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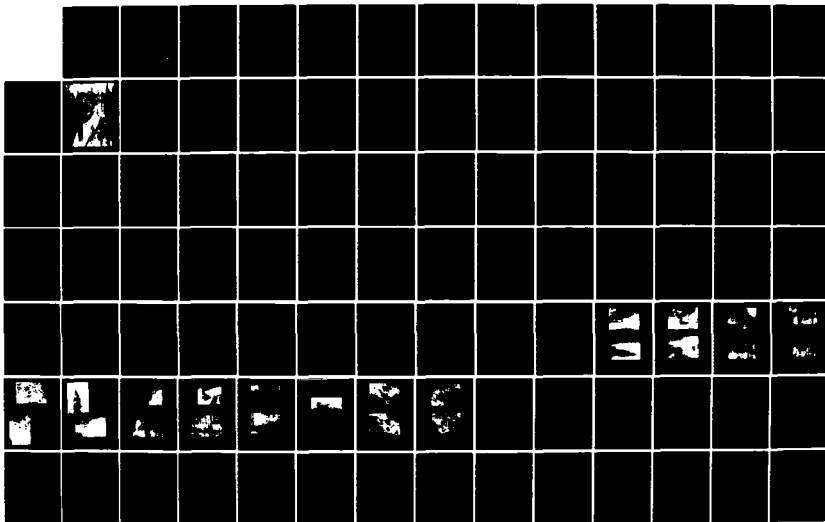
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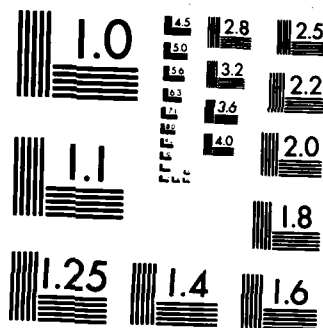
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MASSACHUSETTS COASTAL AREA  
WINCHESTER, MASSACHUSETTS

## SOUTH RESERVOIR DAM AND DIKES

MAIN DAM \_\_\_\_\_ MA 00453  
EAST DIKE \_\_\_\_\_ MA 01278  
WEST DIKE \_\_\_\_\_ MA 01279

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## PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM



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| 1. REPORT NUMBER<br>MA 00453-01278-01279                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2. GOVT ACCESSION NO.<br><b>AD-A154734</b> | 3. RECIPIENT'S CATALOG NUMBER                               |
| 4. TITLE (and Subtitle)<br>South Reservoir Dam and Dikes: Main Dam;<br>East Dike; West Dike<br>NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                            | 5. TYPE OF REPORT & PERIOD COVERED<br>INSPECTION REPORT     |
| 7. AUTHOR(s)<br>U.S. ARMY CORPS OF ENGINEERS<br>NEW ENGLAND DIVISION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                            | 6. PERFORMING ORG. REPORT NUMBER                            |
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| 18. SUPPLEMENTARY NOTES<br>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)<br>DAMS, INSPECTION, DAM SAFETY,<br>Massachusetts Coastal Area<br>Winchester, Massachusetts<br>Offstream tributary to Mystic River                                                                                                                                                                                                                                                                                                                                                                   |                                            |                                                             |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br>The main dam is a 950 foot long, 38 foot hydraulic height earth fill embankment structure with a 25 foot long concrete spillway at the right abutment. There are also two earthfill embankment dikes. The west dike is about 200 ft. long and has a height of 6 ft. The east dike is 100 ft. long and about 13.5 ft. in height. The dam is judged to be in generally good condition and the dikes are in fair condition. The size classification is intermediate and the hazard potential is high. |                                            |                                                             |

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

REPLY TO  
ATTENTION OF:  
NEDED

JUN 19 1980

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

Dear Governor King:

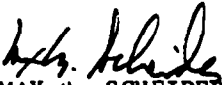
Inclosed is a copy of the South Reservoir Dam and Dikes Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study 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 Winchester, Massachusetts.

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,

  
MAX B. SCHEIDER  
Colonel, Corps of Engineers  
Division Engineer

Incl  
As stated

NATIONAL DAM INSPECTION PROGRAM  
PHASE I INVESTIGATION REPORT  
BRIEF ASSESSMENT

Identification No.: MA 00453, Main Dam; MA 01278, East Dike;  
MA 01279, West Dike

Name of Dam: South Reservoir Dam and Dikes

Town: Winchester

County and State: Middlesex County, Massachusetts

Stream: Offstream Tributary to Mystic River

Date of Inspection: October 24, 1979

The main dam is a 950 foot long, 38 foot hydraulic height earth fill embankment structure with a 25 foot long concrete spillway at the right abutment. There are also two earth fill embankment dikes. The west dike is about 200 feet long and has a hydraulic height of six feet. The east dike is 100 feet long with a hydraulic height of about 13.5 feet.

There were no indepth engineering data available for review. The condition of the dam and dikes was primarily evaluated by visual inspection, past performance history and sound engineering judgement. Based on the visual inspection the dam was judged to be in generally good condition and the dikes were judged to be in generally fair condition. Brush and trees were observed on the dam and dike embankments and vehicle ruts were observed at the crests. An erosion gully was observed in the upstream slope of the east dike.

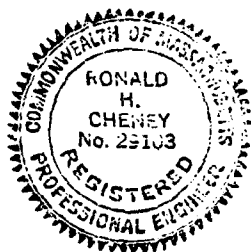
The project has a size classification of intermediate and a hazard potential classification of high. Based upon Corps Guide-

lines, the test flood is the PMF. Test flood inflow from the 0.76 square mile drainage area is 2,280 cfs. The spillway can pass the routed test flood outflow, with and without flashboards. The dam and dikes are not overtopped. The reservoir is surcharged to elevation 162.3, 1.2 foot below the top of dam, without flashboards. The routed test flood outflow is 200 cfs.

It is recommended that the Owner engage a qualified registered professional engineer to perform the following: determine procedures for removing trees growing on the dam and dikes including assistance in selecting material for backfilling voids left due to the removal of root systems; a seismic investigation of the dam and dikes.

Furthermore, the Owner should institute remedial measures which include: develop a formal warning system for alerting downstream impact areas in case of emergency; remove brush from the slopes of the dam and dikes and from the area within 10 feet of the toe; repair vehicle ruts on the crest and establish protective vegetation cover; repair the erosion gully at the east dike; remove brush and small trees from the spillway channel; remove fallen trees from the 30 inch waste pipe outlet channel; clean and maintain the waste pipe outlet; insure that the waste pipe and water supply pipe control valves are operable; establish a formal maintenance procedure; fill in animal holes as they appear; and institute a program of annual technical inspection.

The recommendations and remedial measures should be implemented by the Owner within one year after receipt of this Phase I Investigation Report.



*Ronald H. Cheney*

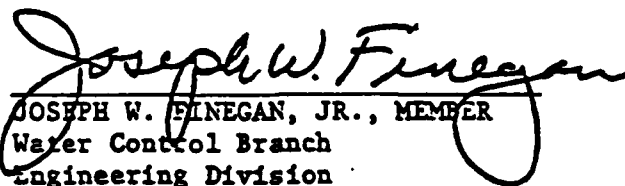
Ronald H. Cheney, P.E.  
Vice President

Hayden, Harding & Buchanan, Inc.  
Boston, Massachusetts

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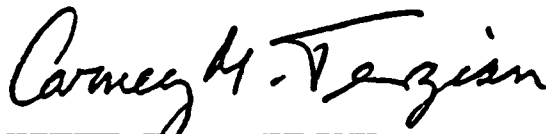


This Phase I Inspection Report on South Reservoir Dam and Dikes has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

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

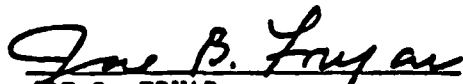


JOSEPH A. MCELROY, MEMBER  
Foundation & Materials Branch  
Engineering Division



CARNEY M. TERZIAN, CHAIRMAN  
Chief, Structural Section  
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, sub-surface 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.

The Phase I Investigation does not 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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PHASE I  
NATIONAL DAM INSPECTION PROGRAM

SECTION 1  
PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Hayden, Harding & Buchanan, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued Hayden, Harding & Buchanan, Inc. under a letter of 24 October 1979 from William E. Hodgson Jr., Colonel, Corps of Engineers. Contract No. DACW 33-80-C-0006 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist 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

South Reservoir Dam is located in the northwestern section of the Town of Medford, approximately 4,500 feet south of the intersection of the Stoneham-Medford-Winchester town lines. The dam is shown on the Boston North, Massachusetts Quadrangle map having approximate coordinates of North  $42^{\circ}26'25''$ , West  $71^{\circ}07'13''$ .

### b. Description of Dam and Appurtenances

South Reservoir Dam is a 950+ foot long, 38 foot hydraulic height, earth embankment structure having a masonry intake structure and a 25 foot long riprap and gravel lined emergency spillway. There is also a 6 foot high, 200 foot long west dike located 300 feet to the right of the main dam and a 13.5 foot high, 100 foot long east dike located approximately 1,300 feet to the left of the main dam. Both dikes are earth embankments built across low areas between the hills surrounding the reservoir.

The upstream side slope of the main dam earth embankment is riprap lined to within 4 to 5 feet of the crest and is inclined at approximately 1.5H:1V, photograph 4 (Appendix C). The downstream side slope is lined with vegetation and inclined at about 1.5H:1V. There is a 14 foot wide berm located approximately 25 feet downstream of the crest. This berm is used as an access road as shown by photograph 14. The crest is approximately 12 feet wide and is also used as an access road.

