° 07' 59", Rockingham County, New Hampshire (see location map page iv).

b. Description of Dike and Appurtenances. Gove Dike is a low earthen embankment with the upstream side partially faced with a nearly vertical wall of rounded boulders. The downstream face consists of a dry masonry wall. The dike, as measured in the field, is about 20 feet wide at the crest, 270 feet in length, and 9 feet in height above the downstream toe. However, past inspection reports and other records (see Appendix B) reflect that the dike is 350 feet in length, while the maximum structural height is 11 feet as given in the Corps of Engineers' Inventory of March 1974. An unpaved roadway runs along the crest of the dike (see sketches in Appendix B). It is evident that fill has been placed sometime prior to 1978 to accommodate another road near the right (westerly) end of the dike.

c. Size Classification. Intermediate (Hydraulic height - 8 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. Significant hazard. A major breach in the dike would probably result in the loss of less than 10 lives and appreciable property damage.

e. Ownership. The present dike, along with Dolloff and Drown's Dams, 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 on to the Lamprey River Improvement Company, a subsidiary of New Hampshire Gas and Electric Company, sometime prior to 1917. The New Hampshire Water Resources Board (NHWRB) 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.

g. Purpose of Dike. 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. Later, under the ownership of the Lamprey River Improvement Company, Pawtuckaway Pond was utilized primarily as upstream storage for generation of hydroelectricity for the region, with some recreational usage. Pawtuckaway Pond is presently being used for recreational purposes only.

h. Design and Construction History. Little information was found concerning the original design and construction of the dike. It is believed that the structure is basically an earth-fill dike faced with vertical dry masonry walls. A 1918 report recommended that an overflow area be created by lowering the crest 2.5 feet over a distance of 125 feet at the western end of the dike. A letter dated 1919 from the owner to the state regulatory agency indicates that this construction was started. Visual inspection found no evidence of an overflow area. Presently, the dike also serves as an unpaved year-round road.

i. Normal Operational Procedures. Not applicable; Gove Dike has no outlet facilities. No written maintenance procedures were found.

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 (Dike)

(1) Outlet works (conduits) - none

(2) Maximum known discharge at damsite (dike) is unknown.

(3) Ungated spillway capacity at maximum pool elevation - not applicable.

(4) Gated spillway capacity at pool elevation - not applicable.

(5) Gated spillway capacity at maximum pool elevation - not applicable.

(6) Total spillway capacity at maximum pool elevation - not applicable.

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. (See Dolloff Dam Inspection Report.)

(1) Top of dike - 253.6

(2) Maximum pool - design surcharge - unknown

(3) Full flood control pool - not applicable

(4) Recreation pool - 250

(5) Spillway crest - not applicable

(6) Upstream portal invert diversion tunnel - none

(7) Streambed at centerline of dike - 244.4 (downstream toe 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 dike - 11,700 (storage based on Dolloff Dam)

f. Reservoir Surface (acres)

(1) Top of dike - 1015

(2) Maximum pool - 975 (based on Dolloff Dam)

(3) Flood control pool - not applicable

(4) Recreation pool - 903

(5) Spillway crest - not applicable

g. Dike

(1) Type - earthen embankment with its upstream face partially covered with round boulders, and a dry masonry downstream face; both faces being nearly vertical.

(2) Length - 270' (measured)
- 350' (from past inspection records)

PERIODIC INSPECTION CHECK LIST

PROJECT Gove Dike, New Hampshire DATE May 31, 1978

PROJECT FEATURE Dike Embankment NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
Crest Elevation	253.6 ft. MSL
Current Pool Elevation	250.1 ft. MSL
Maximum Impoundment to Date	Unknown
Surface Cracks	None
Pavement Condition	Not paved
Movement or Settlement of Crest	None
Lateral Movement	Minor bulging of dry masonry wall on downstream side of dam
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	Some bulldozing on downstream side of west abutment
Sloughing or Erosion of Slopes or Abutments	None
Rock Slope Protection - Riprap Failures	None
Unusual Movement or Cracking at or near Toes	None
Unusual Embankment or Downstream Seepage	Two small seepages near toe of dam, one close to west abutment and one near center of dam
Piping or Boils	None
Foundation Drainage Features	None known
Toe Drains	None known
Instrumentation System	None known

VISUAL INSPECTION CHECKLIST

PARTY ORGANIZATION

PROJECT Gove Dike, New Hampshire

DATE May 30, 1978

TIME 2:00 P.M.

WEATHER Sunny, hot

W.S. ELEV. 250 U.S. 244 DN.S.

(ground surface below dike)

PARTY:

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

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

APPENDIX A

CHECK LIST - VISUAL INSPECTION

(3) The NHWRB should develop a written operational procedure to follow in the event of flood flow conditions of imminent dike failure that could 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.

7.3 b. below should be implemented by the owner within one year.

d. Need for Additional Investigation. The information available from the visual inspection indicates that the problems are overtopping and seepage. 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.

7.2 Recommendations

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

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

(2) Design or specify the remedial measures needed to eliminate or control the seepage along the downstream toe.

(3) Design the correctional measures for the bulge in the downstream dry-masonry wall.

(4) Remove small trees and brush.

(5) Consider measures required to shape the shoulders and pave the road to eliminate possible erosional problems.

7.3 Remedial Measures

a. Alternatives. The NHWRB should consider as alternatives, pending implementation and results of the above recommendations, (see also Dolloff Dam Report) the following:

(1) Purchase downstream land that would be adversely impacted by failure of Gove Dike and restrict human occupancy.

(2) Enhance the stability of Gove Dike to permit overtopping by the test flood without failure.

b. Operation and Maintenance Procedures.

(1) The seepage at the downstream toe should be monitored on a weekly basis.

(2) The tree and brush growth on the dike and downstream for at least 20 feet should be removed and kept free in the future.

SECTION 7
ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection indicates that Gove Dike is in fair condition. The major concerns affecting the overall long-term integrity of the dike are as follows:

(1) The overtopping potential.

(2) The seepage at the downstream toe.

(3) The bulge in the downstream vertical dry masonry wall.

(4) The brush and trees growing on either side of the unpaved roadway.

(5) The possibility of erosion of the unpaved roadway caused by surface runoff from the approach and egress roadways at either end of the dike.

(6) The possibility of erosion of the unpaved roadway if the dike is overtopped.

Because Gove Dike is an integral part of the Pawtuckaway Pond impoundment system that includes Drown's and Dolloff Dams, its relationship to the test flood required hydrologic and hydraulic analyses of all three structures. Under conditions of the test flood all structures are overtopped. The spillway capacity of the combined system is considered inadequate.

Assuming that Drown's and Dolloff Dams do not fail, Gove Dike would be overtopped by 2.9 feet under conditions of the test flood. This depth of overtopping takes into consideration the fact that Gove Dike is about one foot higher than the emergency spillway at Drown's Dam and the low ground adjacent to the left abutment at Dolloff Dam. Gove Dike, however, has stood the test of time - at least 136 years.

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

c. Urgency. The recommendations enumerated in 7.2 below should be implemented by the owner, NHWRB, within two years. The operation and maintenance measures enumerated in

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. Visual observations indicated three potential structural problems: (1) seepage downstream of the toe of the dike, (2) localized bulging of the nearly vertical dry masonry wall which comprises the downstream face of the dike, and (3) trees and brush growing on the dike. (See Section 3.1 b.)

b. Design and Construction Data. No design and construction data are available except the sketch contained in a 1918 condition report that was copied from an 1889 document. Apparently the dike was built during the period between 1839 and 1842 and has remained intact for at least 136 years. (See Appendix B.)

c. Operating Records. No operating records pertaining to the structural stability were disclosed.

d. Post-Construction Changes. Some fill has apparently been placed against the downstream face at the right abutment up to approximately the level of the crest roadway. Also, nume ous large boulders (4 to 5 feet in size) have apparently been dumped immediately downstream of the downstream dry masonry wall near both ends of the dike. Neither of these changes would have any adverse impact on the structural stability of the dike.

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

d. Overtopping Potential. Gove Dike in conjunction with Dolloff and Drown's Dams, is unable to store to test flood without overtopping. The water depth over the lowest point of the crest of the dike was calculated to be 2.9 feet.

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. Hydrologic and hydraulic information, however, dating from the ownership by the Lamprey River Improvement Company of the dikes and dams 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 Gove Dike.

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

To determine the hazard classification for Gove Dike, the impact of failure of the dike 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 dike to the village of West Epping, a distance of about 3 miles. Failure of Gove Dike at maximum pool would probably result in an increase in stage of 6.6 feet at West Epping. An increase in water depth of this magnitude would probably result in the loss of less than 10 lives, sever State Route 156, and damage some agricultural lands.

As a result of the analysis described above, Gove Dike was classified - Significant 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. At least one house on the reservoir's east bank near the dike has its first floor at or below the crest of the dike.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

The NHWRB has operated Pawtuckaway Pond since 1955. Gove Dike has no outlet facilities. The level of the impoundment is controlled by discharge through Dolloff and Drown's Dams. The water level during the recreational season is maintained reasonably constant (250 feet MSL). In the fall, the level is drawn down, allowing abutters to make improvements to their shoreline and providing some storage for spring runoff.

4.2 Maintenance of Dike

The NHWRB is responsible for the maintenance of Gove Dike.

4.3 Maintenance of Operating Facilities

Gove Dike has no outlet facilities.

4.4 Description of Any Warning System in Effect

No written warning system was disclosed for Gove Dike.

4.5 Evaluation

The operation and maintenance procedures for Gove Dike, consisting of a weekly program of inspection, should insure that all 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.

of these cottages may be susceptable to flooding. No evidence of any buildup of sedimentation is visible. (See Appendix C - Figure 5.)

e. Downstream Channel. Because the structure has no outlet, no defined downstream channel exists. The valley downstream of the dike is wooded, and drains into an unnamed tributary to the Pawtuckaway River. The valley has been cleared of trees for a distance of about 20 feet immediately downstream of the dike. (See Appendix C - Figure 6.)

3.2 Evaluation

The observed condition of the dike is fair. The potential problems observed during the visual inspection are listed as follows:

(a) Two seepages at the downstream toe of the dike.

(b) Bulge in the downstream dry masonry wall.

(c) Brush and trees on both faces.

