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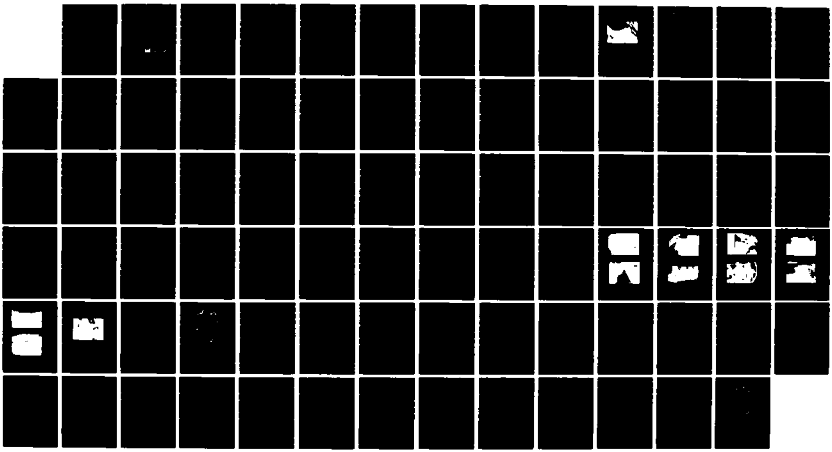

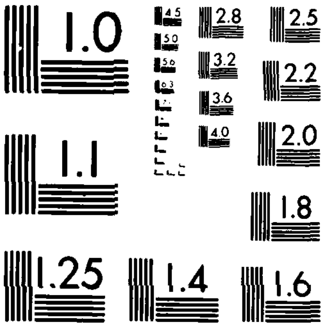

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

MERRIMACK RIVER

BENNINGTON, NEW HAMPSHIRE

MONADNOCK POWER STATION DAM
NH 00249

STATE NO 22.03

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

FEBRUARY 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NH 00249	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Monadnock Power Station 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 February 1979
		13. NUMBER OF PAGES 35
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,

Merrimack River Basin
Bennington, New Hampshire
Contoocook River

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

The dam has a hydraulic height of 22 ft. and is 590 ft. long. It is a run of the river, concrete gravity dam extended on the east and west ends by earthen embankments about 220 and 75 ft. respectively. THe dam is in fair condition. It is small in size with a significant hazard potential.

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REPLY TO
ATTENTION OF:
NEDED

JUL 1 3 1979

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

Dear Governor Gallen:

I am forwarding to you a copy of the Monadnock Power Station Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Monadnock Paper Mills, Bennington, New Hampshire 03442.

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

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

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	NH00249
Name of Dam:	Monadnock Power Station Dam
Town:	Town of Bennington
County and State:	Hillsborough County, New Hampshire
Stream or River:	Contoocook River
Date of Inspection:	November 20, 1978

BRIEF ASSESSMENT

Monadnock Power Station has a hydraulic height of 22 feet, is of varied width, and is 590 feet long. It is a run-of-the-river, concrete gravity dam extended on the east and west ends by earthen embankments about 200 and 75 feet long respectively. Two adjacent spillway sections are 16 feet high and 115 and 50 feet long respectively. The dam spans a reach of the Contoocook River, and is located in south central New Hampshire. Maximum storage capacity is about 240 acre-feet. Monadnock Power Station Dam is used for hydropower purposes. The pond is 4,200 feet in length with a surface area of about 4 acres.

The dam is in fair condition. Major concerns are: some deterioration of concrete in the appurtenant structures and possibly the dam; unknown earthen materials in the eastern embankment and possible seepage at is downstream toe; low elevation of the eastern embankment with respect to the adjacent concrete section; and lack of structural stability analysis of the dam and appurtenant structures.

Based on a small size and significant hazard potential classifications in accordance with Corps guidelines, the test flood is ¼ Probable Maximum Flood (PMF). A test flood outflow of 15,760 cfs would overtop the dam by about 3.1 feet (9.4 feet over spillway crest without flashboards). Because the east embankment crest is sand and gravel and has little or no vegetation, overtopping would probably cause rapid erosion with possibly a breach and/or undercutting and collapse of the adjacent concrete section. The spillway will pass 8,610 cfs or about 55 percent of the test flood. A major breach at top of dam pool would result in the loss of 7-8 lives and appreciable property damage.

The owner, Monadnock Paper Mills, should implement the results of the recommendations and remedial measures given in Section 7.2 and 7.3 within one year after receipt of this Phase I inspection report.

Warren A. Guinan

Warren A. Guinan
Project Manager
N.H. P.E. 2339

This Phase I Inspection Report on Monadnock Power Station 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.

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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.

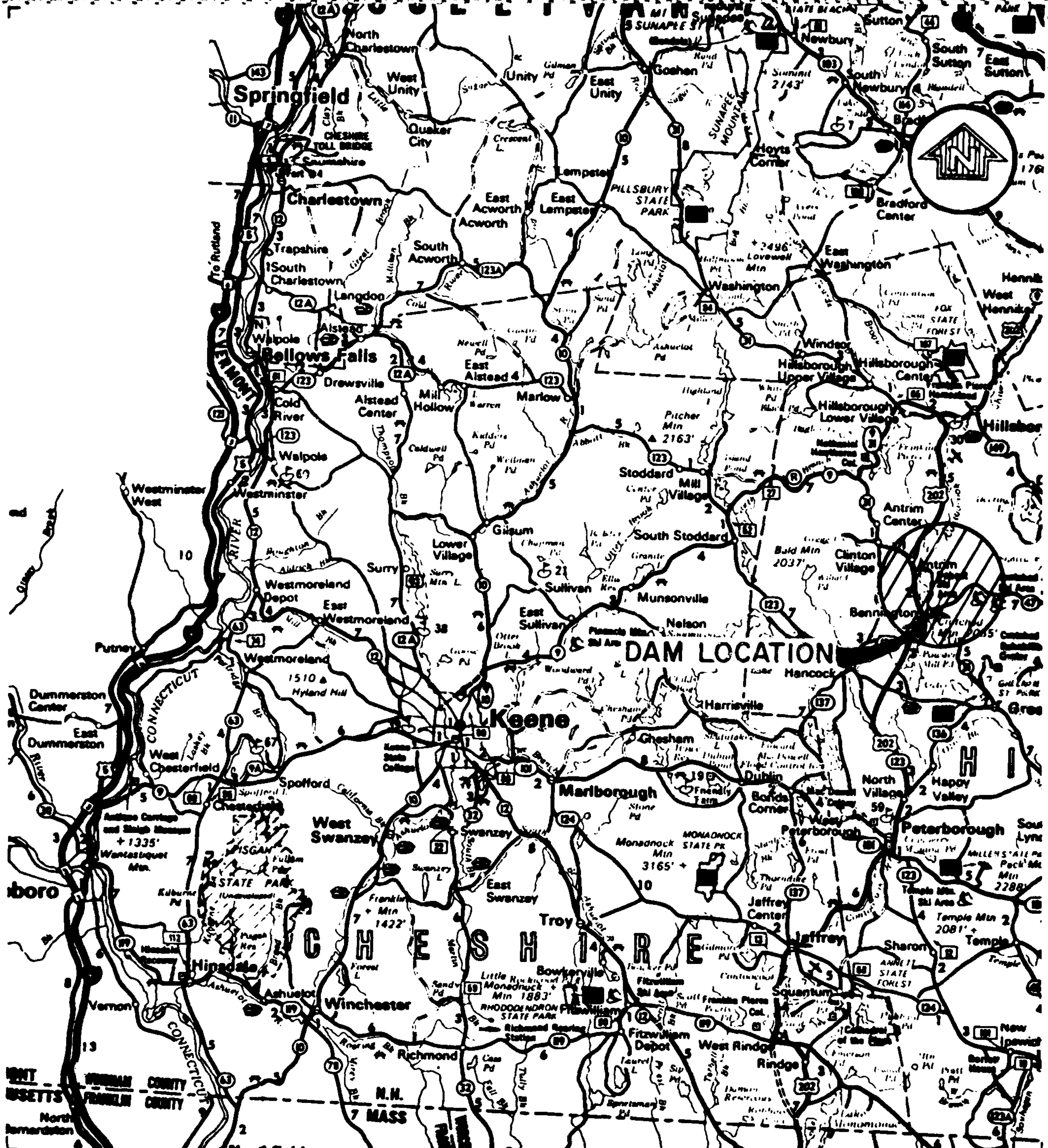
In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving 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.

TABLE OF CONTENTS

Figure 1 - Overview of Monadnock Power Station Dam.



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SCALE IN MILES

0 5 10

MAP BASED ON STATE OF NEW HAMPSHIRE OFFICIAL HIGHWAY MAP.

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

MONADNOCK POWER STATION DAM LOCATION MAP

CONTOOCOOK RIVER NEW HAMPSHIRE

SCALE: SEE BAR SCALE

DATE: FEBRUARY 1979

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
MONADNOCK POWER STATION 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 by Anderson-Nichols under a letter of November 20, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0009 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. Monadnock Power Station Dam is located in the Town of Bennington, New Hampshire and is a run-of-the-river dam spanning the Contoocook River. After discharging over the dam, the Contoocook River flows northerly and then northeasterly for a distance of approximately 43 miles before becoming confluent with the Merrimack River in Concord, New Hampshire. The Contoocook River is a major tributary in the Merrimack River Basin. Monadnock Power Station Dam is shown on the U.S.G.S. Quadrangle, Hillsboro, New Hampshire, with coordinates approximately at N43°00'00", W71°55'36", Hillsborough County, New Hampshire. (See Location Map page vii.)

b. Description of Dam and Appurtenances. Monadnock Power Station Dam is a concrete gravity dam about 590 feet in length and about 26 feet in height. The concrete spillway consists of two sections, one about 115 feet long with an ogee downstream face, and one about 50 feet long with a flat slightly inclined downstream face. Both sections are approximately 16 feet high. Flashboards about two feet high are installed on top of the spillway. The powerhouse is located adjacent to the west end of the spillway. One timber waste gate, 6'W x 6'H and four timber head gates, each 5'W x 9'H are located along the south side of the powerhouse. The hand-wheel operating mechanisms for these gates are located directly above the openings. The powerhouse is about 75 feet long.

A concrete non-overflow section, about 50 feet long, combined with an embankment section containing an exposed concrete core, about 25 feet long, extends southeast of the east end of the spillway. An earthen dike extends further southeast about 200 feet to the east abutment.

A concrete core wall extends westerly from the southwest corner of the powerhouse for about 40 feet to the railroad track. The wall begins again beyond a 22-foot open section and extends westerly about 13 feet to the west abutment. This wall may be notched for the railroad bed and continuous beneath the tracks.

c. Size Classification. Small (Hydraulic height - 22 feet; Storage - 240 acre-feet) based on height and storage ($<$ 40' and $\geq$ 50 to $<$ 1,000 acre-feet) as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant Hazard. A major breach would probably result in the loss of 7-8 lives and appreciable property damage. (See Section 5.1 f.)

e. Ownership. The Monadnock Power Station Dam was acquired by the Monadnock Paper Mills of Bennington, New Hampshire, from the Goodell Company at some unknown date shortly before April 1923. This ownership has remained with the Monadnock Paper Mills who presently own, maintain, and control the dam.

f. Operator. The current owner and operator of the Monadnock Power Station Dam is the Monadnock Paper Mills, Bennington, New Hampshire 03442. Phone: (603) 588-3311.

g. Purpose of the Dam. The original purpose for construction of the dam was not disclosed. The purpose of the dam as reconstructed in 1923 was to create water storage for use in generating hydroelectric power for the Monadnock Paper Mills. This remains its current use.

h. Design and Construction History. Little information was disclosed regarding the design and construction of the original dam other than that it was constructed prior to 1923. The present dam which replaced the original timber dam in the same location was engineered and constructed by the firm of Caughey & Pratt, General Contractors, Antrim, New Hampshire, in 1923.

i. Normal Operating Procedures. No written operating procedures were disclosed for the Monadnock Power Station Dam. The Contoocook River discharge to the dam site is primarily controlled by the Powder Mill Pond Dam, located approximately 4,200 feet upstream. The Monadnock Paper Mills own and control the Powder Mill Pond Dam which they reported is operated generally to provide sufficient discharge at the Monadnock Power Station Dam for use in generation of hydroelectric power to be used in their paper processing plant. Discharge is also sufficient to provide for hydroelectric power generation and industrial water supply at the Pierce Power and Paper Mill dams located approximately 900 to 2,100 feet downstream respectively. The waste gate is normally closed; however, it is reported that every July the sediment which has built up behind the dam is released through the opening of the waste gate. This annual draining of the dam also permits inspection of the gate and operating facilities.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 191 square miles (122,240 acres) of gently rolling terrain.

b. Discharge at Damsite.

(1) Outlet works (conduits) - Waste gate 6'W x 6'H @ invert elevation 650.9' MSL. Gate capacity @ top of dam - 1,035 cfs @ 670.1'MSL. Four head gates each 5'W x 9'H @ invert elevation 656.5' MSL. Head gate capacities - Unknown (controlled by turbines).

(2) The maximum discharge at damsite - a U.S.G.S. gaging station with a drainage area of 368 square miles is located on the Contoocook River near Henniker, New Hampshire. A maximum discharge of 22,000 cfs was reported at this gaging station during the September 1938 flood. Using this figure, the maximum discharge at damsite can be interpolated to be approximately 12,500 cfs.

(3) Ungated spillway (without flashboards) capacity @ top of dam elevation - 8,610 cfs @ 670.1' MSL

(4) Ungated spillway (without flashboards) capacity @ test flood elevation - 15,690 cfs @ 673.2' MSL

(5) Gated spillway capacity @ top of dam elevation - not applicable

(6) Gated spillway capacity @ test flood elevation - not applicable

(7) Total spillway capacity @ test flood elevation - 15,690 cfs @ 673.2' MSL

(8) Total project discharge @ test flood elevation - 15,758 cfs @ 673.2' MSL

c. Elevation (ft. above MSL)

(1) Streambed at centerline of dam - 647.8 (at downstream toe)

(2) Maximum tailwater - During the March 1936 flood with a reported depth of water over the spillway crest of 5.0 feet, the tailwater was reported to have been at 661.5. During a flood of greater discharge in September 1938 the depth of water over the spillway and tailwater elevation were not disclosed.

(3) Upstream portal invert waste gate - 650.9
Upstream portal invert head gates - 656.5

(4) Recreation pool - not applicable

(5) Full flood control pool - not applicable

(6) Spillway crest - 663.8 (without flashboards*)

(7) Design surcharge (Original Design) - Unknown (estimated to be 670.1)

(8) Top of dam 670.1*

(9) Test flood pool - 673.2

d. Reservoir (feet)

(1) Length of maximum pool - 4,200 (to Powder Mill Pond Dam)

(2) Length of spillway crest pool - 4,200 (to Powder Mill Pond Dam)

(3) Length of flood control pool - not applicable

e. Storage (acre-feet)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest pool - 217 (approximate)

(4) Top of dam - 240 (approximate)

(5) Test flood pool - 280 (approximate)

f. Reservoir Surface (acres)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest - 4 (approximate)

(4) Test flood pool - 6 (approximate)

(5) Top of dam - 5 (approximate)

*By survey made 11-20-79 referenced to U.S.G.S. B.M. 661, Elevation 660.810' MSL.

g. Dam

(1) Type - concrete gravity and earth embankment dam

(2) Length - 590'

(3) Height - 26' (structural height)

(4) Top width - varies

(5) Side slopes -

(a) Concrete-upstream face is slightly inclined (Batter estimated to be 1½H:12V); downstream face of west spillway section is ogee; downstream face of east spillway section is flat and inclined (Batter estimated to be 3H:12V).

