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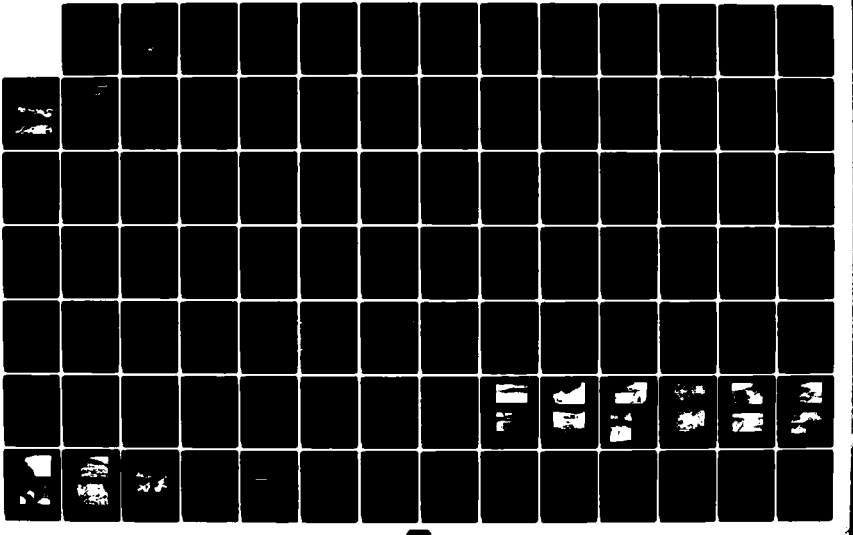

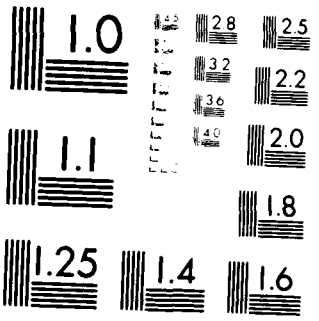

HOUSATONIC RIVER BASIN

LENOX, MASSACHUSETTS

UPPER ROOT RESERVOIR DAM
MA 00019

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGAM

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

MARCH, 1981

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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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,
Housatonic River Basin
Lenox, Massachusetts

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

Upper Root Reservoir Dam is an earth embankment gravity dam with a concrete core wall. The dam has a length of 840 ft. and a maximum hydraulic height of 39.5 feet. Based on engineering judgement and past performance of the dam and outlet works, the project is considered to be in fair condition at the present time. Because the dam is classified as small size and high hazard potential, the test flood was selected as the PMF.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:
NEDED

MAY 26 1981

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Upper Root Reservoir Dam (MA-00019) 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 Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Town of Lenox, Department of Public Works, ATTN: Mr. Allen R. Sykes, Water Department, 31 Main Street, Lenox, Massachusetts 01240.

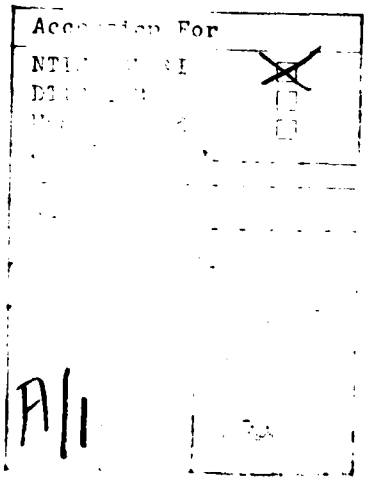
Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely,

C. E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

Incl
As stated



UPPER ROOT RESERVOIR DAM

MA 00019

HOUSATONIC RIVER BASIN
LENOX, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	MA 00019
Name of Dam:	UPPER ROOT RESERVOIR DAM
Town:	LENOX
County and State:	BERKSHIRE, MASSACHUSETTS
Stream:	LENOX MOUNTAIN BROOK
Date of Inspection:	16, 17 NOVEMBER 1980

BRIEF ASSESSMENT

Upper Root Reservoir Dam is an earth embankment gravity dam with a concrete core wall which impounds an 18-acre water supply reservoir for the Town of Lenox. The dam has a length of 840 feet and a maximum hydraulic height of 39.5 feet. The embankment has a top width of 10 feet and side slopes of approximately 2.5H to 1V. The top and downstream slope are vegetated while the upstream face is riprapped to an elevation about 3.5 feet lower than the top of dam. The normal full pool elevation for the reservoir is (at the top of flashboards) 3.5 below the top of dam. There is a 30-foot wide concrete overflow spillway at the east abutment. The crest of the concrete spillway is 6.5 feet lower than the top of dam. The spillway discharges into a 10-foot wide by 3-feet deep concrete channel which conveys the flow around the east end of the dam.

There is a 16-inch low-level outlet conduit and a 12-inch high-level outlet. The reservoir can be drained by the 16-inch conduit.

The reservoir storage capacity is currently being enlarged by excavation. The capacity of the reservoir at the flashboards is expected to be approximately 270 acre-feet (90 million gallons).

Based on engineering judgment and past performance of the dam and outlet works, the project is considered to be in fair condition at the present time. The project does, however, have a number of deficiencies which, if not remedied, have the potential for developing into serious conditions.

Because the dam is classified as small size and high hazard potential, the test flood was selected as the Probable Maximum Flood (PMF). The PMF inflow for Upper Root Reservoir Dam, having a drainage area of 650 acres, was estimated to be 2400 cfs. Without the flashboards the routed test flood outflow would be approximately 2100 cfs at an elevation equivalent to about ½ foot to 1 foot above the existing low areas in the dam's crest. The low areas are most pronounced near the spillway walls.

The flashboard supports are embedded in the spillway crest and do not appear to have been designed as yielding supports.

The capacity of the spillway without flashboards with water at the existing low point in the dam is about 1250 cfs which is 61% of the routed test flood outflow. With Flashboards, the spillway capacity is approximately 690 cfs.

A major breach of the dam would cause loss of the town water supply system. Loss of more than a few lives would also be likely as a result of a major dam break.

A number of recommendations are given in Section 7.2 for implementation by the owner. These recommendations should be implemented within 12 months of receipt of this Phase I Inspection Report with the exception that the owner should retain a qualified Registered Professional Engineer immediately upon receipt of this report to investigate, and design any necessary repairs for conditions causing a localized depression at the upstream slope of the dam near the 12-inch outlet. This condition should be remedied before the reservoir is allowed to fill again to the level of the flashboards unless the depression is found not to pose a threat to the structure. The engineer should inspect the dam during and after filling of the reservoir.

Other recommendations in general are as follows:

Retain a qualified Registered Professional Engineer to:

- Design repairs to the gully at the easterly downstream toe and set up a monitoring program to monitor this area and other areas along the toe for possible unusual seepage.

- Design repairs to restore the crest elevation to a uniform grade, particularly low areas adjacent to the spillway walls. Repairs of wheel ruts on the downstream should be designed.

- Investigate and design repairs for areas of possible undermining of the floor of the spillway channel and backfill of the spillway walls.

- Investigate replacement of existing flashboard supports with yeilding type supports. This investigation should also consider relocating the flashboards upstream of the expansion joints of the spillway walls.

- Design methods to extend the slope protection to a higher elevation on the upstream slope in order to halt undercutting of the crest.

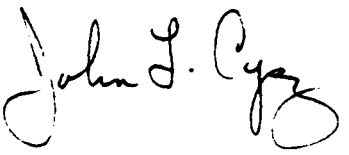
- Investigate the condition and adequacy of the existing toe drainage system, particularly in light of recent construction activity in this area.

- Design procedures and supervise removal of trees within 25 feet of the spillway discharge channel.

In addition, the owner should also implement the recommended remedial program listed in Section 7.3 including servicing of valves, control of the

burrowing animal population, filling of existing animal burrows, establishment of a formal operation and maintenance program and a formal written surveillance and downstream warning program. A qualified Registered Professional Engineer should be engaged to make a comprehensive technical inspection of the dam once a year.

John F. Cysz
Project Manager
MA P.E. No. 28841



This Phase I Inspection Report on Upper Root Reservoir Dam (MA-00019) 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 judgement and practice, and is hereby submitted for approval.

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

ARAMAST MAHTESIAN, MEMBER
Geotechmical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, CHAIRMAN
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

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

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

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

Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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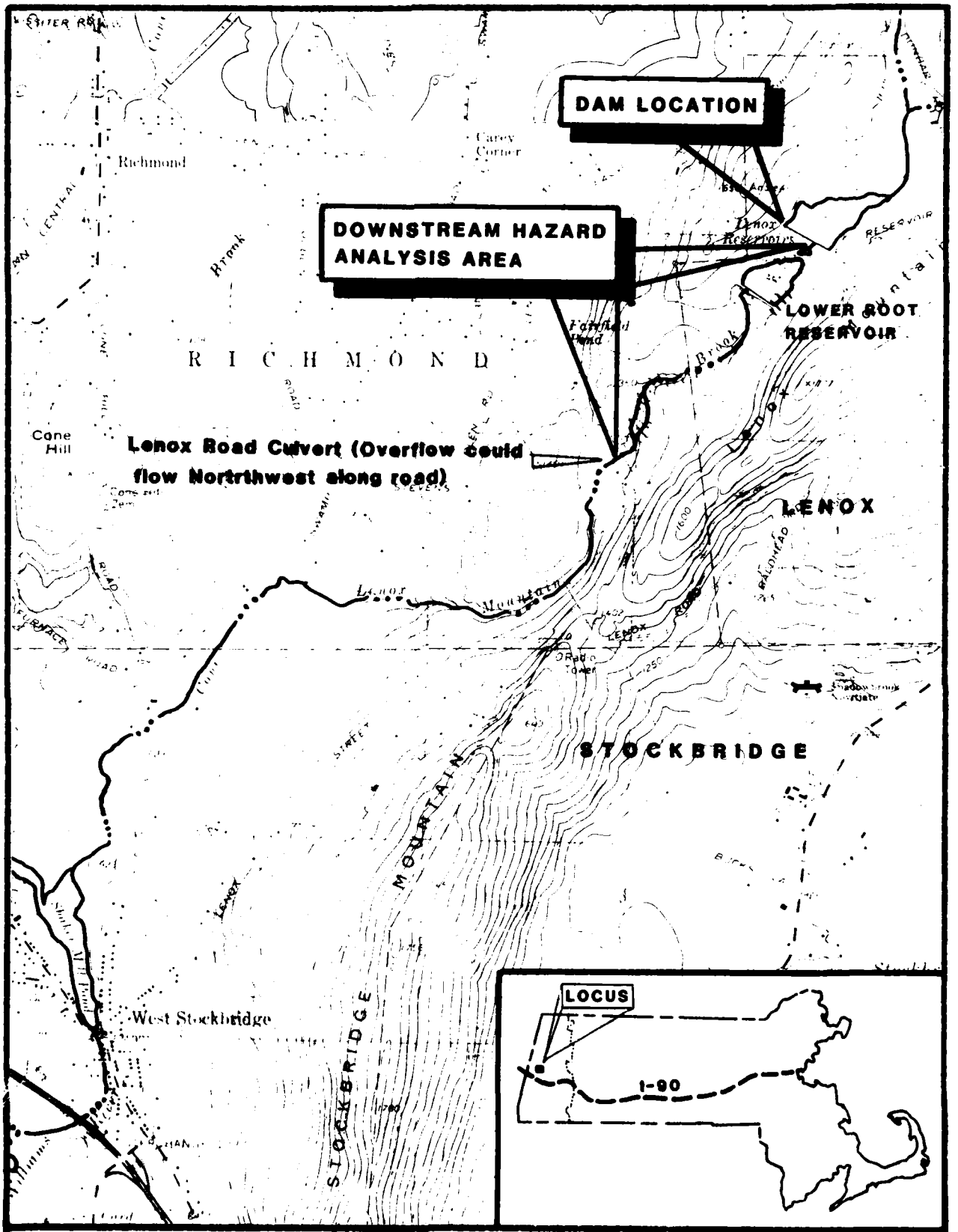
OVERVIEW OF UPPER ROOT RESERVOIR DAM



UPPER ROOT RESERVOIR DAM

LENOX, MASS.

Identification No. MA 00019

N

vi

LOCATION PLAN

Stockbridge Quadrangle

1:25000

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
UPPER ROOT RESERVOIR DAM
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 Inspection of Dams within the New England region. Robert G. Brown & Associates, Inc. has been retained by the New England Division to inspect and report on selected dams in the Commonwealth of Massachusetts and State of Vermont. Authorization and notice to proceed were issued to Robert G. Brown & Associates, Inc. under a letter of 23 October 1980 from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract Number DACW33-81-C-0004 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten 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

Upper Root Reservoir Dam is located in the Town of Lenox, Massachusetts. The dam is on Lenox Mountain Brook approximately 3.6 miles upstream from the brook's confluence with Shaker Mill Pond, the headwaters of the Williams River. The dam impounds Upper Root Reservoir which is one of the two water supply reservoirs for the Town of Lenox. Upper Root Reservoir Dam is shown on the USGS Stockbridge, Mass. quadrangle at latitude 42° 22.2' and longitude 73° 19.6'. Access to the damsite is from Reservoir Road. Upper Root Reservoir is also known as Upper Lenox Reservoir.

b. Description of Dam and Appurtenances

Upper Root Reservoir Dam is an earth fill dam, with a concrete core wall, approximately 840 feet long, with a maximum hydraulic height of about 39.5 feet, measured from the top of the dam to the outlet of the 16" lower intake conduit. The top of the dam is vegetated and has a width of about 10 feet. The axis of the dam is oriented in roughly an east/west direction.

The downstream face of the embankment is vegetated and has a slope of approximately 2.5H:1V. The upstream face has a 2.5H:1V slope and is covered with dumped riprap to within 3.5 feet vertical distance of the top of the dam.

The earth embankment, according to the record plans, is comprised of random glacial till. A 12-inch wide reinforced concrete core wall in the center of the embankment extends from the foundation to a height of 5.5 feet below the top of dam and about 2 feet below the top of flashboards. The concrete core wall sets on a reinforced concrete step footing built on a glacial till foundation (see boring data on sheet 2 of 5 in Record Plans). The maximum height of the core wall is 47 feet at station 8 + 75.

There is a 16-inch diameter cast iron mechanical joint conduit which serves as a low-level outlet. The 16-inch conduit is located near the center of the dam and is regulated by a gate valve set in a 4-foot diameter concrete block manhole positioned near the downstream toe. The inlet to this conduit originally was a concrete headwall with a bar rack. The inlet has recently been modified to include a 5-foot high riser pipe to allow water to be drawn off above the reservoir bottom. The conduit discharges beyond the toe of the dam into a pool formed by the remains of an 1878 stone dam. There is a 12" gate valve approximately 10 feet to the east of the 16-inch conduit. This valving is for a bypass of the 16-inch valve.

There is a 12-inch diameter, mechanical joint, cast iron pipe which acts as a high-level outlet for the reservoir. This conduit is located approximately 190 feet east of the low-level outlet. The inlet of the 12-inch conduit is 15 feet higher than the inlet elevation of the 16-inch conduit. There is a concrete headwall with a bar rack at the upstream end of this conduit. The 12-inch outlet is regulated by a gate valve contained in a 4-foot diameter, concrete block manhole on the downstream slope of the embankment. The 12-inch conduit discharges to the spillway channel.

According to the record plan for this dam, there are no anti-seep collars for either conduit other than the concrete core wall. The conduits are shown as passing through the core wall in lead jointed wall sleeves. Flexible Dresser couplings are shown on the conduits at each side of the core wall.

There ia a 30-foot long reinforced concrete overflow spillway at the easterly abutment. The concrete spillway crest is 6.5 feet below the top of dam and has provisions for 3 feet of flashboard height. The flashboards are supported by 4-inch deep steel H-beams, 7.5 feet on-center, embedded in the concrete spillway crest. The flashboards are supported at the spillway walls by 4-inch channels.

The spillway approach channel has a rock and gravel floor leading to the concrete crest (see Appendix C, Photograph 2).

The spillway discharge is conveyed downstream of the dam in a 10-foot wide, 3-foot deep concrete chute channel. The channel has a length of 350 feet (horizontal projection) and a slope of 10%. There is a channel bucket at the end of the spillway chute channel to deflect the discharge upward. The spillway channel discharges about 50 feet upstream of Reservoir Road and downstream of the remains of the 1878 stone dam. After passing under Reservoir Road the spillway discharge enters Lower Root Reservoir.

There are 3-inch diameter drain holes in the side walls of the spillway channel. These holes were drilled during the 1978 repair program. A 12" sand and gravel bed beneath the floor of the spillway channel is shown on the record plan.

There is an internal drainage system for the earth embankment as shown on Sheet 5 of 5 in the Record Plans (see Appendix B-18). The drainage system consists of a series of 6-inch diameter perforated vitrified clay pipes surrounded by washed gravel. The drainage system appears to have been intended for drainage of the foundation/embankment downstream of the core wall. There are two outlets for the drainage system at the toe of the dam. The drain ending at the outlet closest to the east end of the dam appears to have been added during construction, possibly to intercept a spring, but this could not be confirmed. There appears to be an inconsistency in record elevations for the drain inverts.

c. Size Classification

The dam has a maximum hydraulic height of 39.5 feet and a top of dam storage of 350 acre-feet. Based on height and storage criteria (less than 40 feet high; less than 1000 acre-feet storage) specified in the Recommended Guidelines for Safety Inspection of Dams, the structure is classified as small size.

d. Hazard Classification

The dam is in a high hazard category because a major breach of the dam could cause destruction of property and loss of more than a few lives in the Lenox Road area 0.9 mile downstream of the dam. In addition, a critical source of water for the Town of Lenox would be lost as a result of a dam breach (see Section 5.5).

e. Ownership

The dam is owned by: Town of Lenox
Department of Public Works
Water Department
31 Main Street
Lenox, MA
Tel: (413) 637-0815
Mr. Allen R. Sykes, Superintendent

f. Operator

Day-to-day operation of the dam is assigned to Water Department personnel on a rotating basis. The personnel are dispatched from the Water Department office, 31 Main Street, Lenox, MA, Tel. (413) 637-0815.

g. Purpose of Dam

The dam impounds Upper Root Reservoir which is one of the two water supply reservoirs for the Town of Lenox. The original capacity of 60 million gallons was increased to over 90 million gallons by excavating additional storage in 1980. The excavation program was in progress at the time of this inspection.

h. Design and Construction History

Upper Root Reservoir Dam was constructed on Lenox Mountain Brook immediately upstream of Lower Root Reservoir in 1959 and 1960. Plans dated April 1959 were prepared by Whitman and Howard, Inc. Engineers, 89 Broad Street, Boston, Mass. and are on file at the Lenox Water Department. Copies of significant portions of the plans are included in Appendix B. No specifications, design calculations or construction records were available from the engineer or the owner. The dam was built by T & T Construction of Medford, MA.

In 1978, repairs were made to the concrete spillway. Plans and specifications for this work were prepared by Whitman and Howard, Inc. Engineers, and are on file at the Water Department and with the engineers. The repairs consisted of plugging existing weep holes at the base of the spillway channel walls, cutting new weep holes midway up the walls of the spillway channel, construction of 4-foot by 3-foot gravel and crushed stone drains behind each new weep hole, and replacement of fillers in the joints in the spillway walls and floor. The purpose of the repairs was to control seepage which had reportedly begun to erode around and under the spillway. This work was performed by Peter Francese and Son Inc., Lenox, MA.

In 1980, improvements to the reservoir and dam were designed by J.F. Moynihan & Associates, Inc., Route 102, Lee, MA. The work consisted of excavating approximately 150,000 cubic yards of material from the reservoir bottom to increase the storage capacity from the original design of 60 million gallons to over 90 million gallons. The 16" diameter lower intake was also modified by constructing a 5-foot high 16" diameter riser inlet with a 16" gate valve upstream to act as a pond drain. The work is being performed by Petricca Construction Company, 444 Merrill Road, Pittsfield, MA. This work was underway but not completed at the time of the field inspection for this report. Additional water supply piping and cutting back of trees around the reservoir are being planned.

i. Normal Operation Procedures

Water Department personnel, on a rotating basis, are responsible for checking the reservoir dams daily. The dams are also checked before and during heavy storms, and the water level may be adjusted by operating the gate valves.

The flashboards are removed in the fall and replaced in the spring to prevent ice damage. The dam is mowed at least once a year. No fertilization of vegetation on the embankment is performed.

The upper and lower pipe intakes are operated as required according to the water level in the reservoir. The water is drawn off and directed into the Lower Reservoir where the intake for the town's water distribution system is located. Both gate valves are normally closed except when in use. They are generally used each year. There is no formal written emergency preparedness or downstream warning system in effect for this structure.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area contributing to Upper Root Reservoir is 1.02 square miles. The drainage area is oriented with its long axis in a northerly direction and has a length of approximately 1.7 miles and an average width of approximately 0.6 miles. Approximately 98% of the watershed lies in the Town of Lenox with the remaining 2% lying in the Town of Richmond. The drainage area is drained by Lenox Mountain Brook and an un-named tributary which join about 1/2 mile upstream of the dam.