(d) Crest of dike, being an unpaved road, could be subject to erosion.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The dike is a low embankment on Pawtuckaway Pond and has no spillway or outlet structures. Drown's Dam and Dolloff Dam are the controlling structures for this pond. Numerous cottages and summer homes are sited around the southeastern portion of the reservoir.

b. Dike. The dike consists of an earth embankment approximately 270 feet long, 9 feet high, and 20 feet wide at the crest. (See Appendix C - Figures 2 and 3.) The upstream side is partially faced with a nearly vertical wall of rounded boulders and the downstream face consists of a vertical dry masonry wall. Boulders comprising both walls range in size from 1 to 3 feet. The crest of the dike was approximately 3.5 feet above the pond level at the time of the inspection. The measured water depth on the upstream side varies up to 5 feet deep. The crest of the dike is an unpaved road, maintained year round (See Appendix C - Figure 4.)

Approximately 100 feet from the left abutment, a bulge was observed in the downstream dry masonry wall. The wall is bulged approximately 6 inches at a height of 4 to 5 feet above the ground level.

Numerous large boulders (4 to 5 feet in size) have apparently been dumped immediately downstream of the dike, near both ends. Two 12-inch trees have recently been cut at the west end of the dike near the downstream toe.

Two seepages were observed. One is estimated at .02 cfs (10 gpm) about 15 feet downstream of the wall near the center of the valley. The second, near the right abutment, has a barely visible flow. Discharge water from both seepages is clear. Standing water is visible approximately 20 feet downstream of the downstream face near the right abutment. Some fill has apparently been placed against the downstream face at the right abutment and filled to approximately the height of the roadway.

c. Appurtenant Structures. Not applicable

d. Reservoir Area. The reservoir slopes along the shoreline are gentle and generally covered with trees and brush. Cottages are scattered around the perimeter. Some

SECTION 2
ENGINEERING DATA

2.1 Design

No original design data were disclosed for Gove Dike.

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. Very little engineering data were disclosed for Gove Dike. A search of the files of the NHWRB revealed only a limited amount of recorded information.

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 dike.

(3) Height - 11' (structural height)

(4) Top width - approximately 20'

(5) Side slopes - nearly vertical

(6) Zoning - unknown

(7) Impervious Core - unknown

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - not applicable

i. Spillway - none

PROJECT Gove Dike, New Hampshire DATE May 30, 1978

PROJECT FEATURE Reservoir NAME R. Langen

Pawtuckaway Pond

AREA EVALUATED	REMARKS
Stability of Shoreline	Good
Sedimentation	Minor
Changes in Watershed Runoff Potential	Minor
Upstream Hazards	Several homes along eastern shore. Most are at least 6' above lake.
Downstream Hazards	State Highway 156, nearest village is West Epping about 3 miles downstream.
Alert Facilities	None
Hydrometeorological Gages	None
Operational & Maintenance Regulations	None

APPENDIX B

INSPECTION REPORTS/SKETCHES

GOVE DIKE

NEW HAMPSHIRE WATER CONTROL COMMISSION

REPORT ON DAM INSPECTION

TOWN [illegible] (Nottingham) DAM NO. 184.02 STREAM [illegible]

OWNER [illegible] ADDRESS [illegible]

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

NOTES ON PHYSICAL CONDITION

Abutments [illegible] (GOOD)

Spillway [illegible] (NONE)

Gates [illegible] (NONE)

Other [illegible] (EMBANKMENT - GOOD)

CHANGES SINCE LAST INSPECTION [illegible]

FUTURE INSPECTIONS [illegible] (YES)

This dam (is) (~~is not~~) a menace because of [illegible] (of area of ponds)

REMARKS [illegible] (small head at dike - Pawtuckaway Pond)

(184.02 - the spillway & gates also good - BROWN'S DAM)

Copy to Owner	Date

[illegible]
INSPECTOR
(Francis Moore)

(Additional Notes Over)

GOVE DIKE

NEW HAMPSHIRE WATER CONTROL COMMISSION

REPORT ON DAM INSPECTION

TOWN Nottingham (Nottingham) DAM NO. 154.02 STREAM Pawtuckaway River

OWNER Langley Rice Improvement Co ADDRESS [illegible]

In accordance with Section 20 of Chapter 133, Laws of 1937, the above dam was inspected by me on 12/21/49 12/26/49 accompanied by

NOTES ON PHYSICAL CONDITION

Abutments Good (GOOD)

Spillway None (NONE)

Gates None (NONE)

Other Embankment Good (EMBANKMENT - GOOD)

CHANGES SINCE LAST INSPECTION

FUTURE INSPECTIONS None (YES)

This dam (is) (~~is not~~) a menace because of risk of loss of life (of area of ponds)

REMARKS Spill front of dike (small head at dike (-Pawtuckaway Pond) [illegible] (154.07 - the spillway & gates also good - BROWN'S DAM)

Copy to Owner	Date

[signature]
INSPECTOR
(Francis Moore)

(Additional Notes Over)

FORM ES

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD

TOWN	NOTTINGHAM	TOWN NO.	STATE NO. 184.03
RIVER STREAM	Pawtuckaway Pond (Dike)		GOVE DIKE
DRAINAGE AREA	20.66 Sq. Mi.	POND AREA	934.2 Acres
DAM TYPE	Gravity	FOUNDATION NATURE OF	Earth
MATERIALS OF CONSTRUCTION	Boulders, Earth		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM	8'	TOP OF DAM TO SPILLWAY CRESTS	
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	None	LENGTH OF DAM	350'
FLASHBOARDS TYPE, HEIGHT ABOVE CREST			
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			

Amprey River Improvement Co.
c/o P. H. Burrowes, 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 15-26?

	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
3/15/72	C.D.C.								

NEW HAMPSHIRE WATER RESOURCES BOARD

GOVE DYKE

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Ocean NO.

RIVER Pawtuckaway Pond MILES FROM MOUTH D.A.SQ.MI. 20.66

TOWN Nottingham OWNER Lamprey River

LOCAL NAME OF DAM

BUILT DESCRIPTION Gravity — end earth

POND AREA-ACRES 934.2 DRAINAGE PT. 10WRB POND CAPACITY-ACRE FT. 106 con

HEIGHT-TOP TO BED OF STREAM-FT. MAX. MIN.

OVERALL LENGTH OF DAM-FT. 350 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. NONE FREEBOARD-FT.

FLASHBOARDS-TYPE, HEIGHT ABOVE CREST

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

REMARKS Condition Fair

T.L. into Pawtuckaway R, Lamprey R.

POWER DEVELOPMENT

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

USE Conservation

REMARKS

DATE 36

GOVE DIKE

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-4382

TOWN	Nottingham	TOWN NO. 3	STATE NO 18,6
RIVER STREAM	Pawtuckaway Pond (Dike)		
DRAINAGE AREA	10.00 Sq. Mi.	POND AREA	384.? Acres
DAM TYPE	Gravity	FOUNDATION NATURE OF	Earth
MATERIALS OF CONSTRUCTION	Boulders, Earth		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTION—PUBLIC UTILITY		
HEIGHTS TOP OF DAM TO BED OF STREAM	8'	TOP OF DAM TO SPILLWAY CRESTS	
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	None	LENGTH OF DAM	350'
FLASHBOARDS TYPE, HEIGHT ABOVE CREST			
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- Longrey River Improvement Company

CONDITION- Fair

USAGE- Yes. Will be subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made August 6, 1935, according to notification to owner dated July 31, 1935, and blank for same is enclosed.

Sept. 18, 1935 (Sept. 18, 1935) Samuel J. Lord
Copy to Owner Eng. Eng.

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-4562

TOWN	NOTTINGHAM	TOWN NO. 3	STATE NO. ~~101~~ 184
RIVER STREAM	Pawtuckaway Pond (Dike)		GOVE DIKE
DRAINAGE AREA	20.06 Sq. Mi.	POND AREA	354.2 Acres
DAM TYPE—	Gravity	FOUNDATION NATURE OF	Earth
MATERIALS OF CONSTRUCTION	Boulders, Earth		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM	8'	TOP OF DAM TO SPILLWAY CRESTS	
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	None	LENGTH OF DAM	350'
FLASHBOARDS TYPE HEIGHT ABOVE CREST			
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. 73 P. C. TIME 100 P. C. EFF.	
REFERENCES, CASES, PLANS, INSPECTIONS.			
REMARKS			

OWNER Lamprey River Improvement Co. c/o P. H. Burrowes, Supt. Newmarket CONTRACTOR NO. 5-21

APPLICATION	RECEIVED	INVESTIGATED BY	DATE

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

IS DAM SUBJECT TO PROVISIONS OF P. L. CHAP. 218, SECTS 15-26? Yes

PLANS & SPECIFICATIONS	RECEIVED	CHECKED BY	DATE
	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
9/6/35	L. C. Blake	9/18/35	$4.00	10/14/35					
Condition--Fair									1-

NEW HAMPSHIRE WATER CONTROL COMMISSION

DATA ON DAMS IN NEW HAMPSHIRE

GOVE DIKE

LOCATION STATE NO. 131.02

Town (Nottingham): County (Strafford)

Stream (Pawtuckaway)

Basin-Primary Ocean: Secondary

Local Name

Coordinates—Lat. 43° 01' - 800: Long. 71° 12' - 2300

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 20.33 Sq. Mi.

Overall length of dam 350 ft.: Date of Construction

Height: Stream bed to highest elev. 8 ft.: Max. Structure 8 ft.

Cost—Dam : Reservoir

DESCRIPTION Gravity Boulders and earth Foundation earth

(Gravity Boulders and earth Foundation earth)

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 Earth (Earth)

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on: Downstream on

Length—Right of Spillway : Left of Spillway

Spillway none

Materials of Construction

Length—Total ft.: Net ft.

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

Flashboards—Type : Height ft.

Elevation—Permanent Crest : Top of Flashboard

Flood Capacity cfs.: cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. ft.: Min. ft.

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

OWNER Pawtuckaway Improvement Co. % D.H. Burns

REMARKS Condition fair (Condition fair)

Subject to inspection

Tabulation By Date 7-11-33

USGS 21284

Town No. 3 Town Nottingham No.

GOVE DIKE

Dam by U.S.G.S. File (

Owner Lamprey River Improvement Company

River or Stream Pawtuckaway Pond

Public Utility No Drainage area 18 sq. mi.

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

Type of Construction Stone

Height 16, 12 ft. Operating Head Storage ft.

Length 170, 320 ft. Spillway Length (No. 1) 50 ft. (No. 2) ft.