(b) Earth embankment-upstream and downstream side slopes vary from approximately 1:1 along east embankment to a flattened slope along west embankment.

(6) Zoning -

(a) Concrete - not applicable

(b) Earth embankment - soil exposed at the surface is sand and gravel. No information was disclosed concerning materials within the embankment.

(7) Impervious core -

(a) Concrete - not applicable

(b) Earth embankment - no information disclosed concerning existence of an impervious core within the embankment.

(8) Cutoff - concrete core walls extend into embankment at east end of spillway and west of powerhouse.

(9) Grout curtain - unknown

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

i. Spillway

(1) Type - concrete overflow with an ogee downstream on the west section and a flat slightly inclined downstream face on the east section.

(2) Length of weir - 165'

(3) Crest elevation - 663.8' MSL (without flashboards).

(4) Gates - none (2' flashboards erected on crest of spillway)

(5) U/S Channel - The approach channel to the dam consists of the Contoocook River, about 200 feet in the average width. The channel is open and the banks are tree-lined. The Powder Mill Pond Dam is located about 4,200 feet upstream.

(6) D/S Channel - The channel downstream of the spillway is about 175 feet in average width and unobstructed except for the State Route 31 highway bridge located about 450 feet downstream and the Pierce Power Dam located about 900 feet downstream. It is clear of debris but contains some rocks and boulders. Three houses are located on the banks of the main discharge channel. A separate tailrace from the powerhouse joins the main channel at the end of the east training wall.

j. Regulation Outlets. A 6'W x 6'H timber waste gate at invert elevation 650.9' MSL is located at the west end of the spillway adjacent to the powerhouse. Four 5'W x 9'H timber head gates at invert elevation 656.5' MSL are located along the south side of the powerhouse. Each waste and head gate is manually operated and has its own mechanical operating mechanism.

SECTION 2
ENGINEERING DATA

2.1 Design

No original design data were disclosed for Monadnock Power Station Dam.

2.2 Construction

Three drawings prepared by Caughey and Pratt, General Contractors, Antrim, New Hampshire, were found in the files of the New Hampshire Water Resources Board (NHWRB). These drawings consisted of: (1) Plan of dam and spillway cross section, April 1923, (2) Bulkhead cross section, April 1923, and (3) Spillway cross section May 17, 1923. Inspection of the existing dam and records of the NHWRB disclosed that the construction as proposed by plans (1) and (2) above was not approved or accomplished. The east section of the spillway was constructed with a cross section as shown on plan (3) above. This cross section is shown on a sketch which can be seen in Appendix B.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. Limited engineering data were available for Monadnock Power Station Dam. A search of the files of the NHWRB and direct contact with the owner 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 the visual inspections and hydrologic and hydraulic calculations.

c. Validity. The visual inspection disclosed that the dam and spillway were not constructed consistent with the April 1923 drawings but that the cross section of the west section of the spillway is consistent with the May 1923 drawing. This spillway cross section, along with a cross section of the east spillway section, is shown on a sketch which can be seen in Appendix B.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Monadnock Power Station Dam is a low, run-of-the river dam which impounds a reservoir of small size; its over-all size classification is small. The watershed above the dam is rolling and covered with forest. Several dams are located downstream of Monadnock Power Station Dam. One dam is located upstream which impounds Powder Mill Pond.

b. Dam. The Monadnock Power Station Dam consists of six sections which, from the west to the east abutment, are:

(1) Earthen embankment with concrete core wall, 75 feet long. The top of the concrete wall is about 9.6 feet above the spillway crest (without flashboards).

(2) Concrete/brick powerhouse and gate section approximately 75 feet long and with gate platform about 22 feet above the downstream toe.

(3) Concrete gravity spillway section, with an ogee downstream face, about 115 feet long and 16 feet high.

(4) Concrete gravity spillway section, with a flat slightly inclined downstream face about 50 feet long and 16 feet high.

(5) A concrete non-overflow section about 50 feet long combined with a 25 foot long embankment section containing an exposed concrete core. The top of the concrete non-overflow section and embankment core wall is about 9.5 feet above the spillway crest (without flashboards).

(6) An earthen embankment extends easterly about 200 feet from the end of the core wall to the east abutment. The crest elevation of the embankment is about 8.6 feet higher than the spillway crest (without flashboards). (See Appendix C - Figure 2.)

West of the powerhouse in the earthen embankment, a concrete core wall extends approximately 40 feet to the railroad track. Beyond a 22-foot open section, the concrete wall starts again on the west side of the railroad track and extends approximately 13 feet to the original high ground. Stop log slots are constructed in the end of the concrete wall near the railroad track and at the southwest corner of the powerhouse. Under high water conditions, the concrete wall and stop logs that can be placed in the slots across the railroad tracks and at the corner of the powerhouse and can act as a non-overflow section.

At the time of the inspection a few inches of water were flowing over the flashboards on the crest of the concrete spillway section of the dam.

The upstream face of the concrete sections were not visible beneath the reservoir surface at the time of inspection. The flashboards, which are 2 feet high, are intact over the entire length of the spillway.(See Appendix C - Figure 3.) A few small boards and an abandoned boat were lodged against the flashboards. To the extent that the downstream face of the concrete spillway sections of the dam were visible beneath the overflowing water, no major obvious defects were observed in the concrete. A drawing of the dam indicates that the concrete sections are founded on a "ledge", but this could not be verified during the visual inspection because of the tailwater.

Clean sand and gravel are exposed on the crest of the embankment sections. No records were available to indicate whether the sand and gravel exposed at the crest are representative of the materials within the embankments or whether less pervious types of soil were used in the interior of the embankments. No records are available as to the nature of the foundation materials beneath the embankments. Also no records were available as to how deep the concrete core walls are or what material they are founded on. A vertical crack through the wall was observed near the change in thickness of the east core wall. Approximately ¼ inch of differential horizontal movement was noted between sections on either side of the crack. (See Appendix C - Figure 4.) On the crest of the east embankment there is little or no vegetation, and there is evidence of considerable disturbance of the surface by motorcycles. Trees and brush are growing immediately upstream and downstream of the base. At the downstream toe near the east abutment there is standing water at an elevation about 2½ feet below the reservoir level. It was not possible to determine from the visual inspection whether this standing water was the result of seepage from the reservoir or groundwater discharge from the abutment. The upstream toe of the east embankment section was above reservoir level at the time of inspection.

3.2 Evaluation

Based on the visual inspection, the Monadnock Power Station Dam appears to be in fair condition.

To the extent that it was visible beneath the overflowing water, the concrete section of the dam exhibited no obvious defects and appeared to be in fair condition. This tentative evaluation should be verified by an inspection of the dam at some time when no water is flowing over.

The low non-overflow point of the east embankment is 0.9 feet lower than the top of the concrete non-overflow section at the east end of the spillway. After overtopping of the waste gate platform further overtopping would occur over this embankment which has little or no vegetation on the crest and shows evidence of significant trespassing, rapid erosion and possibly a breach in the embankment would occur, or the concrete section could be undercut and cause it to collapse.

Trees and brush are growing immediately upstream (above reservoir level) and downstream of the embankment, and make it difficult, especially on the downstream side, to see conditions that might reflect potential stability problems. If the trees die, the rotting roots could become potential lines of seepage and piping. Similarly, if the trees are blown over, the disruption of the ground surface and root system could lead to seepage and piping. Standing water was observed at the downstream toe of the embankment and may be the result of seepage from the reservoir. The embankment soil exposed on the crest is sand and gravel, which is not a satisfactory embankment material by itself. Studies should be made to determine if the cross section of the embankment (beneath the crest) is properly designed.

c. Appurtenant Structures. The dam gate structure is located on the upstream face of the powerhouse and is constructed integral with the powerhouse. (See Appendix C - Figure 5.) The exposed portions of the concrete gate structure have several areas of spalling and deterioration. (See Appendix C - Figure 6.) The leading edge of the concrete deck has spalled and the concrete has eroded exposing the reinforcing steel. Efflorescence was also observed on the upstream vertical face of the gate structure. The visible portion of the wooden gates and manual gate operating mechanism were observed to be in good condition. One hand crank was broken. (See Appendix C - Figure 7.)

The downstream face of the powerhouse was observed to have numerous hairline cracks and areas of deterioration. (See Appendix C - Figures 8 and 9.) Efflorenscence was noted emanating from the cracks. No indication of movement of the structural elements was observed.

The powerhouse contains one-100 KW capacity generator with vertical axis turbine which was operating and in good condition. A second generator of 300 KW capacity with vertical axis turbine is being installed.

d. Reservoir Area. The drainage area above the dam is rolling, and is generally covered with forest. (See Appendix C - Figure 10.) Powder Mill Dam and Reservoir are located less than a mile upstream of Monadnock Power Station Dam. It was not possible to see beneath the reservoir water surface to determine how much silt has accumulated in the reservoir behind the dam.

e. Downstream Channel. The channel downstream of the dam is wide and unobstructed. There are trees overhanging the channel, but the channel is wide enough that the trees would not obstruct the channel significantly if they blew over into the channel. Some boulders project above the tailwater close to the dam, but most of the downstream channel is flooded by the reservoir impounded by Pierce Power Dam, which is less than a quarter-mile downstream. A highway bridge crosses the downstream channel between Monadnock Power Station Dam and Pierce Power Dam. (See Appendix C - Figures 11 and 12.)

A dry-masonry training wall with a concrete cap was constructed along the left bank of the tailrace immediately downstream of the powerhouse. Several small sinkholes, about one foot deep or less were noted in the fill behind this training wall. The sinkholes are apparently the result of soil being washed out through the joints between the blocks of rock in the wall.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

No written operational procedures were disclosed for Monadnock Power Station Dam. It is reported that every July the waste gate is opened to release accumulated sediment which has built up behind the dam. The head gates are operated to provide sufficient discharge for use in power generation.

4.2 Maintenance of Dam

Monadnock Paper Mills is responsible for the maintenance of Monadnock Power Station Dam.

4.3 Maintenance of Operating Facilities

The annual releasing of sediment through the waste gate enables the testing of the operating facilities to insure that they are functional. No formal maintenance program was disclosed.

4.4 Description of Any Warning System in Effect

No written warning system was disclosed for Monadnock Power Station Dam.

4.5 Evaluation

The present operational and maintenance procedures are not adequate to insure that all problems encountered be remedied within a reasonable amount of time.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. General. Monadnock Power Station Dam is a run-of-the-river dam having relatively little surcharge storage and high spillage. The total length of the dam is 590 feet of which 165 feet consists of concrete spillway. The dam (without flashboards) has 6.3 feet of freeboard available before overtopping would occur. The main cross-river sections are concrete gravity with earth embankments extending to abutments at each end. Concrete core walls extend from concrete sections along portions of the embankments. The reservoir pool extends to the Powder Mill Pond Dam located about 4,200 feet upstream as the spillway crest elevation (without flashboards) is about 7.8 feet above the downstream toe of the Powder Mill Pond Dam.

b. Design Data. Limited hydrologic and hydraulic design data for the Monadnock Power Station Dam were disclosed for the existing dam as rebuilt in 1923. The drainage area was given as 191 square miles with a flood flow of 3,500 cfs. The spillway discharge at six feet over the crest was given as 8,163 cfs.

c. Experience Data. Information disclosed regarding past overtopping indicated that the depth of water over the crest was 4.3 feet in the spring of 1924 and 5.0 feet in March 1936.

d. Visual Observation. No visual evidence was disclosed of damage to the structure caused by overtopping at the time of inspection.

e. Test Flood Analysis. Monadnock Power Station Dam is classified as being small in size having a height of 22 feet and a maximum (top of dam) storage of 240 acre-feet. Using the Recommended Guidelines for Safety Inspection of Dams, the test flood was determined to be ¼ PMF. Using ¼ PMF, the test flood discharge was determined to be 15,758 cfs. The overtopping analysis indicates that the dam would be overtopped by about 3.1 feet (9.4 feet over the spillway crest) during the test flood. The maximum spillway capacity at top of dam is 8,610 cfs which is 55 percent of the test flood discharge assuming the flashboards would be washed out during a flood event of this magnitude.

f. Dam Failure Analysis. The impact of failure of the dam at normal flow conditions and at top of dam were assessed using the Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers. The analysis covered the reach extending from the dam to the Pierce Power Dam, a distance of about 900 feet downstream. It was determined that breach at top of the dam would create the greater downstream hazard. A breach at top of dam pool would increase the stage about 10.9 feet above the antecedent discharge stage of about 4.3 feet at the State Route 31 highway bridge resulting in overtopping the bridge roadway by about 5.3 feet. These stages are in addition to the normal minimum stage of about 11.0 feet caused by ponding at spillway crest elevation of Pierce Power Dam located 450 feet downstream. The total increase in stage of about 15.2 feet would cause appreciable damage to the State Route 31 highway bridge, an unoccupied building, and two houses resulting in the probable loss of 7-8 lives. A breach at top of dam pool would increase the stage about 3.2 feet above the antecedent discharge stage of 3.4 feet at the spillway crest of the Pierce Power Dam. The total increase in stage of about 6.6 feet would cause appreciable damage to a club building occasionally occupied, and the Pierce Power Dam and Powerhouse.

One should note because of the lack of storage behind the dam, that test flood flows discharging over the dam, assuming the dam did not fail, would have nearly the same effects on the downstream reach as a breach at maximum pool. As a result of the analysis described above, the Monadnock Power Station Dam was classified Significant Hazard.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. To the extent that the concrete section of the dam was visible beneath the overflowing water, no evidence of structural instability was observed.

Trespassing and a lack of vegetation on the crest of the east embankment section of the dam could lead to erosion problems, particularly if the dam should be overtopped.

Standing water at the downstream toe of the embankment section near the east abutment is an indication of possible seepage through the dam, which could lead to a long-term stability problem if remedial measures are not taken

The soil exposed at the crest of the east embankment is sand and gravel. If the entire cross-section consists of sand and gravel, it would probably not be stable with a high reservoir level, especially since this embankment is 0.9 feet lower than the adjacent concrete section.

b. Design and Construction Data. Little information regarding the design and construction data of the dam is available. A plan of the concrete section of the dam and a cross-section of the concrete dam at the deepest part of the valley were disclosed in the files of the NHWRB (See Appendix B).

c. Operating Records. No operating records pertinent to the stability of the dam are available.

d. Post-Construction Changes. No recorded changes subsequent to the construction of the existing dam at this site in 1923 were disclosed.

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

SECTION 7
ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Conditon. The visual inspection indicates that the Monadnock Power Station Dam is in fair condition.

The concrete section of the dam appears to be in fair condition, but it should be inspected when water is not flowing over the dam to verify this tentative conclusion.

The concerns with respect to the long term stability of the powerhouse and appurtenant structures are the deterioration of the exposed concrete and the cracks and efflorescence on the downstream face of the powerhouse.