The intake structure is a 10+ foot square masonry structure with a steel truss, wood deck service bridge, photograph 15.

It is comprised of granite blocks to the level of the crest of dam with a brick masonry gatehouse above this level. It contains manually operated gates to regulate the flow through a 24 inch water supply pipe and 30 inch waste pipe. The 24 inch pipe connects into the Winchester water supply system. The waste pipe discharges at a stone masonry headwall outlet structure (see photographs 9 and 10) located about 45 feet downstream of the toe of dam.

The spillway structure, located about 700 feet to the right of the gatehouse, is about 25 feet long and has 2 foot high concrete weir. There is a concrete and steel beam bridge over the spillway which is used as an access road (see photographs 1 and 3). A 3 foot wide channel divides the weir into two sections of 8 and 14 feet in length. There are provisions for 2 feet of stoplogs in this channel, and 6 inches of flashboards atop the weir crest, which has an elevation of 160.5. The bottom of the roadway bridge is about 6.8 feet above the weir crest. The spillway approach channel (see photograph 3) has riprapped side slopes inclined at 1.5H:1V. The spillway discharge channel is relatively flat for approximately ninety feet. Then the channel drops at a slope of 1H:1V for about 15 feet, and eventually flows into a small brook.

There is another reservoir located immediately to the north known as Middle Reservoir. There is an access road dike separating the South Reservoir from the Middle Reservoir. This dike is divided into two sections by a natural high area and contains culverts to regulate flow between the two reservoirs.

c. Size Classification

Corps guidelines for a size classification of intermediate have a storage capacity range of between 1000 to 50000 a-f and a hydraulic height range of between 40 to 100 feet.

The dam has an intermediate size classification based on its approximate storage capacity of 1,850 acre-feet. Its hydraulic height is about 38 feet.

d. Hazard Classification

The hazard potential due to main dam failure flooding is classified as high. Based on Corps Guidelines, the calculated outflow from dam failure is 41,400 cfs. The impact area downstream of the dam includes areas of substantial residential development. Flood stages could reach depths of up to 10 feet. It is estimated that in excess of 150 homes are located within the impact area. There is a significant potential for the loss of more than a few lives due to dam failure.

Failure of the west dike would result in a high hazard potential. Based on Corps Guidelines, the outflow of the assumed test flood would be 700 cfs. Flooding depths of 2 to 3 feet would occur in the residential areas downstream. Between 5 and 10 homes could suffer damage as a result of the failure of the west dike. There is a potential for the loss of more than a few lives due to failure of the west dike.

A high hazard potential would also occur as a result of the failure of the east dike. Several homes located along South Border Road, about 5,000 feet downstream, could be flooded by 2 to 3 feet of water. Beyond this point it is estimated that 5

homes located to the west of Roosevelt Circle could be flooded by about 5 feet of water. At least 5 more homes could be flooded by 1 to 2 feet of water in the area beyond the Roosevelt Circle Interchange. There is a potential for for the loss of more than a few lives due to failure of the east dike.

e. Ownership

The dam is owned by the Town of Winchester, Massachusetts.

f. Operator

The dam is maintained by the Winchester Department of Public Works. Mr. Tanazuck of the Department of Public Works is the designated caretaker. The address is 15 Lake Street, Winchester, Massachusetts 01890. (Telephone 617-729-3503).

g. Purpose of Dam

The purpose of the dam has always been public water supply.

h. Design and Construction History

No records were found to indicate when or by whom the dam was built or when any subsequent repairs or modifications were made.

i. Normal Operating Procedures

The normal pool level of both the South and Middle Reservoirs in the Winchester Water Supply System, is maintained by pumping water into the Middle Reservoir from nearby Spot Pond Reservoir, a part of the MDC water supply system. The water demand exceeds the natural runoff water supply from the drainage area. About 300 to 400 million gallons per year are pumped from

Spot Pond. The water levels for the South and Middle Reservoirs are normally kept at elevation 155 to 157. Water is released from the Middle Reservoir to the South Reservoir to maintain its level.

At the gatehouse, the control valve for the 30 inch waste line is kept closed. Its functionability is reported to be unknown. The valve for the 24 inch water supply line is always kept open and its operating condition is unknown.

### 1.3 Pertinent Data

#### a. Drainage Area

The South Reservoir is one of three reservoirs comprising the Winchester Water Works. The other impoundments, known as the Middle and North Reservoirs are located directly to the north of South Reservoir. These impoundments are used for water supply purposes. The Middle Reservoir has two outlets into South Reservoir, effectively making these reservoirs act as a unit. The drainage area of these two reservoirs is 0.76 square miles (486 acres) and is generally hilly and forested with little development. The majority of the area is within the MDC's Middlesex - Falls Reservation. The inlet brooks are relatively steep and short.

South Reservoir outlets to a small brook that flows southward to the Mystic River. Middle Reservoir is separated from South Reservoir by a man-made dike used as an access road, formed between a small central natural hill and ridges of high ground on each shore. This dike represents the lowest area surrounding the middle reservoir. Ground elevations along the

dike vary from 168<sup>+</sup> to 164<sup>+</sup>.

A 24<sup>+</sup> inch corrugated metal pipe and a 36<sup>+</sup> inch reinforced concrete pipe are used to discharge water from Middle Reservoir to South Reservoir. The 24 inch pipe (normally kept closed) has an invert elevation of 158<sup>+</sup>. Water flows through the man-made access road dike, with a riser section at the upstream end to regulate the level of the Middle Reservoir. The 36 inch is located through a strip of high ground that runs to a small hill which also serves to separate the reservoir. The 36 inch pipe (invert elevation of 158<sup>+</sup>) has inlet and gaging structures. The inlet structure has provisions for stoplogs. A depth/flow gaging structure is located to the north of the access road. This structure also has provisions for stoplogs. Six feet of stoplogs were found to be in place at this structure during a field inspection.

b. Discharge at Outlet

1. Outlet Works

The outlet works for the South Reservoir consist of a spillway structure and channel, a 30 inch waste drain pipe, and a 24 inch pipe which connects into the Town's water supply system. The inverts of these pipes are not known. Outflow through the waste drain pipe is controlled by a gate located within the gatehouse. The operability of this gate is unknown. The waste pipe discharges from a stone masonry headwall outlet structure located about 45 feet downstream of the toe. The outlet invert is at elevation 120<sup>+</sup>. If the 30 inch waste drain pipe were useable, its maximum capacity would be at about 150

cfs. The 24 inch pipe could have a maximum capacity of 100 cfs.

The spillway (see photograph 2) consists of a 25 foot long by 8 foot 10 inch high opening beneath a roadway overpass. A 3 foot wide channel separates a 2 foot high concrete weir into two sections of 8 and 14 feet in length. There are provisions for 2 feet of stoplogs in the channel and 6 inches of flashboards on the weir. The 2 foot high weir reduces the vertical clearance under the roadway bridge to 6 feet 10 inches. The invert of the channel is at elevation 158.5<sub>+</sub> while the elevation of the weir crest is 160.5<sub>+</sub>.

## 2. Maximum Known Flood

Records of maximum past floods or reservoir impoundments were not located. Data from the U.S. Weather Bureau indicate that over 14 inches of rainfall occurred in the vicinity of South Reservoir during the period of August 19 to 10, 1955.

## 3. Ungated Spillway Capacity at Top of Dam

Under normal operating conditions, with the 30-inch waste drain pipe closed and no flashboards in place at the spillway, the spillway capacity is 450 cfs with the reservoir water level at the top of dam, elevation 163.5.

## 4. Ungated Spillway Capacity at Test Flood

The spillway, with no stoplogs or flashboards in place and the 30-inch waste drain pipe closed, would have a capacity of 200 cfs or 100 percent of the routed test flood outflow. The test flood surcharge elevation would be 162.3 feet.

## 5. Total Project Discharge at Top of Dam

The total project discharge with the reservoir level

at the top of dam, elevation 163.5, no flashboards in the spillway and the 30-inch waste drain pipe closed would be about 450 cfs.