The entire drainage area is wooded and undeveloped. The Town of Lenox owns most of the area. Topography consists of moderately steep to rolling terrain with some upland marsh in the upper reaches and steep valley walls in the lower reaches. Elevations range from 1454 at the toe of the dam to 2123 near the Lenox Lookout Tower at the extreme northern end of the drainage area.

Upper Root Reservoir is the only significant body of open water in the drainage area. Upland marshes cover about 15 acres and the reservoir itself has a surface area of 18 acres, which combined make up about 5% of the total drainage area.

b. Discharge at Damsite

Discharge at the damsite is over the concrete spillway which is regulated with flashboards, and two pipe intakes, a 12" diameter upper intake and a 16" diameter lower intake. The concrete spillway is 30 feet long and 6.5 feet high at the centerline of the dam. Flashboard channels are provided for 3 feet above the spillway floor. Three flashboards each 11" high are normally used. The elevation datum used on the construction plans is U.S.G.S. with the crest elevation being 1487.0 NGVD.

(1) Outlet Works -

a. 12-inch upper intake - regulated by 12" gate valve at downstream toe of dam. Discharge capacity at top of dam 8 cfs. Invert of outlet - 1472.0.

b. 16-inch lower intake - regulated by 16" gate valve in manhole at downstream toe of dam. Discharge capacity at top of dam 28 cfs. Invert of outlet - 1454.0. (Inlet modified in December 1980 by adding a 5' high 16" riser pipe on a tee with a 16" gate valve upstream to act as a pond drain.)

(2) Maximum Flood at Damsite - No flood of record available. Dam has not been overtopped.

(3) Ungated Spillway Capacity at Top of Dam - (at existing low point of embankment) - 425 cfs at 1492.5 NGVD (with flashboards), 1250 cfs at 1492.5 NGVD (without flashboards).

(4) Ungated Spillway Capacity at PMF Test Flood Elevation - 770 cfs at 1493.8 NGVD (with flashboards), 1650 cfs at 1493.8 (without flashboards).

(5) Gated Spillway Capacity at Normal Pool Elevation - not applicable.

(6) Gated Spillway Capacity at Test Flood Elevation - not applicable.

(7) Total Spillway Capacity at Test Flood Elevation - 770 cfs at 1493.8 NGVD (with flashboards), 1650 cfs at 1493.8 NGVD (without flashboards).

(8) Total Project Discharge at Top of Dam - 425 cfs at 1492.5 NGVD (with flashboards), 1250 cfs at 1492.5 (without flashboards).

(9) Total Project Discharge at PMF Test Flood Elevation - 2100 cfs at 1493.8 without flashboards.

c. Elevation (Datum is feet above sea level NGVD)

(1) Streambed at toe of dam - 1454.

(2) Bottom of Cutoff - 1447 (bottom of core wall east of center).

(3) Maximum Tailwater - unknown.

(4) Normal Pool - 1489.8 - with flashboards, 1487.0 - without flashboards.

(5) Full Flood Control Pool - not applicable.

(6) Spillway Crest - 1487.0 without flashboards.

(7) Design Surcharge (Original Design) - design data not available.

(8) Top of dam - 1493.5 by design, 1492.5± at existing low area behind spillway walls.

(9) Test Flood Surcharge - 1493.8 (PMF).

d. Reservoir (length in feet)
(1) Normal Pool - 1400 without flashboards; 1440 with flashboards.

(2) Flood Control Pool - not applicable.

(3) Spillway Crest Pool - 1400.

(4) Top of Dam - 1600.

(5) Test Flood Pool - 1600.

e. Storage (acre-feet)
(1) Normal Pool - top of flashboards - 270 (90 million gallons)

(2) Flood Control Pool - not applicable.

(3) Spillway Crest Pool - 211 (70 million gallons)

(4) Top of Dam - 350.

(5) Test Flood Pool - 355.

f. Reservoir Surface (acres)
(1) Normal Pool - top of flashboards - 20.

(2) Flood Control Pool - not applicable.

(3) Spillway Crest - 18.

(4) Top of Dam - 22.

(5) Test Flood Pool - 22.

g. Dam
(1) Type - earth fill gravity dam with concrete core wall.

(2) Length - 840 feet.

(3) Height - 39.5 feet.

(4) Top Width - 10 feet.

(5) Side Slopes - 2.5H:1V.

(6) Zoning - all fill shown as random glacial till on plan.

(7) Impervious Core - 12" wide reinforced concrete core wall with step footing.

(8) Cutoff - concrete core wall base at 1447± NGVD east of center. Top of core wall at 1488 NGVD.

(9) Grout Curtain - none shown on record plan.

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

i. Spillway

(1) Type - reinforced concrete, overflow weir.

(2) Length of Weir - 30 feet.

(3) Crest Elevation - 1487.0 without flashboards, 1489.7 with flashboards.

(4) Gates - none.

(5) U/S Channel - Upper Root Reservoir.

(6) D/S Channel - Spillway discharge 10 feet wide concrete chute which discharges into a pool downstream of the dam. Lip of spillway channel bucket elevation - 1454.0. After passing under Reservoir Road in two 3-foot diameter culverts, the discharge enters Lower Root Reservoir (with crest elevation 1456).

j. Regulating Outlets

(1) Invert - 1454.0 approximate elevation of low-level outlet.
1472.0 approximate elevation of high-level outlet.

(2) Size - low-level outlet 16" diameter
- high-level outlet 12" diameter.

(3) Description - pipe conduits through dam. Bar screens at inlets. New 5'H 16" diameter riser on low-level intake.

(4) Control Mechanisms - gate valves in concrete block manholes on downstream slope of dam. Valve manholes have standard cast iron frames and covers.

(5) Other - none.

SECTION 2
ENGINEERING DATA

2.1 DESIGN DATA

No design data for original construction other than the record plans were available for Upper Root Reservoir Dam. Plans and specifications for repairs made in 1978 were made available by the owner and are on file with the Lenox Department of Public Works.

2.2 CONSTRUCTION DATA

No construction records other than a set of plans for the original construction were available either through the owner or the designer. The record plans indicate that a drain was added during construction near the east end of the dam, possibly to intercept a spring, but this could not be confirmed.

2.3 OPERATION DATA

According to the Superintendent of the Lenox Department of Public Works, the damsite is visited daily by Water Department personnel. During storm conditions the dam is checked more often.

The embankment is mowed on an annual basis. Flashboards are removed in the fall and reinstalled in the spring. There is no written operation or maintenance program for Upper Root Reservoir Dam.

2.4 EVALUATION OF DATA

a. Availability

No engineering data for the original design or construction of the dam are available. Direct contact with the Lenox Department of Public Works, the designer, and a search of files of the Berkshire County Commissioners and Massachusetts Department of Public Works revealed no data other than the construction record plans. No construction specifications were available. Copies of previous inspection reports and sketches prepared by the Massachusetts Department of Public Works are included in Appendix B-2.

b. Adequacy

The final assessments and recommendations of this investigation are based on the visual inspection and the hydrologic and hydraulic calculations.

c. Validity

No engineering design data for the original construction were available to validate. Based on the visual inspection it appears that all work called for on the 1959 construction plans and 1978 repair plans was completed. The top of the riprap appears to be about one foot lower than the Record Plans indicate.

SECTION 3
VISUAL INSPECTION

3.1 FINDINGS

a. General

Upper Root Reservoir Dam was inspected on November 16 and 17, 1980. The weather on both days was clear and the ground free of snow cover.

At the time of inspection the reservoir was drained and excavation in the reservoir area was in progress.

A floating pump was positioned at the 16-inch low-level outlet to keep the reservoir drained. There was a temporary extension attached to the outlet of the 16-inch conduit to divert the pumped water around the Lower Root Reservoir (see Appendix C, Photographs 4 and 10), in order to prevent silt laden, water from entering into the Town's water distribution system.

A recent excavation had been made near the downstream toe of the dam (see Appendix C, Photograph 4), for the purpose of removing sediment from behind the 1878 dam.

b. Dam

The general layout of the dam with inspection notes is shown in Appendix B. Photographs showing features and conditions are included in Appendix C.

There is about a 75-foot long low area in the crest near the center of the dam. The crest in this area is approximately ½ to 1 foot lower than the top of dam in general. Settlement of the crest has also occurred behind the spillway walls.

The riprap on the upstream face overall is in good condition except that there is an area to the west of the dam center where the riprap surface appears warped, possibly as a result of down-slope creep. The warped area is about 40 feet by 75 feet. The top of riprap is approximately at the same elevation as the top of flashboards and there is a wave bench above the riprap where the water has undercut the embankment crest by up to about 12 inches during times when the water level is at or above the top of flashboards (see Photograph 2, Appendix C).

The vegetation on the top and downstream slope appear to be well established. It is reported that the embankment was not mowed this year because of the on-going reservoir excavation program. There are minor wheel ruts in the dam crest and some 4 to 6-inch deep more recent ruts and wheel tracks on the downstream slope and at the top of the dam. The recent ruts are a result of equipment excavating the area near the toe of the dam. This rutting is considered to be significant because of its potential for causing erosion of the embankment. Also there is potential for the 6-inch toe drains to become broken or plugged as a result of heavy vehicle passage over the toe area. During the preliminary site visit prior to the formal inspection, a total of 2 drain outlets were observed at the toe of the dam. During the inspection, one of the drain outlets was not visible due to construction activities. The owner reports, however, that the second drain outlet has now been uncovered.

There are areas of anomalous vegetation (see Overview Photograph) on the downstream slope which should be monitored for wetness after the reservoir is filled. A couple of small (4 to 6-inch) active animal burrows were noted on the downstream slope.

At the easterly downstream toe of the embankment there is a 1-foot wide by 2-feet deep erosion gully which is largely obscured by matted vegetation. This gully has a length of approximately 120 feet and appears to be an active feature. The cause of this gully is not known. Its presence was not reported in the most recent inspection of the Massachusetts Department of Public Works.

Approximately 7 feet to the north of the headwall for the 12-inch high level outlet at the upstream face of the dam, there is a localized depression 30" diameter and 14 inches deep (see Photographs 7 and 8, Appendix C). This feature appears to be near the intersection of the original ground and the embankment fill slope. The owner reports that this condition is undergoing engineering study at present.

Overall the concrete spillway works are in fair condition. The spillway walls at the crest appear in good horizontal and vertical alignment. There is an expansion joint in these walls exactly at the flashboards. Both expansion joints have recently been caulked and thin concrete patches have been made to repair spalled areas at the ends of the flashboards (see Photographs 13 & 14, Appendix C). According to the public works superintendent, the patches were made in 1978 in an attempt to prevent water from passing through the expansion joint and undermining the foundation and backfill for the spillway. During the inspection, it was possible to probe along the west wall of the spillway to a depth of 4 feet near the expansion joint. The backfill for both the east and the west walls has settled (see Photograph 12, Appendix C). Weep holes in the spillway walls as shown on the record plan were plugged in 1978. The record plans show no cutoffs or projections for the full height of the spillway walls. The core wall for the main embankment is shown as being extended beneath the spillway floor and 4 feet beyond the easterly spillway wall. The core wall extends vertically to elevation 1488 which is 1 foot above the spillway crest and 2 feet below the top of flashboards. Water marks on the spillway walls indicate that the reservoir is maintained at the top of flashboard elevation for lengthy periods.

The approach channel for the spillway is satisfactory with no obstructions noted. The riprap floor for spillway approach is about 1 foot lower than the concrete spillway crest (see Phtoograph 2, Appendix C). The riprap should be graded up to the concrete to form a smoother transition at this point.

The spillway chute channel which conveys the spillway discharge around the east end of the dam shows evidence of recent repairs including caulking of the expansion joints and plugging of old weep holes. There are 3-inch diameter drilled weep holes in both sides of the spillway channel which were part of the 1978 work. The new drain holes are about midway up the sides of the channel walls whereas the plugged original 3-inch drains are located at the bottom of the walls (see Photograph 6, Appendix C).

The floor of the spillway channel shows vertical displacement of approximately 1" at expansion joints within about 60 feet of the spillway crest (see Photograph 13, Appendix C). There is also about a 1½-inch vertical displacement of the channel walls within this area.

The floor of the spillway channel at its transition with the spillway crest has a 12-foot long longitudinal crack near the center. The crack is tight and there is no exposed reinforcing steel.

There is vertical cracking (about 1/8 inch wide) with efflorescence in the walls of the spillway channel, particularly on the east side (see Photograph 6, Appendix C). These cracks are widest near the bases of two large Maple trees growing near the channel as shown in the above referenced photograph. The point where the 12-inch high-level outlet enters the spillway channel is satisfactory with no erosion of the concrete floor. Some dampness was noted at the junction between the west wall and floor of the spillway channel.

Recent excavation work has been done at the end of the spillway channel. Because the spillway was not in operation during the inspection, discharge conditions at the end of the spillway channel could not be observed. There is no riprap at the end of the concrete channel and the plans show no cutoff or header curb at the end of the chute. No undercutting of the channel was noted.

The discharge from the spillway channel enters a small pool and then passes through 2 culverts, 3 feet in diameter, beneath Reservoir Road and then enters Lower Root Reservoir. Backwater from these culverts could submerge the end of the spillway channel during high flows and create a stilling basin effect, particularly when Lower Root Reservoir is full.

c. Appurtenant Structures

The 12-inch high-level outlet, and the 16-inch low-level outlet are both reported to be fully operable. The valve manholes on the downstream slope of the dam are approximately 6 feet deep, 4 feet in diameter. Both manholes have standard 2-foot diameter cast iron covers. The manholes are made of circular, concrete barrel blocks. Courses of blocks are displaced with mortar missing. There is sediment in the bottom of the manholes and the valve bodies are rusted. Backwater from the 1878 dam about 50 feet downstream of the 16-inch outlet could cause submergence of the outlet and bottom of the valve manhole. At the time of inspection there was no water behind the 1878 dam.

The water supply intake and chlorinator for the town distribution system are located at Lower Root Reservoir.

d. Reservoir Area

The entire reservoir area was drained and a program to excavate sediment was on-going at the time of inspection. There are no structures around the reservoir which would be subject to back-flooding. There are no unstable slopes upstream of the dam which would cause any adverse effects.

e. Downstream Channel

Discharges from the damsite pass under Reservoir Road through 2 culverts and then enter Lower Root Reservoir. The culverts are submerged when water in Lower Root Reservoir is at its spillway crest. The area near the inlet of the road culverts has recently been excavated as part of the current work program (see Photograph 4, Appendix C). The two existing culverts under Reservoir Road were installed in 1978 and replaced two older culverts.

3.2 EVALUATION

Based on the visual inspection, Upper Root Reservoir Dam is in fair condition.

The low areas in the crest are serious in that they could cause the dam to overtop and erode during high flows. The areas adjacent to the spillway walls are particularly vulnerable.

The localized depression on the upstream slope of the dam near the inlet for the 12-inch conduit is being investigated by the owner. This condition should be closely monitored and the investigation continued until the cause of the depression is determined. The presence of anomalous vegetation on the downstream slope and the presence of a deep erosion gully at the toe of the dam might indicate unusual seepage and should be investigated further. The record plans indicate that a drain was constructed in this area during construction, possibly to intercept a spring, but this could not be confirmed. Construction records might yield information on reason for this drain.

An inspection report dated 1971 indicated seepage in the same area of the toe as the existing gully. Subsequent inspection reports did not.

The riprap on the upstream face does not provide sufficient protection to the embankment against wave erosion when the reservoir is at or above the top of flashboards. This condition should be corrected.

The concrete core wall at the spillway extends to elevation 1488 which is about 2 feet below the top of flashboards. In addition, the 1959 plans do not show any anti-seep cutoffs behind the spillway walls. When the reservoir is maintained at top of flashboard elevation, the potential exists for seepage and piping behind the spillway walls.

The settlement of the embankment adjacent to the spillway walls (see Photograph 12, Appendix C) and the erosion gully at the easterly downstream toe may be an indication of this condition and should be investigated.

The flashboards are positioned at the expansion joints in the spillway walls. The thin concrete patches placed to seal these joints are beginning to crack. This condition will require continual maintenance and monitoring to prevent water from eroding the spillway foundation and backfill. The possibility for relocating the flashboards upstream of this joint should be evaluated.

A complete listing of Recommendations and Remedial Measures are given in Section 7.

SECTION 4
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 OPERATIONAL PROCEDURES

a. General

Operational procedures for the project are not formally established but are based on the experience of the operating personnel.

b. Description of any Warning System in Effect

There is no written surveillance or warning system in effect. According to the Superintendent of the Lenox Department of Public Works, the dam is visited daily and is observed during storm periods.

4.2 MAINTENANCE PROCEDURES

a. General

There is no formal maintenance manual for the project. Maintenance is carried out as needed.

b. Operating Facilities

Mowing and removal of brush from embankments is done annually. The last repairs to the dam were completed in 1978. Repair plans were prepared by Whitman and Howard Inc., designers of the dam. A current program to increase the reservoir storage by excavation is on-going.

4.3 EVALUATION

A formal written operational and maintenance plan, including an annual comprehensive technical inspection by a qualified Registered Professional Engineer, should be developed to insure that problems that are encountered can be remedied within a reasonable period of time. A formal written surveillance and downstream warning (emergency preparedness program) plan should be established for this structure.

SECTION 5
EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 GENERAL

Upper Root Reservoir is located on the upper reach of Lenox Mountain Brook. The total drainage area contributing to Upper Root Reservoir Dam is about 650 acres. The watershed is moderately steep to rolling terrain with mostly hardwood forest cover. The reservoir lies in an apparent bedrock valley mantled by glacial debris of variable thickness. The glacial till has been documented by twelve borings taken in 1959 in connection with dam construction.

5.2 DESIGN DATA

No hydraulic or hydrologic design data or criteria were available from either the owner or the designer of the dam. An effort should be made by the owner and designer to recover the original design data for future reference.

5.3 EXPERIENCE DATA

The dam reportedly has not overtopped at any time since its construction in 1960. Work on the spillway in 1978 was required to stop water from entering the embankment through joints and weep holes in the spillway walls. There has been no apparent damage to the spillway as a result of any floods at the damsite.

5.4 TEST FLOOD ANALYSIS

Upper Root Reservoir Dam is classified as small size having a hydraulic height of 39.5 feet and a top of dam storage of 350 acre-feet. The dam was determined to have a high hazard classification. Using the Recommended Guidelines for Safety Inspection of Dams, the test flood range is 50% to 100% of the Probable Maximum Flood (PMF).

Because the dam height is at the upper end of the range for height criteria, the PMF was selected as the Test Flood. The PMF was estimated using methods contained in "Preliminary Guidance for Estimating Maximum probable Discharges in Phase I Dam Safety Investigations" issued by the New England Division Corps of Engineers. The curve for mountainous terrain was used in this estimate. The PMF test flood inflow for the 1.02 square mile drainage area was estimated to be 2400 cfs. Storage effects would reduce the test flood inflow to a routed test flood outflow of 2100 cfs.

Since the flashboard supports are of the non-yielding type, the hydraulic analysis considered spillway performance both with and without flashboards.

During test flood conditions without flashboards in-place, water would rise to elevation 1493.8 which is 0.3 feet above the design top of dam and about 1 foot above the low areas in the existing crest. This assumes the reservoir at elevation 1487 at the start of the test flood.

With flashboards, a flood equal to 50% of the test flood inflow would cause water to rise to elevation 1493.5 which is the design top of dam. Under the existing conditions, however, the dam would be overtopped at the low areas near the

center of the dam and behind the spillway walls. The estimated depth of overtopping would be between 1/2 foot and 1 foot.

Both analyses assume that the 12-inch outlet is open. Since the 16-inch outlet would normally be closed and may be inaccessible under test flood conditions, no flow was assumed from this conduit.

The overtopping of the dam could cause serious erosion of the embankment at its highest point which could lead to a breach in the dam.

5.5 DAM FAILURE ANALYSIS

The impact of failure of the dam was assessed using Corps of Engineers "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs." The estimate assumes:

a. the reservoir surface is at the top of the dam at the time of the breach, and

b. a breach of 40% of the dam length at mid-height occurs (180 feet).

The estimated discharge resulting from the breach would be 73,700 cfs. The addition of spillway flow would cause a total breach flow of 75,250 cfs.

Under the assumed breach conditions, Lower Root Reservoir Dam would be overtopped (see Photograph 4, Appendix C). The intake system for the town water distribution would probably be destroyed.