Several concerns are noted below with respect to the long-term stability of the embankment section of the dam (most of which is above reservoir level when water is flowing only a few inches over the flashboards):

(1) Trespassing and lack of vegetation on the crest of the eastern embankment.

(2) Standing water at the downstream toe of the embankment near the east abutment. Possibly this water is due to seepage through the embankment and/or its foundation.

(3) Possibility that the cross-section of the east embankment consists only of sand and gravel, which is the only material exposed at the crest.

(4) The low point of the east embankment is 0.9 feet lower than the top of the adjoining concrete non-overflow section.

b. Adequacy of Information. The information available is such that the assessment must be made on the basis of the visual inspection. Because this is a run-of-the-river dam and water was flowing over the dam at the time of inspection, it is recommended below that this assement be verified by an inspection of the dam when no water if flowing over it.

c. Urgency. The recommendations and remedial measures made in 7.2 and 7.3 below should be implemented within 1 year after receipt of this Phase I report.

7.2 Recommendations

The owner should engage a Registered Professional Engineer to:

a. Investigate the cross-section and elevation of the east embankment section to determine if it consists of materials that will be stable when the reservoir is at its highest level, and to design remedial measures if needed.

b. Investigate the source of the standing water at the downstream toe of the east embankment section and design remedial measures if needed.

c. Design and specify remedial repairs for the deteriorated concrete in the appurtenant structures and in the dam if found to be deteriorated, after inspection when water is not flowing over the dam.

d. Evaluate further the structural stability of the dam and appurtenant structures.

The owner should carry out such construction as is recommended by the engineer who performs the investigations recommended above.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Control trespassing on the eastern embankment section of the dam.

(2) Cut the trees and brush for a distance of 20 feet upstream and downstream of embankment sections and cut any new trees or brush annualy.

(3) If the present embankment cross-section is found to be adequate and does not need to be rebuilt, plant and maintain a good grass cover on the crest and slopes of the embankment.

(4) Monitor the seepage on the downstream toe of the embankment section on a weekly basis.

(5) Establish a surveillance and warning program to follow in event of floodflow conditions or imminent failure of the dam.

(6) Inspect the dam weekly, and engage a Registered Professional Engineer to make a more comprehensive inspection once every 2 years.

7.4 Alternatives. None.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT: Monadnock Power Station Dam

DATE: November 20, 1978

TIME: 2:20 PM

WEATHER: Cloudy, Cool

U.S. ELEV. 666 U.S. 652 DN.S.

PARTY:

1. Warren Guinan
2. Robert Langen
3. Stephen Gilman
4. Leslie Williams
5. Robert Ojendyk
6. Ronald Hirschfeld
7. Harold Wilcox (1/3/79)
8. John Falcione (1/3/79)
9.
10.

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

PERIODIC INSPECTION CHECKLIST

PROJECT Monadnock Power Station Dam, NH DATE November 20, 1978

PROJECT FEATURE Easterly Embankment NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	672.4' msl
Current Pool Elevation	665.8' msl
Maximum Impoundment to Date	Unknown
Surface Cracks	None apparent
Pavement Condition	Not paved
Movement or Settlement of Crest	None apparent
Lateral Movement	None apparent
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	None apparent
Trespassing on Slopes	Motorbike ruts where bikes turn on crest
Sloughing or Erosion of Slopes or Abutments	None apparent
Rock Slope Protection - Riprap Failures	No riprap
Unusual Movement or Cracking at or Near Toes	None apparent
Unusual Embankment or Downstream Seepage	One area of minor seepage 2½ feet below reservoir level at downstream toe of slope.
Piping or Boils	None apparent
Foundation Drainage Features	None apparent
Toe Drains	None apparent
Instrumentation System	None
Vegetation	No vegetation on embankment, trees growing immediately upstream and downstream of embankment.

PERIODIC INSPECTION CHECKLIST

PROJECT Monadnock Power Station Dam DATE November 20, 1978

PROJECT FEATURE Intake Channel & Structure NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Contoocook River
Slope Conditions	Good
Bottom Conditions	Not visible below reservoir surface
Rock Slides or Falls	None
Log Boom	None
Debris	Little
Condition of Concrete Lining	Not visible
Drains or Weep Holes	None
b. Intake Structure	
Condition of Concrete	Fair, leading edges of concrete structure have spalled near waterline
Stop Logs and Slots	
Bar Rack	Rusted

PERIODIC INSPECTION CHECKLIST

PROJECT Monadnock Power Station Dam DATE November 20, 1978

PROJECT FEATURE Control Tower NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good
Spalling	Some at leading edges of concrete Some at u/s face of gate structure
Visible Reinforcing	No major structural elements visible.
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	On d/s face at hairline cracks
Joint Alignment	No apparent movement
Unusual Seepage or Leaks in Gate Chamber	None visible
Cracks	A few hairline cracks
Rusting or Corrosion of Steel	Only where reinforcing steel is exposed.
b. Mechanical and Electrical	
Air Vents	4 wooden sluice gates each hand operated were found to be in good condition. The operation of these gates was not observed due to the frozen lock and icy conditions.
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECKLIST

PROJECT Monadnock Power Station Dam, NH DATE November 20, 1978

PROJECT FEATURE Outlet Structure & Channel NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	See Control Tower
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	None apparent
Channel	
Loose Rock or Trees Overhanging Channel	None
Condition of Discharge Channel	Good

PERIODIC INSPECTION CHECKLIST

PROJECT Monadnock Power Station Dam, N.H. DATE November 20, 1978

PROJECT FEATURE Spillway Weir NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Some trees overhanging east bank, but channel is wide.
Floor of Approach Channel	Not visible beneath reservoir surface.
b. Weir and Training Walls	
General Condition of Concrete	Fair, surface of concrete eroded 1 inch where exposed to water, training walls good.
Rust or Staining	Only at exposed reinforcing.
Spalling	Limited to isolated parts.
Any Visible Reinforcing	None
Any Seepage or Efflorescence	Only at hairline cracks
Drain Holes	None visible
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Channel	Boulders and bedrock
Other Obstructions	None apparent
d. Miscellaneous	
Flashboards	Wood - fair condition.
Flashboard supports	Iron pipe embedded in concrete- some rusting
East concrete non-overflow section	Crack between sections indicate ¼" of horizontal movement.

PROJECT Monadnock Power Station Dam DATE November 20, 1978

PROJECT FEATURE Reservoir NAME R. Langen

AREA EVALUATED	REMARKS
Stability of Shoreline	Stable
Sedimentation	Not visible
Changes in Watershed Runoff Potential	None
Upstream Hazards	Railroad track on west bank
Downstream Hazards	Route 31 highway bridge, two houses west bank, two houses east bank, Pierce Power Station Dam.
Alert Facilities	None
Hydrometeorological Gages	None visible
Operational & Maintenance Regulations	None posted

APPENDIX B

ENGINEERING DATA

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 22.03

Town Bennington : County Hillsboro

Stream Contoocook River

Basin-Primary Merrimack R : Secondary Contoocook

Local Name Monadnock Station

Coordinates—Lat. 43° 00' + 200 : Long. 71° 55' - 2600

GENERAL DATA

Drainage area: Controlled ...... Sq. Mi.: Uncontrolled ...... Sq. Mi.: Total ~~1915~~ 191.5 Sq. Mi.

Overall length of dam 244.2 ft.: Date of Construction 1923

Height: Stream bed to highest elev. ~~20.5~~ 20.6 ft.: Max. Structure 14.95 ft.

Cost—Dam ...... : Reservoir ......

DESCRIPTION O G Fade—— Concrete

Waste Gates

Type ......

Number 1 : Size 6 ft. high x 6 ft. wide

Elevation Invert 14.95 : Total Area 36 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 172.1 ft.: Net ...... ft.

Height of permanent section—max. 14.95 ft.: Min. ...... ft.

Flashboards—Type ...... : Height 2 ft.

Elevation—Permanent Crest ...... : Top of Flashboard ......

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

Abutments

Materials: ......

Freeboard: Max. 5.65 5.65 ft.: Min. ...... ft.

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

OWNER Monadnock Paper Mills, Bennington, N.H. — Caughey & Pratt, Antrim N H

REMARKS Condition Good—
Hydro Electric Power for Paper Mill

Tabulation By A. A. M. & R. L. T. MB Date October 19, 1938 7/23/42

1206

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 22.03

Town: Bennington : County: Hillsboro

Stream: Contoocook River

Basin-Primary: Merrimack : Secondary: Contoocook

Local Name: Monadnock Station

GENERAL DATA

Head-Max. 14 ft.: Min. ft.: Ave. ft.

Date of Construction 1923 : Use of Power Industrial

Pondage ac. ft.: Storage ac. ft.

DESCRIPTION

Racks

Size of Rack Opening

Size of Bar : Material

Area: Gross Sq. Ft.: Net sq. ft.

Head Gates

Type

Number 4 : Size 9 ft. high x 5 ft. wide

Elevation of Invert 9.35 : Total Area 180 sq. ft.

Hoist

Penstock

Number 1-27" : Material Leffel Elec Mach Co 2300 V 31.5 A--180 RPM

Size : Length

Turbines

Number : Makers

Rating HP. per unit : Total Capacity 150 HP.

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

Drive

Type

Generator

Number 1

Make 125 K V A Elec Mach Co 2300 V

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

Exciter

Number : Make

Rating-per unit : Total Capacity K. W.

OUTPUT—KWHRS

19......	:	19......	
19......	:	19......	
19......	:	19......	
19......	:	19......	
19......	:	19......	

OWNER Monadnock Paper Co.

Tabulation By A N & R L T LRB Date October 18, 1938 7/23/42

Form E80

NEW HAMPSHIRE WATER RESOURCES BOARD

QUESTIONNAIRE

WATER POWERS OF NEW HAMPSHIRE

Monadnock Paper Mills
Bennington
New Hampshire

Gentlemen:

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

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

Very truly yours,

R. S. Holmgren

RSH:GMB
Encl.

Richard S. Holmgren
Chief Engineer

- -

Dam No. 22.03 : Location: Contoocook River at Bennington

1. Will you please check or correct:

	Our Data	Your Corrections
Drainage Area - Sq.Mi.	191.5	
Head - feet	15	14
Capacity (Total)	200	150 HP
Wheel - H.P.		
Generator - K.W.		

2. Is the power plant now in operation? Yes

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

4. Is the dam in good repair? Yes

(Signed) A. F. Bell Treas

Date 7/23-42

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Merrimack — NO. 3 3 22.03 — 190 Staffo
RIVER Contoocook — MILES FROM MOUTH 146.7 D.A.SQ.MI 191.5 WRB — 192 USC
TOWN Bennington — OWNER Monadnock Paper Mills
LOCAL NAME OF DAM Monadnock Station
BUILT 1923 DESCRIPTION Concrete Gravity — 194 PSC

POND AREA-ACRES ____ DRAWDOWN FT. ____ POND CAPACITY-ACRE FT. ____
HEIGHT-TOP TO BED OF STREAM-FT. 45' AE ~~46 PSC~~ 20.6 AE MAX. ____ MIN. ____
OVERALL LENGTH OF DAM-FT. 212' AE ~~200 PSC~~ MAX FLOOD HEIGHT ABOVE CREST-FT. ____
PERMANENT CREST ELEV.U.S.G.S. 665.85 LOCAL GAGE ____
TAILWATER ELEV.U.S.G.S. ____ LOCAL GAGE ____
SPILLWAY LENGTHS-FT. 120 PSC 172.1 AE FREEBOARD-FT. 5.65 AE
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST 2.0'
WASTE GATES-NO. WIDTH MAX. OPENING DEPTH SILL BELOW CREST

NO.	WIDTH	MAX. OPENING	DEPTH SILL BELOW CREST
4	5.0	9.0	9.35' AE wheelgates
1	6.0	6.0	14.95 AE waste gate.

REMARKS 4 I Condition Good Maximum High water 667.85
Built by Caughey & Pratt, Antrim, N.H.

POWER DEVELOPMENT

UNITS NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE
	~~1000~~	~~30~~ USGS 1951			
	~~290~~	~~13~~	~~PSC~~		
					27" Leffel
1	200 ?	15 Braid		125 KVA	Electric Machinery Co. Minneapolis 2300 V 31.5A 180 R.P.M.

USE Hydro Electric Power for paper mill.

REMARKS Primary HP 90% of time 84.0
Accompanying sketch copied from Army Engineers field notes.
Information from Mr Braid, Chief Engineer. Did not know size nor make of waterwheel.

DATE 1925 PSC
10/14/37 R v J.H.S.

DAMS AND THEIR LOCATIONS IN TOWN OF Bennington

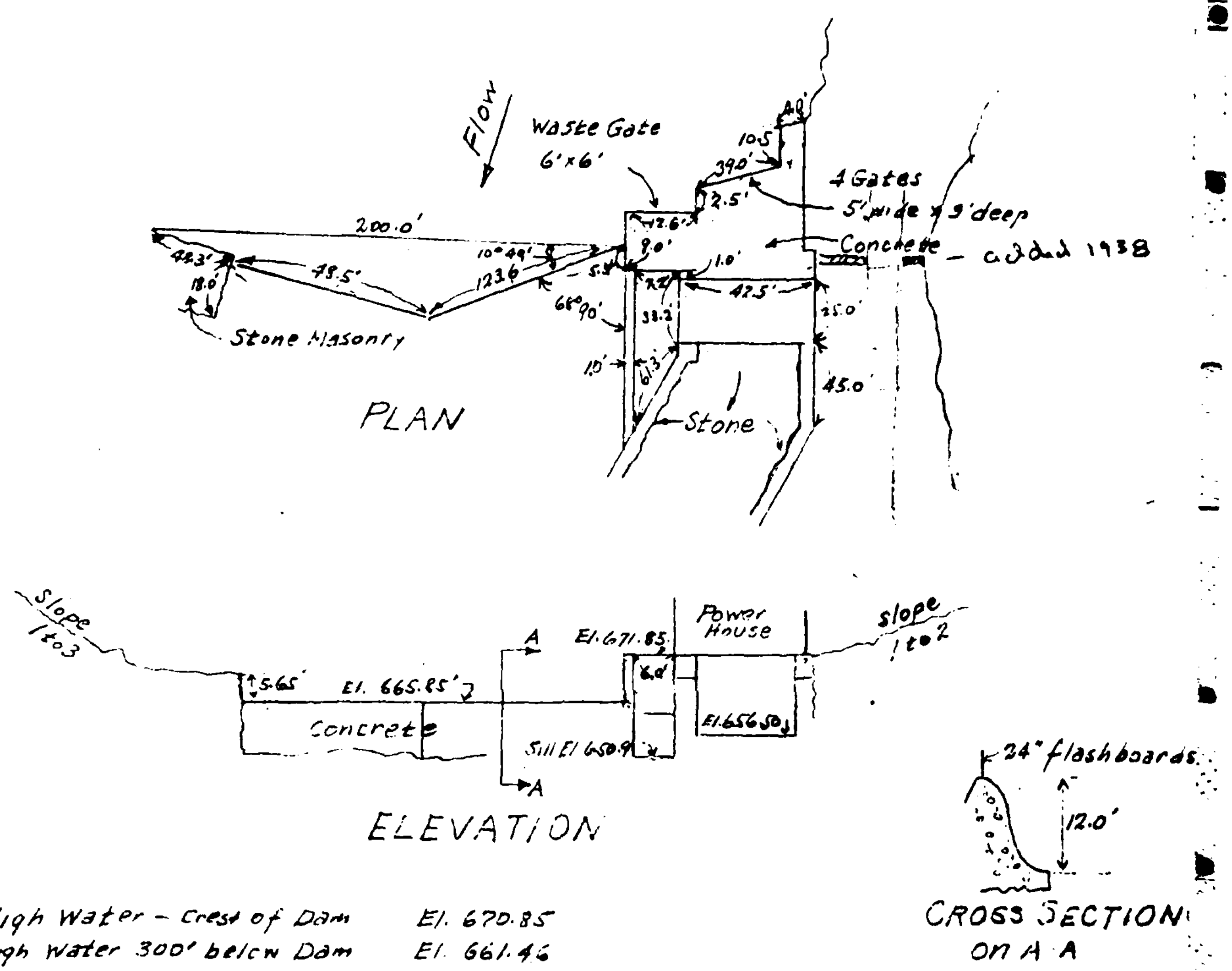
No.	Location	River, Brook, Pond or Lake	Condition Ruins or Operable	Owner	Owner's Address
1.	Powder Mill Dam	Lake	Concrete	Monadnock Paper Mills	Bennington
2.	Monadnock Power Station Dam	River	"	"	"
3.	Pierce Power Station Dam	River	"	"	"
4.	Paper Mill Dam	River	"	"	"
5.					
6.	Three Dams on two brooks Town Water works		Operable	Town of Bennington	
7.					
8.	Lake George		Non-operable	Monadnock Paper Mills	"
9.					
10.					
11.					
12.					
13.					