Would Failure of Dam do Harm? Yes

Present Condition Good Date 1922

LWB Good 1925

PAWTUCKAWAY AND MENDUM PONDS

REPORT FROM H. F. DUNHAM

to

D. A. BELDEN, PRESIDENT

LAMPREY RIVER IMPROVEMENT COMPANY

December 5, 1913

M. F. DUNHAM
SINGER BUILDING
149 BROADWAY, NEW YORK
TELEPHONE, 3167 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

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 stege 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.

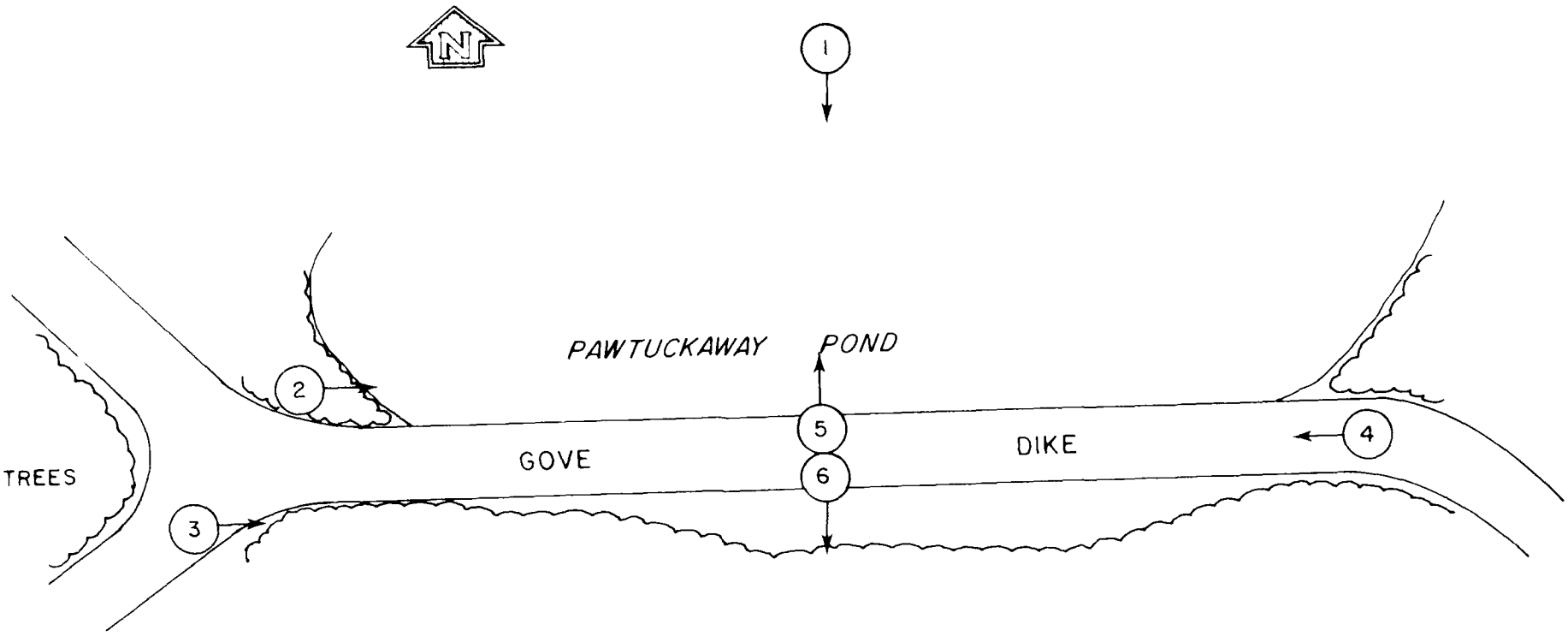
> "2. Rock-fill dams with a central core of steel plates and without hand-laid facing walls."
>
> "4. Rock-fill dams with facing of masonry built vertically backed with earth and covered on the lower side with blocks of stone laid in mortar."

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

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 1989, 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--



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

GOVE DIKE
PHOTO INDEX

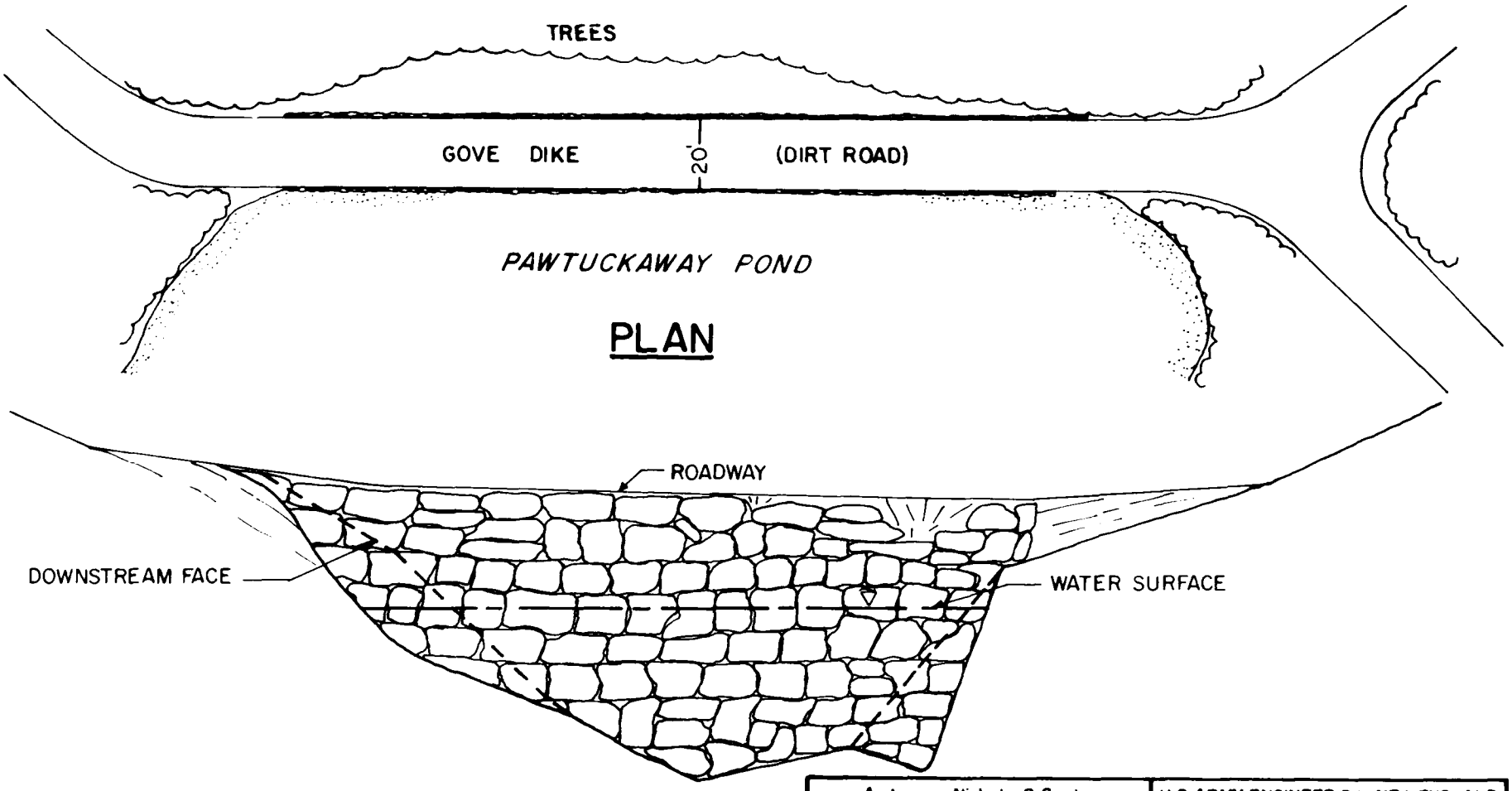
PAWTUCKAWAY POND NEW HAMPSHIRE

SCALE: NOT TO SCALE

DATE: JULY 1978

APPENDIX C

PLOT GRAPHS



PLAN

ELEVATION

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

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

GOVE DIKE

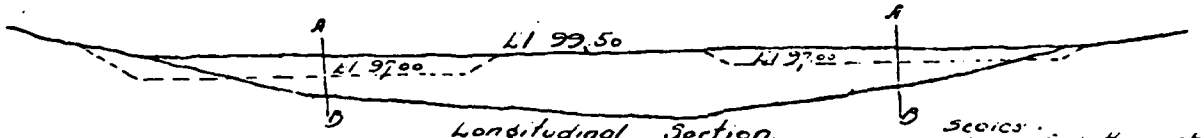
PAWTUCKAWAY POND NEW HAMPSHIRE

SCALE: NOT TO SCALE

DATE: JULY 1978

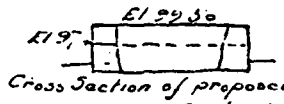
Changes to be made at Gore Dam (No 3)

Fig 1.



Longitudinal Section

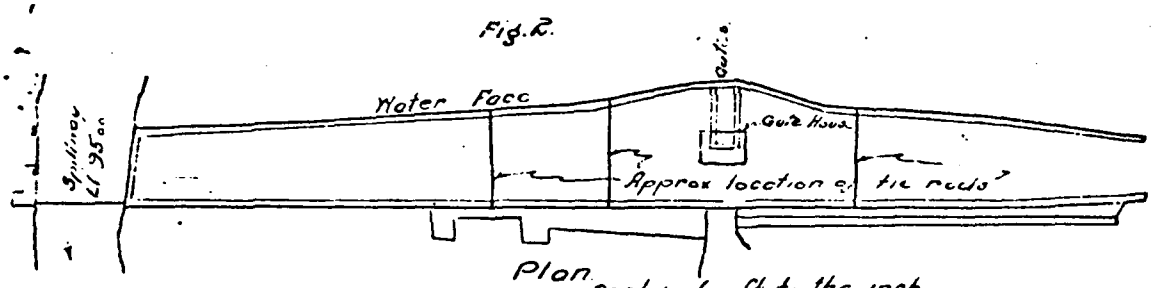
Scales:
Hor 60 ft to the inch
Vert 20 ft to the inch



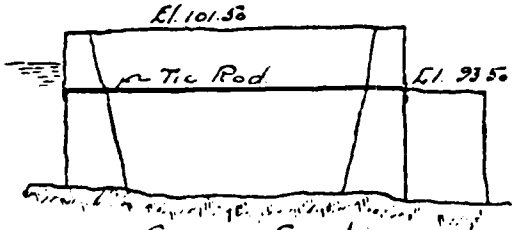
Cross Section of proposed spillway at A-B
Scale: 20 ft to the inch.