Downstream of Lower Root Reservoir, the brook is contained in a narrow valley which drops 140 feet in 3300 feet. There are no large natural storage areas within this reach which would provide for any significant attenuation of the flood wave.

Approximately 0.9 miles downstream of the damsite, Lenox Mountain Brook crosses beneath Lenox Road in a 4-foot diameter culvert with approximately 1.5 feet of earth cover at its upstream end. The flood wave would cause water to pass over the road at an estimated depth of 13 feet. There are 2 to 4 homes in this area which have floor elevations about 5 feet to 8 feet above the low point in the road. These homes would be damaged or destroyed by impact and flooding. Prior to the breach, water would be passing over the low point in the road at an estimated depth of 3 feet.

Because of the potential for loss of more than a few lives in the downstream area, Upper Root Reservoir Dam was classified High Hazard.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 VISUAL OBSERVATIONS

The most significant visual observations about this dam are the low areas at the crest, particularly adjacent to the spillway walls. Also, the local depression at the upstream slope of the dam near the 12-inch conduit warrants further investigation, as do the areas of anomalous vegetation and the deep gully at the easterly downstream toe. The cause of this gully is not known. Its presence was not reported in the most recent inspection of the Massachusetts Department of Public Works.

The cracked floor of the spillway channel could be caused by undermining of its base and should be monitored on a continuing basis.

Animal burrows are a threat to any earth embankment dam. Control of the rodent population near the damsite should be part of the normal maintenance program.

6.2 DESIGN AND CONSTRUCTION DATA

No design or construction records for the original construction were available, other than a set of record plans on file with the Lenox Department of Public Works. Copies of record plans are included in Appendix B.

6.3 POST-CONSTRUCTION CHANGES

There have been no post-construction changes to this structure according to the public works superintendent. The last repairs to the dam were made in 1978 and consisted of work on the concrete spillway to halt suspected erosion of the spillway channel floor and spillway wall backfill. Old weep holes at the base of the spillway channel walls were filled and new 3-inch drain holes in the walls of the spillway channel were drilled in 1978. This work was performed by Peter Francese and Son Inc. based on specifications prepared by Whitman and Howard, Inc., designers of the dam.

A 5-foot high riser pipe has recently been added to the upstream end of the 16-inch outlet to allow water to be drawn off above the reservoir bottom.

There is a program, which is near completion, to enlarge the reservoir storage capacity. The new storage volumes were taken into account during preparation of this inspection report. The current work is being performed by Petricca Construction Company of Pittsfield, MA under the supervision of J. F. Moynihan & Associates of Lee, MA.

6.4 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 AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Condition

The Phase I visual inspection of Upper Root Reservoir Dam indicates that the dam is in fair condition. However, a number of deficiencies were observed, which if not remedied, could develop into hazardous conditions.

b. Adequacy of Information

The lack of in-depth engineering data did not allow for a definitive review. Therefore, the condition of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Urgency

The recommendations and remedial measures described in Paragraphs 7.2 and 7.3 should be implemented by the owner within 12 months after receipt of this Phase I Inspection Report except as noted.

7.2 RECOMMENDATIONS

The owner should retain a qualified Registered Professional Engineer to:

(1) Investigate and design any necessary repairs for conditions causing the depression at the upstream slope of the dam near the 12-inch outlet. This should be done immediately upon receipt of this report. The reservoir should not be allowed to refill without the recommendation of the engineer based on his evaluation of this condition. The engineer should inspect the dam during and after filling of the reservoir.

(2) Investigate the cause and design repairs for the gully at the easterly downstream toe of the dam and set up a program to monitor this area and other areas along the toe for possible unusual seepage.

(3) Design repairs to rutted areas on the downstream slope and at the toe of the dam.

(4) Design repairs to restore the crest elevation of the dam to a uniform grade of at least the design elevation. Permanent reference points should be established to allow future checks on possible movements in the crest, particularly near the spillway walls and also the riprap surface on the upstream slope, westerly end.

(5) Investigate the spillway channel for possible undermining and/or seepage, particularly where the floor is cracked downstream of the spillway crest. This investigation should include the walls of the spillway and spillway channel where settlement has been noted.

(6) Investigate replacement of existing flashboard supports with yielding type supports. This investigation should also consider relocating the flashboards upstream of the expansion joints of the spillway walls.

(7) Design methods to extend the slope protection to a higher elevation on the upstream face in order to halt undercutting of the embankment.

(8) Investigate the condition and adequacy of the existing toe drainage system, particularly in light of recent construction activity in this area. The drain outlets should be located and their locations permanently referenced, and protected with small animal guards. Repairs should be designed to the drains as necessary. A means should be designed to allow discharges from the drains to be gaged. The engineer should establish a method and schedule for recording these discharges and the reservoir elevation at the time of observation.

(9) Design procedures and supervise removal of trees within 25 feet of the spillway discharge channel.

The owner should carry out all the recommendations made by the engineer. All work should be done under supervision of the engineer.

7.3 REMEDIAL MEASURES

a. Operation and Maintenance Procedures

The owner should implement the following remedial measures:

(1) Clean out valve manholes on downstream slope, and clean and lubricate valve bodies to insure operability.

(2) Establish a formal written program for operation and maintenance.

(3) Provide round-the-clock surveillance during the periods of unusually heavy precipitation.

(4) Develop a formal written program for warning downstream residents in case of emergency (emergency preparedness program).

(5) Engage a qualified Registered Professional Engineer to make comprehensive technical inspection once a year.

(6) Control the population of burrowing animals and fill in all existing animal burrows.

(7) Recover construction data and original data and criteria used in the design of the dam; in particular, information about the drain added at the east end of the dam.

(8) Seal all cracks in the spillway walls and floor, and walls of the spillway channel.

(9) Record discharges from toe drain outlet in accordance with the schedule and methods specified by the engineer.

7.4 ALTERNATIVES

There are no practical alternatives to the above recommendations.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INSPECTION PROGRAM

DAM: Upper Root Reservoir MA 00019

DATE: November 16 & 17, 1980

TIME: 10:30 a.m. (11/16/80)

WEATHER: Clear, sunny 40°F

W.S. ELEV. at low level outlet U.S. _____ DN.S.

ELEV. DATUM: Water surface elevation (NGVD) on Record Plans.

Note: Reservoir being dredged at time of inspection

INSPECTION PARTY:

1. J.F. Cysz, P.E. (11/16; 11/17)
2. J.E. Walsh, P.E. (Baystate Environmental Consultants, Inc.) (11/16)
3. K.N. Hendrickson, P.E. (11/17)
4. L.D. Zwingelstein (11/17)
5. _____
6. _____

OTHERS PRESENT DURING INSPECTION:

1. Contractors - Petricca Construction - Excavating in drawn down Reservoir area. (11/17)
2. _____
3. _____
4. _____

VISUAL INSPECTION CHECKLIST

DAM: Upper Root Reservoir MA 00019 DATE: November 16 & 17, 1980

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	Embankment crest elevation is between 1493.5 and 1492.5±.
Current Pool Elevation	Reservoir is drained at present. Normal pool is 1490 which is top of flashboards. Spillway crest is 1487.
Maximum Impoundment to Date	Unknown - water mark 5" over flash boards.
Surface Cracks	None observed, several animal burrows on d/s slope.
Pavement Condition	Not paved
Movement or Settlement of Crest	Sag about 1' near dam center, settlement 1' behind spillway walls.
Lateral Movement	None visible
Vertical Alignment	Sag about 1' near dam ctr. 1' low areas behind spillway walls.
Horizontal Alignment	OK
Condition at Abutment and at Concrete Structures	Settlement and voids behind spillway abutments and downstream walls (for spillway chute)
Indications of Movement of Structural Items on Slopes	No structural items on slope, concrete headwalls for outlet pipes are OK.
Trespassing on Slopes	Vehicle tracks on crest and at right downstream toe and construction activity at d/s toe near center
Vegetation on Slopes	Thick grass, matted areas of anomalous vegetation, appears mowed.
Sloughing or Erosion of Slopes or Abutments	No sloughing visible on d/s. Erosion gully (see Appendix C) at left d/s toe. Erosion wave bench at normal pool on u/s face.
Rock Slope Protection - Riprap Failures	Warping and thin areas of riprap on u/s slope. Riprap is dumped, graded-max. 18" size.

VISUAL INSPECTION CHECKLIST

DAM: Upper Root Reservoir MA 00019 DATE: November 16 & 17, 1980

AREA EVALUATED	CONDITION
DAM EMBANKMENT (cont'd.)	
Unusual Movement or Cracking at or near Toes	No cracking observed. 2' deep x 1' wide gully at left d/s toe.
Unusual Embankment or Downstream Seepage	Reservoir drawn down for several months prior to inspection; areas of anomolous vegetation noted.
Piping or Boils	14-inch deep, 2½' diam. sink hole 7' northeast of 12" high level outlet, on upstream slope.
Foundation Drainage Features	Foundation drain outlet noted at toe to the east of dam center. Flow about 1/4 gpm, no animal guard, drain requires maintenance. Rust color sediment at drain outlet. No drain outlet visible to west of center (area of recent excavation). (Second drain outlet shown on record plan.)
Toe Drains	2" stone fill observed in excavation. Rock toe drain may have been disturbed by recent excavation activity.
Instrumentation System	None

VISUAL INSPECTION CHECKLIST

DAM: Upper Root Reservoir MA 00019 DATE: November 16 & 17, 1980

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	2 pipe outlets. 16" CI low level (about 28' below crest of flashboards). 12" CI high level outlet about 13' below crest of flashboards.
a. Approach Channel	OK. No formal approach channel
Slope Conditions	Not applicable
Bottom Conditions	Not applicable
Rock Slides or Falls	Not applicable
Log Boom	None
Debris	Not applicable
Condition of Concrete Lining	Not applicable
b. Intake Structure	Concrete headwalls with steel grates
Condition of Concrete	Good
Stop Logs and Slots	No stop logs or slots

VISUAL INSPECTION CHECKLIST

DAM: Upper Root Reservoir MA 00019 DATE: November 16 & 17, 1980

AREA EVALUATED	CONDITION	
OUTLET WORKS - CONTROL TOWER	No control tower; outlets controlled by horizontal mount gate valves in concrete block manholes at toe of downstream slope - manholes about 6' deep, 4' diameter. Both a. and b. on this sheet apply to the manholes (valve pits).	
	16"	12"
a. Concrete and Structural		
General Condition	Poor	Fair
Condition of Joints	Poor - courses of block displaced; mortar missing; cover manhole frame not anchored.	Fair - Joints not pointed.
Spalling	Not applicable	Not applicable
Visible Reinforcing	Not applicable	Not applicable
Rusting or Staining of Concrete	Not applicable	Not applicable
Any Seepage or Efflorescence	Reservoir drawn down. Sediment in bottom of valve pit.	Reservoir drawn down. Sediment in bottom of valve pit.
Joint Alignment	Poor- courses of concrete block out of alignment.	Fair
Unusual Seepage or Leaks in Gate Chamber	Reservoir drawn down. Sediment in bottom of valve pit.	Reservoir drawn down. Sediment in bottom of valve pit.
	Could be backwater in manhole bottoms from 1878 dam. No water behind 1878 dam at time of inspection.	

VISUAL INSPECTION CHECKLIST

DAM: Upper Root Reservoir MA 00019 DATE: November 16 & 17, 1980

AREA EVALUATED	CONDITION	
OUTLET WORKS - CONTROL TOWER (cont'd.)	16"	12"
Cracks	Courses of block displaced; mortar missing; cover manhole frame not anchored.	Joints not pointed.
	Courses of concrete block out of alignment.	
Rusting or Corrosion of Steel	Gate valve and outlet pipe rusted.	Gate valve and outlet pipe rusted.
b. Mechanical and Electrical		
Air Vents	None	None
Float Wells	None	None
Crane Hoist	None	None
Elevator	No steps in manholes	No steps in manholes.
Hydraulic System	Not applicable	Not applicable
Service Gates	Rusted - no handwheel. Valve nut only.	Rusted, has handwheel.
Emergency Gates	None	None
Lightning Protection System	None	None
Emergency Power System	None	None
Wiring and Lighting System in Gate Chamber	None	None

VISUAL INSPECTION CHECKLIST

DAM: Upper Root Reservoir MA 00019 DATE: November 16 & 17, 1980

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	16" C.I. outlet conduit discharges at pool, pool formed by old dam d/s of dam. 12" C.I. outlet conduit discharges into spillway chute; interiors of conduits not visible. Recent excavation at discharge end of 16" outlet; erosion of toe at 16" discharge is not known (see photo). There is a temporary extension of the 16" outlet to divert outflow away from lower reservoir during excavation in upper reservoir (see photo).
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

VISUAL INSPECTION CHECKLIST

DAM: Upper Root Reservoir MA 00019 DATE: November 16 & 17, 1980

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	See previous sheet - no endwalls for 16" outlet. 12" C.I. outlet discharges to spillway chute. 16" C.I. outlet discharges to pool behind remains of old dam - (1878): then to 3' diameter CMP culverts at terminus of spillway chute.
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	
Channel	
Loose Rock or Trees Overhanging Channel	None
Condition of Discharge Channel	Area of ongoing excavation/construction at discharge area for 16" upstream of old dam. Note: There is a valve box with cover about 10' east of manhole for 16" gate valve. This valve is on a 12" C.I. outlet just to the east of the 16" outlet. According to plan, this is a bypass for the 16" valve.

VISUAL INSPECTION CHECKLIST

DAM: Upper Root Reservoir MA 00019 DATE: November 16 & 17, 1980

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	Note: Spillway has 2½" wood plank flashboards, 2'-9" high - 4"x4½" - H - beam members @ 7.5' O.C. support flashboards - supports not hinged or knotched (non yielding).
a. Approach Channel	Sloped riprap and concrete
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Riprap is below concrete floor in approach channel.
b. Weir and Training Walls	Weir is 2'-9" - height of wood flashboards - there is no concrete weir control section. Flashboards are at expansion joint.
General Condition of Concrete	Fair - cracked, some joint displacement at floor and walls of discharge chute, thin patches cracked and loose at flashboards where flashboards meet spillway abutments. Vertical alignment of walls satisfactory. Settlement and voids behind spillway abutments and chute walls. 2 large trees near chute walls. Honeycomb concrete at joint between chute walls and chute floor (dampness noted).
Rust or Staining	Yes, at cracks
Spalling	Yes, near expansion joints of spillway abutments.
Any Visible Reinforcing	None
Any Seepage or Efflorescence	Yes - efflorescence at cracks, dampness at joint between chute walls and chute floor.
Drain Holes	Yes. 3" diameter drilled holes, no pipes visible, backfill type not known.

VISUAL INSPECTION CHECKLIST

DAM: Upper Root Reservoir MA 00019 DATE: November 16 & 17, 1980

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS (continued)	
c. Discharge Channel	Spillway chute discharges into pool upstream of 2 - 3' diameter C.I.P. road culverts. Road culverts drain into Lower Root Reservoir.
General Condition	Active construction/excavation in discharge channel.
Loose Rock Overhanging Channel	
Trees Overhanging Channel	No
Floor of Channel	Not visible.
Other Obstructions	None

VISUAL INSPECTION CHECKLIST

DAM: Upper Root Reservoir MA 00019 DATE: November 16 & 17, 1980

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	There is no service bridge over spillway.
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

APPENDIX B

ENGINEERING DATA

LIST OF AVAILABLE DESIGN,

CONSTRUCTION AND MAINTENANCE RECORDS

A. PLANS AND SPECIFICATIONS

A set of plans with as-built data is on file with the owners, Lenox Water Department, 31 Main Street, Lenox, MA. Reduced copies of significant portions of the plans are included in Appendix B. No specifications were available from either the owner or the design engineer.

B. DESIGN RECORDS

No design records were available from either the owner or the design engineer.

C. CONSTRUCTION RECORDS

No construction records were available.

D. MAINTENANCE

Recent maintenance records are available from the owner.

PREVIOUS INSPECTION REPORTS

A. Inspections of dams were performed by the Massachusetts Department of Public Works, District 1, and reports are on file at District 1 Headquarters, Pittsfield-Lenox Road, Lenox, MA - Latest Report, related correspondence, and 1973 Description of Dam are attached.

B. Earlier inspections of dams were performed by the Berkshire County Engineer for the County Commissioners, and reports are filed at the County Engineer's office, County Court House, Pittsfield, MA - Latest Report is attached.

L-1?8

INSPECTION REPORT - DAMS AND RESERVOIRS

1. Location: ~~City~~/Town LENOX. Dam No. 1-2-152-4.

Name of Dam Upper Root Reservoir. Inspected by: RDJordan - RJSpaniol

Date of Inspection 9-29-76.

2. Prev. Inspection X.

Owner/s: per: Assessors_____.

Reg. of Deeds_____. Pers. Contact_____.

1. Lenox Water Co. Lenox, MA 637-0421
Name St. & No. City/Town State Tel. No.

2. _____
Name St. & No. City/Town State Tel. No.

3. _____
Name St. & No. City/Town State Tel. No.

3. Caretaker [if any] e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

_____
Name St. & No. City/Town State Tel. No.

4. No. of Pictures taken 1.

5. Degree of Hazard: [if dam should fail completely]*

1. Minor X. 2. Moderate_____.

3. Severe_____. 4. Disastrous_____.

*This rating may change as land use changes [future development]

6. Outlet Control: Automatic_____. Manual X.

Operative X yes._____no.

Comments:_____

_____

Upstream Face of Dam: Condition:

1. Good X. 2. Minor Repairs_____.

3. Major Repairs_____. 4. Urgent Repairs_____

Comments:_____

_____

_____

8.

Downstream Face of Dam: Condition: 1. Good X. 2. Minor Repairs___.

3. Major Repairs___ 4. Urgent Repairs___.

Comments:_____

_____.

9.

Emergency Spillway: Condition: 1. Good X. 2. Minor Repairs_____.

3. Major Repairs_____.4. Urgent Repairs_____.

Comments:_____

_____

_____

10.

Water level @ time of inspection: 0.2'. ft. above_____. below x.

top of dam_____.

principal spillway x_____.

other_____.

11.

Summary of Deficiencies Noted:

Growth [Trees and Brush] on Embankment NONE.

Animal Burrows and Washouts " .

Damage to slopes or top of dam " .

Cracked or Damaged Masonry " .

Evidence of Seepage " .

Evidence of Piping .

Erosion " .

Leaks " .

Trash and/or debris impeding flow " .

Clogged or blocked spillway " .

Other " .

DAM NO. 1-2-152-4

12. Remarks & Recommendations: [Fully explain] PREVIOUS INSPECTION DATE: January 31, 1974

This dam is in good condition and appears to be safe.

For location see Topo Sheet 2-D.

---

13. Overall Condition:

1. Safe X.
2. Minor repairs needed_____.
3. Conditionally safe - major repairs needed_____.
4. Unsafe_____.
5. Reservoir impoundment no longer exists [explain]

   Recommend removal from inspection list_____.

February 17, 1972

Superintendent-Water Department
Town Hall
Lenox, Massachusetts

Re: Inspection of Dam
Lenox
Upper Root Reservoir #2 Dam

Dear Sir:

The Massachusetts Department of Public Works inspected Upper Root Reeervoir #2 Dam in the Town of Lenox of which the Town of Lenox is the owner.

The inspection was made in accordance with Chapter 253 of the Massachusetts General Laws, as amended by Chapter 595 of the Acts of 1970.

The results of the inspection indicated that no immediate maintenance or repairs were required; however, the following item was noted that will require your attention in the future:

1. Investigate and correct seepage at toe of dam from flume to approximately 150' west.

We are calling this item to your attention now before it becomes more serious and expensive to correct.

Very truly yours,

FRED. C. SCHWEIM P.E.
Deputy Chief Engineer

LRA:mrm
c.c. Dean P. Amidán

L-169

DESCRIPTION OF DAM

DISTRICT ONE .

Submitted by RDJordan Dam No. 1-2-152-4

Date 11/9/72 . City/Town Lenox

Name of Dam Upper Root Reservoir

1.

Location: Topo Sheet No. 2-D .

Provide 8-1/2" x 11" in clear copy of topo map with location of Dam clearly indicated.

.

2.

Year built: 1959-60 . Year/s of subsequent repairs

3.

Purpose of Dam: Water Supply X . Recreational .

Irrigation . Other .

4.

Drainage Area: 1 sq. mi. acres.

5.

Normal Ponding Area: 15 Acres; Avg. Depth .

Impoundment: gals; acre ft.

6.

No. and type of dwellings located adjacent to pond or reservoir

i.e. summer homes etc. none

7.

Dimensions of Dam: Length 850' . Max. Height 36' .

Slopes: Upstream Face earth riprapped 3:1 .

Downstream Face earth 3:1 .

Width across top 10' .

8.