REC'D 8/5/37
ROUTE
INFORM.

CONTOOCOOK RIVER
MONØDNOCK POWER DAM A

Bennington, N.H.
Mile 146.70

22.03



High Water - Crest of Dam El. 670.85
High water 300' below Dam El. 661.46
Owner - Monodnock Mills
Use - Hydro Electric Power
Damage - None
Age - Built 1923 Caughey + Pratt, Antrim, N.H
Peak of Flood - March 19, 1936
No Gage Readings
Information from D. Braid, Engineer
By H. W. Poole
Date of report Aug. 22. 1936

Bennington, Dams in 1924

1

2 Monadnock Mills (Powder Mill)
Plan D-1296 I-1500 Bennington, N.H.

3 Monadnock Mills Rebuilt in 1923
I-1431 I-1335 Plan D-47 Bennington, N.H.

4-5 Combined into one dam 1921
Plan D-33 I-1142 Bennington, N.H.

6 Monadnock Mills built in 1922
Plan D-45 Bennington, N.H.

Town No. 3 Town Bennington No. 151

Data by I. W. B. File I-1335

Owner Monadnock Paper Mills

River or Stream Contoocook River

Public Utility No Drainage area 192 sq. mi.

Wheel Capacity H. P. 290 { Primary H. P. 90% time } 84

Type of Construction Concrete

Height 16 ft. Operating Head 13 ft.

Length 200 ft. Spillway Length (No. 1) 720 ft. (No. 2) ft.

Would Failure of Dam do Harm? Yes

Present Condition Good 1924 Date 1924
Good 1925

7374

(1923)

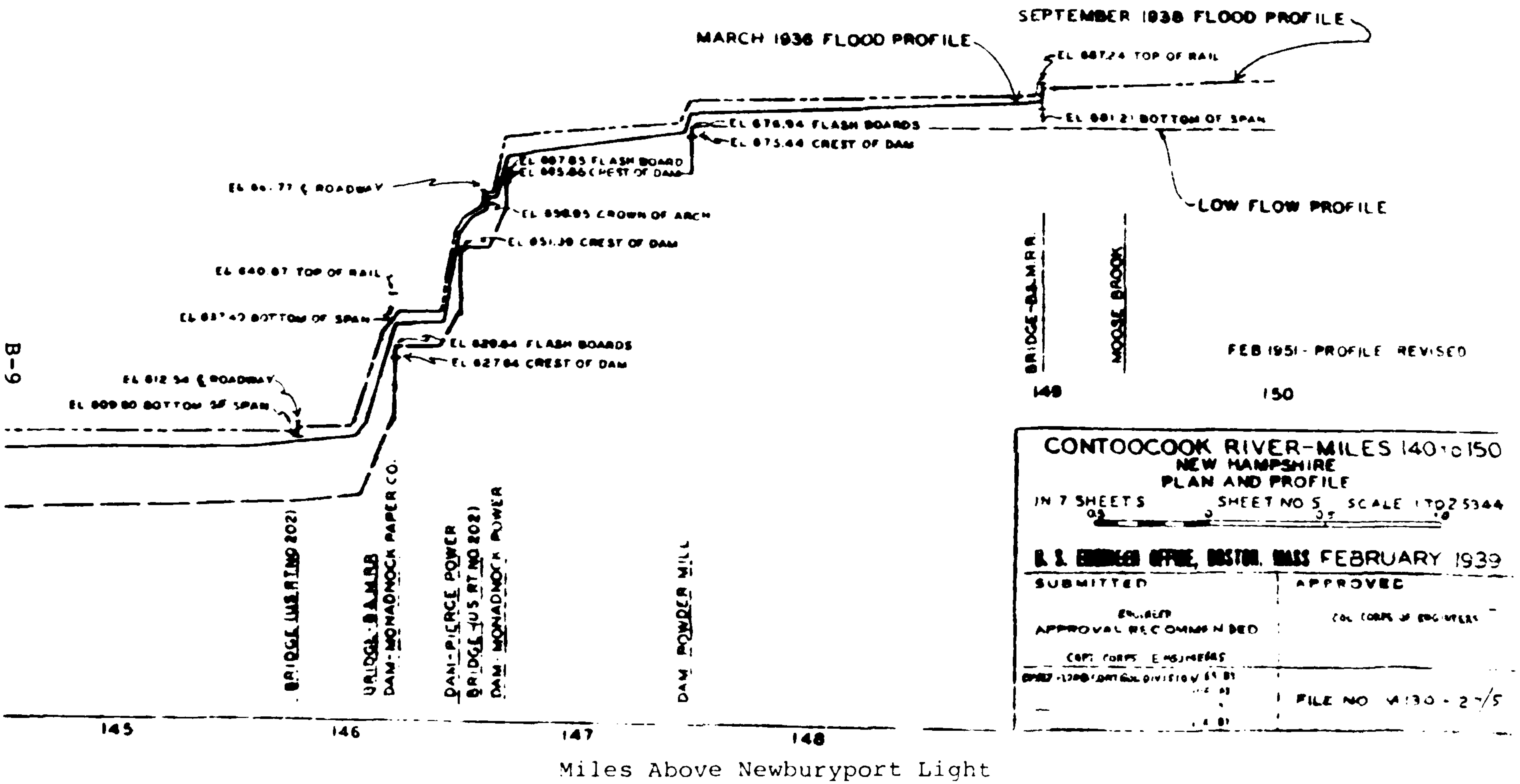
Monadnock Paper Mills. Owners.
Caughey and Pratt. Contractors.
Bennington, N. H.
Contoocook River, Monadnock Dam. below Powder Mill Dam

Started May 1923. Completed Spring 1924.

Plans filed with commission April 16, 1923. The design of dam was not accepted by the commission. May 19, 1923, a new plan was filed which was accepted by the commission and May 21st permission to go ahead with construction was granted.

This is a solid concrete dam 200' long with spillway 120' in length. The dam is 16' high. This dam was built for the generation of power. A 13' head is developed. The wheel capacity installed is 290 H.P. The drainage area is 192 square miles.

Informal 1431 Plan D-47.

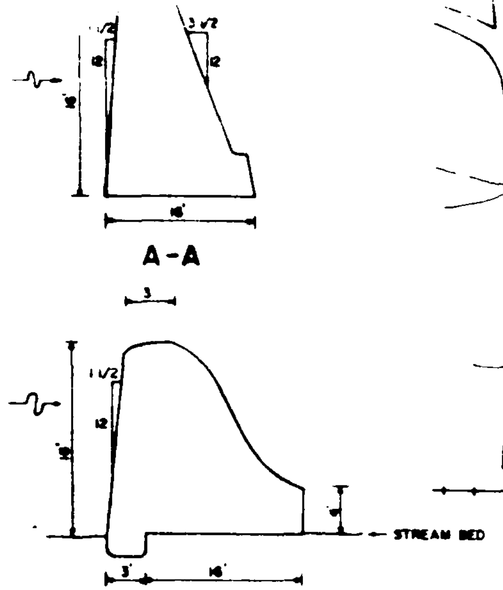

SEPTEMBER 1938 FLOOD PROFILE
MARCH 1936 FLOOD PROFILE
EL 687.24 TOP OF RAIL
EL 681.21 BOTTOM OF SPAN
EL 676.94 FLASH BOARDS
EL 675.44 CREST OF DAM
EL 667.85 FLASH BOARD
EL 665.86 CREST OF DAM
EL 658.85 CROWN OF ARCH
EL 651.30 CREST OF DAM
EL 640.87 TOP OF RAIL
EL 629.64 FLASH BOARDS
EL 627.64 CREST OF DAM
EL 612.54 ℄ ROADWAY
EL 609.80 BOTTOM OF SPAN
LOW FLOW PROFILE
BRIDGE-B&M.R.R.
MOOSE BROOK
FEB 1951 - PROFILE REVISED
BRIDGE (US RT NO 202)
BRIDGE-B&M.R.R.
DAM-MONADNOCK PAPER CO.
DAM-PIERCE POWER
BRIDGE (US RT NO 202)
DAM-MONADNOCK POWER
DAM POWDER MILL
145
146
147
148
149
150
Miles Above Newburyport Light
CONTOOCOOK RIVER-MILES 140 to 150
NEW HAMPSHIRE
PLAN AND PROFILE
IN 7 SHEETS
SHEET NO 5
FEBRUARY 1939
SUBMITTED
APPROVED
APPROVAL RECOMMENDED
FILE NO

NEW HAMPSHIRE WATER CONTROL COMMISSION

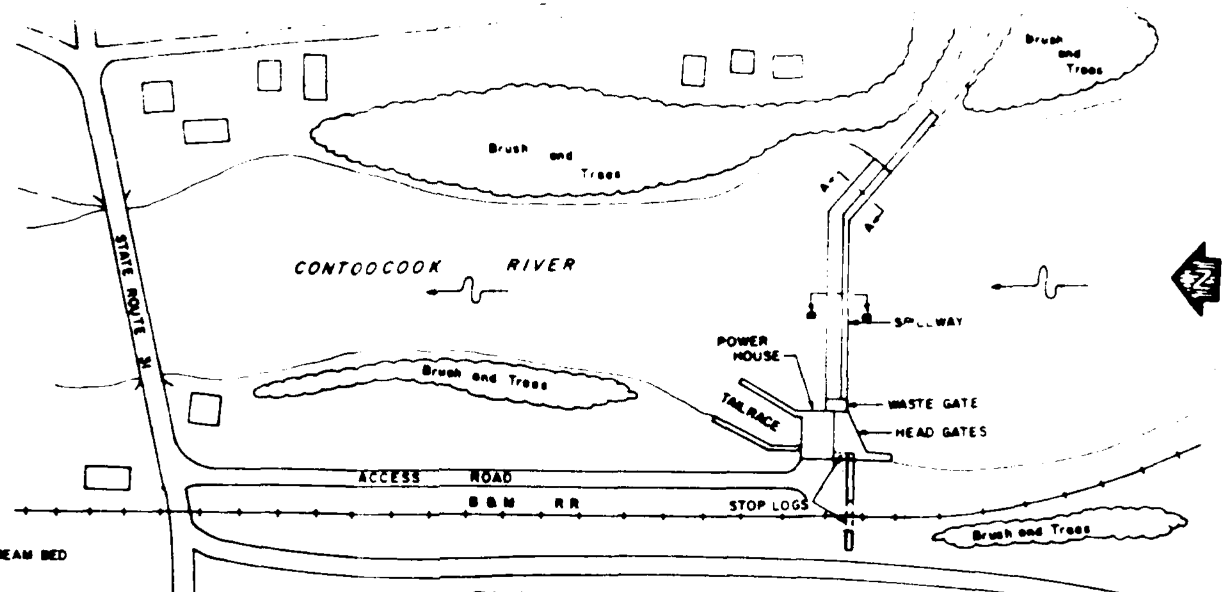
Dams on Which Information is Available in the

Town of Bennington

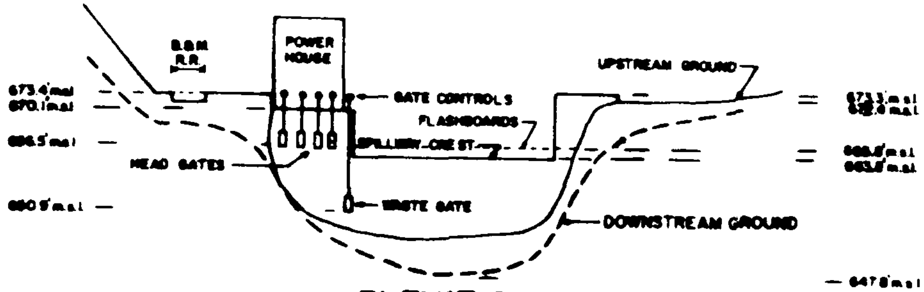
State No.	Location Stream	Name of Body of Water Created	Owner	Condition
22.01	Nameless Bk.	Whittemore Lake	"Monadnock Paper Mills Inc" A.J. Pierce	Ruin
22.02	Contoocook R.	Powder Mill Dam	Monadnock Paper Mills	Operable
22.03	Contoocook R.	---	Monadnock Paper Mills	Operable
22.04 & 5	Contoocook R.	---	Monadnock Paper Mills	Operable
22.06	Contoocook R.	---	Monadnock Paper Mills	Operable
22.07	Nameless Brook	---	J. Dow	Operable
22.08	Jukes Brook	---	Bennington Water Board	Operable
22.09	Cold Spring Bk.	---	Bennington Water Board	Operable
22.10	Cold Spring Bk.	---	Bennington Water Board	Operable