Changes to be made at Mendum Dam.

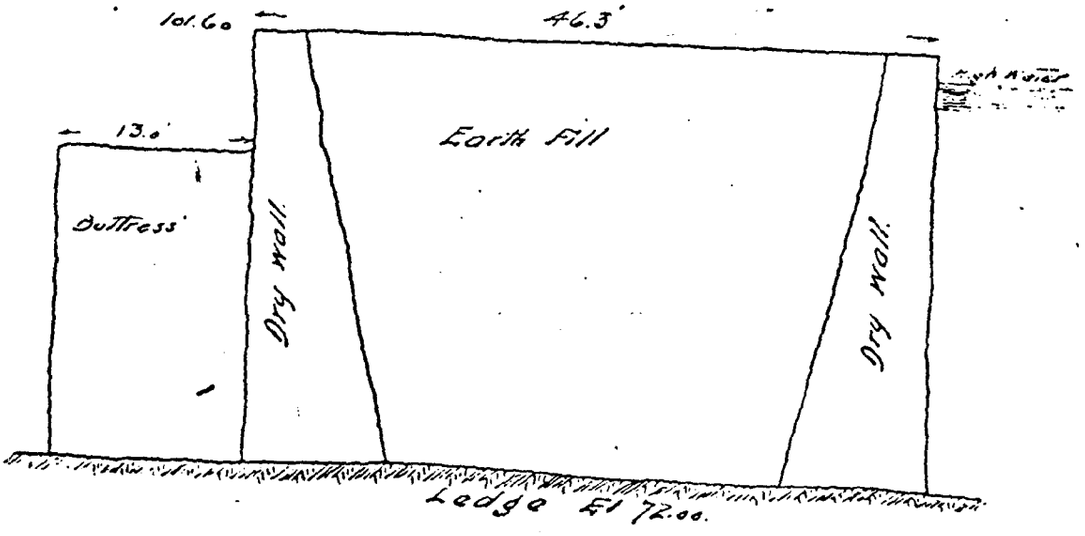
Fig. 2.



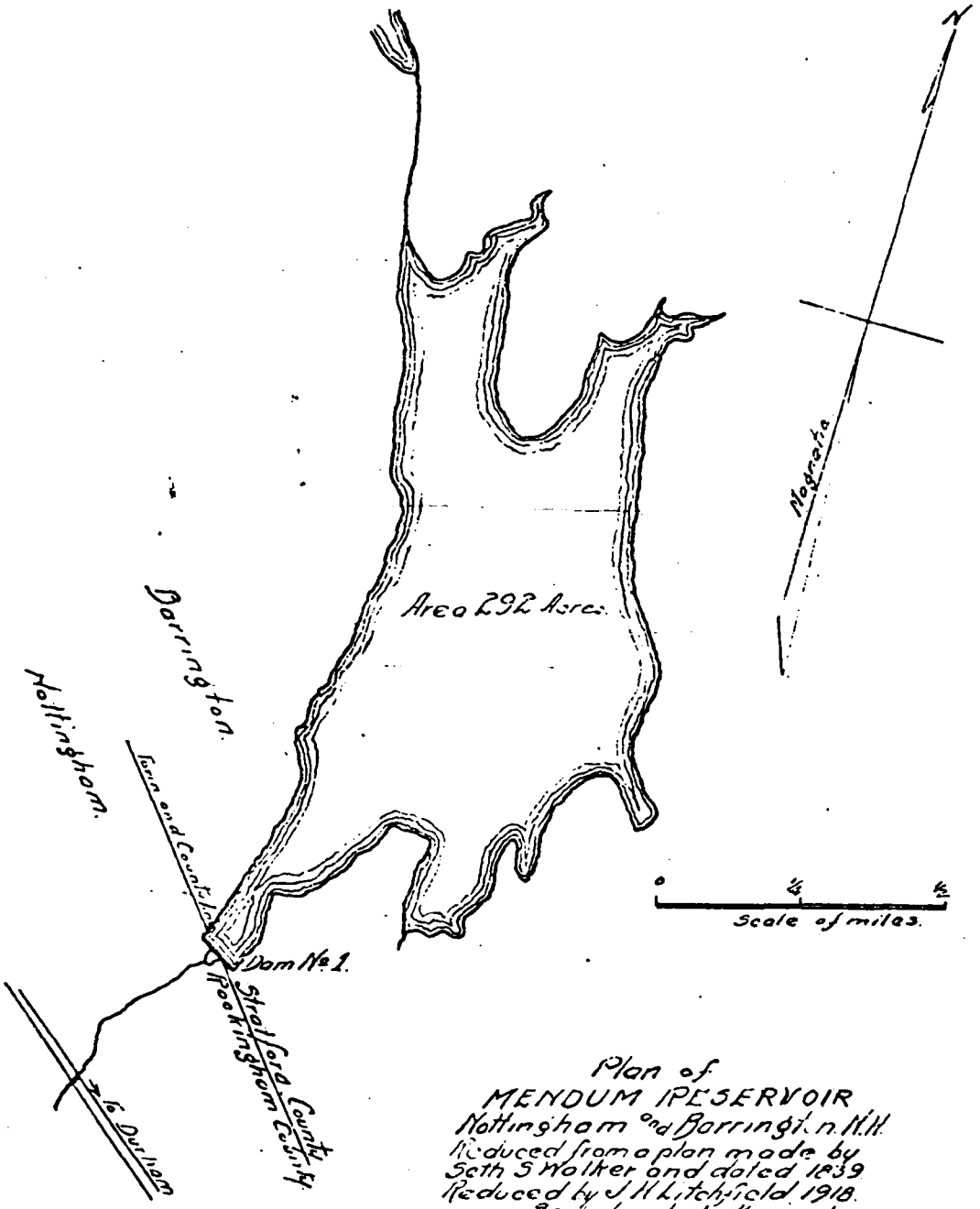
Plan Scale:- 60 ft to the inch.



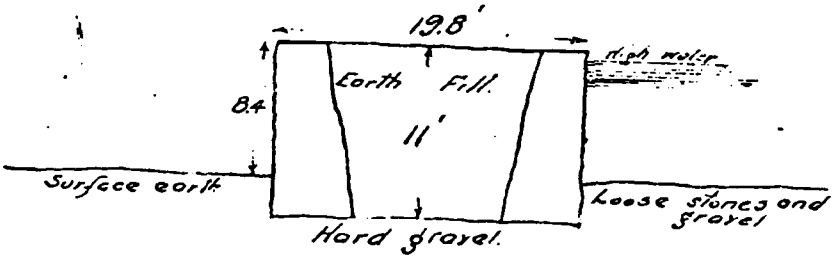
Cross Section
Scale - 20 ft. to the inch.



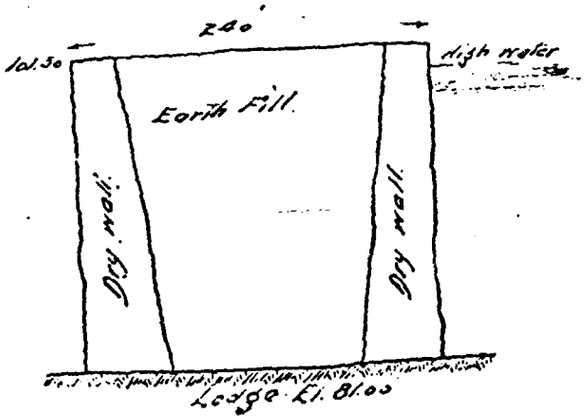
Cross Section
of
MENDUM DAM
Nottingham & Barrington N.H.
Scale 10 to the inch
Copied Nov 1918 by J.H. Litchfield
from drawings in a report by
W.M. Oliver C.E. to the Newmarket
Manufacturing Co. dated 1889.



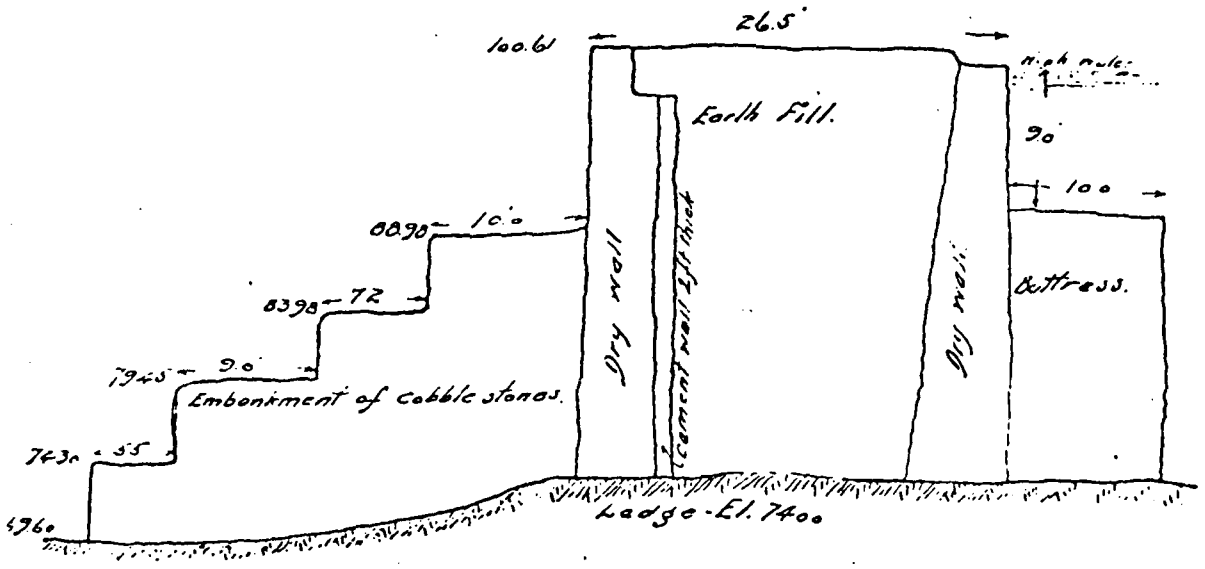
Plan of
MENDUM RESERVOIR
Nottingham and Barrington N.H.
Reduced from a plan made by
Seth S Walker and dated 1839
Reduced by J H Litchfield 1918.
Scale ¼ mile to the inch.