Classification of Dam by Material:

Earth x . Conc. Masonry . Stone Masonry .

Timber . Rockfill . Other .

9.

A. Description of present land usage downstream of dam:

100 %rural; % urban.

B. Is there a storage area or flood plain downstream of dam which could accommodate the impoundment in the event of a complete dam failure

Yes . No X .

L-169 A

DAM NO. 1-2-152-4

10.

Risk to life and property in event of complete failure.

No. of people 10±.

No. of homes 4.

No. of Businesses none.

No. of Industries " . Type .

No. of Utilities " . Type .

Railroads " .

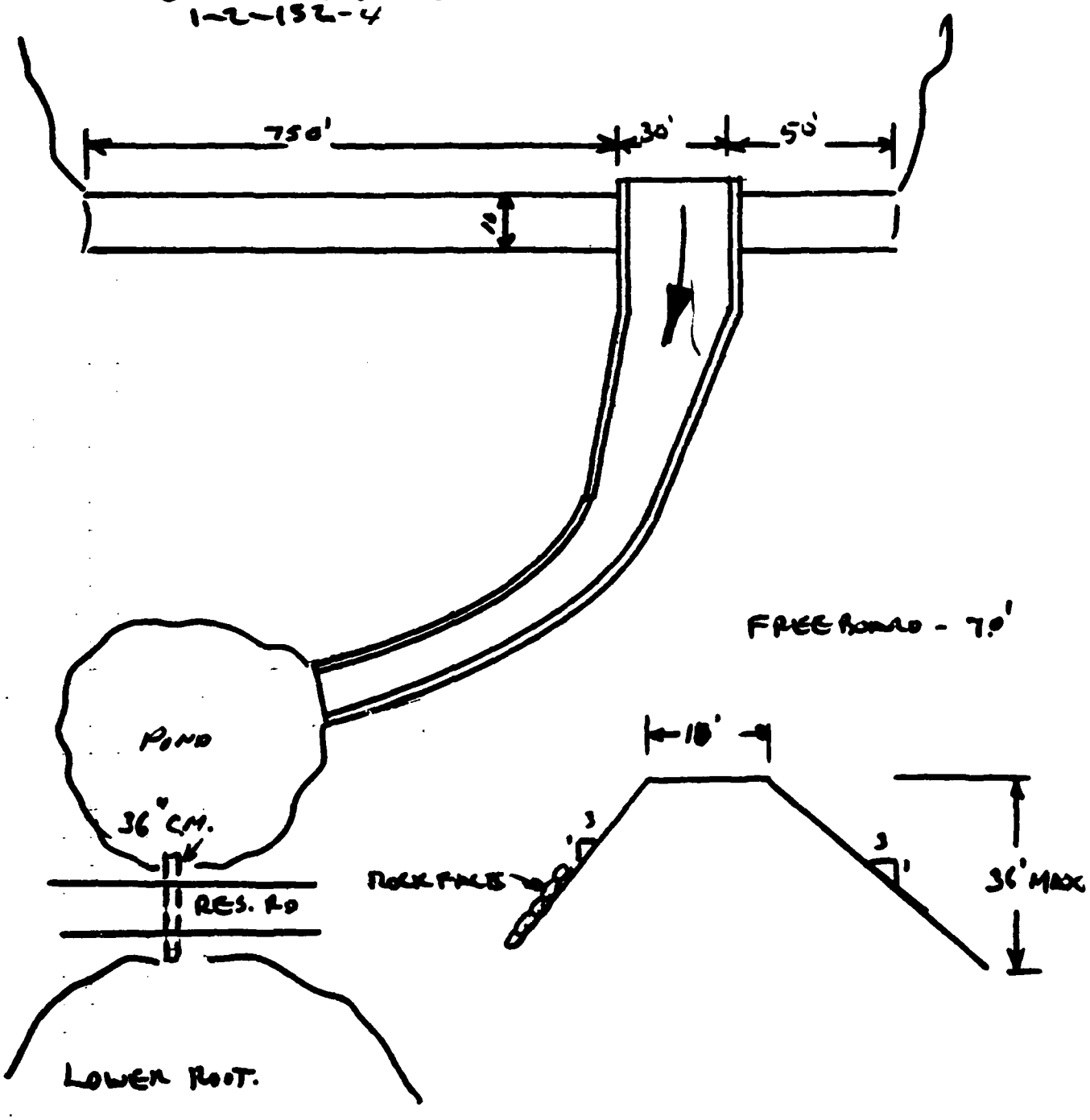
Other dams Lower Root .

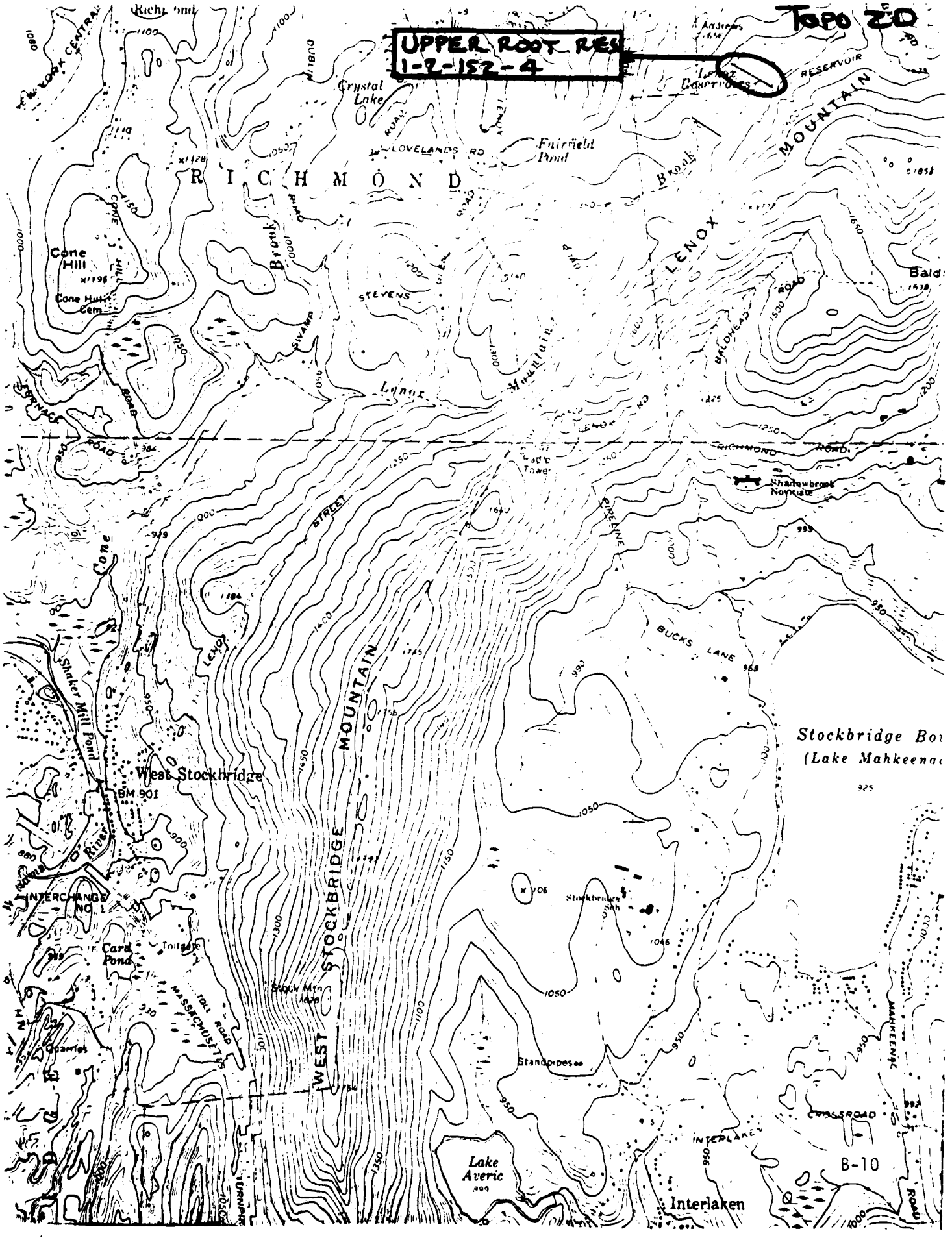
Other .

11.

Attach Sketch of dam to this form showing section and plan on 8-1/2" x 11" sheet.

UPPER ROOT RES
1-2-152-4




Topo 20
UPPER ROOT RES
1-2-152-4
RICHMOND
LENOX MOUNTAIN
STOCKBRIDGE MOUNTAIN
WEST STOCKBRIDGE MOUNTAIN
Crystal Lake
Fairfield Pond
Cone Hill
Cone Hill Cem
Stevens Swamp
Lenox
Baldhead
Shadowbrook Novitiate
Shaker Mill Pond
West Stockbridge
BM 901
Housatonic River
INTERCHANGE NO. 1
Card Pond
Toll Gate
MASSACHUSETTS TOLL ROAD
Stockbridge Bowl
(Lake Mahkeenac
Stockbridge Sch
Standpipe
Lake Averic
Interlaken
CROSSROAD
INTERLAKEN
MAHKEENAC
BUCKS LANE
RICHMOND ROAD
PIPELINE
STREET
B-10

(County of Berkshire Engineering Department) Dam 12-

INSPECTION OF DAMS

City or Town of Lenox Date [illegible]

Name of Dam Upper Pool Reservoir #2 Inspector [illegible]

Owner Town of Lenox Address Town Hall, Lenox [illegible]

Caretaker Superintendent Water Dept. Address Town Hall, Lenox

Location North Side Reservoir Road. 1-2 miles west of Reservoir Road and Dunbar Road intersection.

Type of Dimensions Earth cons. core 240' long, 34' high, 10' dam at top.

Spillway, type and size Cons. 200' long, 2' deep, 10' ± wide East side of dam

Outlets, type and size 12" and 10" pipe and gate.

Flashboards, type and height 36" wood

Date Built 1959-60 Condition Good

When last repaired - - - By whose orders - - -

Nature of Repairs - - -

Purpose of Dam Town water supply

Approximate storage of water 15 acres 50MG Flashboards 45 MG

Approximate area of water shed 1 sq. mile

Possible damage due to failure of dam Farm Road and bridge below and to Lower Pool Reservoir.

Remarks Water 2" over flashboards. Seepage at toe of dam from flume to 150' west.

Recommendations Investigate seepage.

A. SKETCHES COMPILED DURING PHASE I INSPECTION SHOWING GENERAL LAYOUT OF DAM, TYPICAL SECTIONS AND DETAILS OF SIGNIFICANT FEATURES:

Figure 1. General Plan of Damsite

B. RECORD PLANS:

Cover Sheet

Plan - Sheet 1

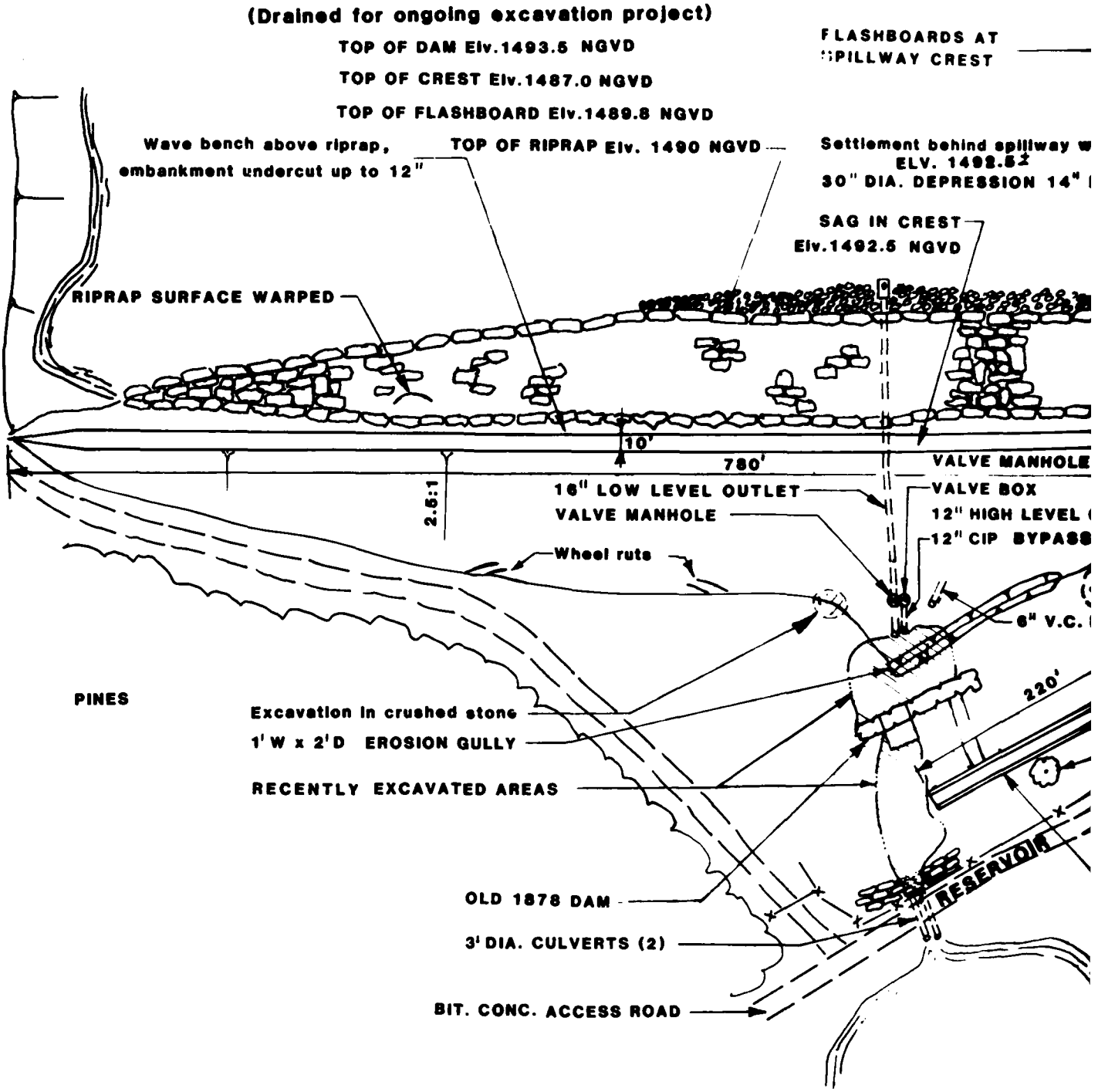
Sections - Sheet 3

Spillway - Sheet 4

Details - Sheet 5

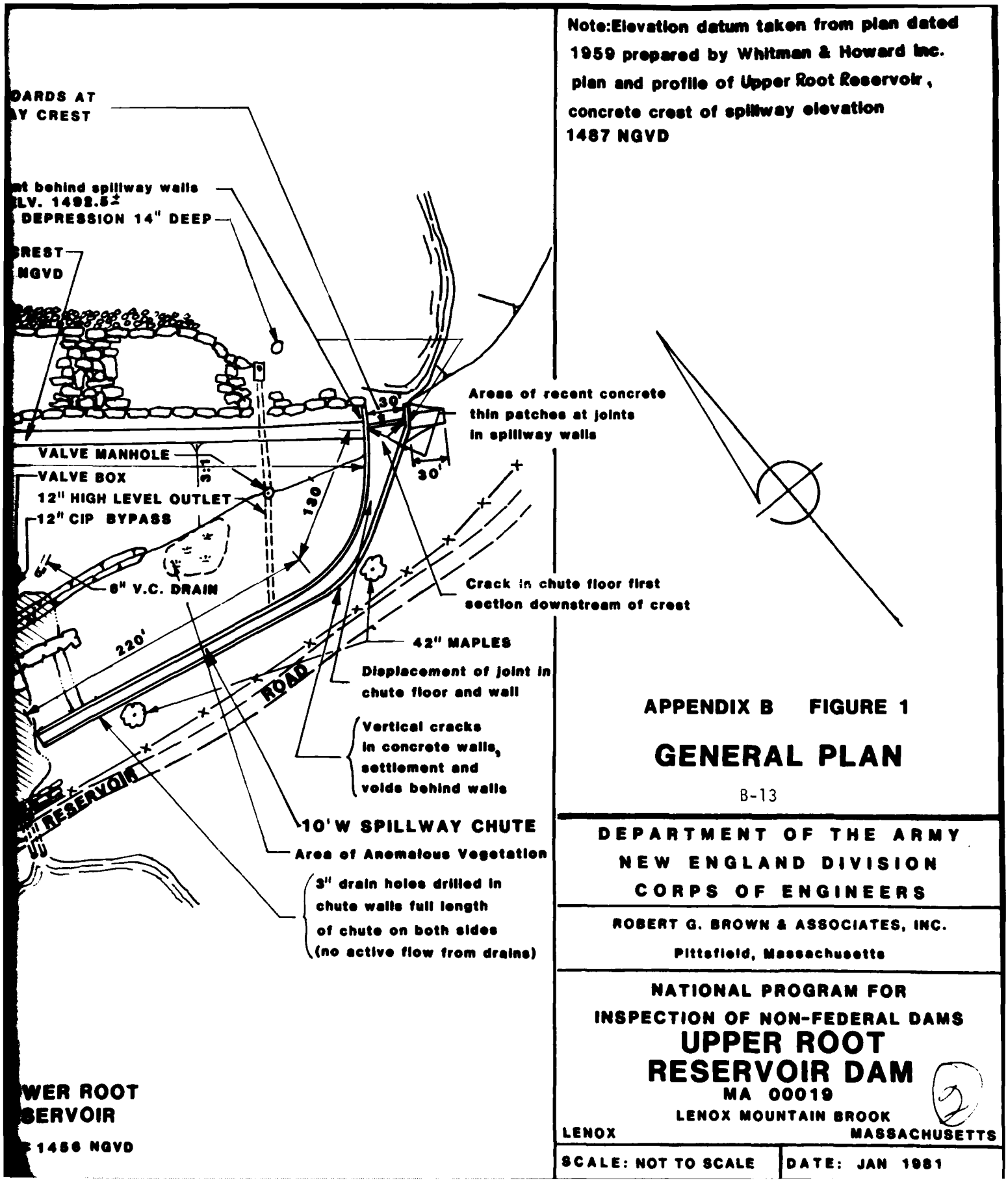
UPPER ROOT RESERVOIR

(Drained for ongoing excavation project)



LOWER ROOT RESERVOIR

EL.= 1456 NGVD



Note:Elevation datum taken from plan dated 1959 prepared by Whitman & Howard Inc. plan and profile of Upper Root Reservoir, concrete crest of spillway elevation 1487 NGVD

APPENDIX B FIGURE 1

GENERAL PLAN

B-13

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

ROBERT G. BROWN & ASSOCIATES, INC.
Pittsfield, Massachusetts

NATIONAL PROGRAM FOR
INSPECTION OF NON-FEDERAL DAMS

UPPER ROOT RESERVOIR DAM

MA 00019

LENOX MOUNTAIN BROOK

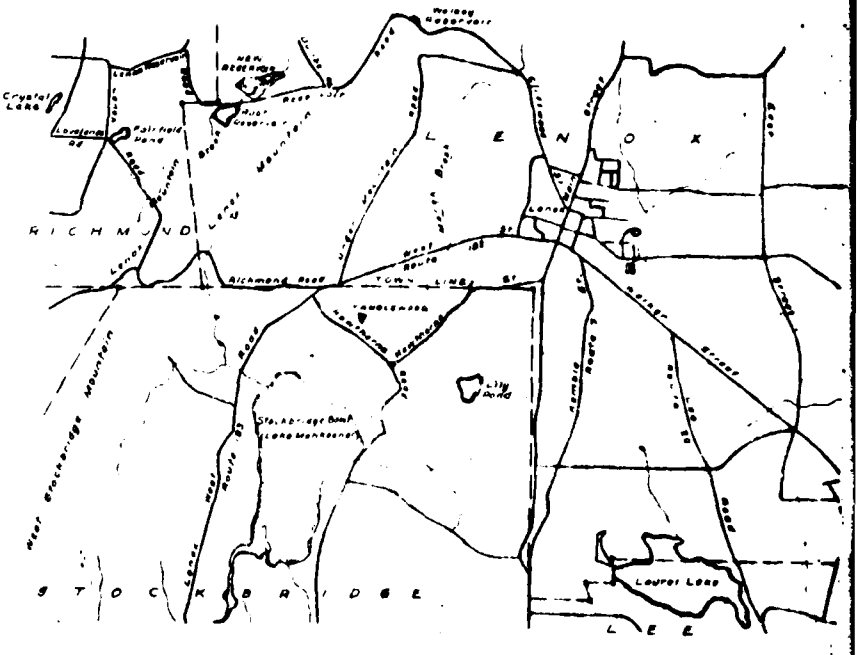
LENOX MASSACHUSETTS

SCALE: NOT TO SCALE | DATE: JAN 1981

WATER SUPPLY RESERVO

LENOX, MAS

Whitman & Howard, Inc., Engineers
89 Broad St. Boston, Mass.
April, 1959



LOCUS PLAN
Scale: 1 inch = ½ mile

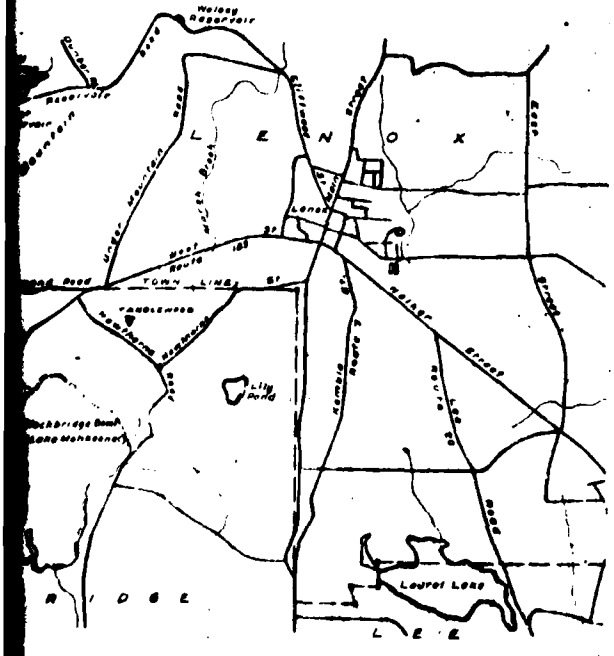
(1)

SUPPLY RESERVOIR

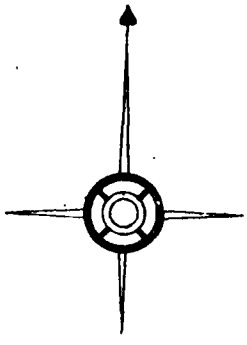
OX, MASS.