SPILLWAY SECTIONS



PLAN



ELEVATION

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

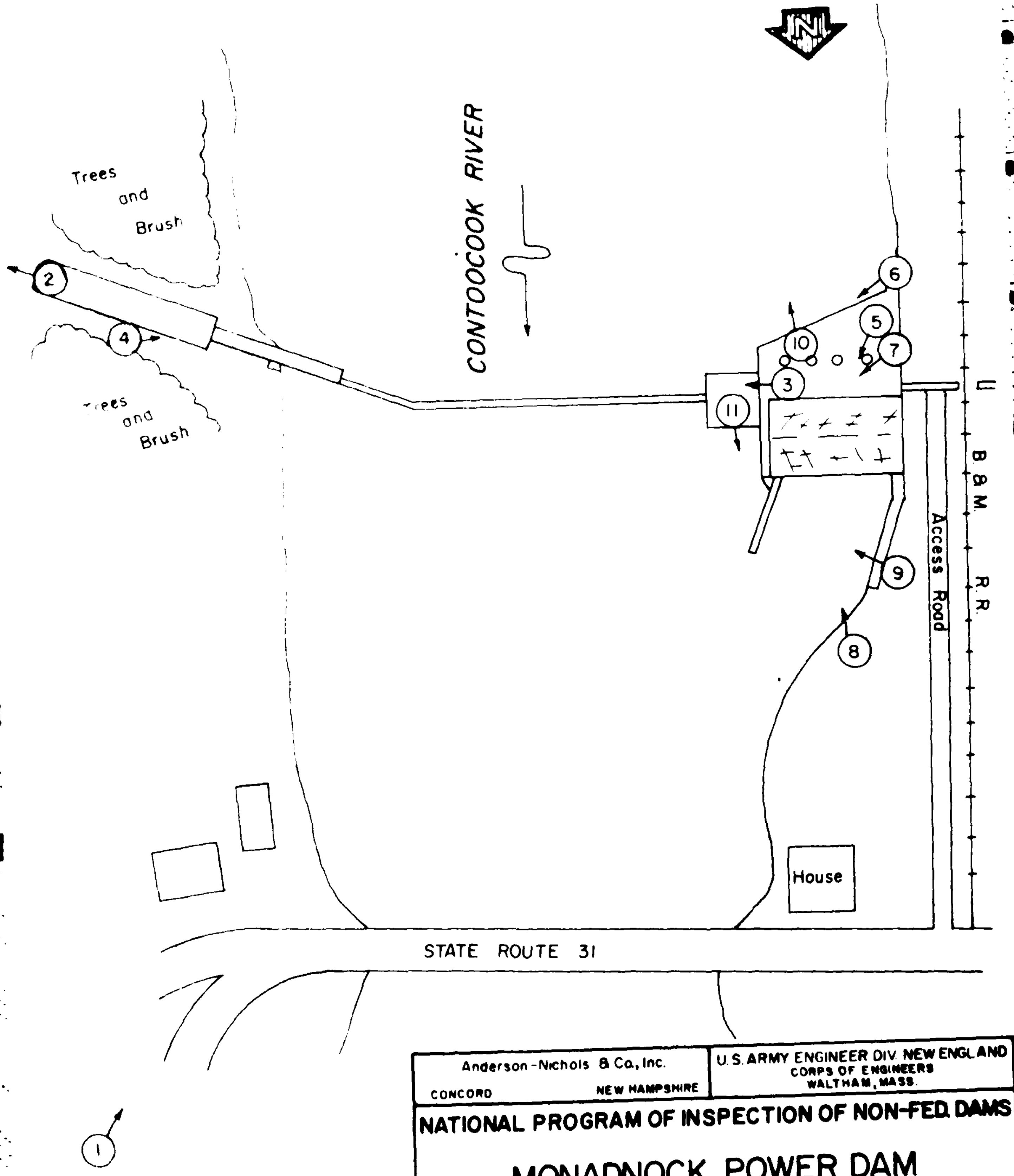
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

MONADNOCK POWER STATION DAM

CONTOOCOOK RIVER — NEW HAMPSHIRE

APPENDIX C

PHOTOGRAPHS



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

MONADNOCK POWER DAM
PHOTO INDEX

CONTOOCOOK RIVER NEW HAMPSHIRE

SCALE: NOT TO SCALE
DATE: FEBRUARY 1979

Figure 2 - Looking across the crest of the easterly dike.

Figure 3 - Looking east across the crest of the spillway. Note the intact flashboards.

Figure 4 - View of the vertical crack observed in the change in thickness of the concrete non-overflow section located east of the spillway.

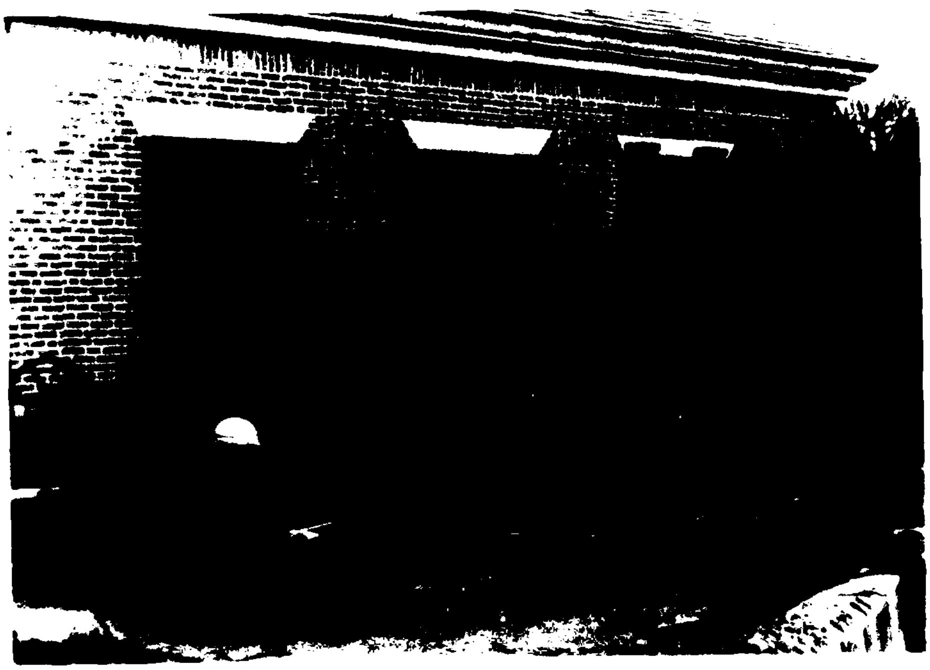


Figure 5 - Looking at the gate structure on the upstream side of the powerhouse.

Figure 6 - View of the exposed portion of the concrete gate structure where spalling has occurred.

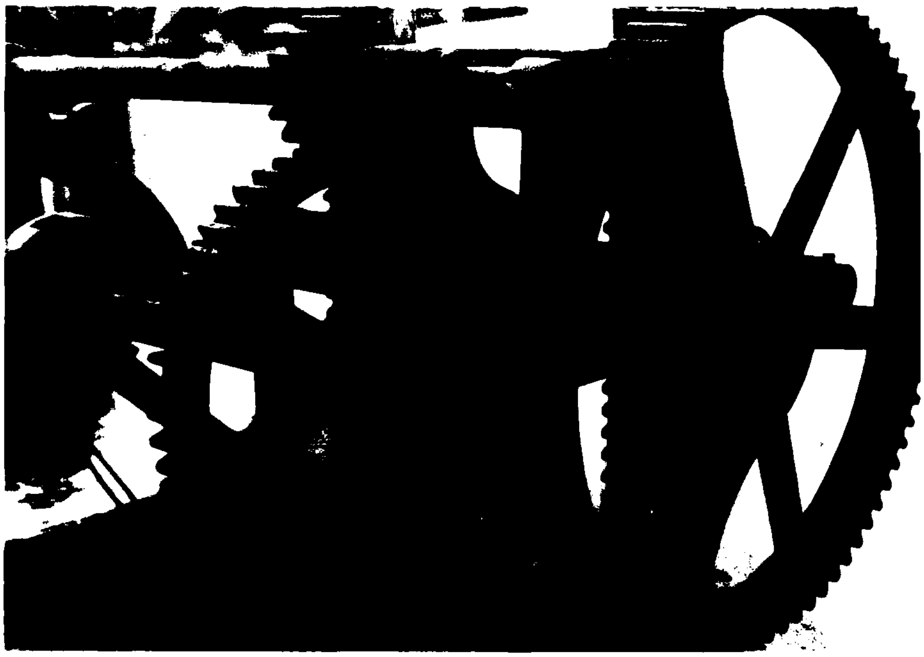


Figure 7 - Looking at the broken hand wheel operating mechanism.

Figure 8 - Looking at the downstream face of the powerhouse. Note the numerous areas of deterioration.

Figure 9 - Close-up view of the deterioration on the downstream face of the powerhouse.

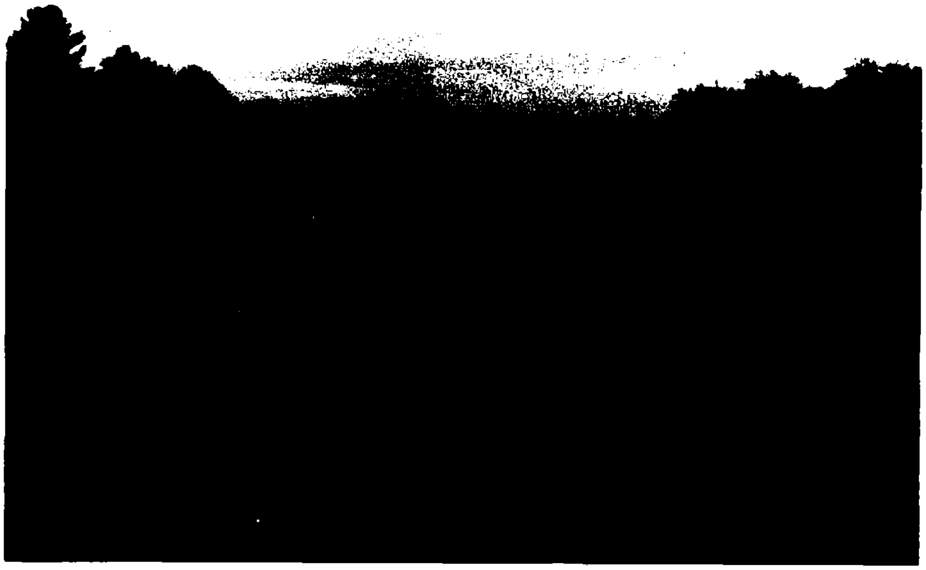


Figure 10 - Looking upstream into the reservoir from the dam.

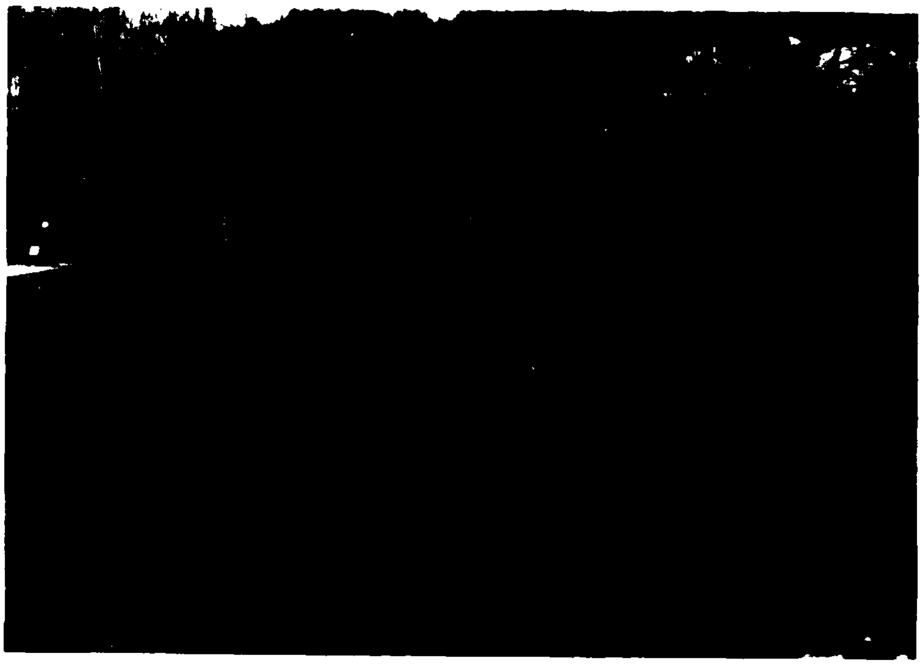
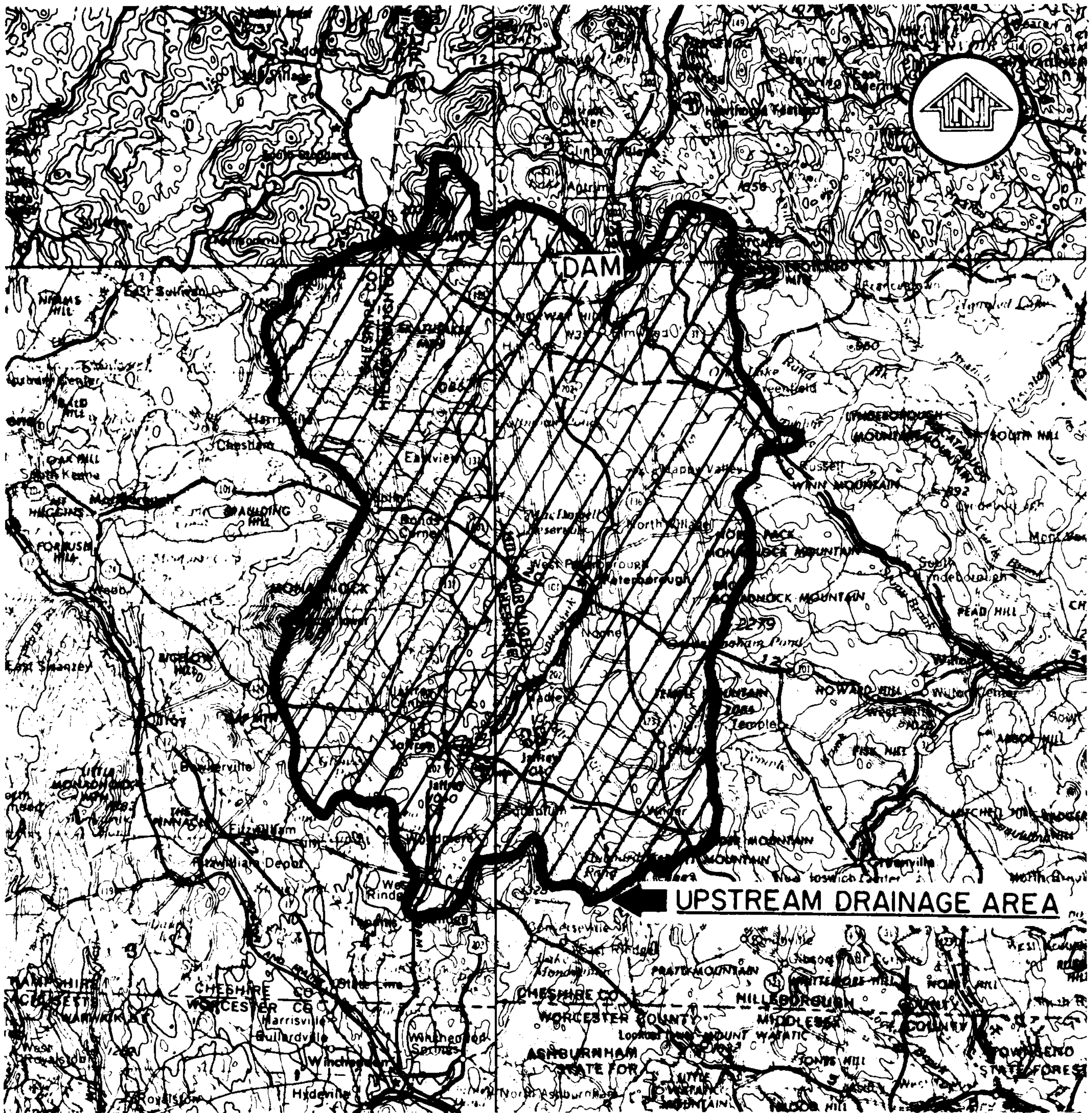


Figure 11 - Looking at the downstream channel from the dam. Note the highway bridge located about 450 feet from the dam.