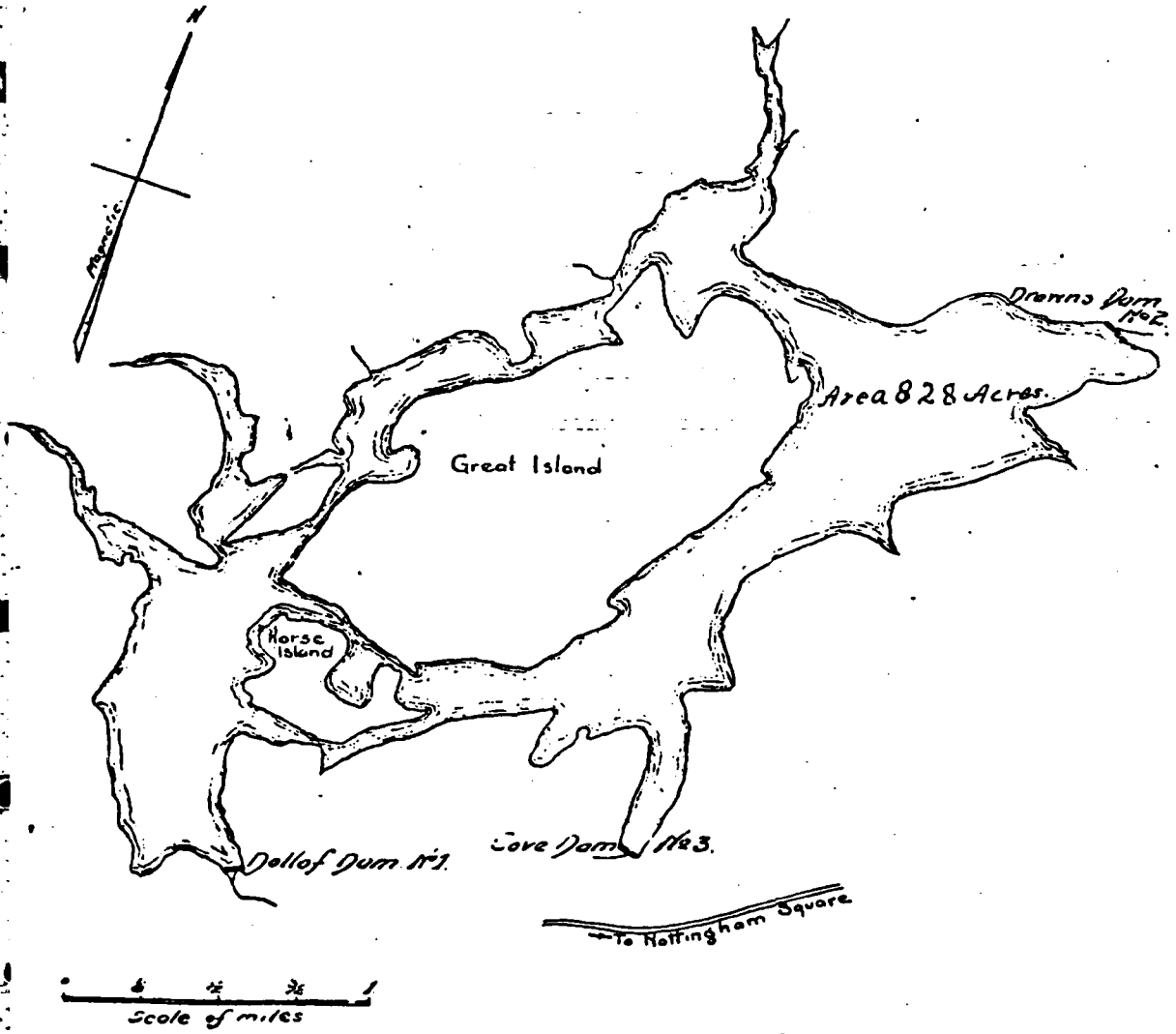
Cross Section
of
GOVE DAM. (No 3)
Nottingham N.H.
Scale 10' to the inch
Copied Nov. 1918. by J.H. Litchfield
from drawings in a report by
W.M. Oliver C.E. to the Newmarket
Manufacturing Co. dated 1889



Cross Section
of
DROWN'S DAM (No. 2)
Nottingham NH
Scale 10' to the inch
Copied Nov. 1918. by J.H. Litchfield.
from drawings in a report by
W.M. Oliver C.E. to the Northampton
Manufacturing Co. dated 1889.



Cross Section
of
DOLLOF DAM. (No 1)
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 Merrimack
Manufacturing Co. dated 1869.



Plan of
P.A.WTUCKAWAY RESERVOIR
Nottingham NH
Traced from a plan made by
Sam Walker and dated 1839
Reduced by J.H.Litchfield 1916
Scale ½ mile to the inch.

Mendum's.

At the Mendum reservoir there is less need to make changes. The bottom of the present spillway should be brought to a uniform level and all growth of small trees and obstacles of all descriptions, driftwood, old stumps, etc. should be removed and the entire space kept clear. One further recommendation needs attention at your convenience. The upstream wall at Mendum's is of very large rough stone, boulders for the most part, and at two or three places these have cracked under the pressure which has been concentrated at various points by the 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 2¾ inches in diameter with upset ends and provided with washers or crabs 3 or 4 feet in diameter. The location of the rods and a section is shown in Fig. 2 on the last sheet attached to this report. The rods should be free from rust bedded and packed in fine gravel concrete in proportions 1, 2, 3. Very little need be used. The exposed parts should be painted. Then with general supervision and economic control the reservoirs should continue for a long time to give good service without causing you any anxiety or disquiet.

Yours truly,

H.F.D./R.

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

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

Their records were virtually barometer readings.)

Gate Repairs.

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

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

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

Recommendations.

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

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

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

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

Figure 2 - Looking at the upstream face of the dike from the west bank of the reservoir.

Figure 3 - View taken from the west abutment looking east at the downstream face.

Figure 4 - Looking west along the center of the dike from the east abutment.

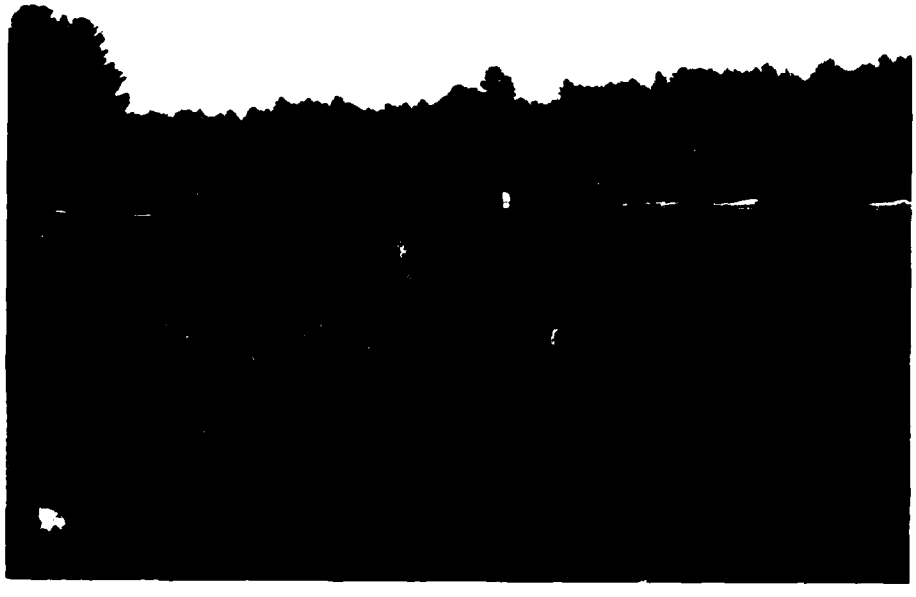
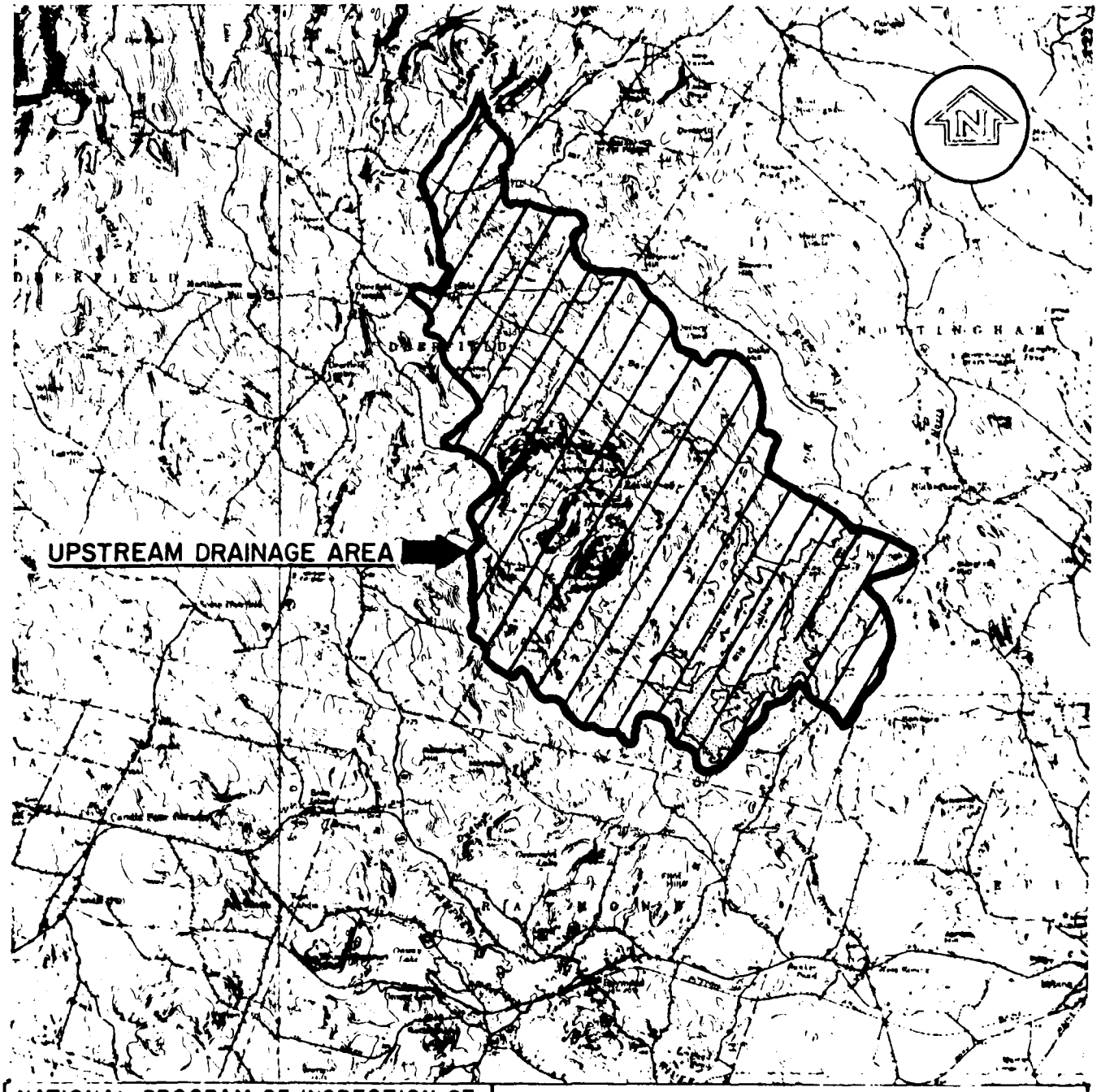


Figure 5 - View looking upstream at Pawtuckaway Pond from the center of the dike.