#7

man & Howard, Inc., Engineers
Broad St. Boston, Mass.
April, 1959

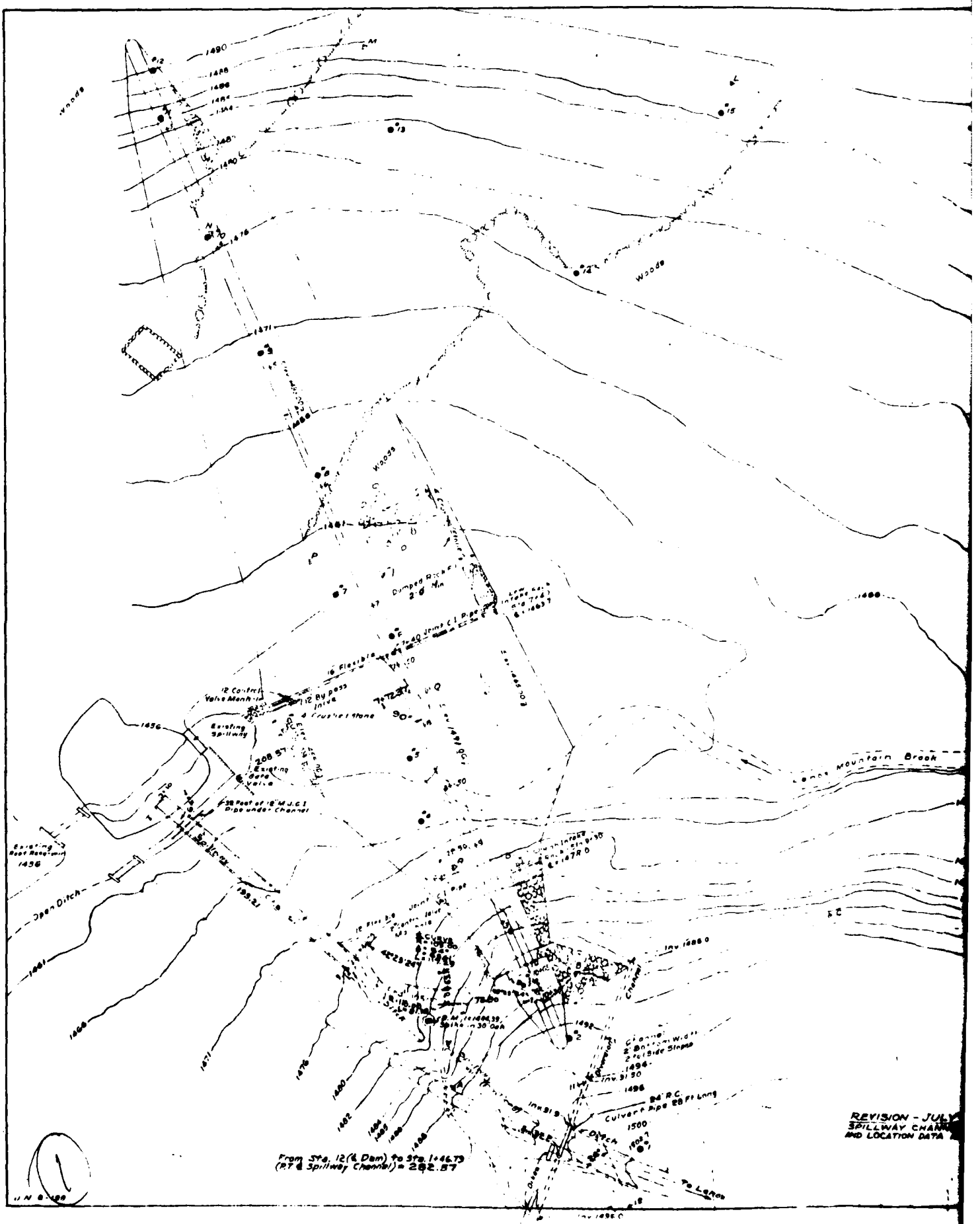


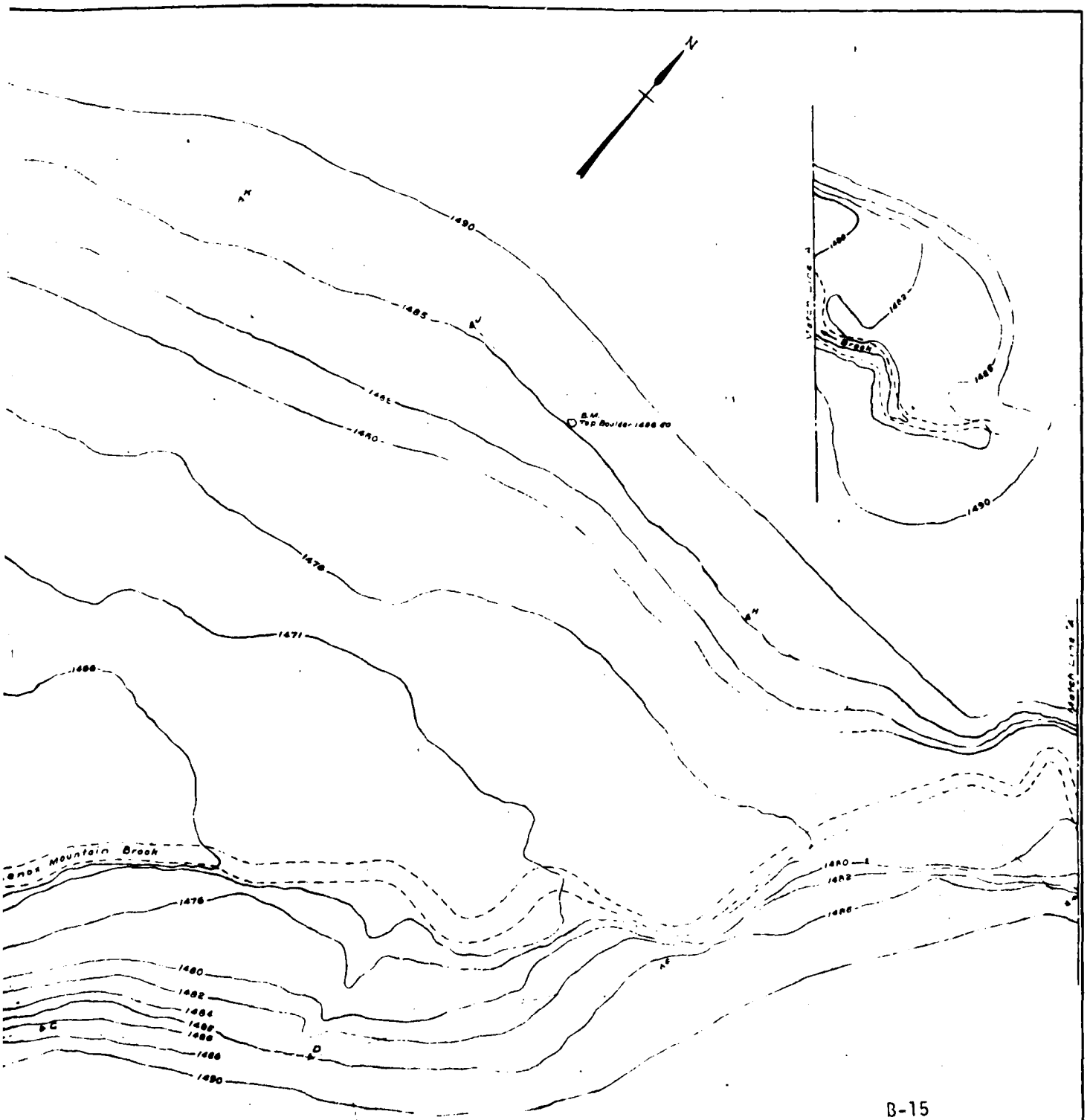
LOCUS PLAN
Scale: 1 inch = ½ mile



(2)

63


Woods
Dumped Rock Fill
Existing Spillway
Existing Gate Valve
Open Ditch
Lenox Mountain Brook
Channel
2' Bottom Width
2 to 1 Side Slopes
Culvert Pipe 28 Ft Long
To Lenox
From Sta. 12(6 Dam) to Sta. 1+46.73
(R.T. Spillway Channel) = 282.57
REVISION - JULY
SPILLWAY CHANNEL
AND LOCATION DATA



B-15

LEGEND

Test hole ●

Datum USGS.
Spillway Root Reservoir Elev 1466

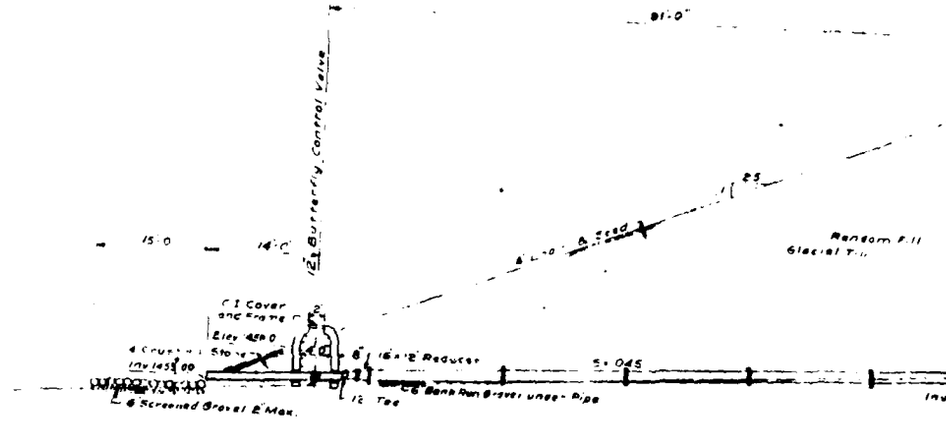
REVISION - JULY 15, 1959.
SPILLWAY CHANNEL REVISED
AND LOCATION DATA ADDED.

WATER SUPPLY RESERVOIR
LENOX, MASS.

Scale 1" = 40' April, 1959

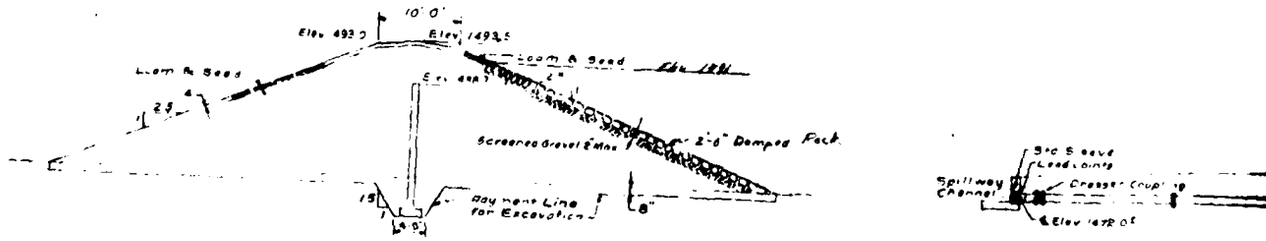
Whitman & Howard, Inc. Engineers
89 Broad St. Boston, Mass.

Sheet 1 of 5



SECTION THR

Scale: 1"

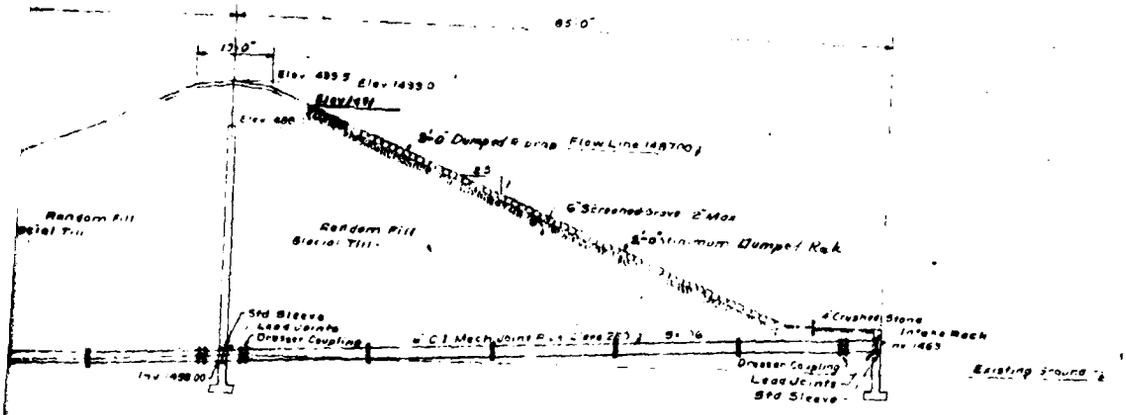


SECTION

Scale: 1"=10'

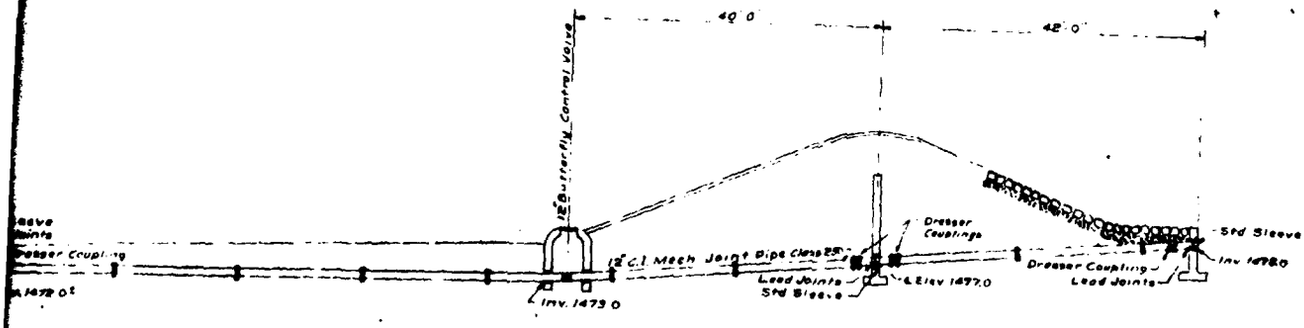
(1)

JNA 198



SECTION THRU LOWER INTAKE

Scale: Hor. 1"=10'
Vert. 1"=10'



SECTION THRU UPPER INTAKE

Scale: Hor. 1"=10'
Vert. 1"=10'

B-16

WATER SUPPLY RESERVOIR
DETAILS OF DAM
LENOX, MASS.

Scale: As Noted

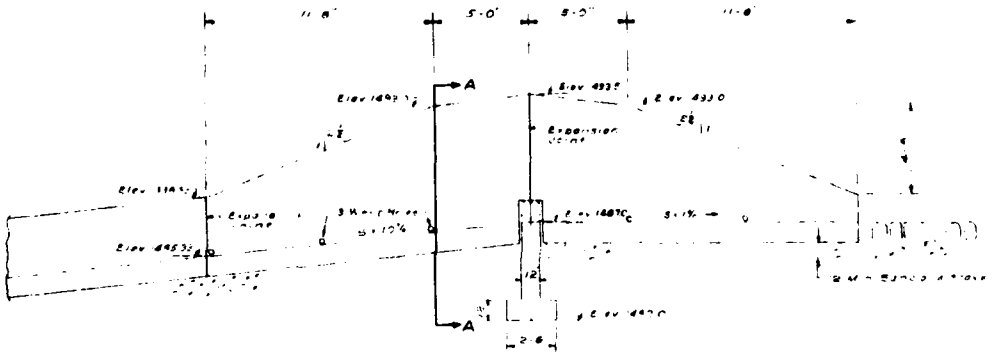
April 1959

Whitman & Howard, Inc., Engineers
45 Bread St., Boston, Mass.

Sheet 9 of 9

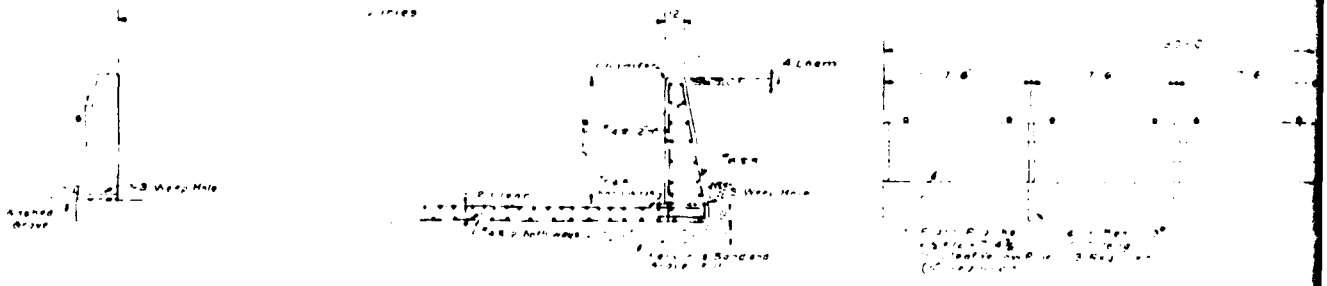
PROFILE OF SPILLWAY CHANNEL

Scale: Horiz. 1" = 40'
Vert. 1" = 10'



SECTION THRU SPILLWAY

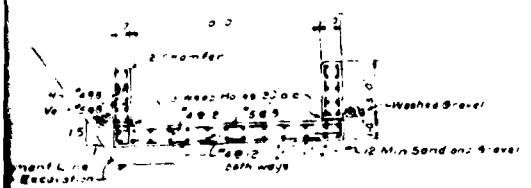
Sta 10+05



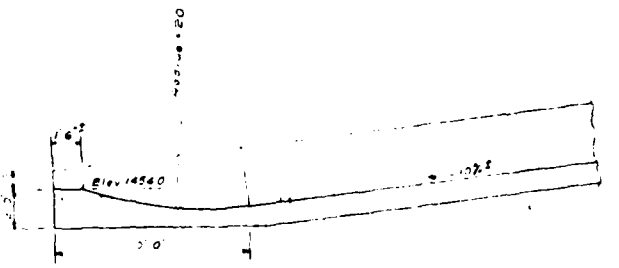
SECTION A-A

Scale ⅛" = 1'-0"