6. Project Discharge at Test Flood Elevation

The total project discharge for the test flood condition with the 30-inch waste drain pipe open would be approximately 350 cfs, for a reservoir elevation of about 162.6. The total project discharge with this waste drain pipe closed is 200 cfs.

c. Elevation (ft. above NGVD - approximate only)

|      |                                          |                    |
|------|------------------------------------------|--------------------|
| (1)  | Streambed at toe of dam -----            | 125.5 <sub>+</sub> |
| (2)  | Bottom of cutoff -----                   | Unknown            |
| (3)  | Maximum tailwater -----                  | Unknown            |
| (4)  | Normal pool -----                        | 158 <sub>+</sub>   |
| (5)  | Full flood control pool -----            | N/A                |
| (6)  | Spillway crest -----                     | 158.5              |
|      | top of 2' foot concrete weir             | 160.5              |
| (7)  | Design surcharge (Original Design) ----- | Unknown            |
| (8)  | Top of dam -----                         | 163.5              |
| (9)  | Top of East Dike -----                   | 163.5              |
| (10) | Top of West Dike -----                   | 163.5              |
| (11) | Test flood surcharge -----               | 162.6 <sub>+</sub> |

d. Reservoir (Length in feet; South & Middle Reservoir)

|     |                                   |                   |
|-----|-----------------------------------|-------------------|
| (1) | Normal pool (elevation 158) ----- | 7300 <sub>+</sub> |
| (2) | Spillway crest pool -----         | 7600 <sub>+</sub> |
| (3) | Top of dam -----                  | 7650 <sub>+</sub> |
| (4) | Test flood pool -----             | 7650 <sub>+</sub> |
| (5) | Flood control pool -----          | N/A               |

e. Storage (acre-feet; South & Middle Reservoir)

|     |                             |       |       |
|-----|-----------------------------|-------|-------|
| (1) | Normal pool (elevation 158) | ----- | 1790+ |
| (2) | Spillway crest pool         | ----- | 1850  |
| (3) | Test flood pool             | ----- | 2550  |
| (4) | Top of dam                  | ----- | 2720  |
| (5) | Flood control pool          | ----- | N/A   |

f. Reservoir Surface (acres; South & Middle Reservoir)

|     |                                  |       |     |
|-----|----------------------------------|-------|-----|
| (1) | Normal pool                      | ----- | 129 |
| (2) | Spillway crest (elevation 158.5) | ----- | 133 |
| (3) | Test flood pool                  | ----- | 164 |
| (4) | Top of dam                       | ----- | 171 |
| (5) | Flood control pool               | ----- | N/A |

g. Dam

|                                      | <u>West Di</u>   | <u>East Di</u> |
|--------------------------------------|------------------|----------------|
| (1) Type - gravity, earth embankment | earth embankment |                |
| (2) Length - 950'                    | 200'             | 100'           |
| (3) Height - 38'                     | 6'               | 13.5'          |
| (4) Top Width - 12'                  | 15'              | 32'            |
| (5) Side Slopes - Approx.<br>1.5H:1V | 2H:1V            | 1.5H:1V        |
| (6) Zoning - Unknown                 | Unknown          |                |
| (7) Impervious Core - Unknown        | Unknown          |                |
| (8) Cutoff - Unknown                 | Unknown          |                |
| (9) Grout curtain - Unknown          | Unknown          |                |

h. Diversion and Regulating Tunnel ----- None

i. Spillway

|     |                      |                   |
|-----|----------------------|-------------------|
| (1) | Type -----           | broadcrested weir |
| (2) | Length of weir ----- | 25'               |

- (3) Crest elevation (top of concrete weir) --- 160.5 no  
flashboards  
2'x3' channel opening elevation 158.5
- (4) Gates ----- None
- (5) U/S Channel ----- 26' wide with 1.5H:1V side slopes
- (6) D/S Channel ----- 26'+ wide, with 15' drop at  
1H:1V slope 90' downstream of spillway
- (7) General ----- weir has 3' wide by 2' high  
channel opening which divides  
it into two sections

j. Regulating Outlets

The regulating outlets for the South Reservoir are the 24 inch water supply pipe and the 30 inch waste pipe. Discharge to the water supply system through the 24 inch pipe or to a brook downstream through the 30 inch waste drain pipe is controlled by manually operated gates located within the gatehouse. The elevations of the intakes for either of these pipes is not known. The outlet for the waste pipe (photographs 9 and 10) is located about 45 feet downstream of the toe of dam. It has an invert elevation of approximately 120 and a stone masonry outlet structure with a 3 foot wide headwall and two 15 foot long sidewalls.

SECTION 2  
ENGINEERING DATA

2.1 Design Data

No information was located indicating when or by whom the dam was designed. No indepth design calculations were located.

2.2 Construction Data

No construction data was located for this dam. A stone marker over the door of the gatehouse gives a date of 1890.

2.3 Operation Data

No operational manual exists for this dam.

2.4 Evaluation of Data

a. Availability

No engineering data was located regarding South Reservoir Dam. A State Inspection Report for 1974 was made available at the State Department of Environmental Quality Engineering, Division of Waterways, Boston Office.

b. Adequacy

No indepth engineering data was made available. This, therefore, does not permit structural and hydraulic assessment of the dam from the standpoint of review of design calculations, but must be based primarily on the visual inspection, past performance history, and sound engineering judgement.

c. Validity

The visual inspection of the dam indicated a maximum height of approximately 38 feet and a length of 950 feet. The State Inspection Report indicated a maximum height of 10 feet and a length of 200 feet. The existence of dikes were not indicated within the State Inspection Report.

SECTION 3  
VISUAL INSPECTION

3.1 Findings

a. General

The visual inspection included the main dam and the two dikes located to the east and west of the main dam. The water level in the reservoir was about 11.5 feet below the crest of dam at the time of inspection. Although the control gate for the waste pipe is reported to be closed, water was observed within the outlet channel which may indicate leakage.

b. Dam

The dam is an earth embankment about 38 feet high, 950 feet long, and 12 feet wide at the crest. A spillway is located at the right abutment and outlet works are located near the center of the dam. Bedrock outcrops at the left abutment of the dam and in the spillway channel at the right abutment of the dam.

Upstream Slope

The upstream slope of the dam is inclined at about 1.5H:1V and is protected by riprap up to about 4 to 5 feet below the crest, as shown in photograph 4. The riprap is in good condition. The upper 4 to 5 feet of the upstream slope above the riprap is overgrown with brush, and a few small trees are growing on the slope. Minor erosion gullies were noted on the slope at both sides of the service bridge to the brick gatehouse which is located in the reservoir near the center of the dam.

### Crest

The crest of the dam is rutted by vehicular traffic, as shown in photograph 5, and bare soil is exposed in the ruts. No evidence of cracking or misalignment of the crest was observed.

### Downstream Slope

The downstream slope of the dam is separated into upper and lower portions by a midslope berm, as shown in photographs 12 and 14. The slope is inclined at 1.5H:1V. An unpaved access roadway runs along the midslope of the downstream slope, photograph 6, and a few small animal holes were observed on the slope. The lower portion of the downstream slope is heavily overgrown with brush, and a few small trees are growing on the slope, photographs 7 and 8. Much of the brush on the lower downstream slope consists of new growth from stumps of trees that have been cut in the past. Several minor erosion scarps and gullies (up to 2 to 3 feet wide and 6 to 12 inches deep) were noted on the lower downstream slope. No seepage was observed on the downstream side of the dam.

### East Dike

The east dike is an earth embankment about 13.5 feet high, 100 feet long, and 32 feet wide at the crest, located to the east of the main dam.

### Upstream Slope

The upstream slope of the dike is inclined at 1.5H:1V and is protected by riprap up to about 4 to 5 feet below the crest, as shown in photograph 22. Brush is growing on the upstream slope above the riprap, as shown in photograph 22. There is an erosion gully approximately 4 feet wide and 2.5 feet deep

on the upstream slope at the left abutment, as shown in photographs 20 and 21.

#### Crest

A dirt access road runs along the crest of the dike, as shown in photograph 19. No evidence of cracking or misalignment was observed.

#### Downstream Slope

The downstream slope of the dike is inclined at 1.5H:1V and is shown in photograph 23. There is a 2 to 3 foot high rubble stone wall at the toe of the slope. Several small trees are growing on the downstream slope and at the downstream toe, as shown in photograph 23.

#### West Dike

The west dike is an earth embankment about 6 feet high, 200 feet long, and 15 feet wide at the crest, located to the west of the main dam.

#### Upstream Slope

The upstream slope of the west dike is shown in photograph 18. The upper portion of the slope is inclined at 2H:1V down to about 3 feet below the crest. Below this point, the slope becomes relatively flat, forming a broad berm about 3 feet above the toe. The toe of the slope is protected by riprap extending about 2 to 3 feet above the toe. A number of trees are growing on the upstream slope, as shown in photograph 18.

#### Crest

A dirt access road runs along the crest of the west dike and the surface of the crest is rutted from vehicular traffic,

photograph 17. No evidence of cracking or misalignment was observed.

#### Downstream Slope

The downstream slope of the west dike is inclined at 2H:1V. A number of large trees (up to 2.5 feet diameter) are growing on the slope and at the downstream toe, as shown in photograph 16. Several of these trees appear to be dead. Several large exposures of rock were observed on the downstream slope, as shown in photograph 16. It is not known whether these rock exposures are bedrock outcrops or large boulders embedded in the slope.

#### c. Appurtenant Structures

##### Spillway

The spillway is cut through the right abutment of the dam. The floor of the spillway channel is bare soil with no lining to protect against erosion; however, the soil in the floor of the channel does not appear to be highly susceptible to erosion and no signs of erosion were evident. There is a 2 foot high concrete weir at the spillway crest, as shown in photograph 2. The spillway training walls are constructed of mortared stone masonry blocks and are in good condition.

The spillway approach channel is shown in photograph 3. The banks of the approach channel are lined with a smooth hand-fitted riprap facing which is in good condition. The spillway discharge channel is shown in photograph 1. Heavily jointed bedrock is exposed in the banks and floor of the discharge channel. There is some brush and a few small trees growing in the

approach and discharge channels, as shown in photograph 1. The concrete and steel beam access road bridge which passes over the spillway was observed to be in good condition.

#### Outlet Works

A brick gatehouse, shown in photograph 15, is located about 300 feet from the left abutment. A water treatment building is located at the downstream toe of the dam directly downstream from the gatehouse, as shown in photographs 7 and 12. A 30-inch waste drain pipe discharges into a stone masonry-lined outlet channel just to the left of the brick water treatment building at the downstream toe of the dam, as shown in photographs 9, 10, and 11. It is not known if the 30-inch pipe and valve are usable. A 24-inch water supply pipe is used daily with the control valve left open. The condition of this valve is not known. A few dead trees have fallen across the channel, as shown in photograph 11. The service bridge and gatehouse appear to be in generally good condition.