Figure 6 - Looking at the downstream valley from the top of the dike.

APPENDIX D

HYDROLOGY/HYDRAULICS



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
PAWTUCKAWAY POND
GOVE DIKE
NOTTINGHAM, NEW HAMPSHIRE

REGIONAL VICINITY MAP

JULY 1978

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

ANDERSON NICHOLS & CO., INC. CONCORD, NH

SCALE IN MILES

1 ½ 0 1 2 3

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

H/H

GOVE DIKE 1018

6/29/78
P.O

HYDROLOGY

PAWTUCKAWAY LAKE

STEP 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})

HYDROLOGY

7/7/78
BO

PAWTUCKAWAY LAKE

STEP 2: a 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
		14,871 cfs

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

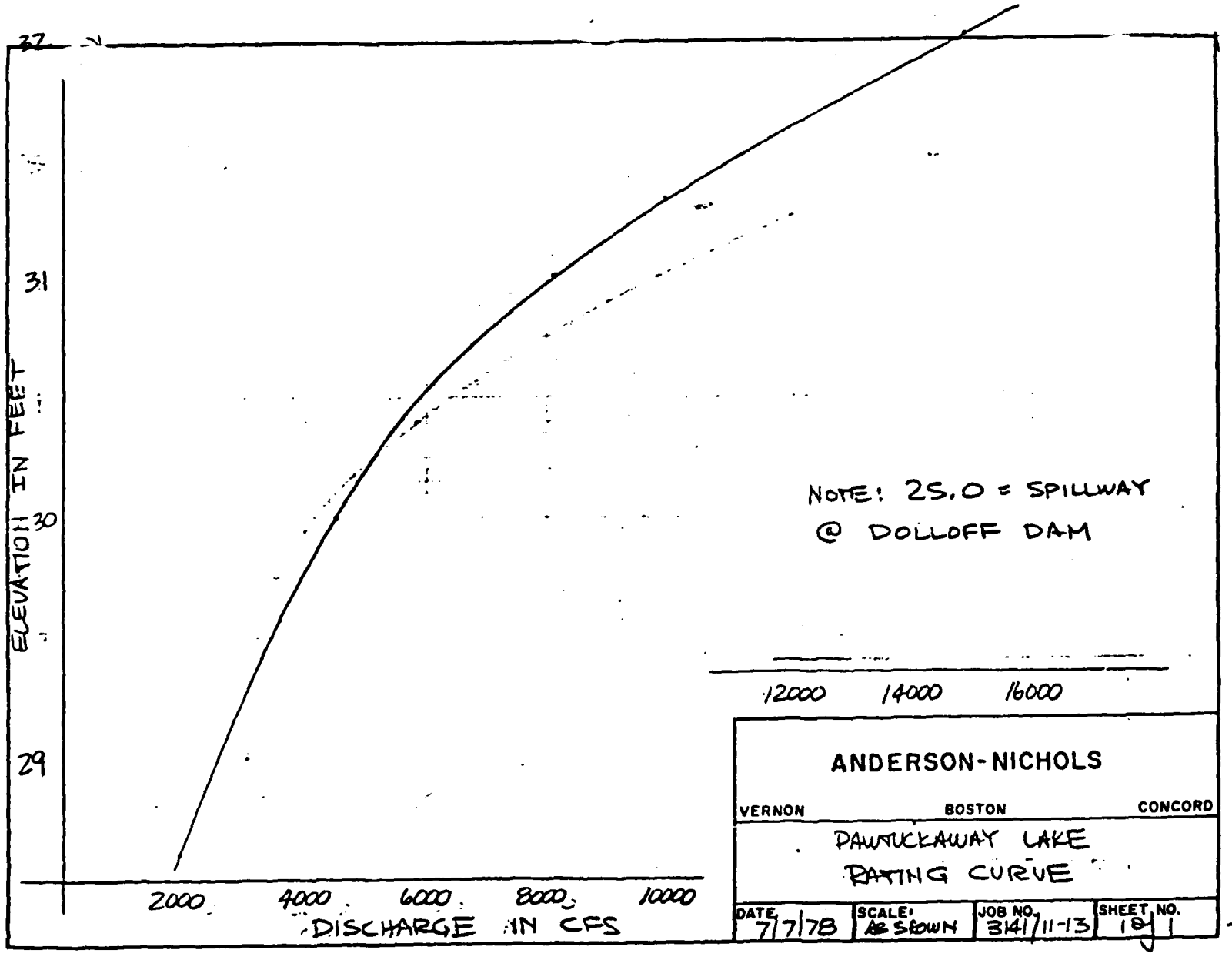
INVENTORY -

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) = 2200 AF



ANDERSON-NICHOLS

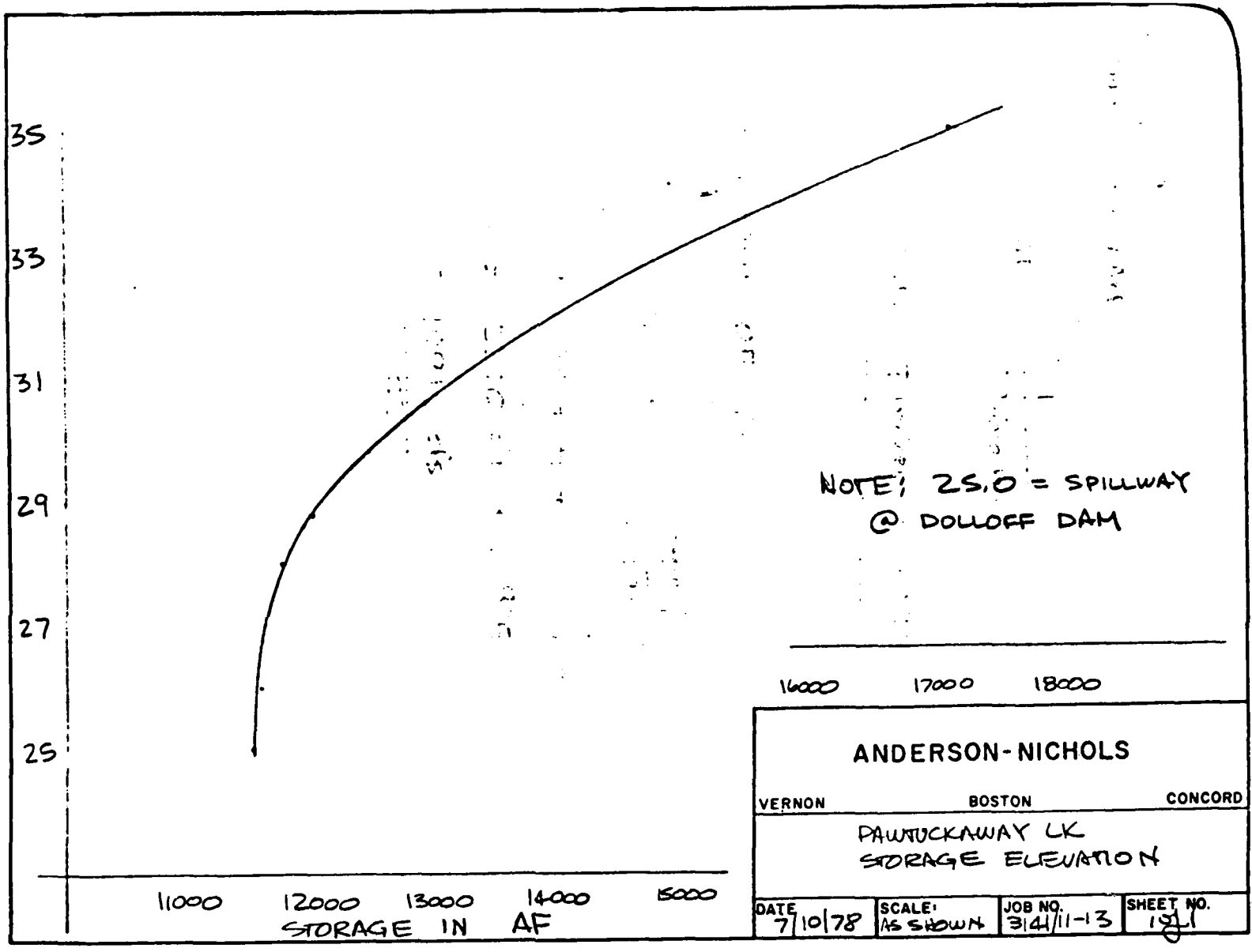
VERNON BOSTON CONCORD

PAWTUCKAWAY LAKE
RATING CURVE

DATE	SCALE	JOB NO.	SHEET NO.
7/7/78	AS SHOWN	3141/11-13	10

D-5

4-18


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

HYDROLOGY
PAWTUCKAWAY LAKE

7/10/78
(3)

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

0.17 ft = 2 inches of RUNOFF OVER BASIN

C. DETERMINATION OF Q_{P2}

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

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

$$= 12200\ cfs \times 0.895$$

$$= 10916\ cfs$$

DROLOGY
HUCKAWAY LAKE

7/10/78
BO

EP 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_{PS}

CHECK of ½ PEAK OUTFLOW

½ PEAK OUTFLOW = 5600 cfs

FROM RATING CURVE

5600 cfs → 30.41 ft

7/6/78
RO
3141-12

Gove Dike
Rating Curve Comps

$Q = CLH^{3/2}$
$C = 2.7$

25.0 = SPILLWAY @ DOLLOFF DAM

@ 28.6 $Q = 0$

@ 28.8 $H = 0.2'$
$L_1 = 78' \Rightarrow L = 39'$

$Q = CLH^{3/2}$
$= 2.7(39)(0.2)^{3/2}$
$= 9.4$ cfs

9.4cfs

@ 28.9 $H = 0.3'$ OVER WEIR

① $H = 0.3'$
$L_1 = 130' \Rightarrow L = 65'$
$Q = CLH^{3/2}$
$= 2.7(65)(0.3)^{3/2} = 28.8$ cfs