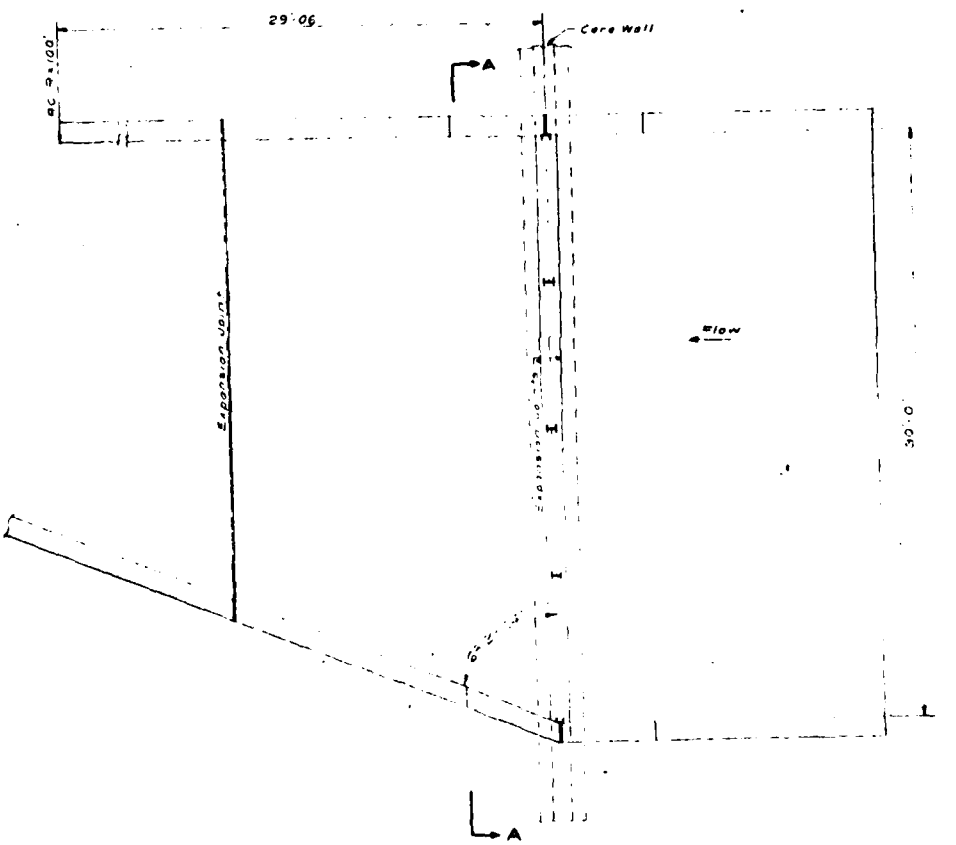
PLAN OF FLASH PL



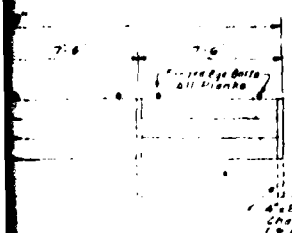
SPILLWAY CHANNEL
Scale ⅛"=1'-0"



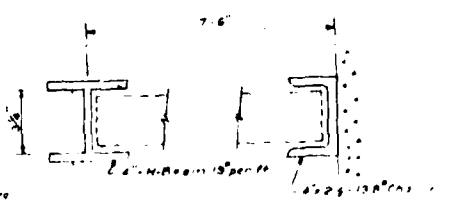
SPILLWAY CHANNEL BUCKET
Scale ¼"=1'-0"



PLAN OF SPILLWAY
Scale ¼"=1'-0"



ASH PLANKS
¾"=1'-0"



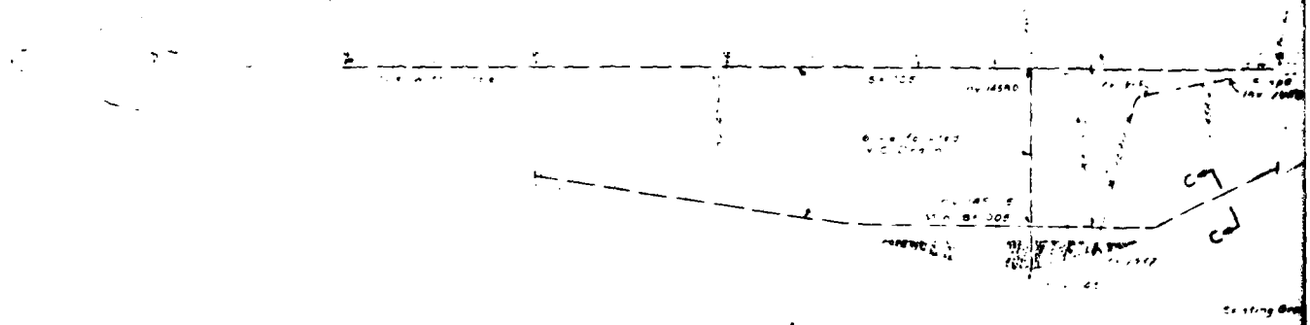
DETAIL OF FLASH PLANKS
Scale 3"=1'-0"

REVISION-JULY 15, 1959
SPILLWAY REVISED
DATA ADDED

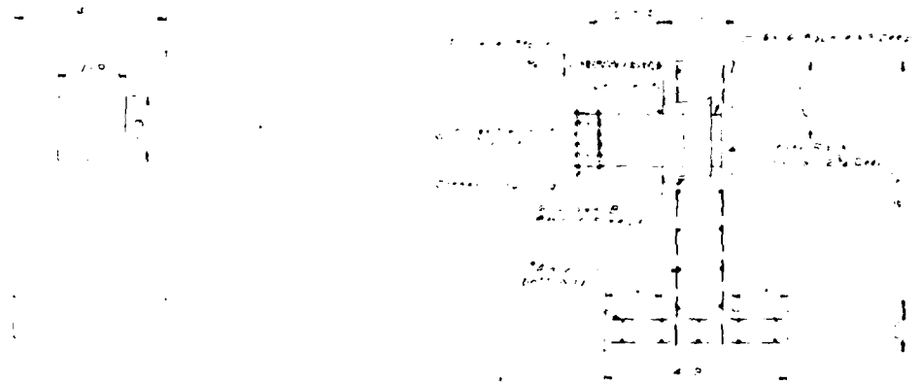
B-17

WATER SUPPLY RESERVOIR
SPILLWAY
LENOX, MASS.

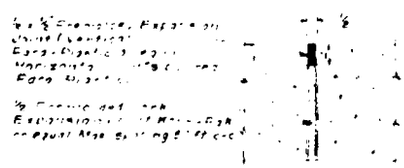
April 1949



PLAN OF SUB DRAINAGE



INLET DETAIL

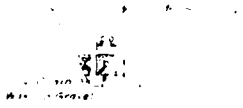


EXPANSION JOINT DETAIL

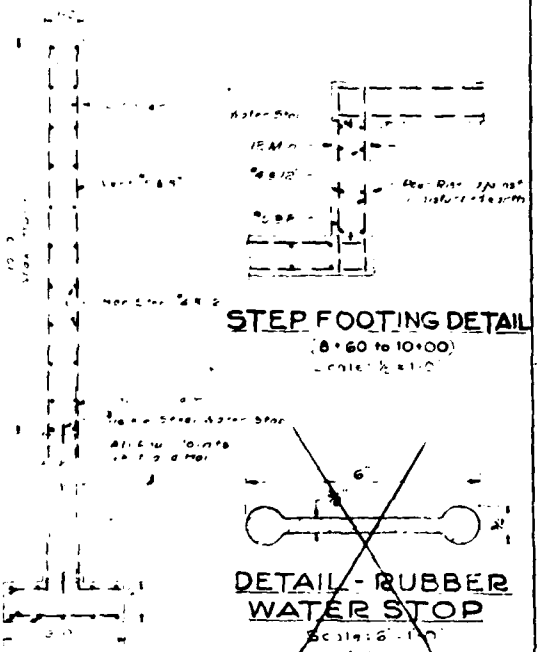
SECTION A-A

RACK DETAIL

SECTION C-C
Scale: ⅛"=1'-0"



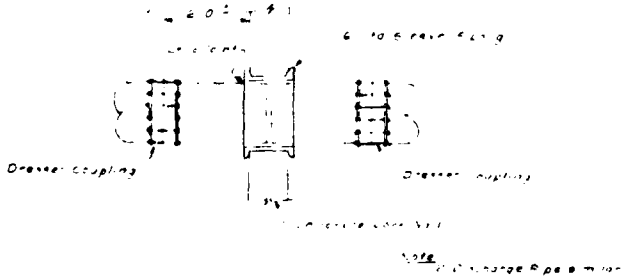
SECTION B-B
Scale ¼"=1'-0"



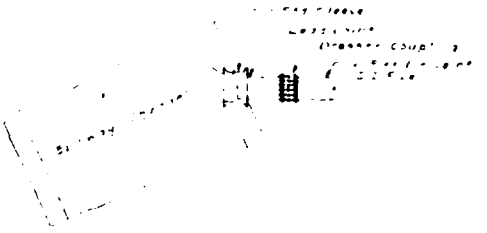
CORE WALL STEEL DETAIL
Scale ¼"=1'-0"

STEP FOOTING DETAIL
(8+60 to 10+00)
Scale ½"=1'-0"

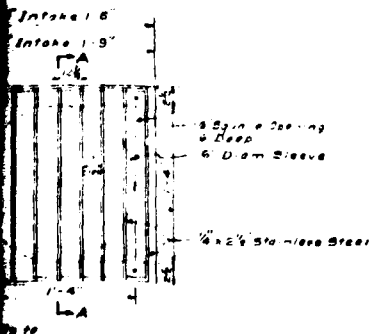
DETAIL - RUBBER WATER STOP
Scale 6"=1'-0"



DETAIL OF 16" DISCHARGE PIPE AT CORE WALL
Scale ½"=1'-0"



PLAN OF UPPER INTAKE DISCHARGE
Scale ¼"=1'-0"



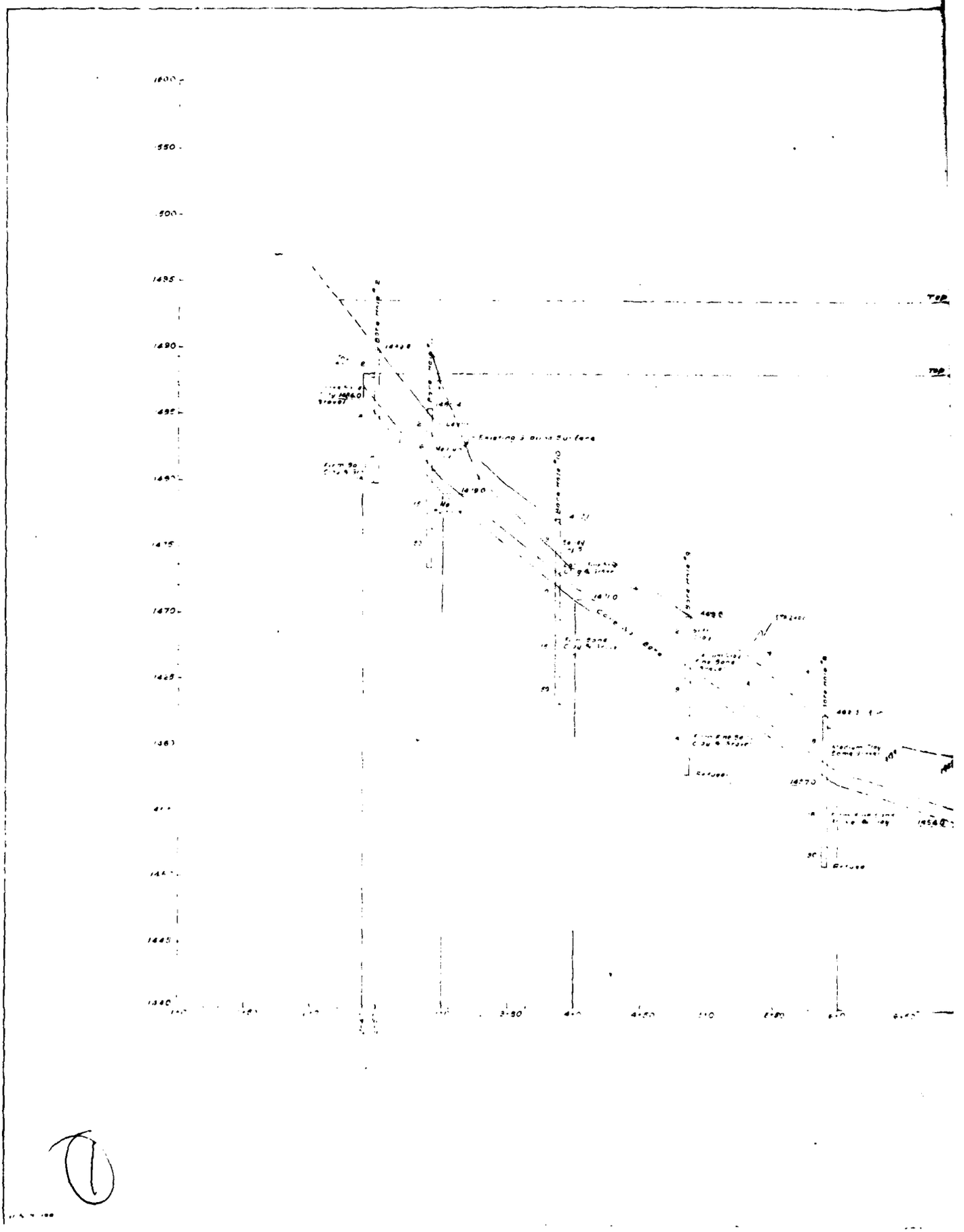
DETAIL
½"=1'-0"

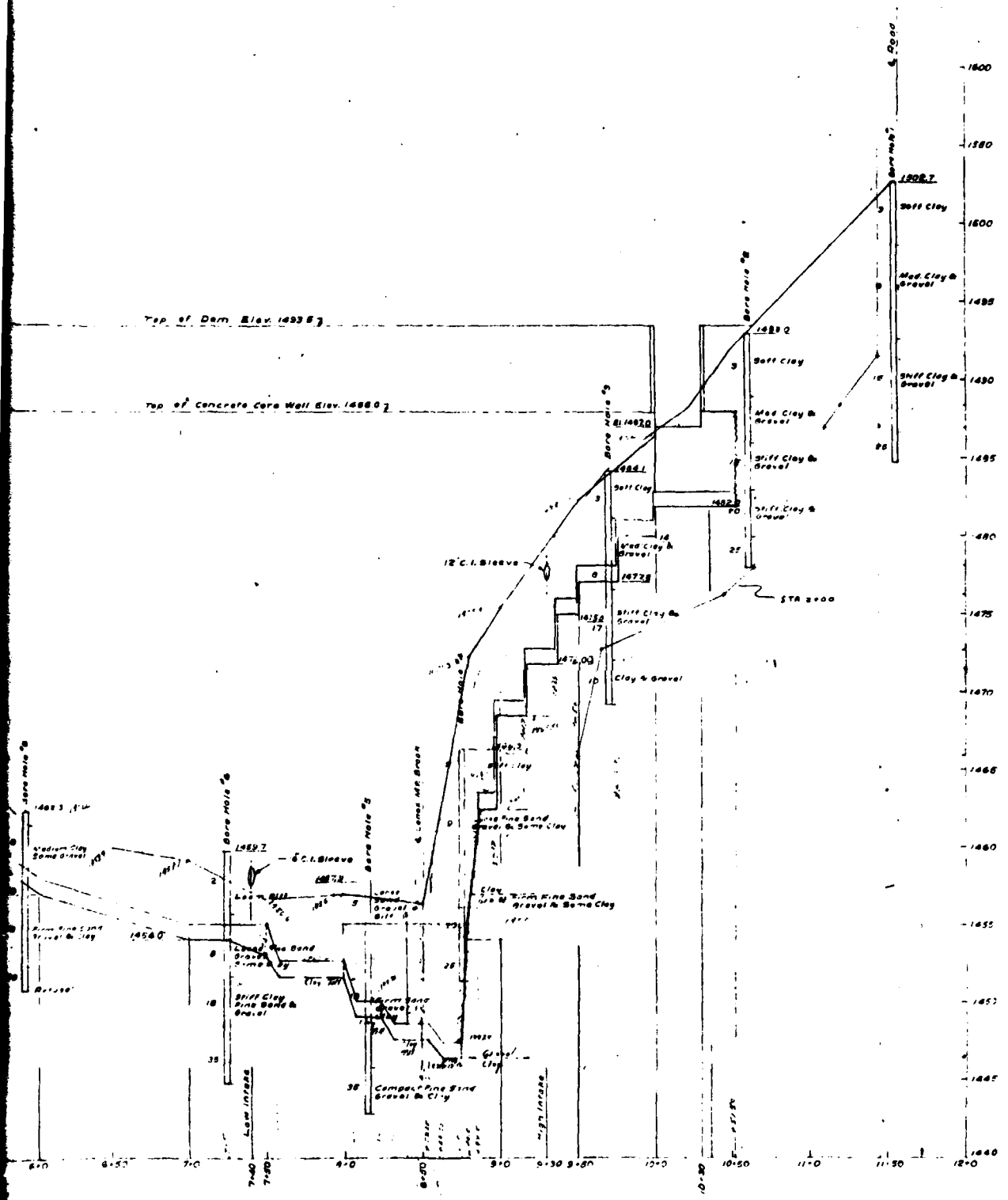
B-18

WATER SUPPLY RESERVOIR
DETAILS OF DAM
LENOX, MASS

TYPICAL BORING LOGS

A. Record Plan, Sheet 2





WATER SUPPLY RESERVOIR
PROFILE ALONG ℄ OF DAM
LENOX, MASS.

B-20

Hor 1"=50'
Ver 1"=4'

April, 1978

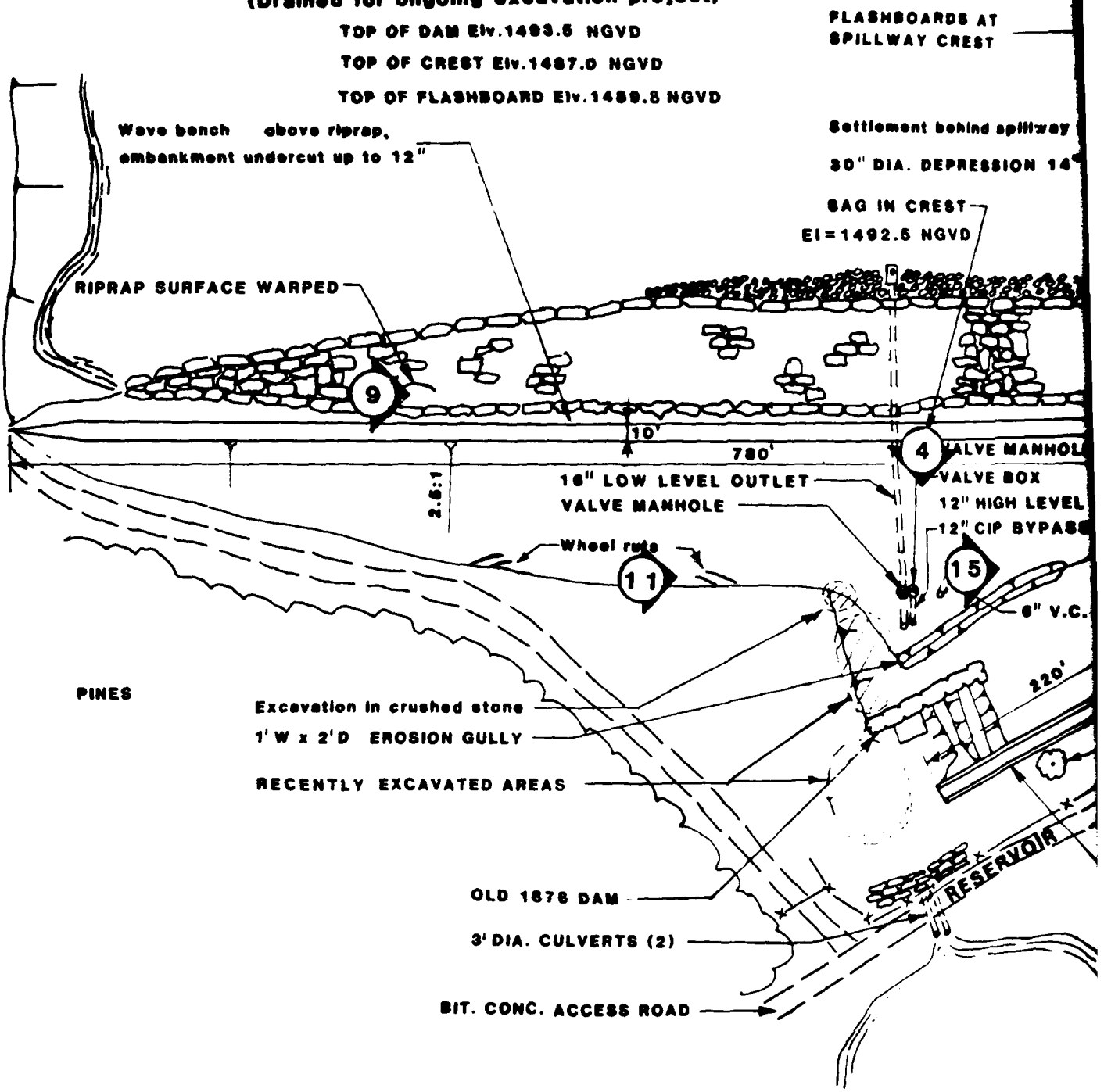
Bryan & Howard, Inc., Engineers
89 Ruggles St., Pittsfield, Mass.