Figure 12 - Looking at highway bridge located about 450 feet downstream from the dam. The dam is located just beyond the top of the photograph.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

MONADNOCK POWER STATION DAM

BENNINGTON, NEW HAMPSHIRE

REGIONAL VICINITY MAP

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

ANDERSON-NICHOLS & CO., INC. CONCORD, N.H.

SCALE IN MILES

0 5 10

MAP BASED ON U.S.G.S. 1:250,000 SERIES TOPOGRAPHIC MAPPING. ALBANY, NY, CT, MA, NH, VT, 1956. REV. 1974. BOSTON, MA, NH, CT, RI, ME, 1956, REV. 1970. PORTLAND, ME, NH. 1956, REV. 1972 GLENS FALLS, NY, VT, NH. 1956, REV. 1972.

MONADNOCK POWER STATION DAM

DA = 191 MI^2
SIZE CLASSIFICATION = SMALL
HAZARD CLASSIFICATION = SIGNIFICANT
TEST FLOOD = 1/4 PMF

CALCULATE PMF USING "PRELIMINARY GUIDANCE FOR ESTIMATING MAXIMUM PROBABLE DISCHARGES IN PHASE I DAM SAFETY INVESTIGATIONS, MARCH 1978."

SLOPE OF WATERSHEAD IS ≈ 17 FT/MI.; HOWEVER BECAUSE OF POWDER MILL POND LOCATED APPROXIMATELY 0.8 MILE UPSTREAM AND OTHER STORAGE AVAILABLE IN UPSTREAM LAKE. AND PONDS, THE PROBABLE MAXIMUM FLOOD (PMF) PEAK FLOW RATE HAS BEEN SELECTED FOR FLAT AND COASTAL TERRAIN.

FOR DA = 191 MI^2 - PMF = 330 CFS/MI^2
PMF DISCHARGE = 330 CSM · 191 MI^2
= 63,030 CFS
1/4 PMF = $\frac{63030}{4}$ = 15,758 CFS

TEST FLOOD DISCHARGE = 15,758 CFS

DEVELOP A DAM DISCHARGE RATING CURVES USING THE WEIR CROSS SECTION SHOWN ON PAGE D-7

ASSUMPTIONS: STOP LOGS ARE IN PLACE ON WALL WEST OF POWERHOUSE
* C = 3.3 (SPILLWAY)
C = 2.8 (WALL)
C = 2.7 (EMBANKMENT)

MONADNOCK POWER
STATION DAM

GATES (CONT'D)

* ESTIMATED FROM ORIGINAL DESIGN DATA AND HANDBOOK OF HYDRAULICS BY KING AND BRATER

TRIAL #1 @ 663.8 msl SPILLWAY CREST (W/O FLASHBOARDS)

$Q = 0$ cfs

TRIAL #2 @ 665.8 msl

$Q = 3.3 \cdot 165 \cdot 2.0^{3/2}$
$= 1,540.0$ cfs

TRIAL #3 @ 667.8 msl

$Q = 3.3 \cdot 165 \cdot 4.0^{3/2}$
$= 4,356.0$ cfs

TRIAL #4 @ 672.4 msl

$Q = 3.3 \cdot 165 \cdot 8.6^{3/2}$
$= 13,732.4$ cfs

TRIAL #5 @ 673.3 msl

$Q_{sw} = 3.3 \cdot 165 \cdot 9.5^{3/2}$
$= 15,943.5$ cfs

$Q_{weir} = 2.8 \cdot 10 \cdot (673.3 - 670.1)^{3/2}$
$+ 2.7 \cdot \frac{1}{2} \cdot 100 \cdot (673.3 - 672.4)^{3/2}$
$= 160.3 + 115.3 = 275.6$ cfs

$Q_T = 15,943.5 + 275.6 = 16,219.1$ cfs

MONADNOCK POWER
STATION DAM

2-7?
RTC

TRIAL #6 @ 676.8 msl

$$Q_{SW} = 3.3 \cdot 165 \cdot (676.8 - 663.8)^{3/2}$$
$$= 25,521.9 \text{ cfs}$$

$$Q_{WEIR} = 2.7 \cdot \tfrac{1}{2} \cdot 100 \cdot (676.8 - 672.4)^{3/2}$$
$$+ 2.8 \cdot 75 \cdot (676.8 - 673.3)^{3/2}$$
$$+ 2.8 \cdot 10 \cdot (676.8 - 670.1)^{3/2}$$
$$+ 2.8 \cdot 75 \cdot (676.8 - 673.4)^{3/2}$$
$$= 1,246.0 + 1,375.0 + 485.6$$
$$+ 1,316.6$$
$$= 4,423.2 \text{ cfs}$$

$$Q_T = 25521.9 + 4423.2$$
$$= 29,945.1 \text{ cfs}$$

TRIAL #1A @ 665.8 msl SPILLWAY CREST (W/ FLASHBOARDS)

$$Q = 0 \text{ cfs}$$

TRIAL #2A @ 669.0 msl

$$Q = 3.3 \cdot 165 \cdot (669.0 - 665.8)^{3/2}$$
$$= 3,116.9 \text{ cfs}$$

TRIAL #3A @ 671.0 msl

$$Q = 3.3 \cdot 165 \cdot (671.0 - 665.8)^{3/2}$$
$$= 6,456.6 \text{ cfs}$$

TRIAL #4A @ 672.4 msl

$$Q = 3.3 \cdot 165 \cdot (672.4 - 665.8)^{3/2}$$
$$= 9,232.4 \text{ cfs}$$

MONADNOCK POWER
STATION DAM

2-79
RTO

TRIAL #5A @ 676.8 msl

$$Q_{SW} = 3.3 \cdot 165 \cdot (676.8 - 665.8)^{3/2}$$
$$= 19{,}864.9 \text{ cfs}$$

$$Q_{WEIR} = 2.7 \cdot \tfrac{1}{2} \cdot 100 \cdot (676.8 - 672.4)^{3/2}$$
$$+ 2.8 \cdot 75 \cdot (676.8 - 673.3)^{3/2}$$
$$+ 2.8 \cdot 10 \cdot (676.8 - 670.1)^{3/2}$$
$$+ 2.8 \cdot 75 \cdot (676.8 - 673.4)^{3/2}$$
$$= 1246.0 + 1375.1 + 485.6 + 1316.6$$
$$= 4{,}423.3 \text{ cfs}$$

$$Q_T = 19864.9 + 4423.3 = 24{,}288.2 \text{ cfs}$$

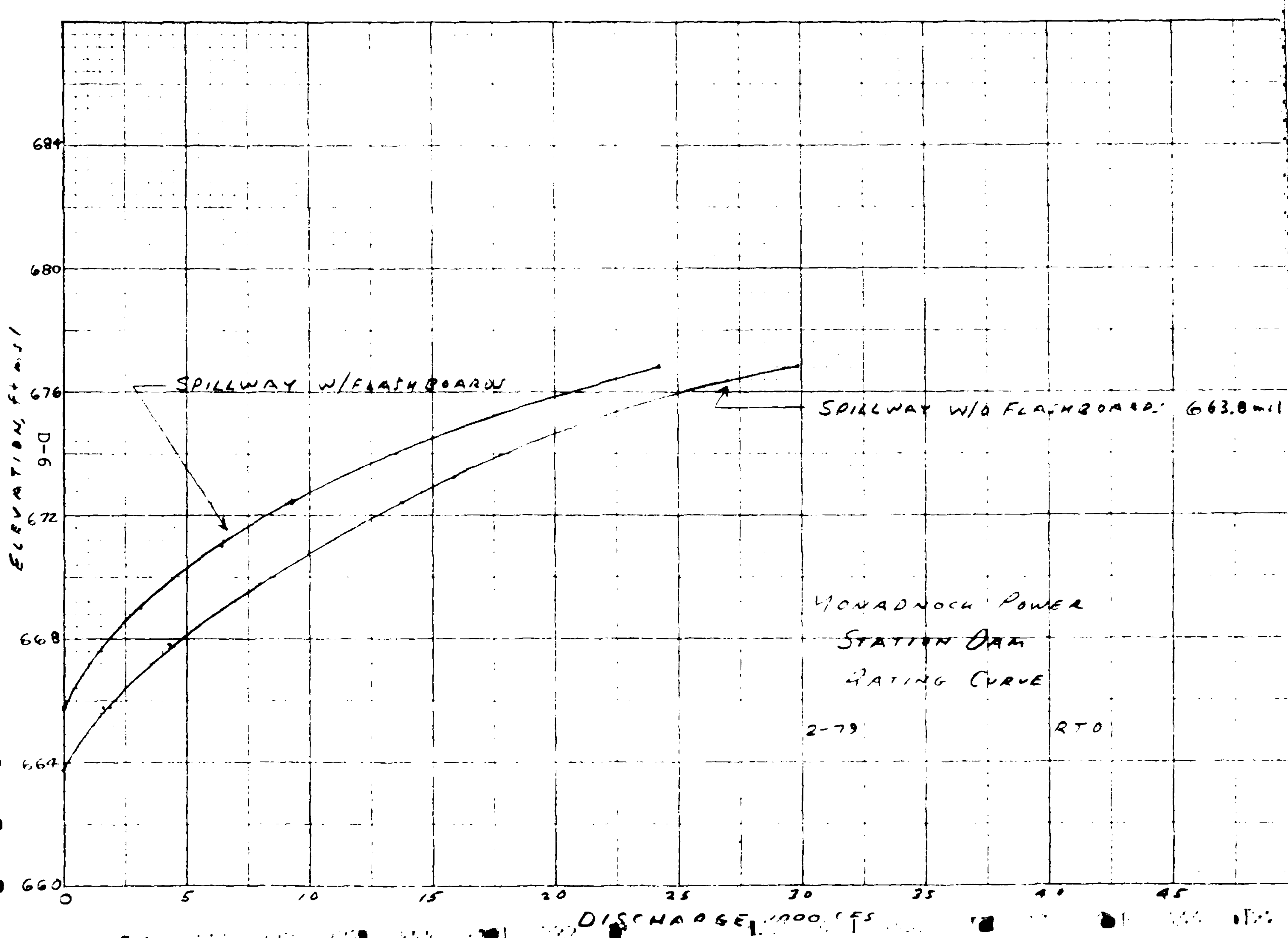
TEST FLOOD = 15,758 CFS

REFER TO RATING CURVE (W/O FLASHBOARDS) ESTABLISHED FROM THE ABOVE TRIALS (PAGE D-6)

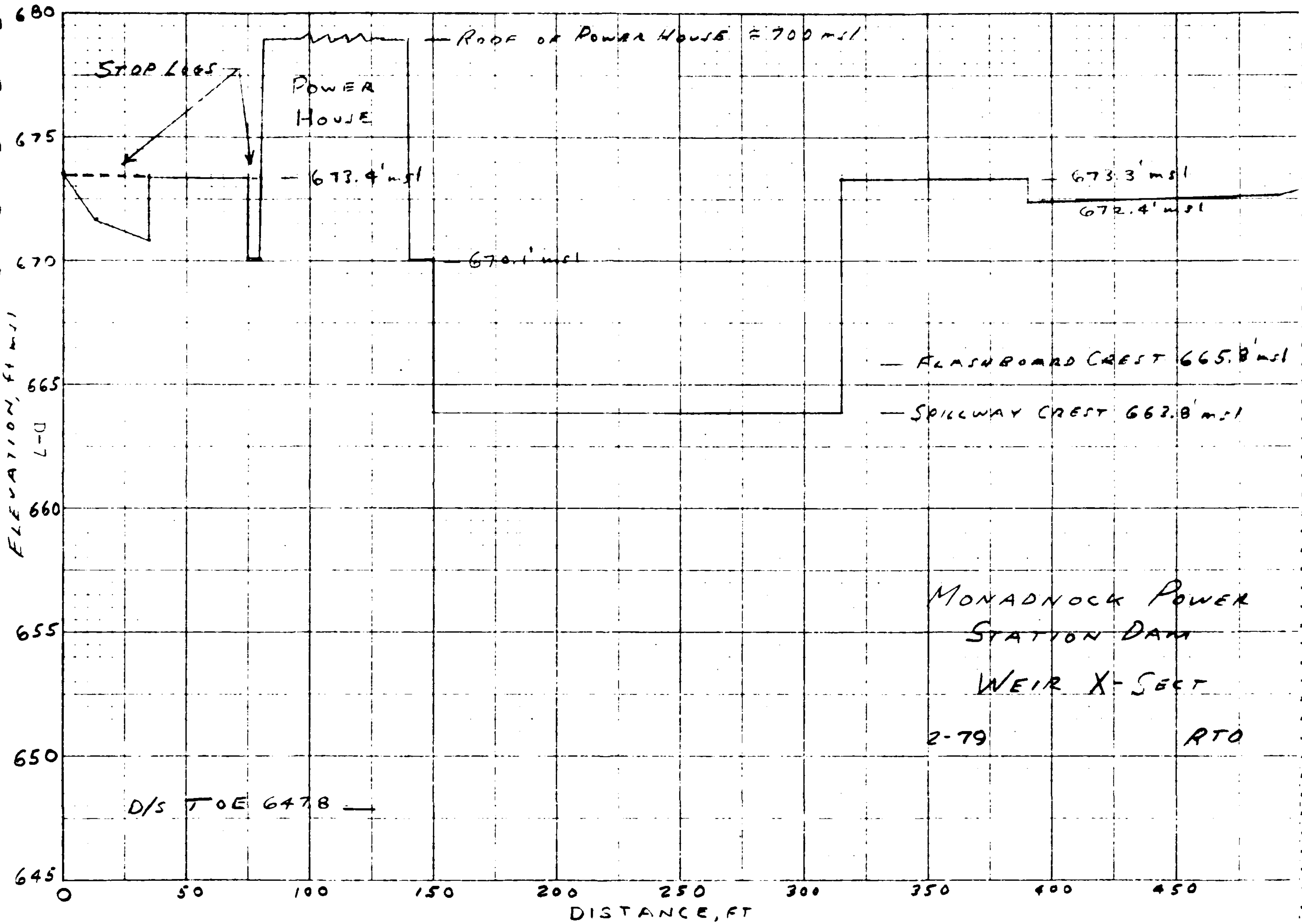
WITH Q = 15,758 CFS AN ELEVATION OF 673.2' msl CAN BE READ.