② $H = 0.1'$
$L_1 = 56' \Rightarrow L = 28'$
$Q = CLH^{3/2}$
$= 2.7(28)(0.1)^{3/2} = 2.4$ cfs

31.2 cfs

31.2cfs

@ 29.0 $H = 0.4'$ OVER WEIR

① $H = 0.1'$
$L = 245'$
$Q = CLH^{3/2}$
$= 2.7(245)(0.1)^{3/2}$
$= 20.9$ cfs

ADD TO THIS THE PREVIOUS TRIM $\Rightarrow 20.9 + 31.2 =$ 52.1 cfs

5. @ 29.3 $H = 0.7'$ OVER WEIR

① $H = 0.4'$
$L = 275'$
$Q = CLH^{3/2}$
$= (2.7)(275)(0.4)^{3/2}$
$= 187.8$ cfs

ADD TO THIS TRIAL 2 $187.8 + 31.2 = 219.0$

2. @ 29.6 $H = 1.0'$ OVER WEIR

① $H = 0.3'$
$L = 327'$
$Q = CLH^{3/2}$
$= 2.7(327)(0.3)^{3/2}$
$= 145.1$ cfs

ADD TO THIS THE PREVIOUS TRIAL $145.1 + 219.0 \Rightarrow 364.1$

1. @ 30.0 $H = 1.4'$ OVER WEIR

① $H = 0.4'$
$L = 370'$
$Q = CLH^{3/2}$
$= 2.7(370)(0.4)^{3/2}$
$= 252.7$

ADD TO THIS THE PREVIOUS TRIAL $252.7 + 364.1 = 616.8$

3. @ 30.4 $H = 1.8'$ OVER WEIR

$Q = (2.7)(417)(0.4)^{3/2} + 616.8 = 901.6$ cfs

@ 31.0 H= 2.4' OVER WEIR

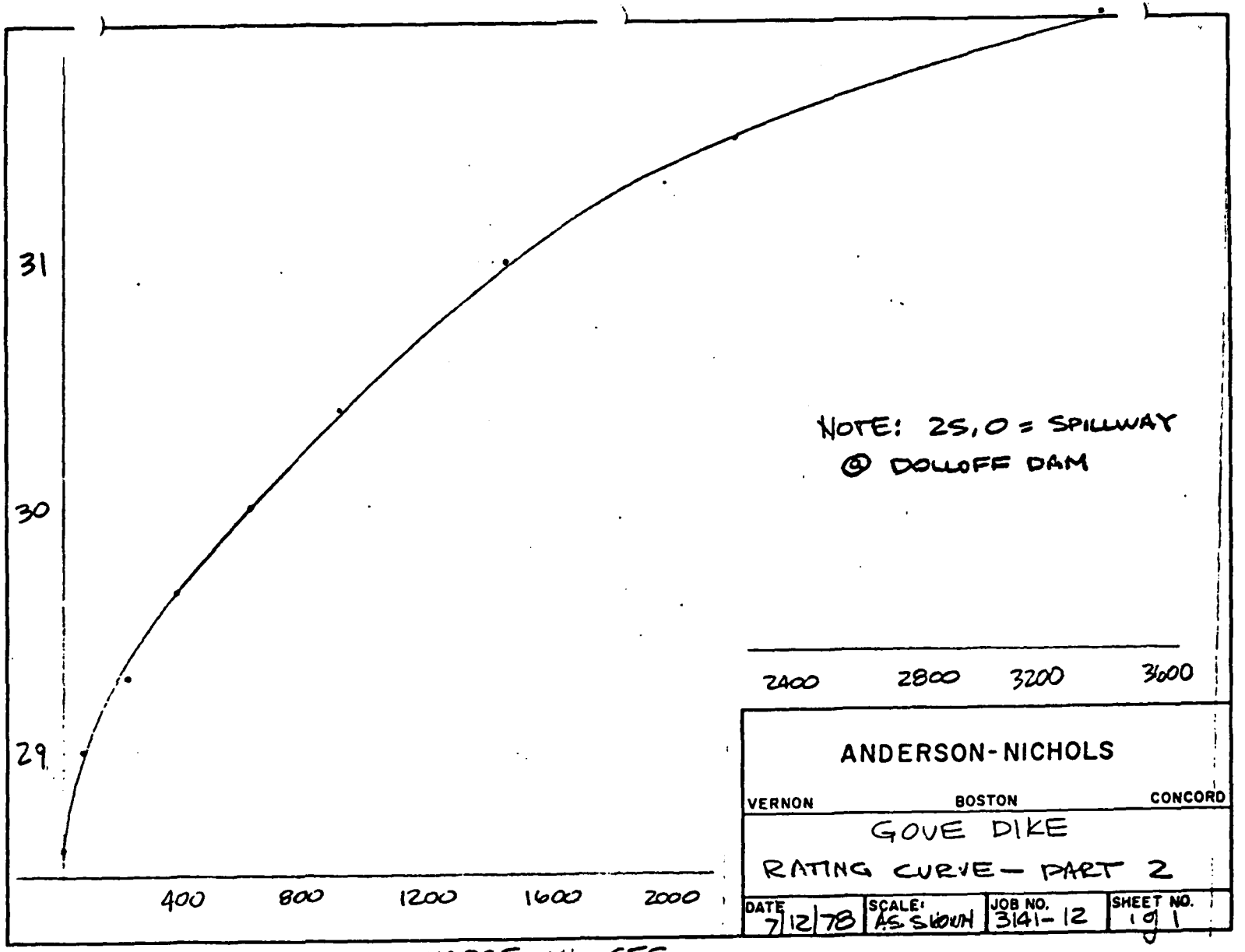
$Q = (2.7)(441)(0.6)^{3/2} + 901.6 = 1455$ cfs

@ 32.0 H= 3.4' OVER WEIR

$Q = (2.7)(454)(1.6)^{3/2} + 901.6 = 3382.4$ cfs

@ 31.65 H = 3.05' OVER WEIR

$Q = (2.7)(449)(1.25)^{3/2} + 901.6 = 2596$ cfs



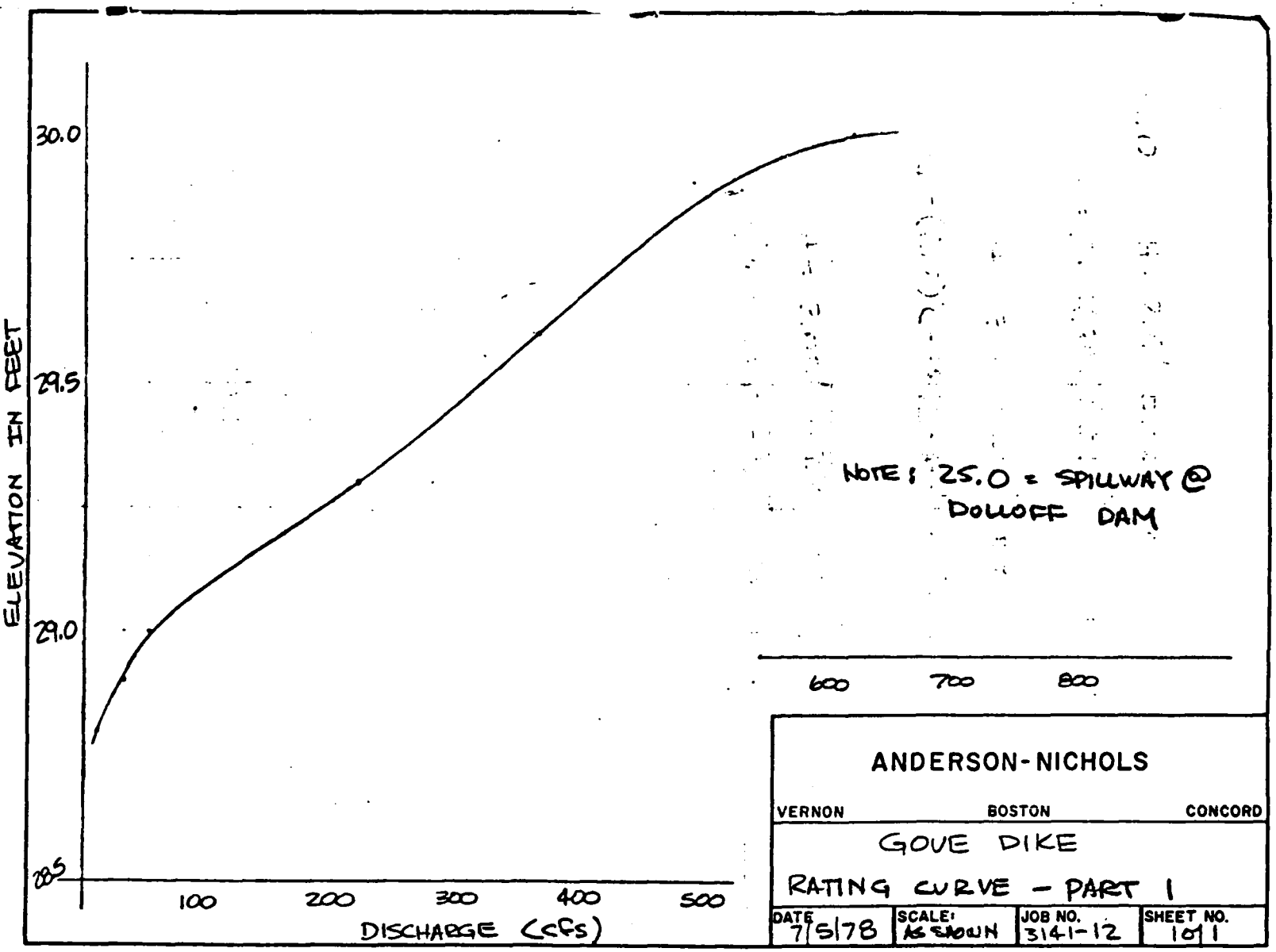
ANDERSON-NICHOLS

VERNON BOSTON CONCORD

GOVE DIKE

RATING CURVE – PART 2

DATE	SCALE:	JOB NO.	SHEET NO.
7/12/78	AS SHOWN	3141-12	19 1



ANDERSON-NICHOLS

VERNON BOSTON CONCORD

GOVE DIKE

RATING CURVE – PART 1

DATE	SCALE:	JOB NO.	SHEET NO.
7/5/78	AS SHOWN	3141-12	10 1

PAWTUCKAWAY LAKE
GOUE DIKE
BO 8|16|78
DOWNSTREAM HAZARD

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

GOUE DIKE
MAX POOL = 252.7 MSL

PEAK FAILURE OUTFLOW FROM BREACH:

$$Q_B = (8/27)\, w_b \sqrt{g}\, y^{3/2}$$

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

ASSUMING OTHER STRUCTURES HOLD ;
BREACH WIDTH = 50'