APPENDIX C

PHOTOGRAPHS

UPPER ROOT RESERVOIR

(Drained for ongoing excavation project)

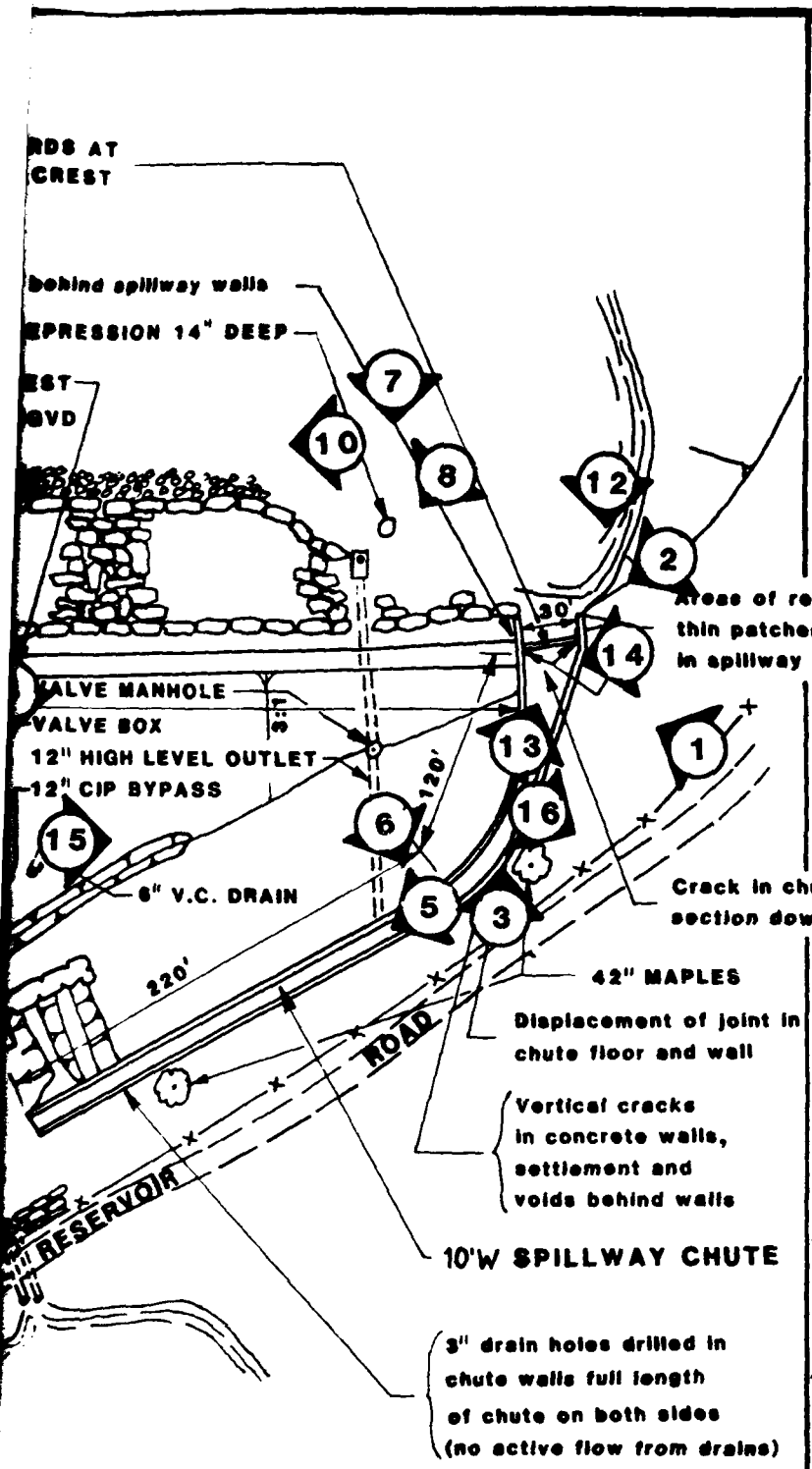


#17 - PHOTO OF OUTLET WORKS FOR LOWER ROOT RESERVOIR

(1)

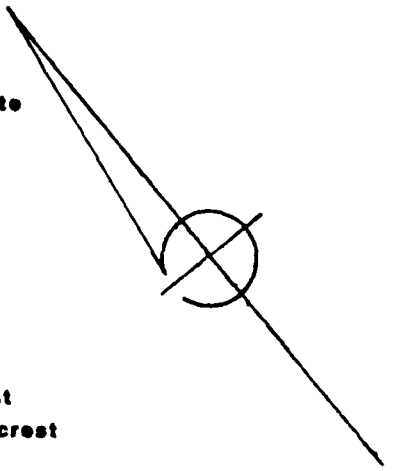
LOWER ROOT RESERVOIR

EL.= 1486 NGVD



Note:Elevation datum taken from plan dated 1959 prepared by Whitman & Howard Inc. plan and profile of Upper Root Reservoir, concrete crest of spillway elevation 1487 NGVD

1 – INDICATES PHOTOGRAPH NUMBER AND DIRECTION IN WHICH PHOTOGRAPH WAS TAKEN



APPENDIX C-1

PHOTOGRAPH INDEX

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

ROBERT G. BROWN & ASSOCIATES, INC.
Pittsfield, Massachusetts

NATIONAL PROGRAM FOR
INSPECTION OF NON-FEDERAL DAMS

UPPER ROOT RESERVOIR DAM

MA 00019

LENOX MOUNTAIN BROOK

LENOX MASSACHUSETTS

SCALE: NOT TO SCALE | DATE: JAN 1981

WER ROOT
SERVOIR
1486 NGVD

Photograph 1 - Downstream slope and crest looking west.

Photograph 2 - Upstream slope, crest and spillway approach looking west. Note level of water mark in relationship to top of riprap elevation.

Photograph 3 - Spillway looking upstream showing flash-boards and spillway channel.

Photograph 4 - Downstream area from top of dam. Note remains of old dam and 2 culverts under Reservoir Road. Lower Root Reservoir is in the background. Areas beyond toe of dam have recently been excavated. Note valve manhole for 16" conduit at toe.

Photograph 5 - Spillway discharge channel looking downstream. Note joints in channel floor and projecting joint fillers in channel walls.

Photograph 6

View of 3-inch diameter drilled weep holes in walls of spillway channel. Note vertical cracks in wall and tree beyond. Note plugged weep hole at base of wall.

Photograph 7 - View of headwall at inlet to 12" high level conduit. Note depression to left of headwall.

Photograph 8 - Close up view of depression shown in Photograph 7.

Photograph 9 - View of wave bench with 12-inch undercutting of embankment above riprap on upstream slope.

Photograph 10 - View of upstream slope showing inlet for 16-inch low level conduit. A 5' riser has since been added at this inlet.

Photograph 11 - View of easterly downstream toe showing area of anomalous vegetation and gully (obscured by matted grass). Excavated area in foreground shows 3" to 4" crushed stone at toe.

Photograph 12 - Typical low area behind spillway walls. Areas are approximately 1 foot lower than the top of dam. There are no cutoffs of projections of the spillway walls.

Photograph 13 - Spillway channel showing vertical displacement in floor and wall. Note recent caulking of expansion joint.

Photograph 14 - Area at end of flashboards showing 1978 concrete thin patch at expansion joint in spillway wall.

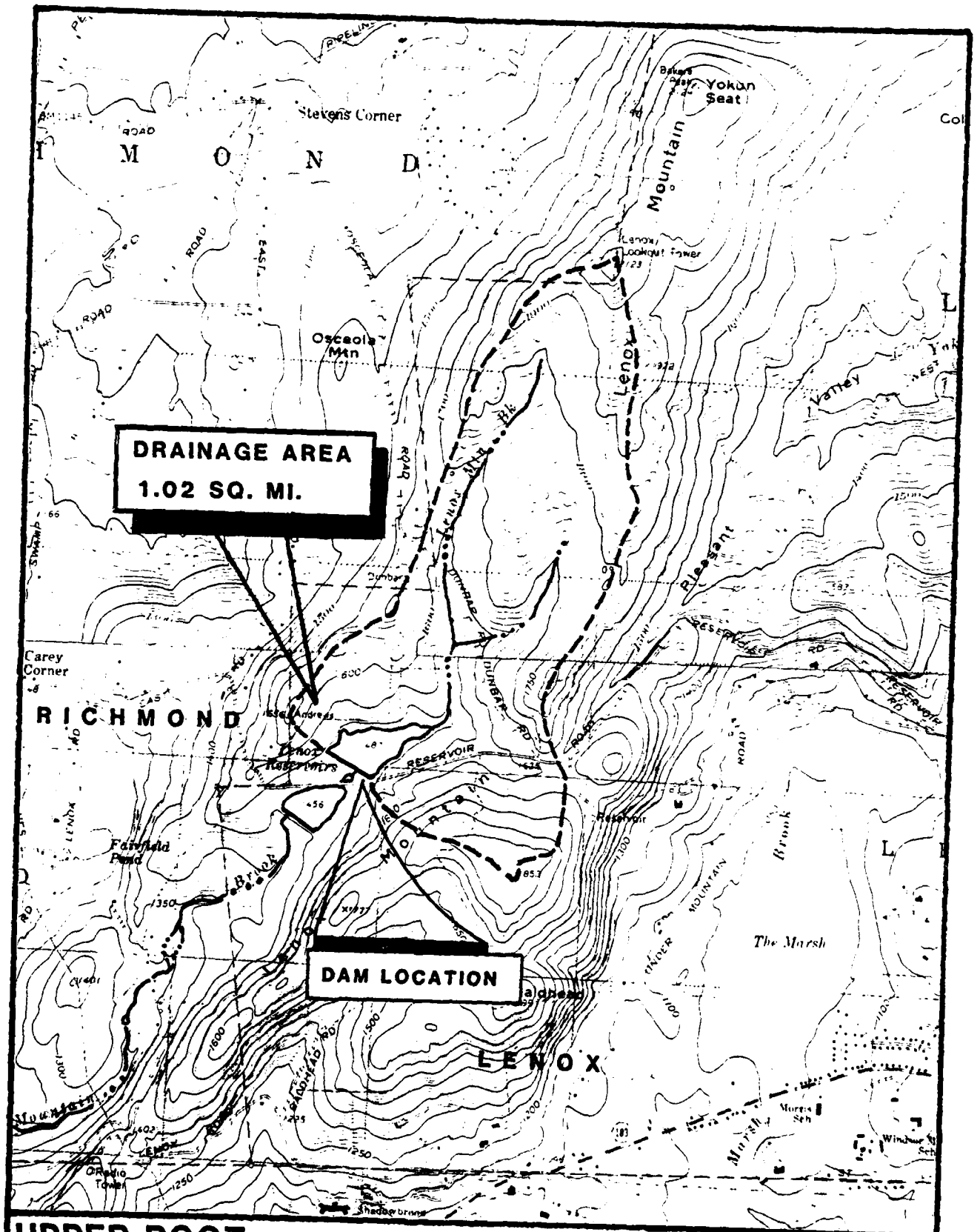
Photograph 15 - Area of anomalous vegetation at easterly downstream toe.

Photograph 16 - One of a couple of active animal burrows at the damsite.

Photograph 17 - View of spillway (looking upstream) for Lower Root Reservoir Dam.

APPENDIX D

HYDRAULIC AND HYDROLOGIC COMPUTATIONS



UPPER ROOT RESERVOIR DAM

LENOX, MASS.

Identification No. MA 00019

N

APPENDIX D-1

Stockbridge Quadrangle

DRAINAGE AREA MAP

1:25000

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB [illegible]
SHEET NO [illegible] OF [illegible]
CALCULATED BY [illegible] DATE [illegible]
CHECKED BY [illegible] DATE [illegible]
SCALE

Drainage Area 650 Ac ([illegible])

Size: Small because of impoundment
and ht. H: 31.5' [illegible]
Max. impoundment 650 Ac-ft [illegible]

Hazard: High because of potential for loss
of more than a few lives

Test Flood: ½ PMF to PMF range
use PMF because ht is at
upper limit

From Prelim guidance curves - Mountainous Terrain

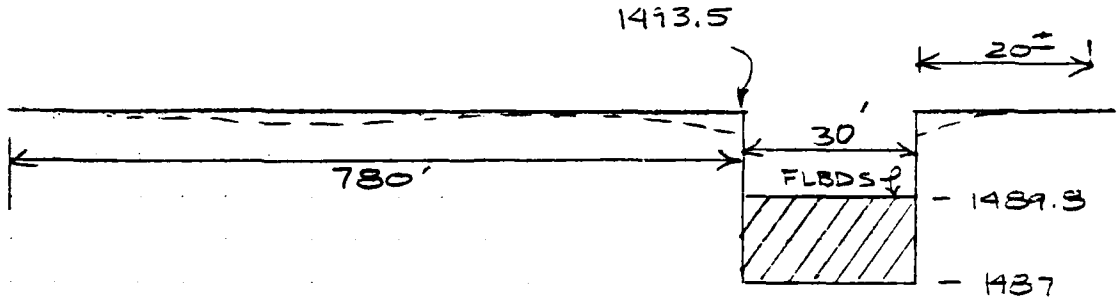
Max CSM$_{PMF}$ = 2400 cfs/sm

<u>Use</u> PMF = 2400 cfs => Test Flood

(Note - this is about [illegible] of 100 yr
flow as estimated by SCS
Modified Soil Cover complex [illegible])

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB MA 00013 Upper Root Res.
SHEET NO 2 OF 13
CALCULATED BY JFC DATE 12/29/90
CHECKED BY JEW DATE 1/15/91
SCALE



Compute stage / disch curve with flashboards and without flashboards. Assume high level 12" conduit in open position and low level outlet in normally closed position

Spillway & Over Dam $Q = C L H^{3/2}$
use Max C = 3.1 for Broad Crest Weir

Conduit Flow - $Q = a\sqrt{\frac{2gh}{1+k_m+k_p l}}$

$n = 0.013$
$l = 175'$
$k_p = 0.0313$
$k_m = 1.0$
$a = \frac{\pi d^2}{4} = 0.785$ less trash bars Say 0.7 s.f. net

$\therefore Q \quad \frac{a\sqrt{2gh}}{(1+k_m+k_p l)^{\frac{1}{2}}} = 0.36\, a\sqrt{2gh} = 2.05\sqrt{h}$

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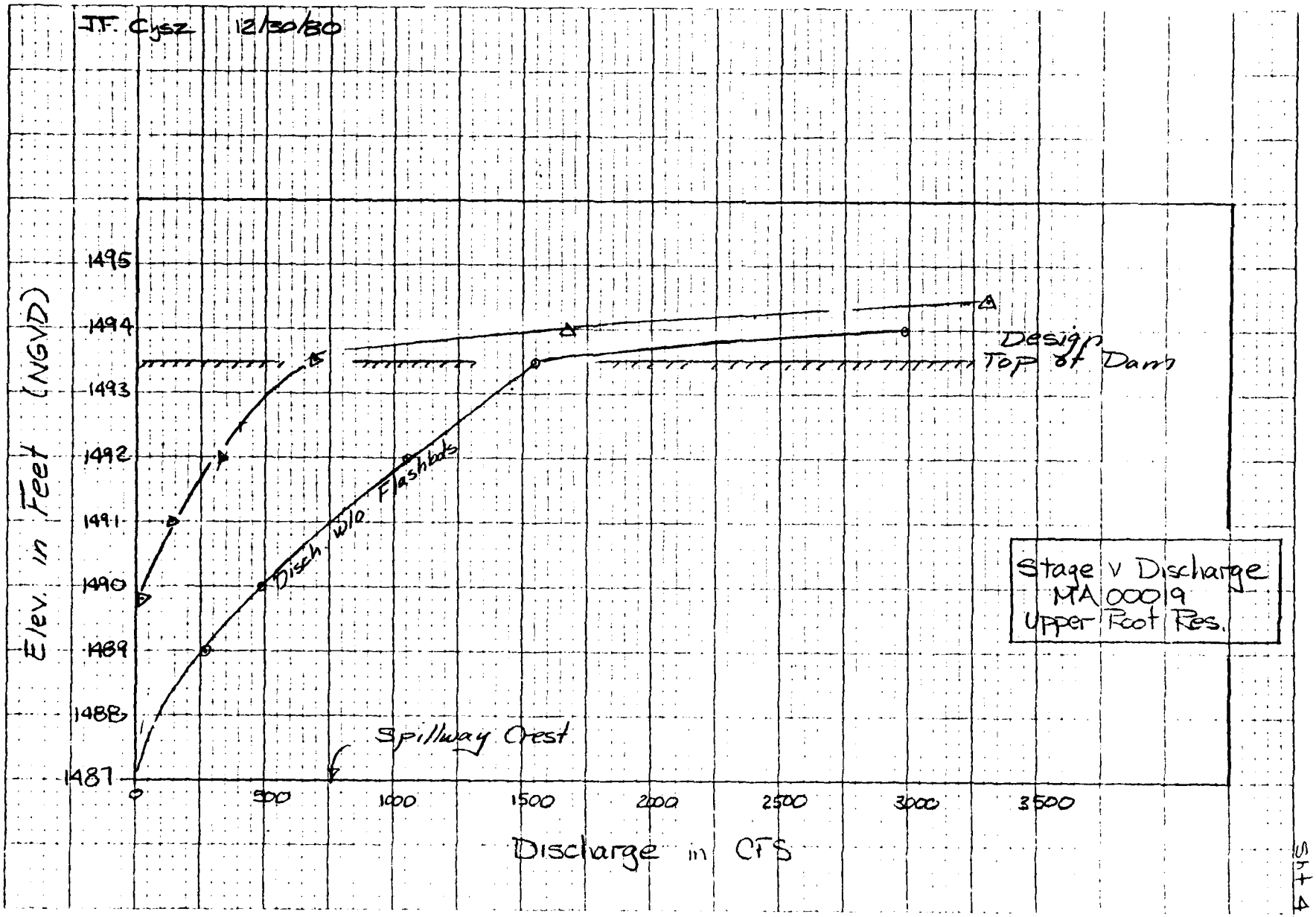
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB MA00019 Upper Boot Res.
SHEET NO 3 OF 13
CALCULATED BY JFC DATE 12/30/80
CHECKED BY CEN DATE 1/5/81
SCALE

$Q = CLH^{3/2}$ $Q = 2.05\sqrt{h}$ $Q = CLH^{3/2}$

Elev.	Spillway C	Spillway L	Spillway H	Spillway Q	Conduit (ℓ 1478.5') C	Conduit Q	Conduit h	Conduit Q	Flow over Dam C	Flow over Dam L	Flow over Dam H	Flow over Dam Q	Total Q (cfs)
w/o Flashboards													
1487	3.0	30	0	0	0.36	0.7	8.5	6.0					6
1489	"	"	2	254	"	"	10.5	6.6					261
1490	3.1	"	3	483	"	"	11.5	7.0					490
1492	"	"	5	1040	"	"	13.5	7.5					1048
1493.5	"	"	6.5	1541	"	"	15	8.0	2.9	800	0	820	1549
1494	"	"	8.0	2104	"	"	15.5	8.0	"	"	0.5	820	2932
1493.8			6.8	1649									
w/ Flashboards													
1487		7' Flashboards											7
1489.8	3.2	30	0	0	0.36	.7	11.3	7.					133
1491	"	"	1.2	126	"	"	12.5	7					321
1492	"	"	2.2	313	"	"	13.5	8					691
1493.5	"	"	3.7	683	"	"	15	8	2.9	800	0	820	1654
1494.	"	"	4.2	826	"	"	15.5	8	"	"	0.5	820	≈306
1494.5	"	"	4.7	978	"	"	16.0	8	"	"	1.0	2320	
1													
1492.5	3.2	30	2.7										


J.F. Cysz 12/30/80
Elev. in Feet (NGVD)
1495
1494
1493
1492
1491
1490
1489
1488
1487
0
500
1000
1500
2000
2500
3000
3500
Discharge in CFS
Design Top of Dam
Disch w/o Flashbds
Spillway Crest
Stage v Discharge
MA 00019
Upper Root Res.