SPILLWAY CREST = 663.8' msl

∴ SPILLWAY WILL BE OVERTOPPED BY APPROXIMATELY 9.4 FEET DURING THE TEST FLOOD (1/4 PMF)



SPILLWAY W/FLASHBOARDS
SPILLWAY W/O FLASHBOARDS: 663.8 msl
MONADNOCK POWER
STATION DAM
RATING CURVE
2-79
RTO
ELEVATION, ft msl
DISCHARGE, 1000 CFS
684
680
676
672
668
664
660
0
5
10
15
20
25
30
35
40
45



ROOF OF POWER HOUSE ≈ 700 msl
STOP LOGS
POWER HOUSE
673.4' msl
670.1' msl
673.3' msl
672.4' msl
FLASHBOARD CREST 665.8' msl
SPILLWAY CREST 663.8' msl
D/S TOE 647.8
MONADNOCK POWER STATION DAM
WEIR X-SECT
2-79
RTO
ELEVATION, ft msl
DISTANCE, FT
680
675
670
665
660
655
650
645
0
50
100
150
200
250
300
350
400
450

MONADNOCK POWER STATION DAM

BREACH ANALYSIS

TO DETERMINE DOWNSTREAM HAZARD CLASSIFICATION, FAILURE OF THE DAM WILL BE CONSIDERED AT TWO DIFFERENT RESERVOIR POOL ELEVATIONS; I.E. (1) NORMAL POOL ELEVATION AND (2) TOP OF DAM POOL ELEVATION (MAXIMUM POOL/LOWEST NON-OVERFLOW POINT ELEVATION)

DETERMINE NORMAL FLOW CONDITION FOR CONTOOCOOK RIVER. (USING MEAN ANNUAL FLOW.)

REFERENCE: WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1976, U.S. GEOLOGICAL SURVEY WATER-DATA REPORT NH-VT-76-1, AUGUST 1977

AT GAGE STATIONS ON CONTOOCOOK RIVER:

DA = 68.1 mi^2 ; MAF = 144 CFS OR 2.11 CSM
DA = 368 mi^2 ; MAF = 858 CFS OR 2.33 CSM

DUE TO UPSTREAM STORAGE OF POWDER MILL POND, 2.33 CSM IS APPLIED TO DA AT MONADNOCK POWER STATION DAM (DA = 191 mi^2)

∴ NORMAL FLOW (MAF) = 191 · 2.33 = 445 CFS

FROM RATING CURVE FOR DAM W/FLASHBOARDS (PAGE D-6), DISCHARGE OF 445 CFS CORRESPONDS WITH ELEVATION OF 666.4' msl OR 666.4' − 665.8' = 0.6' ABOVE CREST OF FLASHBOARDS.

(1) NORMAL POOL ELEVATION = 666.4' msl

U/S RIVER BED ELEVATION ASSUMED TO BE APPROXIMATELY AT WASTE GATE INVERT ELEVATION (SEDIMENT ESTIMATED TO BE DEPOSITED TO THIS ELEVATION) = 650.9' msl

$$Q_1 = \frac{8}{27} \cdot W_b \cdot g^{1/2} \cdot y_0^{3/2}$$ = DISCHARGE THRU BREACH

W_b = BREACH WIDTH

$g = 32.2$ FT/SEC^2

y_0 = POOL ELEV. − U/S RIVERBED ELEV.

$W_b = 0.4 \cdot 165' = 66'$

$y_0 = 666.4 - 650.9 = 15.5'$

$$Q_1 = \frac{8}{27} \cdot 66 \cdot 32.2^{1/2} \cdot 15.5^{3/2}$$

= 6771.6 CFS

Q_2 = DISCHARGE OVER SPILLWAY W/FLASHBOARDS NOT BREACHED

$$Q_2 = 445 \cdot \frac{165-66}{165} = 267 \text{ CFS}$$

MONADNOCK POWER STATION
STATION DAM

2-79
RTO

TOTAL BREACH $Q_T = Q_1 + Q_2$

$= 6771.6 + 267$

$= 7040$ cfs ← USE

(2) TOP OF DAM POOL ELEVATION = 670.1 msl

$Q_1 = \frac{8}{27} \cdot W_b \cdot g^{1/2} \cdot y_0^{3/2}$ = DISCHARGE THRU BREACH

W_b = BREACH WIDTH = 0.4 · 165' = 66'

$g = 32.2$ ft/sec²

y_0 = POOL ELEV. − U/S RIVERBED ELEV.

$= 670.1 - 650.9 = 19.2'$

$Q_1 = \frac{8}{27} \cdot 66 \cdot 32.2^{1/2} \cdot 19.2^{3/2}$

$= 9,335.8$ cfs

Q_2 = DISCHARGE OVER SPILLWAY
W/O FLASHBOARDS NOT BREACHED

$Q_2 = C L H^{3/2}$

$= 3.3 \cdot 99 \cdot 6.3^{3/2}$

$= 5,166.1$ cfs

C = 3.3
L = 165' − 66 = 99
H = 670.1 − 663.8
= 6.3

TOTAL BREACH $Q_T = Q_1 + Q_2$

$= 9,335.8 + 5,166.1$

$Q_T = 14,500$ cfs ← USE

MONADNOCK POWER
STATION DAM

2-79
RTO

NORMAL POOL OF THE [illegible] DAM [illegible] ≈ [illegible] FEET DOWNSTREAM EXTENDS UPSTREAM TO THE BASE OF MONADNOCK POWER STATION DAM. NORMAL ANALYSIS [illegible] CHANNEL CAPACITY [illegible] BECAUSE THE POOL STAGE IS CONTROLLED BY [illegible] THEREFORE THE INCREASE IN STAGE CAUSED BY FAILURE OF THE MONADNOCK POWER STATION DAM WILL BE ESTIMATED BY CALCULATING INCREASES IN STAGE AT THE [illegible] DAM RESULTING FROM A COMBINATION OF BREACH AND ANTECEDENT DISCHARGES UNDER CONDITIONS OF NORMAL AND TOP OF DAM POOLS

FOR BREACH AT NORMAL POOL (666.4 MSL)
(NORMAL FLOW OVER SPILLWAY W/FLASHBOARDS)

WHEN ANTECEDENT DISCHARGE = 445 CFS
* STAGE = 654.0' MSL (W/FLASHBOARDS)

WHEN BREACH + ANTECEDENT DISCHARGE =
7040 + 445 = 7485 CFS
* STAGE = 657.0 MSL (W/FLASHBOARDS)

NOTE: * FROM [illegible] POWER STATION DAM [illegible] CURVE (SEE PAGE D-21)

INCREASE IN STAGE = 657.0 - 654.0
= 3.0' ←

MONADNOCK POWER STATION DAM

2-79
RTO

FOR BREACH AT TOP OF DAM POOL (670.1' MSL)
(MAXIMUM FLOW OVER SPILLWAY W/O FLASHBOARDS)

ANTECEDENT DISCHARGE @ 670.1' MSL

$Q = CLH^{3/2}$ $C = 3.3$

$= 3.3 \cdot 165 \cdot 6.3^{3/2}$ $L = 165$

$= 8,610$ CFS $H = 670.1' - 663.8'$

$= 6.3'$

* STAGE = 654.8' MSL (W/O FLASHBOARDS)

BREACH + ANTECEDENT DISCHARGE =

14,500 + 8,610 = 23,110 cfs

* STAGE = 658.0' (W/O FLASHBOARDS)

NOTE: * FROM PIERCE POWER STATION DAM RATING CURVE (SEE PAGE D-21)

INCREASE IN STAGE = 658.0' − 654.8'

= 3.2' ←

DEVELOP A RATING CURVE FOR THE STATE ROUTE 31 BRIDGE USING THE WEIR CROSS SECTION SHOWN ON PAGE D-17.

$Q = \frac{1.49}{n} \cdot A \cdot R^{2/3} \cdot S^{1/2}$ (MANNINGS EQUATION)

$Q = CLH^{3/2}$ (WEIR FORMULA)

$Q = CA(2 \cdot g \cdot H)^{1/2}$ (ORFICE EQUATION)

$R = \frac{A}{P} = \frac{\text{AREA}}{\text{WETTED PERIMETER}}$

MONADNOCK POWER STATION DAM

2-79
RTD

ASSUME n = 0.03 (CONCRETE BRIDGE WITH EARTH BOTTOM)

S = 0.008

$C_{1,2,3,4} = 2.7$ (EMBANKMENT & ROAD)

C = 0.9 (OPENING UNDER BRIDGE)

MINIMUM WATER SURFACE ELEVATION IS CONTROLLED BY PIERCE POWER DAM = 11' AT BRIDGE

Q_1 = DISCHARGE ABOVE MINIMUM WSEL.

TRIAL #1 @ ELEVATION 11'

Q_1 = 0 cfs ←

TRIAL #2 @ ELEVATION 16'

$$Q = \frac{1.49}{n} \cdot A \cdot R^{2/3} \cdot S^{1/2}$$

$$A = \frac{1}{2} \cdot 10 \cdot 85 + 1 \cdot \left(\frac{85+90}{2}\right) + 5 \cdot \left(\frac{90+115}{2}\right)$$

$$= 425 + 87 + 512 = 1024 \text{ ft}^2$$

$$WP = 2 \cdot (42^2 + 10^2)^{1/2} + 2 \cdot (15^2 + 6^2)^{1/2}$$

$$= 2 \cdot 43 + 2 \cdot 16 = 118 \text{ ft}$$

$$R = \frac{1024}{118} = 8.68$$

$$Q = \frac{1.49}{0.03} \cdot 1024 \cdot 8.68^{2/3} \cdot 0.008^{1/2}$$

= 19,212 cfs

MONADNOCK POWER STATION DAM

2-79
RTD

$$Q_1 = \frac{A_1}{A} \cdot Q$$

$$= \frac{512}{1024} \cdot 19{,}212 = \underline{9{,}606 \text{ cfs}} \longleftarrow$$

TRIAL #3 @ ELEVATION 21'

$$Q = C \cdot A \cdot (2 \cdot g \cdot H)^{1/2}$$

$$A = 425 + 87 + 512 + 2 \cdot \tfrac{1}{2} \cdot 58.3$$

$$= 1198 \text{ ft}^2$$

$$Q = 0.9 \cdot 1198 \cdot \left(2 \cdot 32.2 \cdot \left(\tfrac{19}{2} + 2\right)\right)^{1/2}$$

$$= 29{,}342 \text{ cfs}$$

$$Q_1 = \frac{686}{1198} \cdot 29{,}342 = \underline{16{,}802 \text{ cfs}} \longleftarrow$$

TRIAL # 4 @ ELEVATION 23'

$$Q = C \cdot A \cdot (2 \cdot g \cdot H)^{1/2} + C_1 L_1 H_1^{3/2} + C_2 L_2 H_2^{3/2}$$

$$A = 1198 \text{ ft}^2$$

$$L_1 = 43 + 65 = 108 \text{ ft} \qquad L_2 = 40 \text{ ft}$$

$$H = \tfrac{19}{2} + 4 = 13.5 \text{ ft}$$

$$H_1 = \tfrac{2}{2} = 1 \text{ ft} \qquad H_2 = 2 \text{ ft}$$

$$Q = 0.9 \cdot 1198 \cdot (2 \cdot 32.2 \cdot 13.5)^{1/2} + 2.7 \cdot 108 \cdot 1^{3/2} + 2.7 \cdot 40 \cdot 2^{3/2}$$

$$= 31{,}791 + 292 + 305 = 32{,}388 \text{ cfs}$$

$$Q_1 = \frac{686}{1198} \cdot 32,355$$

$$= 18,546 \text{ cfs}$$

TRIAL #5 @ ELEVATION 25

$$Q = CA(2gH)^{1/2} + C_1L_1H_1^{3/2} + C_2L_2H_2^{3/2} + C_3L_3H_3^{3/2}$$

A = 1198 ft² $\quad H = \frac{19}{2} + 6 = 15.5$

L_1 = 170 + 65 = 235 ft

L_2 = 40 ft $\quad L_3$ = 100 ft

$H_1 = \frac{4}{2} = 2$ ft

H_2 = 4 ft $\quad H_3$ = 2 ft

$$Q = 0.9 \cdot 1198 \cdot (2 \cdot 32.2 \cdot 15.5)^{1/2} + 2.7 \cdot 235 \cdot 2^{3/2} + 2.7 \cdot 40 \cdot 4^{3/2} + 2.7 \cdot 100 \cdot 2^{3/2}$$

$$= 34,065 + 1,795 + 864 + 764$$

$$= 37,488 \text{ cfs}$$

$$Q_1 = \frac{686}{1198} \cdot 37,488$$

$$= \underline{21,466 \text{ cfs}}$$

TRIAL #6 @ ELEVATION 30

$$Q = CA(2gH)^{1/2} + C_1L_1H_1^{3/2} + C_2L_2H_2^{3/2} + C_3L_3H_3^{3/2} + C_4L_4H_4^{3/2}$$

A = 1198 ft² $\quad H = \frac{19}{2} + 11 = 20.5$

L_1 = 62 + 65 = 127 ft $\quad H_1 = \frac{5}{2} = 2.5$ ft

L_2 = 235 ft $\quad H_2 = \frac{4}{2} = 2.0$ ft

$L_3 = 40$ ft $\qquad H_3 = 9.0$ ft

$L_4 = 100$ ft $\qquad H_4 = 7.0$ ft.

$$Q = 0.9 \cdot 98 \cdot (2 \cdot 32.2 \cdot 20.5)^{1/2} + 2.7 \cdot 127 \cdot 2.5^{3/2} + 2.7 \cdot 235 \cdot 2.0^{3/2} + 2.7 \cdot 40 \cdot 9.0^{3/2} + 2.7 \cdot 100 \cdot 7.0^{3/2}$$

$$= 39{,}116 + 1{,}555 + 1{,}795 + 2{,}916 + 5{,}000$$

$$= 50{,}242 \text{ cfs}$$

$$Q_1 = \frac{686}{1198} \cdot 50{,}242$$

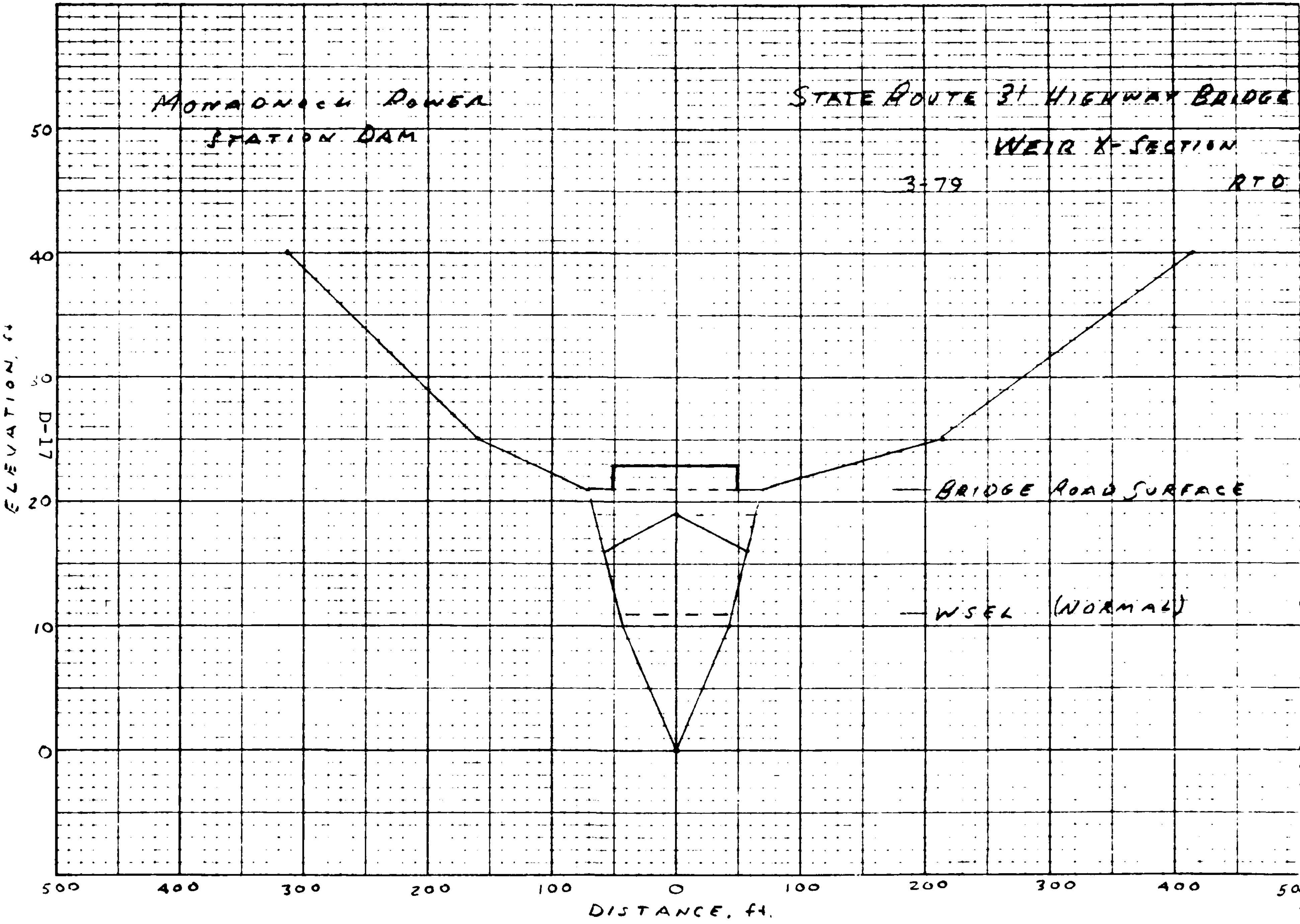
$$= \underline{28{,}770 \text{ cfs}} \leftarrow$$