#### d. Reservoir Area

There are no indications of instability along the banks of the reservoir in the vicinity of the dam.

### 3.2 Evaluation

Based on the visual inspection, the dam appears to be in generally good condition and the dikes appear to be in generally fair condition. The inspection disclosed the following items which require attention:

a. The trees growing on the slopes and at the downstream toe of the dam and dikes could cause seepage or erosion problems

if a tree blows over and pulls out its roots or if a tree dies and rotting roots provide pathways for seepage.

b. The crests of the dam and dikes are rutted by vehicular traffic and there is no protective vegetation, gravel or paving to protect the crests against erosion.

c. A large erosion gully has formed on the upstream slope of the east dike at the left abutment.

d. Brush and several small trees are growing in the spillway channel, creating a potential obstruction for the spillway flow.

e. Fallen trees are obstructing the outlet discharge channel.

f. The control valves for the 30-inch waste drain pipe and 24-inch water supply pipe should be inspected and repairs made as necessary to make them useable.

## SECTION 4

### OPERATIONAL AND MAINTENANCE PROCEDURES

#### 4.1 Operational Procedures

##### a. General

The purpose of the dam is for public water supply. The reservoirs are supplied by natural runoff and water pumped from the MDC facilities at Spot Pond Reservoir through a 12 inch force main into the Middle Reservoir.

Flow into the Winchester water supply system is controlled by a manually operated gate in the gatehouse which is always kept open. Although not normally used, stoplogs and flashboards can be installed at the spillway to regulate the outflow and reservoir level.

Flow between the Middle and South Reservoir is regulated by a valve and stoplogs at the two culverts between the reservoirs. The stoplogs are manually installed at the intake or gaging structure of the 36 inch culvert. Flow from Spot Pond pumped into Middle Reservoir could reach 300 to 400 million gallons per year. The water level of South and Middle reservoirs normally varies between elevations 155 to 157±.

##### b. Description of Warning Systems

There are no warning systems in effect at this dam.

#### 4.2 Maintenance Procedures

##### a. General

The Winchester Department of Public Works is responsible for the maintenance of this dam. The dam and its associated

structures are checked by employees of the Winchester Department of Public Works.

b. Operating Facilities

There is no formal maintenance procedure for this facility. As the dam is used for water supply purposes, any deficiencies in the operational facilities could be detected during normal operation.

4.3 Evaluation

There are no formal written operational or maintenance procedures. The Winchester Department of Public Works periodically checks the facility and performs general maintenance. A program of annual technical inspection should be instituted.

## SECTION 5

### EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

#### 5.1 General

The South and Middle Reservoirs are located in the northwest section of Medford near the Medford-Stoneham-Winchester corporate boundaries. Their combined drainage area of 0.76 square miles (486 acres) is generally forested and undeveloped. It is made up of hilly terrain which drains directly to the reservoirs. The surface area of the South Reservoir is 100 acres at the top of dam, elevation 163.5, while that of the Middle Reservoir is 71 acres at the top of dam. The reservoirs are separated by an access road dike and natural ground which connects the shore line to a small hill near the middle of the reservoirs.

The dam and its outlets are located at the southern end of the South Reservoir. Water from the spillway and waste pipe is discharged to a small brook which flows southerly along South Border Road towards Medford Square, where substantial residential development occurs.

An earth embankment dike is located across a low area about 1,300 feet to the northeast of the main dam. This East Dike has a length of about 100 feet and a crest elevation of approximately 163.5. A swampy area, due to the topography, is located just below the dike, and a small stream flows from the swamp to the south and then southeast towards Route 93 and South Border Road. A number of homes are located along the road in this area.

Approximately 300 feet to the west of the main dam and about

200 feet from South Border Road is the West Dike. The West Dike is an earth embankment dike having a height of about 6 feet and a length of about 200 feet. The top of this dike is about 3 feet above the pavement elevation of South Border Road. The drainage path beyond the West Dike follows along low ground to the southwest towards the residential areas of West Medford.

A map of the drainage area along with plans and sketches of the structure and its outlets is contained in Appendixes B and D. Additional information on the drainage area and reservoir can be found in Sections 1.2 and 1.3. Photographs of the facilities are shown in Appendix C.

#### 5.2 Design Data

Hydraulic/hydrologic design data for this project could not be located.

#### 5.3 Experience Data

Records of past flood experiences and possible overtopping of the dam could not be located. During the period from August 17 to 20, 1955, U.S. Weather Bureau records indicate about 14 inches of rainfall occurred near the general location of South Reservoir. Similar data from the Weather Bureau shows almost 6 inches of rainfall fell from September 17 to 23, 1938.

#### 5.4 Test Flood Analysis

The dam has an intermediate size classification and a high hazard potential. Based upon Corps Guidelines, the test flood would be the PMF. The test flood inflow from the 0.76 s.m. drainage area was determined to be 2,280 cfs. Runoff from the small 0.76 s.m. drainage area is below the 2.0 s.m. lower limit of the Corps Guideline Chart for Runoff. For these small areas,

test flood runoff rates are based upon 3000 cfs per square mile.

Under normal operation, with no flashboards in place, the 30-inch waste drain gate closed, and the initial pool elevation at 158.5, spillway crest, the test flood would surcharge the reservoirs to elevation 162.3, about 1.2 feet below the top of dam. The routed test flood outflow is 200 cfs through the spillway. The reservoirs would provide stage storage for approximately 17.4 inches of runoff. The test flood would not overtop the natural land between the two reservoirs, the access road dike, or either of the west and east dikes.

If 6 inch flashboards were used on top of the concrete weir (elevation 161, top of flashboard) at the spillway, the routed test flood outflow would be 190 $\pm$  cfs, at elevation 162.7 $\pm$ . The crest of dam (elevation 163.5) would not be overtopped.

#### 5.5 Dam Failure Analysis

South Reservoir has a main dam and two dikes. The west dike is located approximately 300 feet to the west of the main dam; the east dike about 1,300 feet to the northeast. A failure analysis was performed for the main dam and both dikes, assuming an initial reservoir elevation of 163.5, top of dam. Each failure will be discussed separately. See the dam and dikes failure impact maps shown in Appendix D.

No failure analysis was performed for the access road dike. Under normal operating conditions, the maximum pool level difference between the two reservoirs would be no more than 1

foot. The sudden drawdown of the South Reservoir, as a result of the failure of the main dam for example, could cause the subsequent failure of the access road dike. This secondary flood wave could result in additional flood damages within the main dam failure impact area.

#### Main Dam

The main dam has a hydraulic height of 38 feet and a maximum storage capacity of 1,500 acre-feet. Immediately prior to dam failure, the spillway (assuming the waste pipe closed) would be discharging approximately 450 cfs. If the gate to waste pipe were open, the combined pre-failure discharge would be approximately 540 cfs. These flows, with flood stages of about 1 to 2 feet, would result in little or no flood damages to structures downstream.

Based on Corps "rule of thumb" guidance, failure of the dam would result in a calculated peak outflow of 41,400 cfs. This flow was developed by assuming 40 percent of a 260 foot length of dam, measured at midheight at the original stream location, has failed. It also includes the spillway base flow of about 480 cfs. As the area immediately downstream of the dam is undeveloped, no homes would be inundated by failure flooding within the first 3,300 feet downstream, although portions of South Border Road could be flooded by up to 10 feet of water. In the area between 3,300 and 6,000 feet downstream, at least 10 homes could be damaged from flood stages of 1 to 6 feet in depth, including base flow depths of about 1 foot deep. Downstream of this point, an area of moderate to heavy urban residential

development occurs. A high number of homes, estimated to be in excess of 150 structures, could be inundated by 1 to 10 feet of water. Loss of more than a few lives and excessive property damage could occur as a result of the failure of this dam, therefore, a high hazard classification is established.

#### West Dike

The west dike has a structural height of 6 feet. However, the South Border Road embankment cuts across the outlet brook about 200 feet beyond the dike. This embankment, which is about 3 feet below the top of the dike, would act as a secondary dam and reduce the extent of the failure of the dike and the resulting failure outflow.

Based on Corps "rule of thumb" guidance and a hydraulic height of 3 feet (for that portion of the dike above the roadway), the peak outflow from failure of the west dike was determined to be 700 cfs. South Border Road would be overtopped by about 3 feet, but there would be no damage for 3,000 feet downstream, as the failure discharge flows through the Middlesex Fells Reservation. Beyond, about 3,900 feet downstream of the west dike, an estimated 5 to 10 homes and several roads would be inundated by 2 to 3 feet of water. Loss of more than a few lives due to failure flooding is possible; thus the West Dike is classified as high hazard.

#### East Dike

The east dike is approximately 100 feet long and has a hydraulic height of 13.5 feet. Failure of this dike would result in a flood outflow of 3,330 cfs, based on Corps "rule of thumb"

guidance. There is no development within the impact area of the east dike for a substantial distance downstream, (between 5,000 and 5,500 feet). The failure outflow would overtop South Border Road near Bellevue Pond, and could flood several houses by 1 to 3 feet. After crossing South Border Road, the flood water would fill a depression located about 300 feet to the west of Roosevelt Circle. About five houses would be inundated by 5 feet or more.