D-5

Sht 4/13

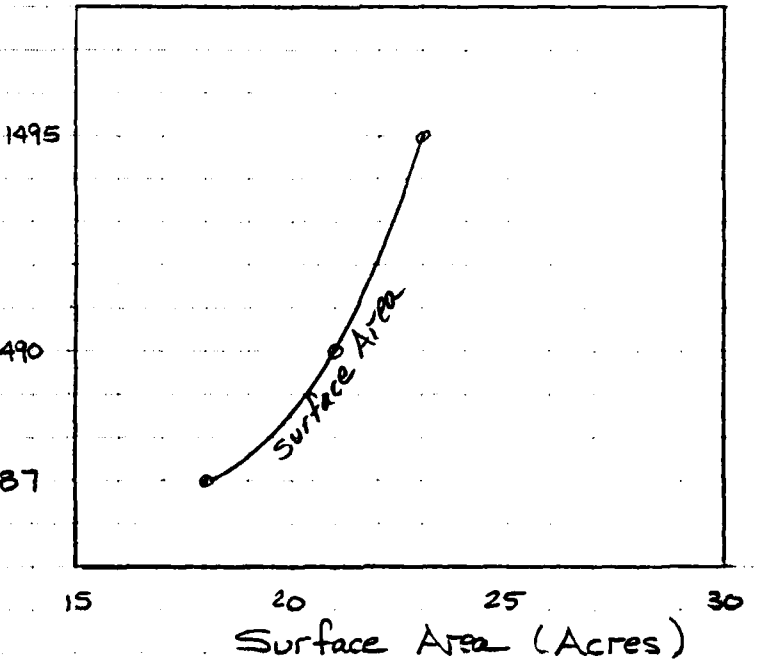
Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB MA00019 Upper Root Res.
SHEET NO. 5 OF 13
CALCULATED BY JFC DATE 12/30/80
CHECKED BY JEW DATE 1/15/81
SCALE

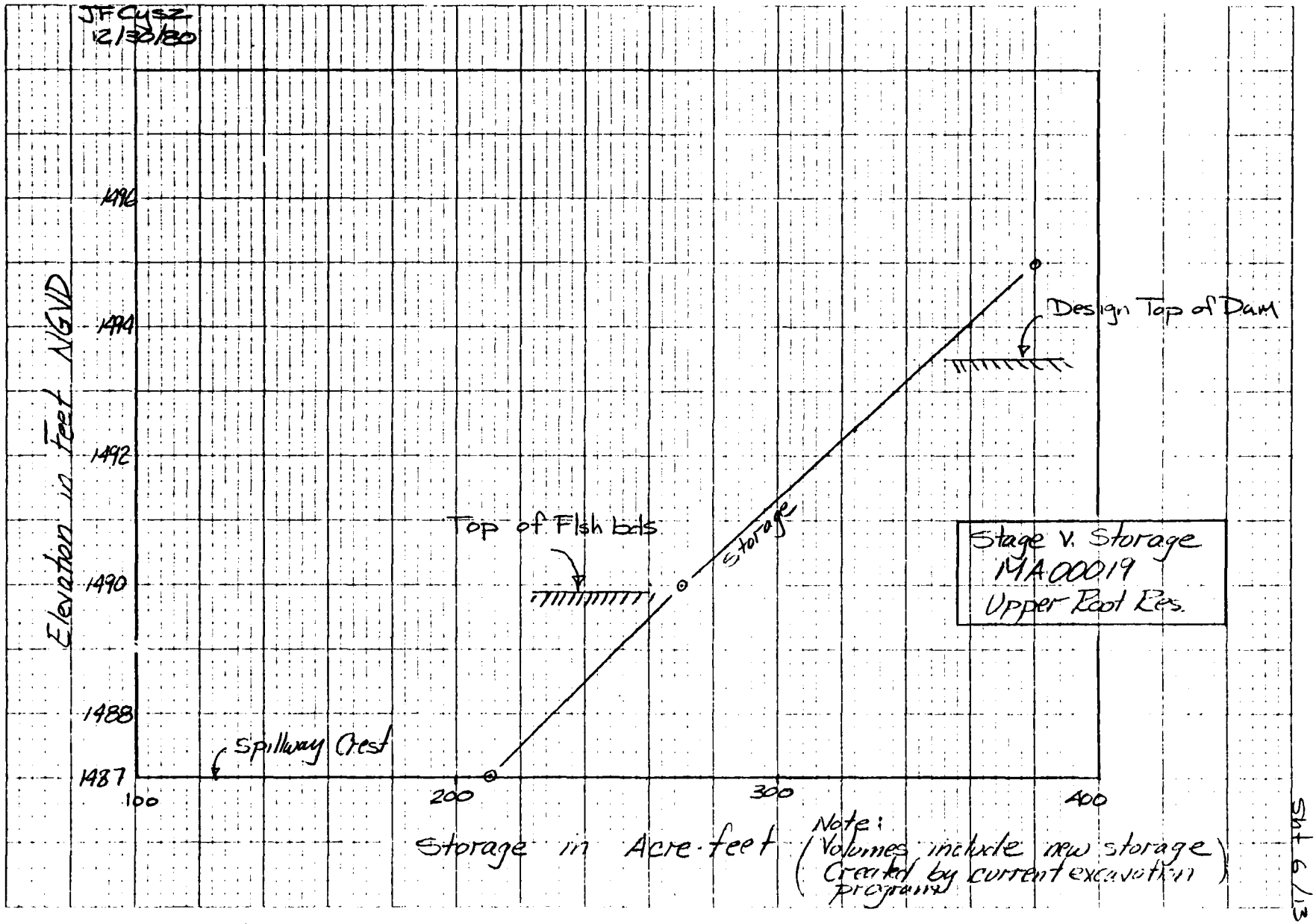
Stage V. storage

Elev.	Area Ac.	Δ Storage Ac-ft	Σ Storage Ac-ft
1487	18	211	211
1490	21	59	270
1495	23	110	380

Note
- orig storage at top of flashboards about 60 mg or 180 Ac ft. Recent excavation program will increase storage to about 90 mg or 270 Ac ft. according to town engineer



Stage V.
Surface Area
MA00019


JFC 4/82
12/30/80
1496
1494
1492
1490
1488
1487
Elevation in feet NGVD
Design Top of Dam
Top of Fish bds
Storage
Spillway Crest
Stage V. Storage
MA00019
Upper Pool Res.
100
200
300
400
Storage in Acre-feet
Note:
Volumes include new storage
Created by current excavation
program

Sht 6/13

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB MA00019 Upper Root Res.
SHEET NO. 7 OF 13
CALCULATED BY JFC DATE 12/30/80
CHECKED BY JEW DATE 1/15/81
SCALE

½ PMF with Flashboards

Q_{P_1} = 1200 cfs
RO = 19/2 = 9.5"

Q_{P_1} → El. 1493.8 → 355 Ac ft
Storage @ 1489.8 = 266 Ac ft

Δ Storage = 89 Ac ft

$89 \times \frac{1}{1.02} \times \frac{1}{53.3}$ = 1.64" (STOR 1)

$Q_{P_2} = 1200\left(1 - \frac{1.64}{9.5}\right)$ = 993 cfs →
El. 1493.7 → 332 Ac ft

Δ Storage = 66 Ac ft

$79 \times \frac{1}{1.02} \times \frac{1}{53.3}$ = 1.21" (STOR 2)

STOR AVE = $\frac{1.64 + 1.21}{2}$ = 1.43"

1.43 × 1.02 × 53.3 = 78 Ac ft

(78 + 266) = 344 Ac-ft →

Approx. El. 1493.5 → 690 cfs → 350 Ac ft

Water at design top of dam w/ flashboards

PMF Test Flood without Flashboards

Q_{P_1} = 2400 cfs
use RO = 19"

Q_{P_1} → El. 1493.8 → 355 Ac ft

Δ Storage = 144 Ac ft

$144 \times \frac{1}{1.02} \times \frac{1}{53.3}$ = 2.65" (STOR 1)

$Q_{P_2} = Q_{P_1} \times \left(1 - \frac{\text{STOR 1}}{\text{RO}}\right)$

$Q_{P_2} = 2400 \times \left(1 - \frac{2.65}{19}\right)$ = 2065 cfs →

El. 1493.8 → 354 Ac ft
Δ storage = 143 Ac ft
$131 \times \frac{1}{1.02} \times \frac{1}{53.3}$ = 2.63"

STOR AVE = $\frac{2.65 + 2.63}{2}$ = 2.64"

2.53 × 1.02 × 53.3 = 144 Ac ft

(144 + 211) = 355 Ac ft →
El. 1493.8 → 2065 cfs

Overtops ≈ 0.3' over design top of dam or 1'-1½' over exisiting low pts in crest

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB MA20019 Upper Root Res.
SHEET NO 8 OF 13
CALCULATED BY JFC DATE 12/30/20
CHECKED BY JEW DATE 1/15/21
SCALE Summary

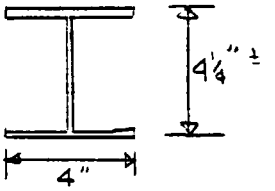
	½ PMF w/Flashboards	PMF w/o Flashboards
Inflow	1200 cfs	2400 cfs
Routed Outflow	690 cfs	2065 cfs
Flood Elev.	1493.5	1493.8
Storage at Flood Elev.	350 Ac-ft	355 Ac-ft
Spillway Cap. at Flood Elev.	690 cfs	1650 cfs
Design Top of Dam El.	1493.5	
Low Pt in Existing Top	1492.5±	
Spillway Cap. at Design Top of Dam	690 cfs	1550 cfs
Spillway Cap. at Existing Low Pt.	425 cfs	1250 cfs
% Routed Outflow	62%	61%
(%) = Values if crest adjusted to design grades	(100%)	(75%)

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB MA0019 Upper Foot Res.
SHEET NO. 9 OF 13
CALCULATED BY JEC DATE 11/17/20
CHECKED BY JEW DATE 11/15/21
SCALE

Check Yield of Flashboard supports

Approx. depth 4¼"
Approx. width 4"

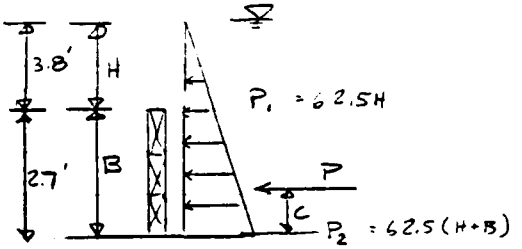


Light WF Jr. Beam

$S_{xx} = 6.67\ in^3$
Use $F_y = 33000$ psi

$M_{Max} = S F_y = (6.67\ in^3 \times 33000 \frac{lb}{in^2}) = 220,110$ in-lb
(Plastic Hinge)

Supports @ ≈ 7½' o.c. = L



Overflow Condition

$$P = \left[\frac{62.5H + 62.5(H+B)}{2}\right] B$$

$$C = \left[\frac{B(2P_1 + P_2)}{3(P_1 + P_2)}\right] = \frac{B(3H+B)}{3(2H+B)}$$

$$M_{in\text{-}lb} = 12 \times L \times P \times C \quad ; \quad M = 375 B^2 L \left(H + \tfrac{B}{3}\right)$$

Try H = 3.8' = Top of Dam

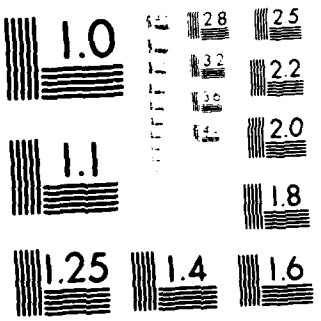
$$M = (375)(2.7)^2(7.5)(3.8 + \tfrac{2.7}{3}) = 96,365 \text{ in-lb}$$

Conclude - flashboard supports probably won't yield with water at top of dam

Ref. Eng. News Record
Apr 30, '36

AD-A145 186 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS UPPER ROOT RESERVOIR..(U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV MAR 81 2/2

UNCLASSIFIED F/G 13/13 NL



Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB MA 00019 Upper Root Res.
SHEET NO 10 OF 13
CALCULATED BY JFC DATE 12/30/80
CHECKED BY JEW DATE 1/15/81
SCALE

Breach Analysis

Assume Breach Width = W_b = 40% crest length at mid ht.

$W_b = 0.4 \times 450'$

$W_b = 180'$

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

y_o = Ht. from stream to pool level at failure

$y_o = 39'$ ($12''$ Inv out to Top of Dam)

$Q_p = (8/27 \times 180 \times 32.2^{1/2} \times 39^{3/2}) = 73{,}700$ cfs

Antecedent Discharge (Spillway capacity at Top of dam)
w/ flashbds - 690 cfs
w/o flashbds - 1550 cfs

Storage S at Top of Dam = 350 Ac-ft.

For Total Breach Q use $Q_p + Q_{spillway}$
= 73,700 + 1550 cfs = 75,250 cfs.

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB MA00019 Upper Root Res.
SHEET NO 11 OF 13
CALCULATED BY JFC DATE 12/30/80
CHECKED BY JEW DATE 1/15/81
SCALE

Notes- Lower Root Reservoir lies immediately downstream of Upper Root Res. Dam is older than Upper Root - is about 600' long, spillway length 55'; 26" Frbd above spillway crest, 12 Ac normal surface area.

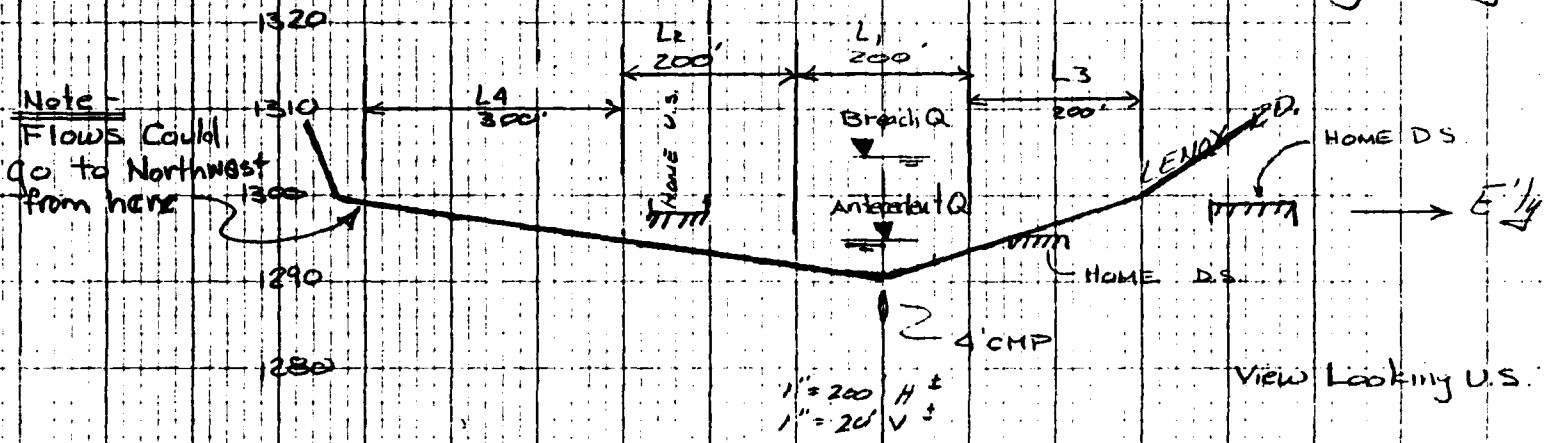
Storage avail between spillway crest and top of dam = $\left(\frac{26}{12}\right)^3 \times 12\ Ac = 26\ Ac\text{-}ft$

This storage is small in relationship to S and would not significantly reduce breach Q from Upper Res. Spillway Capacity for lower Root is about $3.2 \times 55 \times \left(\frac{26}{12}\right)^{3/2} = 560$ cfs. Flows greater than this would overtop dam first at westerly end.

Below Lower Root, the brook is confined in a narrow valley section. Stream drops 140 ft in about 3300' ($S_{ave} \simeq 4.2\%$)
Stream crosses under Lenox Rd 0.9 mile downstream of damsite in 4' Diam. CMP culvert with 1.5' earth cover. About 3-4 homes in the area of Lenox Rd could be endangered in this area.
Flooding estimated between 1 and 10 feet - Potential for loss of more than a few lives in this area. Hazard High
(See Shts 12 & 13)

JFC 4-82 12/30/80

Note Cross Section Data from USGS Sheet Not by Survey



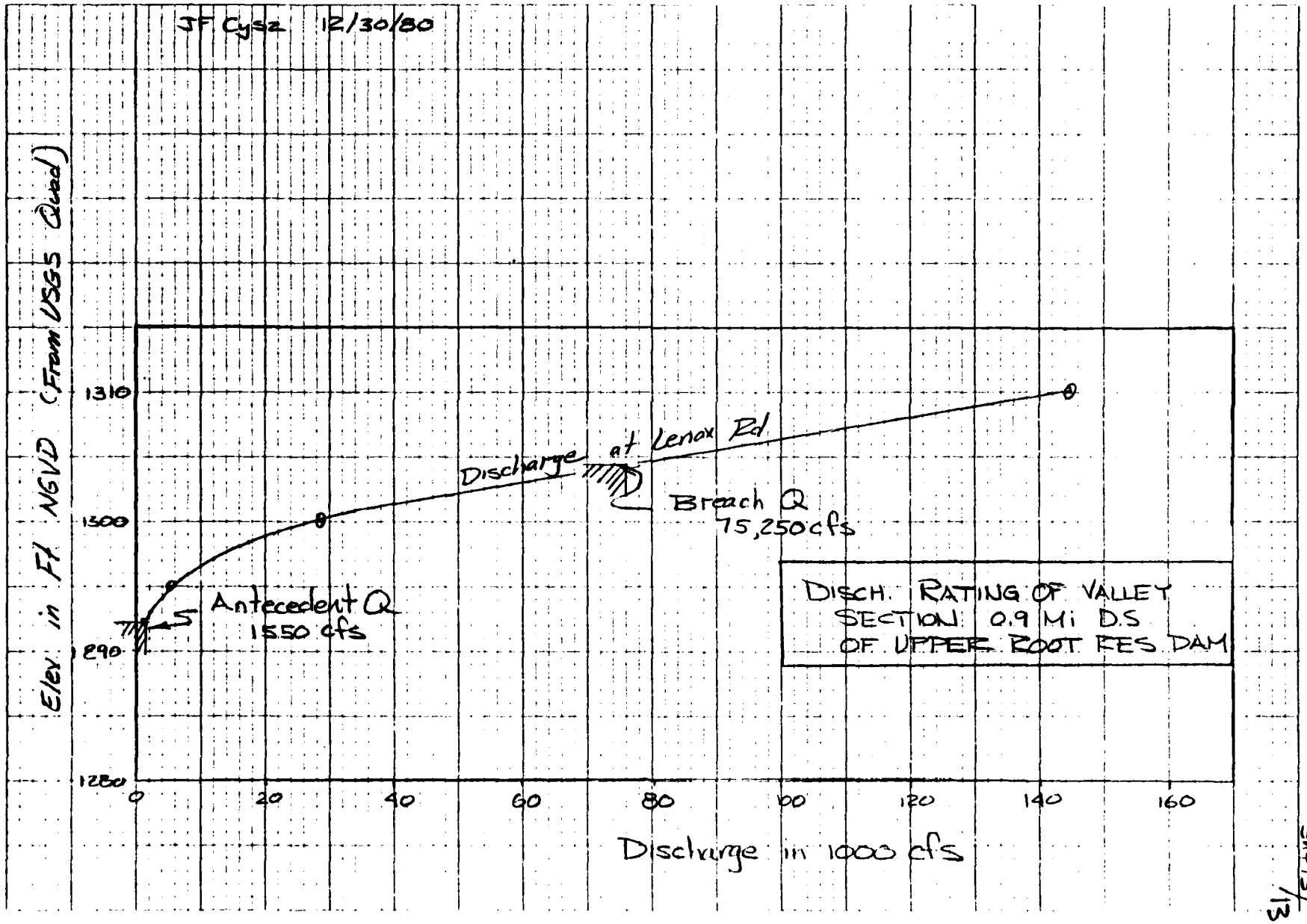
RATING OF VALLEY SECT AT LENOX RD 0.9 M. DS of UPPER ROOT RES.

		L1			L2			L3			L4			
Elev	C	H	L1	Q	H	L2	Q	H	L3	Q	H	L4	Q	Q TOTAL
1290	2.8							—			—			
1295	"	4'	200	4480	1	200	200	—			—			4680
1300	"	8'	"	12670	6	"	8230	3	200	2900	3	300	4365	28165
1310	"	18	"	42765	16	"	35840	13	"	26250	13		39370	144225

Note - Neglect Culvert - Capacity ≃ 100 cfs
Could Plug w/ debris during high flows

SHT 12/13

D-13


JF Cysz 12/30/80
E/ev in Ft NGVD (From USGS Quad)
1310
1300
1290
1280
0
20
40
60
80
100
120
140
160
Discharge in 1000 cfs
Discharge at Lenox Rd
Breach Q
75,250 cfs
Antecedent Q
1550 cfs
DISCH. RATING OF VALLEY
SECTION 0.9 Mi D.S
OF UPPER ROOT RES DAM

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME


ATE
LMED