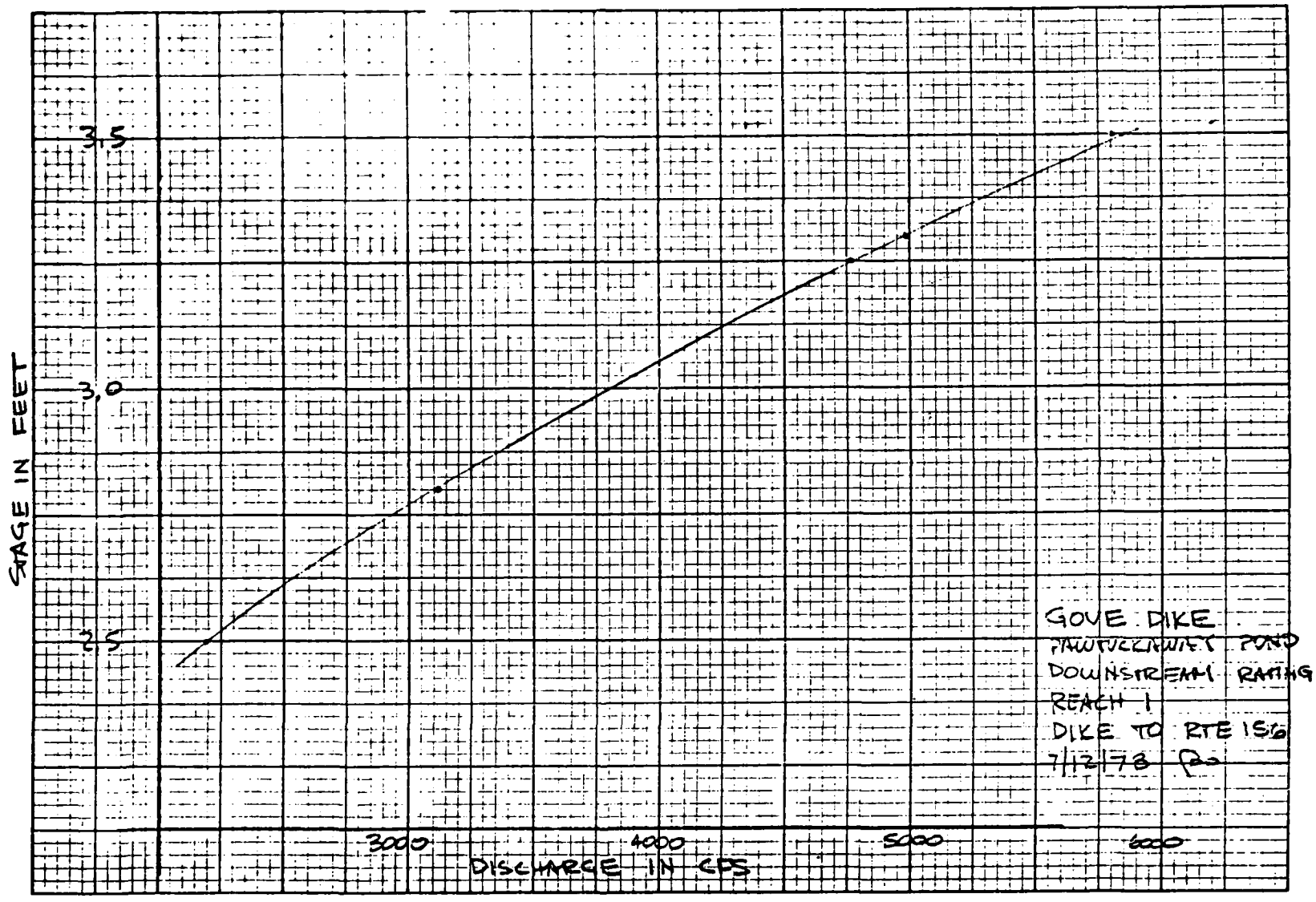
REACH 1

$$Q_B = \left(\frac{8}{27}\right)(50)(\sqrt{32.2})(252.7 - 245.0)^{3/2}$$
$$= 1800 \text{ cfs}$$

NO OTHER INFLOW INTO REACH OTHER THAN THAT FROM BREACH

FROM D/S HAZARD REACH 1 RATING CURVE:
← DIKE TO RTE 156

STAGE @ 1800 cfs = 2.5 FEET


STAGE IN FEET
3.5
3.0
2.5
3000
4000
5000
6000
DISCHARGE IN CFS
GOVE DIKE
PANTUCKHIST POND
DOWNSTREAM RATING
REACH 1
DIKE TO RTE 156
7/12/78 Qo

REACH 1 LENGTH = 2000' ±

VOLUME WITHIN REACH = V_1

$V_1 = 2000 \times 590 = 27\,AF$

STORAGE @ MAX. POOL = 11700 AF = S

$V_1 < 1/2\,S$ ∴ REACH ok

$Q_2 = Q_B (1 - V_1/S) = 1800 (1 - 27/11700)$

= 1800 cfs (vol negligible)

@ Q = 1800 cfs
STAGE = 2.5 FEET
STORAGE WITHIN REACH = 27AF

REACH 2

INFLOW INTO REACH = 1800 cfs

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

STAGE @ 1800 cfs = 6.6 FEET

REACH 2 LENGTH = 14000'

VOLUME WITHIN REACH = V_2

$V_2 = 14000 \times 750 = 240\,AF$

SINCE $V_2 < 1/2\,S$ D-17 REACH ok ✓

$$Q_2 = Q_1 (1 - V_2/S) = 1800 (1 - 240/11700)$$

$$= 1765 \text{ cfs}$$

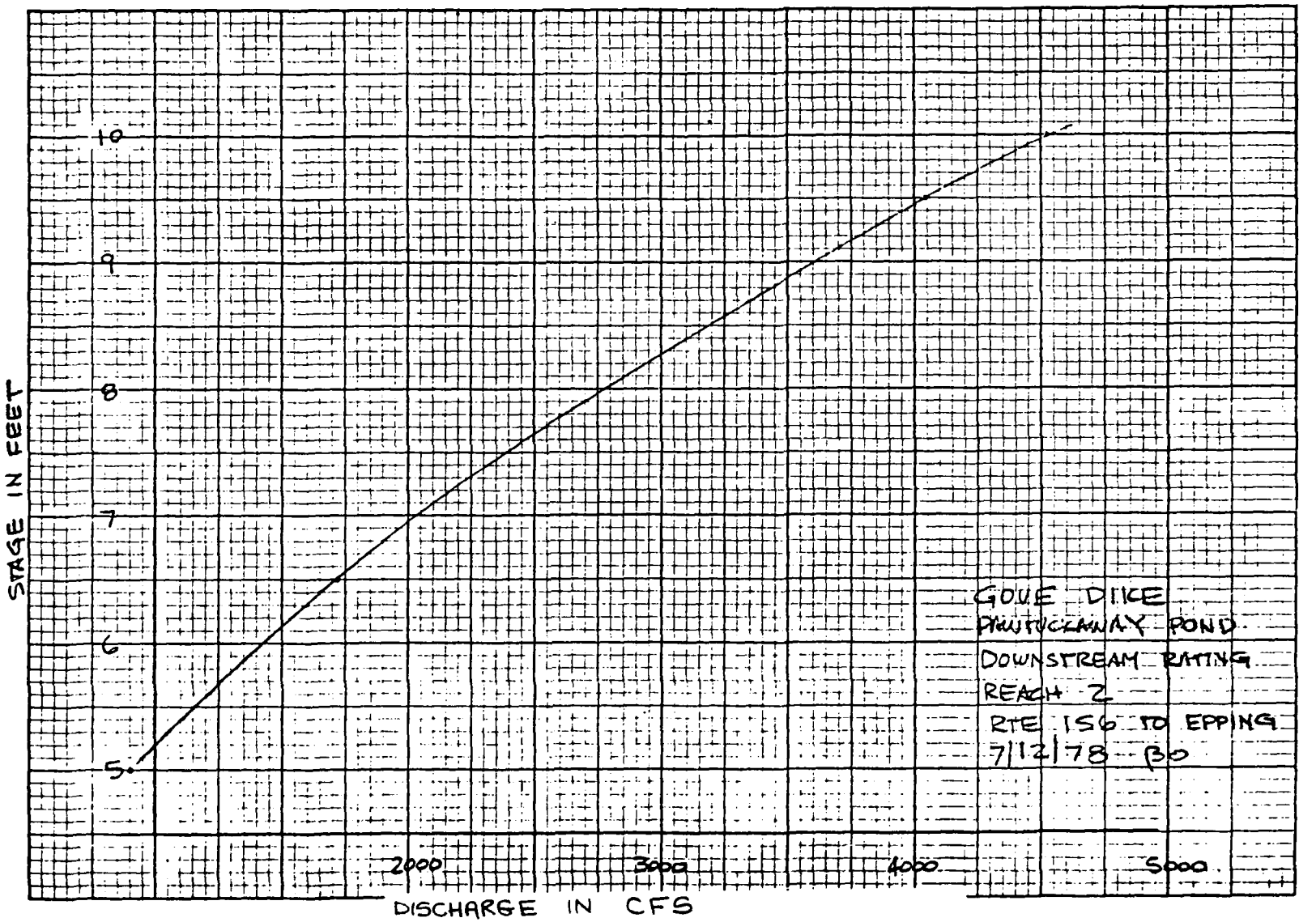
@ 1765 cfs; STAGE = 6.6 FEET

SINCE THIS WOULD RESULT IN THE SAME VOLUME WITHIN REACH

$$Q_{FINAL} = (1800 + 1765)/2 = 1780 \text{ cfs}$$

@ Q = 1780 cfs
STAGE = 6.6 FEET
STOR = 240 AF

WAVE INTO EPPING



APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

END

FILMED

8-85

DTIC