In addition, the impact area would extend to the Roosevelt Circle Interchange area and Route 93, where another 5 to 10 homes and portions of the interchange, could be flooded by 1 to 2 feet of water. Loss of more than a few lives due to failure flooding is possible; therefore, the East Dike is classified as high hazard.

## SECTION 6

### EVALUATION OF STRUCTURAL STABILITY

#### 6.1 Visual Observations

The visual inspection did not disclose any immediate stability problems.

#### 6.2 Design and Construction Data

No original design and construction data are available for the dam.

#### 6.3 Post-Construction Data

No information is available about post-construction changes.

#### 6.4 Seismic Stability

The dam is located in Seismic Zone 3 and considering its height, a seismic stability investigation should be conducted as recommended in Section 7.

## SECTION 7

### ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

#### 7.1 Dam Assessment

##### a. Condition

Based on a visual inspection, the dam is judged to be in generally good condition and the dikes are judged to be in generally fair condition.

##### b. Adequacy of Information

The information made available, along with the visual inspection, is adequate for a Phase I level investigation.

##### c. Urgency

The recommendations and remedial measures presented below should be implemented by the Owner within one year after receipt of this Phase I Inspection Report.

#### 7.2 Recommendations

The Owners should engage a qualified registered professional engineer to:

a. Determine procedures for removal of trees growing on the dam and dike embankments and to assist in the selection of suitable fill materials for backfilling of the voids left in the embankment after removal of the tree root systems.

b. Perform a seismic investigation of the dam and dikes.

#### 7.3 Remedial Measures

##### a. Operation and Maintenance Procedures

1. Brush should be cleared from the slopes of the dam and dike embankments and from the area within 10 feet of the downstream toe.

2. The vehicle ruts on the crest of the dam and dikes should be repaired, and the bare soil on the crest should be protected against erosion by a cover of protective vegetation, gravel surface or pavement. Erosion gullies located near the service bridge to the gatehouse should be repaired.

3. The erosion gully on the upstream slope of the east dike at the left abutment should be repaired, and provisions should be made to channel the local runoff at the left abutment so as to prevent future erosion.

4. The brush should be removed from the spillway channel.

5. The fallen trees should be removed from the outlet discharge channel.

6. The Owner should develop a formal warning system for downstream areas in case of an emergency.

7. The Owner should inspect both the 30 inch diameter waste pipe and 24 inch diameter water supply pipe and their valves and make any necessary repairs to insure they can function properly. The waste pipe outlet channel should be cleaned and kept operable.

8. Animal holes should be filled as they appear.

9. The Owner should develop a formal maintenance procedure for the dam and dikes.

10. The owner should institute a program of annual technical inspection.

#### 7.4 Alternatives

There are no practical alternatives for these recommendations.

APPENDIX A  
INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST  
PARTY ORGANIZATION

PROJECT SOUTH RESERVOIR DAM

DATE Nov. 1, 1979

TIME 7:45 am

WEATHER Cool (~45°), clear

W.S. ELEV. 152<sup>+</sup> U.S.        DN.S.

PARTY:

- |                                            |                                             |
|--------------------------------------------|---------------------------------------------|
| 1. <u>R. Cheney, HHB</u>                   | 6. <u>                                </u>  |
| 2. <u>D. Vine, HHB</u>                     | 7. <u>                                </u>  |
| 3. <u>D. LaGatta, GEI</u>                  | 8. <u>                                </u>  |
| 4. <u>D. Shields, GEI</u>                  | 9. <u>                                </u>  |
| 5. <u>                                </u> | 10. <u>                                </u> |

| PROJECT FEATURE                             | INSPECTED BY                | REMARKS  |
|---------------------------------------------|-----------------------------|----------|
| 1. <u>East Dike</u>                         | <u>D LAGATTA, D SHIELDS</u> |          |
| 2. <u>West Dike</u>                         | <u>"</u>                    | <u>"</u> |
| 3. <u>Dam Embankment</u>                    | <u>"</u>                    | <u>"</u> |
| 4. <u>Intake Structure</u>                  | <u>ALL</u>                  |          |
| 5. <u>Outlet Structure &amp; Channel</u>    | <u>ALL</u>                  |          |
| 6. <u>                                </u>  |                             |          |
| 7. <u>                                </u>  |                             |          |
| 8. <u>                                </u>  |                             |          |
| 9. <u>                                </u>  |                             |          |
| 10. <u>                                </u> |                             |          |

# PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979  
 PROJECT FEATURE Earth Embankment Dam NAME D. LaGatta  
 DISCIPLINE Geotechnical Engineer NAME R. Cheney  
Structural Engineer

| AREA EVALUATED                                        | CONDITION                                                                                                 |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <u>DAM EMBANKMENT</u>                                 |                                                                                                           |
| Crest Elevation                                       | 163.5                                                                                                     |
| Current Pool Elevation                                | 152 <sup>+</sup>                                                                                          |
| Maximum Impoundment to Date                           | Unknown                                                                                                   |
| Surface Cracks                                        | None observed.                                                                                            |
| Pavement Condition                                    | No pavement, dirt roadway.                                                                                |
| Movement or Settlement of Crest                       | None observed.                                                                                            |
| Lateral Movement                                      | None observed.                                                                                            |
| Vertical Alignment                                    | No misalignment observed.                                                                                 |
| Horizontal Alignment                                  | No misalignment observed.                                                                                 |
| Condition at Abutment and at Concrete Structures      | Minor erosion gullies at sides of service bridge to gatehouse.                                            |
| Indications of Movement of Structural Items on Slopes | None observed.                                                                                            |
| Trespassing on Slopes                                 | No evidence of trespassing.                                                                               |
| Sloughing or Erosion of Slopes or Abutments           | Few minor erosion scarps and gullies (up to 2-3 ft wide and 6-12 in. deep) on the lower downstream slope. |
| Rock Slope Protection - Riprap Failures               | Riprap in good condition.                                                                                 |
| Unusual Movement or Cracking at or Near Toe           | None observed.                                                                                            |
| Unusual Embankment or Downstream Seepage              | None observed.                                                                                            |
| Piping or Boils                                       | None observed.                                                                                            |
| Foundation Drainage Features                          | None observed.                                                                                            |
| Toe Drains                                            | None observed.                                                                                            |
| Instrumentation System                                | None.                                                                                                     |
| Vegetation                                            | Brush and several small trees on slopes.                                                                  |

# PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979  
 PROJECT FEATURE East Dike NAME D. LaGatta  
 DISCIPLINE Geotechnical Engineer NAME R. Cheney  
Structural Engineer

| AREA EVALUATED                                        | CONDITION                                                                               |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------|
| <u>DIKE EMBANKMENT</u>                                | <u>EAST DIKE</u>                                                                        |
| Crest Elevation                                       | 163.5 ±                                                                                 |
| Current Pool Elevation                                | 152 ±                                                                                   |
| Maximum Impoundment to Date                           | Unknown                                                                                 |
| Surface Cracks                                        | None observed.                                                                          |
| Pavement Condition                                    | No pavement, dirt roadway.                                                              |
| Movement or Settlement of Crest                       | None observed.                                                                          |
| Lateral Movement                                      | None observed.                                                                          |
| Vertical Alignment                                    | No misalignment observed.                                                               |
| Horizontal Alignment                                  | No misalignment observed.                                                               |
| Condition at Abutment and at Concrete Structures      | Erosion on upstream slope at left abutment.                                             |
| Indications of Movement of Structural Items on Slopes | None observed.                                                                          |
| Trespassing on Slopes                                 | No evidence observed.                                                                   |
| Sloughing or Erosion of Slopes or Abutments           | Large erosion gully (4 ft wide and 2.5 ft deep) on upstream slope at the left abutment. |
| Rock Slope Protection - Riprap Failures               | Riprap in reasonably good condition, some minor sloughing.                              |
| Unusual Movement or Cracking at or Near Toes          | None observed.                                                                          |
| Unusual Embankment or Downstream Seepage              | None observed.                                                                          |
| Piping or Boils                                       | None observed.                                                                          |
| Foundation Drainage Features                          | None observed.                                                                          |
| Toe Drains                                            | None observed.                                                                          |
| Instrumentation System                                | None.                                                                                   |
| Vegetation                                            | Brush and several small trees on slopes and at downstream toe.                          |

# PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979  
 PROJECT FEATURE West Dike NAME D. LaGatta  
 DISCIPLINE Geotechnical Engineer NAME R. Cheney  
Structural Engineer

| AREA EVALUATED                                        | CONDITION                                                 |
|-------------------------------------------------------|-----------------------------------------------------------|
| <u>DIKE EMBANKMENT</u>                                | <u>WEST DIKE</u>                                          |
| Crest Elevation                                       | 163.5 ±                                                   |
| Current Pool Elevation                                | 152 ±                                                     |
| Maximum Impoundment to Date                           | Unknown                                                   |
| Surface Cracks                                        | None observed.                                            |
| Pavement Condition                                    | No pavement, dirt roadway.                                |
| Movement or Settlement of Crest                       | None observed.                                            |
| Lateral Movement                                      | None observed.                                            |
| Vertical Alignment                                    | No misalignment observed.                                 |
| Horizontal Alignment                                  | No misalignment observed.                                 |
| Condition at Abutment and at Concrete Structures      | None observed.                                            |
| Indications of Movement of Structural Items on Slopes | None observed.                                            |
| Trespassing on Slopes                                 | No evidence observed.                                     |
| Sloughing or Erosion of Slopes or Abutments           | None observed.                                            |
| Rock Slope Protection - Riprap Failures               | No riprap.                                                |
| Unusual Movement or Cracking at or Near Toes          | None observed.                                            |
| Unusual Embankment or Downstream Seepage              | None observed.                                            |
| Piping or Boils                                       | None observed.                                            |
| Foundation Drainage Features                          | None observed.                                            |
| Toe Drains                                            | None observed.                                            |
| Instrumentation System                                | None.                                                     |
| Vegetation                                            | Trees growing along crest, downstream slope and toe area. |

# PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979  
 PROJECT FEATURE Intake Structure NAME D. LaGatta  
 DISCIPLINE Geotechnical Engineer NAME P. Cheney  
Structural Engineer

| AREA EVALUATED                                                                                                                                                                                                                                                                                                                                            | CONDITION                                                                                                                                                                               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u></p> <p>a. Approach Channel</p> <p>Slope Conditions</p> <p>Bottom Conditions</p> <p>Rock Slides or Falls</p> <p>Log Boom</p> <p>Debris</p> <p>Condition of Concrete Lining</p> <p>Drains or Deep Holes</p> <p>b. Intake Structure</p> <p>Condition of Concrete</p> <p>Stop Logs and Slots</p> | <p>Not visible, intake under water.</p> <p>Granite Block and Brick Gatehouse was in good condition on the outside. Building was locked during inspection. Inside was not inspected.</p> |

| PERIODIC INSPECTION CHECKLIST                                         |  |                          |                                                                                                                                    |  |  |
|-----------------------------------------------------------------------|--|--------------------------|------------------------------------------------------------------------------------------------------------------------------------|--|--|
| PROJECT <u>SOUTH RESERVOIR DAM</u>                                    |  | DATE <u>Nov. 1, 1979</u> |                                                                                                                                    |  |  |
| PROJECT FEATURE <u>Control Tower</u>                                  |  | NAME <u>D. LaGatta</u>   |                                                                                                                                    |  |  |
| DISCIPLINE <u>Geotechnical Engineer</u><br><u>Structural Engineer</u> |  | NAME <u>R. Cheney</u>    |                                                                                                                                    |  |  |
| AREA EVALUATED                                                        |  |                          | CONDITION                                                                                                                          |  |  |
| <u>OUTLET WORKS - CONTROL TOWER</u>                                   |  |                          |                                                                                                                                    |  |  |
| a. Concrete and Structural                                            |  |                          | NONE                                                                                                                               |  |  |
| General Condition                                                     |  |                          |                                                                                                                                    |  |  |
| Condition of Joints                                                   |  |                          |                                                                                                                                    |  |  |
| Spalling                                                              |  |                          |                                                                                                                                    |  |  |
| Visible Reinforcing                                                   |  |                          |                                                                                                                                    |  |  |
| Rusting or Staining of Concrete                                       |  |                          |                                                                                                                                    |  |  |
| Any Seepage or Efflorescence                                          |  |                          |                                                                                                                                    |  |  |
| Joint Alignment                                                       |  |                          |                                                                                                                                    |  |  |
| Unusual Seepage or Leaks in Gate Chamber                              |  |                          |                                                                                                                                    |  |  |
| Cracks                                                                |  |                          |                                                                                                                                    |  |  |
| Rusting or Corrosion of Steel                                         |  |                          |                                                                                                                                    |  |  |
| b. Mechanical and Electrical                                          |  |                          | All gates are manually operated. The operating condition of these valves is unknown. They were not operated during the inspection. |  |  |
| Air Vents                                                             |  |                          |                                                                                                                                    |  |  |
| Float Wells                                                           |  |                          |                                                                                                                                    |  |  |
| Crane Hoist                                                           |  |                          |                                                                                                                                    |  |  |
| Elevator                                                              |  |                          |                                                                                                                                    |  |  |
| Hydraulic System                                                      |  |                          |                                                                                                                                    |  |  |
| Service Gates                                                         |  |                          |                                                                                                                                    |  |  |
| Emergency Gates                                                       |  |                          |                                                                                                                                    |  |  |
| Lightning Protection System                                           |  |                          |                                                                                                                                    |  |  |
| Emergency Power System                                                |  |                          |                                                                                                                                    |  |  |
| Mining and Lighting System                                            |  |                          |                                                                                                                                    |  |  |

# PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979  
 PROJECT FEATURE Transition & Conduit NAME D. LaGatta  
 DISCIPLINE Geotechnical Engineer NAME R. Cheney  
Structural Engineer

| AREA EVALUATED                                                                                                                                                                                                                                | CONDITION |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <u>OUTLET WORKS - TRANSITION AND CONDUIT</u><br><br>General Condition of Concrete<br>Rust or Staining on Concrete<br>Spalling<br>Erosion or Cavitation<br>Cracking<br>Alignment of Monoliths<br>Alignment of Joints<br>Numbering of Monoliths | NONE      |

# PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979  
 PROJECT FEATURE Outlet Structure & Channel NAME D. LaGatta  
 DISCIPLINE Geotechnical Engineer NAME R. Chenev  
Structural Engineer

| AREA EVALUATED                                                                                                                                                                                                                                                                                                                               | CONDITION                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u><br><br>General Condition of Concrete<br>Rust or Staining<br>Spalling<br>Erosion or Cavitation<br>Visible Reinforcing<br>Any Seepage or Efflorescence<br>Condition at Joints<br>Drain holes<br>Channel<br>Loose Rock or Trees Overhanging Channel<br>Condition of Discharge Channel | Granite Block outlet pipe headwall is in good condition, outlet pipe is almost completely silted in.<br><br><br><br><br><br><br><br><br><br><br>None.<br><br>Lined with unmortared stone masonry blocks (floor not visible below water). Several small trees overhanging channel, few dead trees fallen across channel.<br><br>Silted in and partially blocked by debris. |

# PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979  
 PROJECT FEATURE Spillway NAME D. LaGatta  
 DISCIPLINE Geotechnical Engineer NAME R. Cheney  
Structural Engineer

| AREA EVALUATED                                                       | CONDITION                                                          |
|----------------------------------------------------------------------|--------------------------------------------------------------------|
| <u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u> |                                                                    |
| a. Approach Channel                                                  |                                                                    |
| General Condition                                                    | Good.                                                              |
| Loose Rock Overhanging Channel                                       | None.                                                              |
| Trees Overhanging Channel                                            | Not significant.                                                   |
| Floor of Approach Channel                                            | Floor unlined. Minor brush and few small trees growing in channel. |
| b. Weir and Training Walls                                           |                                                                    |
| General Condition of Concrete                                        | Good                                                               |
| Rust or Staining                                                     | None observed                                                      |
| Spalling                                                             | None observed.                                                     |
| Any Visible Reinforcing                                              | None observed.                                                     |
| Any Seepage or Efflorescence                                         | None observed.                                                     |
| Drain Holes                                                          | None.                                                              |
| c. Discharge Channel                                                 |                                                                    |
| General Condition                                                    | Fair.                                                              |
| Loose Rock Overhanging Channel                                       | Not significant.                                                   |
| Trees Overhanging Channel                                            | Not significant.                                                   |
| Floor of Channel                                                     | Floor unlined. Brush and small trees growing in channel.           |
| Other Obstructions                                                   | None.                                                              |

# PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979  
 PROJECT FEATURE Service Bridge NAME D. LaGatta  
 DISCIPLINE Geotechnical Engineer NAME R. Cheney  
Structural Engineer

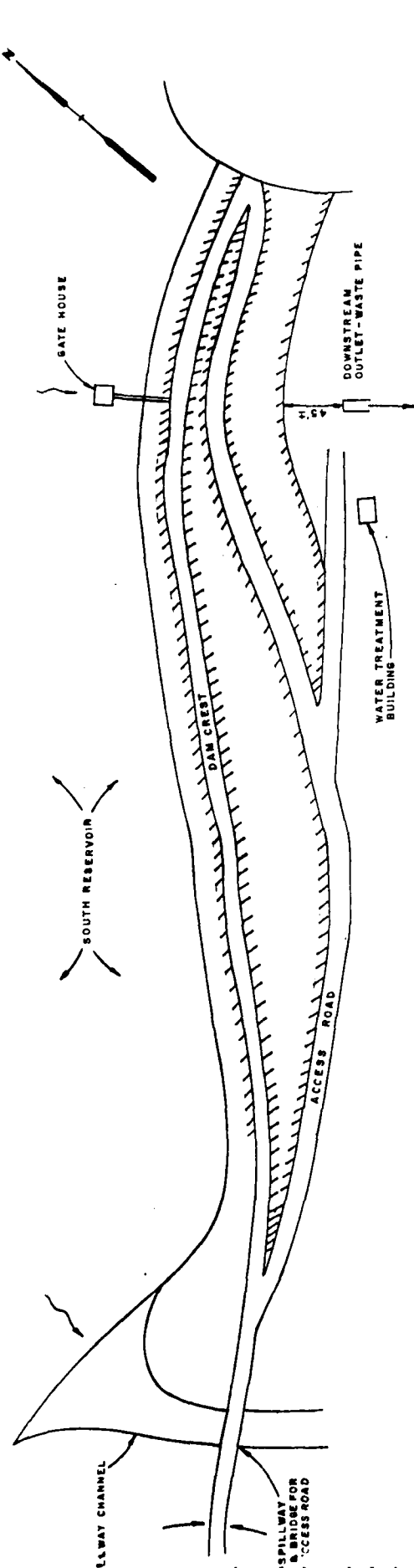
| AREA EVALUATED                       | CONDITION                                                                                  |
|--------------------------------------|--------------------------------------------------------------------------------------------|
| <u>OUTLET WORKS - SERVICE BRIDGE</u> |                                                                                            |
| a. Super Structure                   | The painted steel truss and wood deck service bridge was observed to be in good condition. |
| Bearings                             |                                                                                            |
| Anchor Bolts                         |                                                                                            |
| Bridge Seat                          |                                                                                            |
| Longitudinal Members                 |                                                                                            |
| Underside 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