AT TEST FLOOD DISCHARGE = 15,758 cfs
WATER SURFACE ELEVATION = 20.2 FT.
FROM STATE ROUTE 31 HIGHWAY
BRIDGE RATING CURVE. (SEE PAGE D-18)

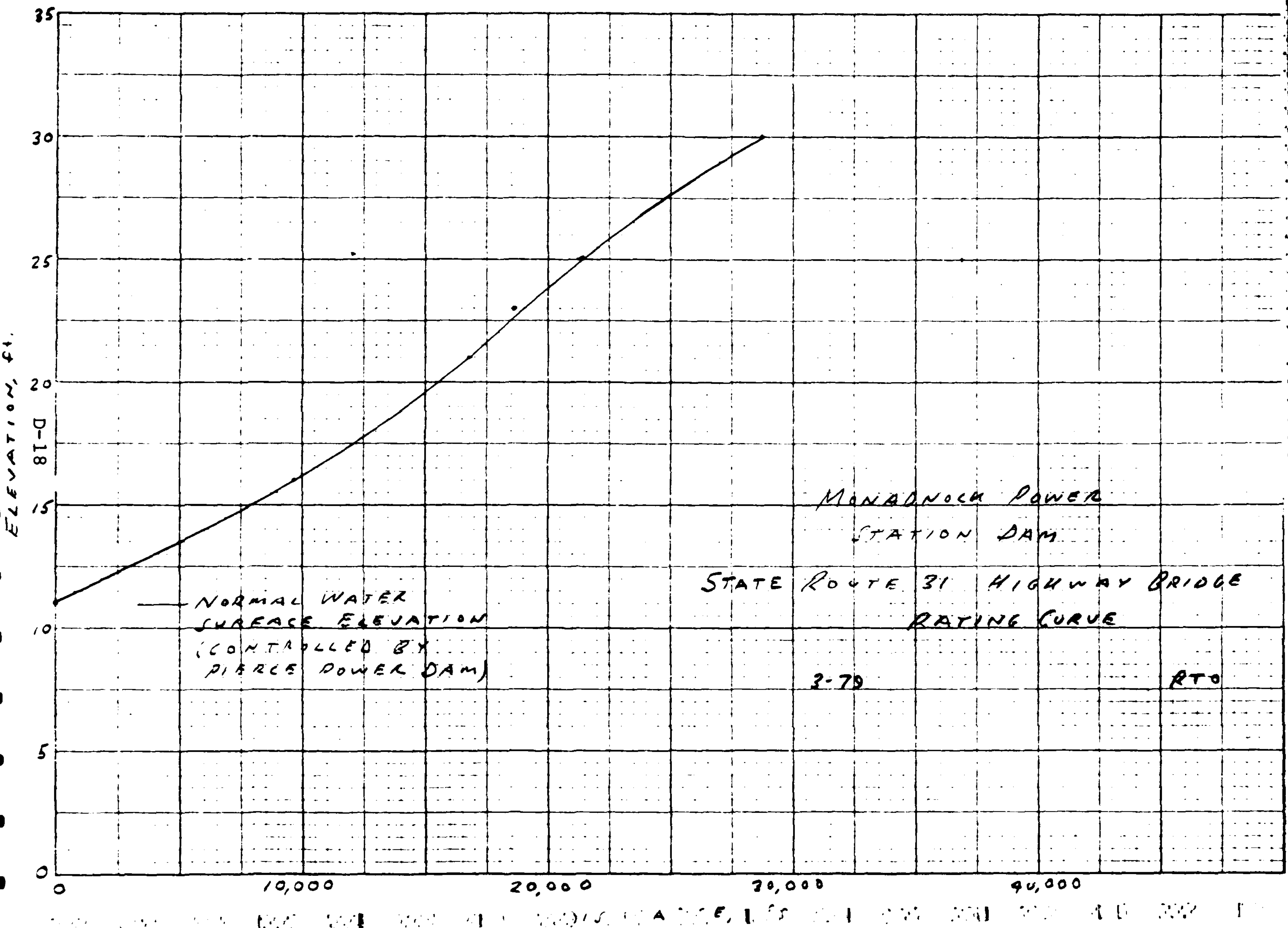
INCREASE IN STAGE = 20.2′ − 11.0′ = <u>9.2 FT.</u> ←

AT TOP OF DAM BREACH DISCHARGE = 23,[illegible] cfs
WATER SURFACE ELEVATION = 26.3 FT
FROM STATE ROUTE 31 HIGHWAY
BRIDGE RATING CURVE (SEE PAGE D-18)

INCREASE IN STAGE = 26.3′ − 11.0′ = <u>15.3 FT.</u> ←
OVERTOPPING OF HIGHWAY = 26.3′ − 21.0′ = <u>5.3 FT</u> ←



MONADNOCK POWER
STATION DAM
STATE ROUTE 31 HIGHWAY BRIDGE
WEIR X-SECTION
3-79
RTD
BRIDGE ROAD SURFACE
WSEL (NORMAL)
ELEVATION, ft
DISTANCE, ft.
50
40
30
20
10
0
500
400
300
200
100
0
100
200
300
400
500


MONADNOCK POWER
STATION DAM
STATE ROUTE 31 HIGHWAY BRIDGE
RATING CURVE
3-79
RTO
NORMAL WATER
SURFACE ELEVATION
(CONTROLLED BY
PIERCE POWER DAM)
ELEVATION, ft.
35
30
25
20
15
10
5
0
0
10,000
20,000
30,000
40,000

MONADNOCK POWER
STATION DAM

2-79
RTO

DETERMINE DISCHARGE CAPACITY
OF WASTE GATE

DATA SIZE - 6'W x 6'H
ELEV INVERT - 650.9' msl

$Q = C \cdot A \cdot (2gH)^{1/2}$ $K = \frac{1}{C^2}$ $R = \frac{A}{P}$

$K_f = \frac{29.1\, n^2 \cdot L}{R^{4/3}}$

$n = 0.015$ (CONCRETE)
$L = 45'$ (ESTIMATED)
$A = 6 \cdot 6' = 36\ FT^2$
$P = 6 \cdot 4 = 24\ FT$
$R = \frac{36}{24} = 1.5$

$K_{(ENTRANCE + EXIT)} = 1.10$ (ESTIMATED)

$K_f = \frac{29.1 \cdot 0.015^2 \cdot 45}{1.5^{4/3}}$

$= 0.17$

$K_T = 0.17 + 1.10$
$= 1.27$

$C = \left(\frac{1}{1.27}\right)^{1/2} = 0.89$

CAPACITY @ 666.4 msl (NORMAL POOL ELEV)
(W/FLASHBOARDS)

$H = 666.4' - (650.9' + \frac{6}{2}) = 12.5$

$Q = 0.89 \cdot 36 \cdot (2 \cdot 32.2 \cdot 12.5)^{1/2}$
$= 909.1$ CFS ←

MONADNOCK POWER
STATION DAM

D-19
RTO

CAPACITY @ 670.1 (TOP OF DAM POOL ELEV.)

$$H = 670.1 - \left(650.9 + \frac{6}{2}\right) = 16.2$$

$$Q = 0.89 \cdot 36 \cdot (2 \cdot 32.2 \cdot 16.2)^{\frac{1}{2}}$$

$$= \underline{1,034.9 \text{ CFS}} \leftarrow$$

CAPACITY @ 663.8' (SPILLWAY CREST POOL ELEV.)
(W/O FLASHBOARDS)

$$H = 663.8 - \left(650.9 + \frac{6}{2}\right) = 9.9'$$

$$Q = 0.89 \cdot 36 \cdot (2 \cdot 32.2 \cdot 9.9)^{\frac{1}{2}}$$

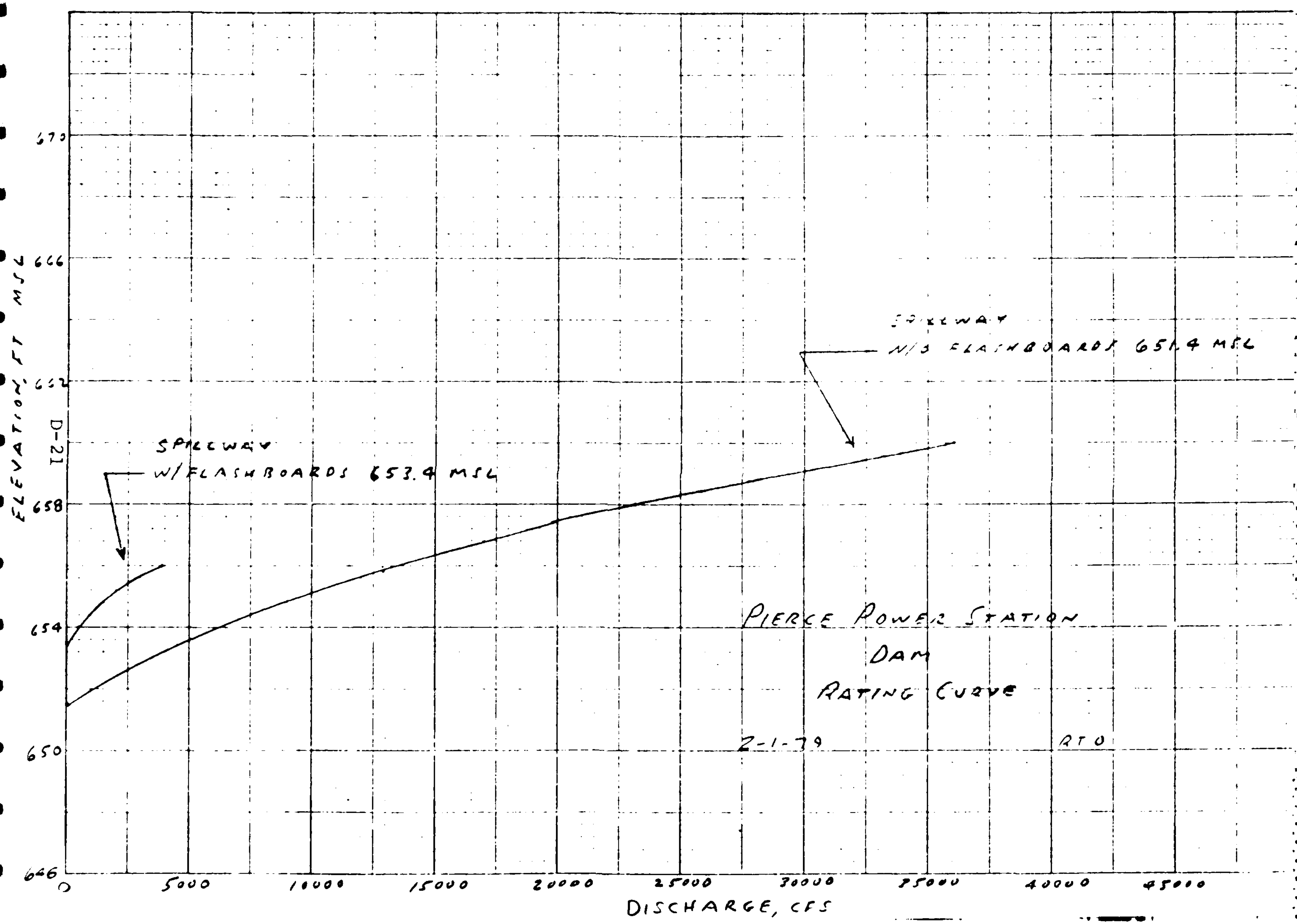
$$= \underline{809.0 \text{ CFS}} \leftarrow$$

CAPACITY @ 673.2' (TEST FLOOD POOL ELEV.)

$$H = 673.2 - \left(650.9 + \frac{6}{2}\right) = 19.3'$$

$$Q = 0.89 \cdot 36 \cdot (2 \cdot 32.2 \cdot 19.3)^{1/2}$$

$$= \underline{1,129 \text{ CFS}} \leftarrow$$


PIERCE POWER STATION
DAM
RATING CURVE
2-1-79
RTO
SPILLWAY
W/FLASHBOARDS 653.4 MSL
FLASHBOARDS 651.4 MSL
ELEVATION, FT MSL
DISCHARGE, CFS
670
666
658
654
650
646
0
5000
10000
15000
20000
25000
30000
35000
40000
45000

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR. DIST.	STATE	COUNTY	CONGR. DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
NH	249	NED	NH	011	02				MONADNOCK POWER STATION DAM	4300.0	7155.6	15FEB79

POPULAR NAME	NAME OF IMPOUNDMENT
MONADNOCK DAM	CONTOOCOOK RIVER

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	05	CONTOOCOOK RIVER	BENNINGTON	0	639

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
RECTPG	1923	H	26	22	240	217	NED	N	N	N	N	07MAR79

REMARKS

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
2	590	C	165	9650		.1	.4									

OWNER	ENGINEERING BY	CONSTRUCTION BY
MONADNOCK PAPER MILLS	CAUGHEY AND PRATT	CAUGHEY AND PRATT

REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NHWRB	NHWRB	NHWRB	NHWRB

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
ANDERSON-NICHOLS + CO.	20NOV78	PL 92-367

REMARKS

END

FILMED

8-85

DTIC