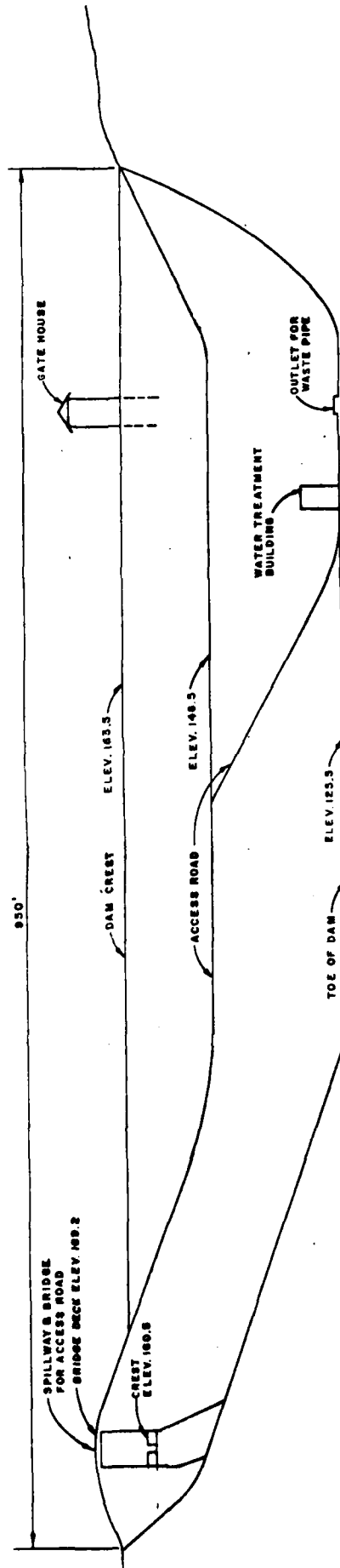
LIST OF ENGINEERING DATA

A State Inspection Report for March, 1974, is available from the Department of Environmental Quality, Waterways Division, 100 Nashua Street, Boston, Massachusetts.

No additional engineering data was located.



PLAN VIEW



ELEVATION

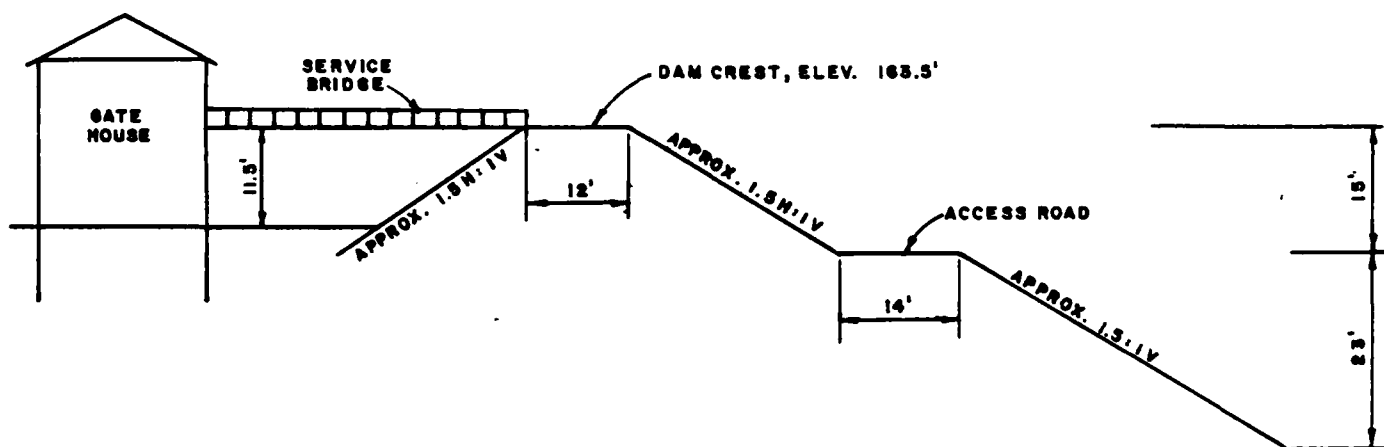
NOTE: PLAN DEVELOPED FROM ON-SITE INVESTIGATION

HAYDEN, HARDING & BUCHANAN, INC. U.S. ARMY ENGINEER DISTRICT NEW ENGLAND  
CORPS OF ENGINEERS  
BOSTON, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

# SOUTH RESERVOIR DAM PLAN & ELEVATION

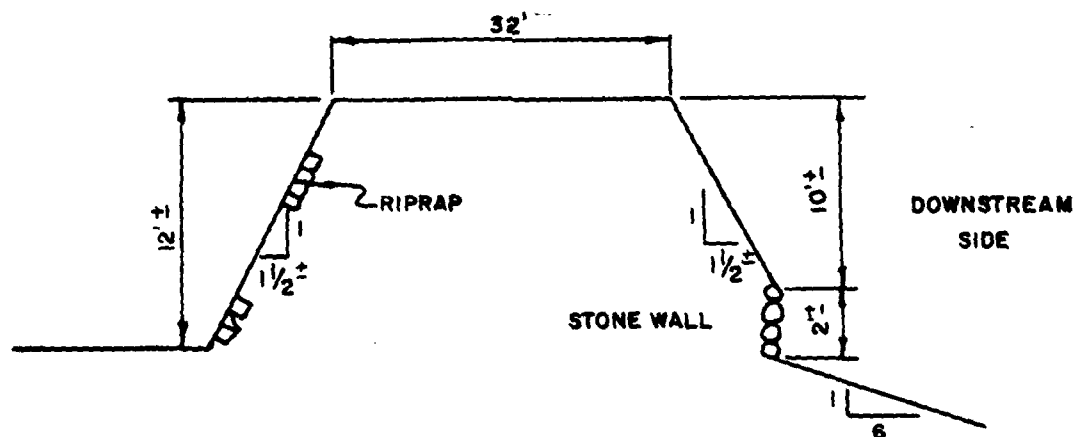
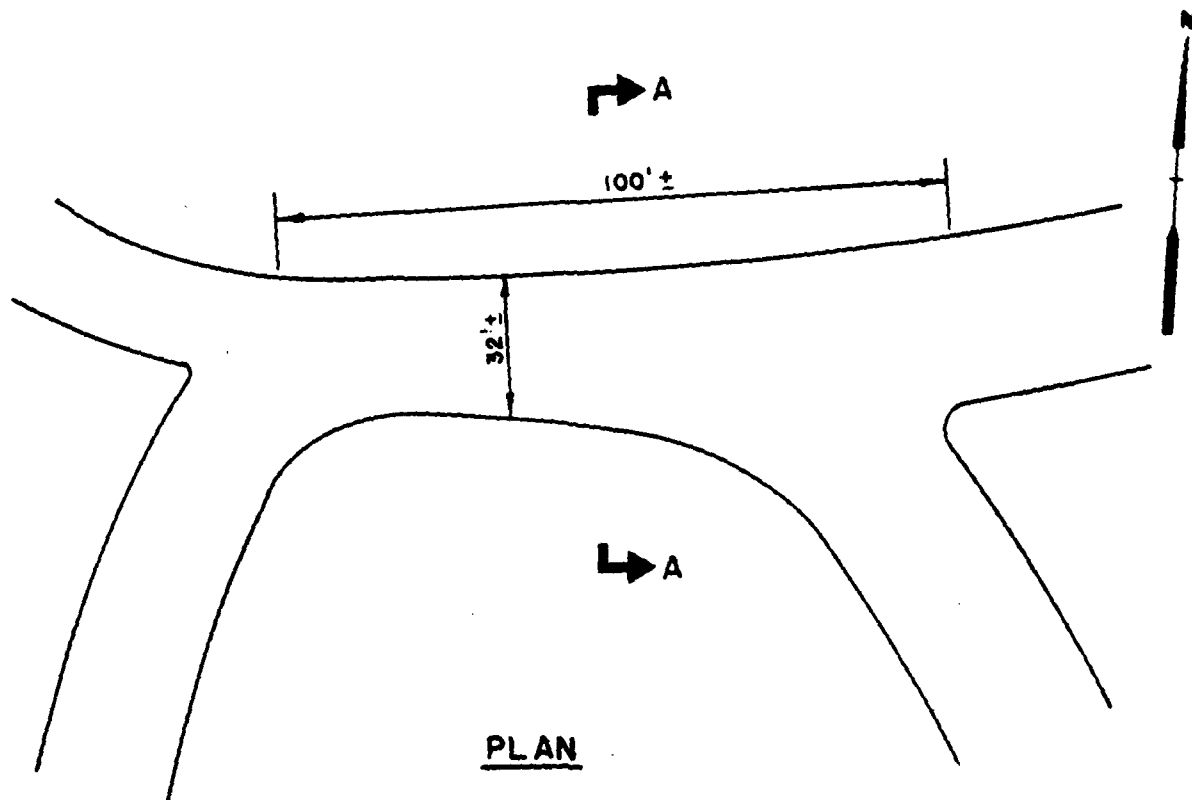
WINCHESTER MASSACHUSETTS  
SCALE NOT TO SCALE  
DATE MARCH 1980



### SOUTH RESERVOIR DAM SECTION

NOTE:  
PLAN DEVELOPED FROM ON-SITE INVESTIGATION

|                                                                                   |  |                                                                            |  |
|-----------------------------------------------------------------------------------|--|----------------------------------------------------------------------------|--|
| HAYDEN, HARDING & BUCHANAN, INC.<br>CONSULTING ENGINEERS<br>BOSTON, MASSACHUSETTS |  | U.S. ARMY ENGINEER DIV. NEW ENGLAND<br>CORPS OF ENGINEERS<br>WALTHAM, MASS |  |
| NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS                                   |  |                                                                            |  |
| <b>SOUTH RESERVOIR DAM<br/>SECTION</b>                                            |  |                                                                            |  |
| WINCHESTER                                                                        |  | MASSACHUSETTS                                                              |  |
|                                                                                   |  | SCALE: NOT TO SCALE                                                        |  |
|                                                                                   |  | DATE: MARCH 1980                                                           |  |



HAYDEN, HARDING & BUCHANAN, INC  
CONSULTING ENGINEERS  
BOSTON, MASSACHUSETTS

U.S. ARMY ENGINEER DIV NEW ENGLAND  
CORPS OF ENGINEERS  
WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

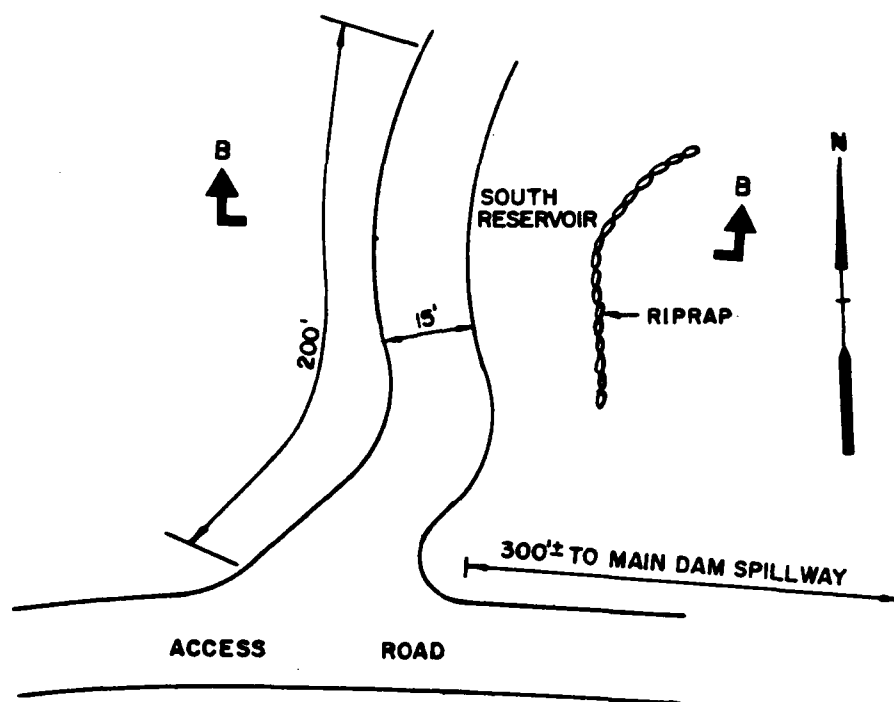
## SOUTH RESERVOIR DAM

EAST DIKE PLAN & SECTION

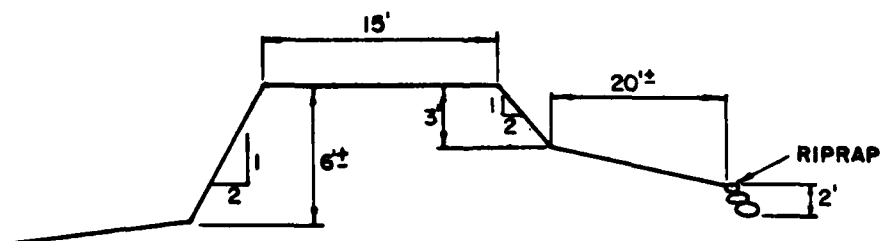
MASSACHUSETTS

SCALE: NOT TO SCALE

DATE MARCH 1980

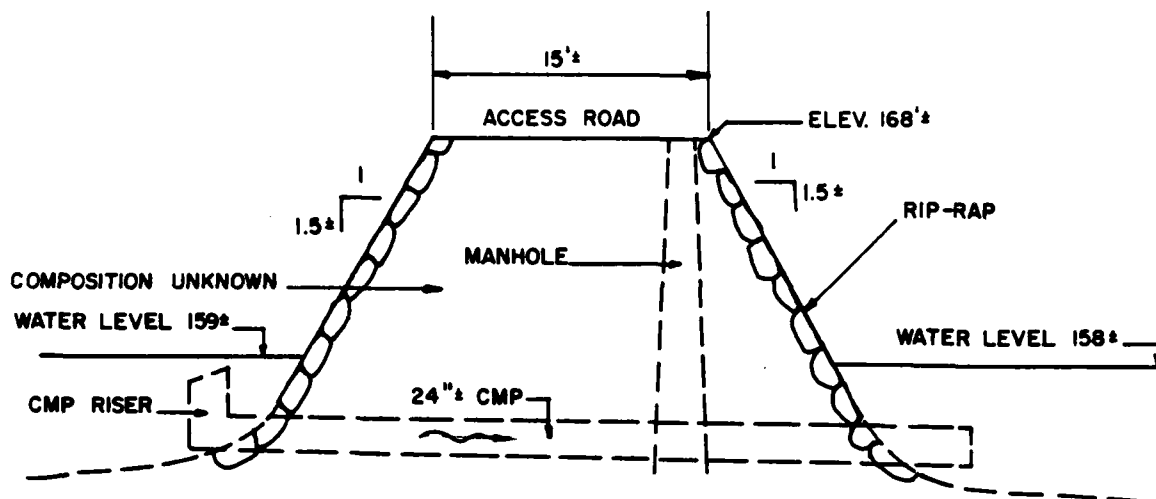


**WEST DIKE**

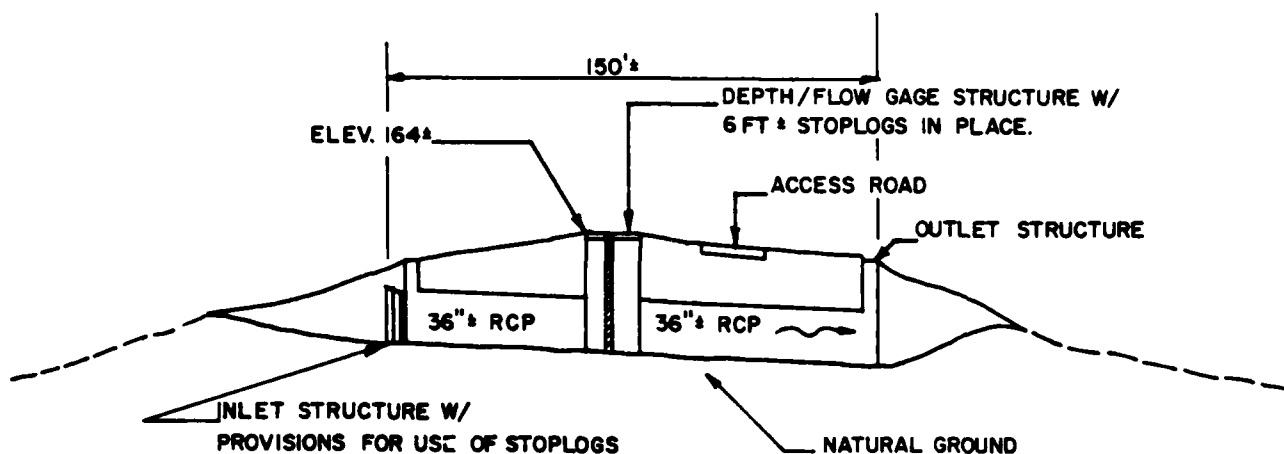


**SECTION B-B**

|                                                                                   |  |                                                                             |                     |
|-----------------------------------------------------------------------------------|--|-----------------------------------------------------------------------------|---------------------|
| HAYDEN, HARDING & BUCHANAN, INC.<br>CONSULTING ENGINEERS<br>BOSTON, MASSACHUSETTS |  | U.S. ARMY ENGINEER DIV. NEW ENGLAND<br>CORPS OF ENGINEERS<br>WALTHAM, MASS. |                     |
| NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS                                   |  |                                                                             |                     |
| SOUTH RESERVOIR DAM<br>WEST DIKE PLAN & SECTION                                   |  |                                                                             |                     |
| WINCHESTER                                                                        |  | MASSACHUSETTS                                                               |                     |
|                                                                                   |  |                                                                             | SCALE: NOT TO SCALE |
|                                                                                   |  |                                                                             | DATE MARCH 1980     |



**SECTION AT ACCESS ROAD DIKE  
SHOWING CROSS-CULVERT**

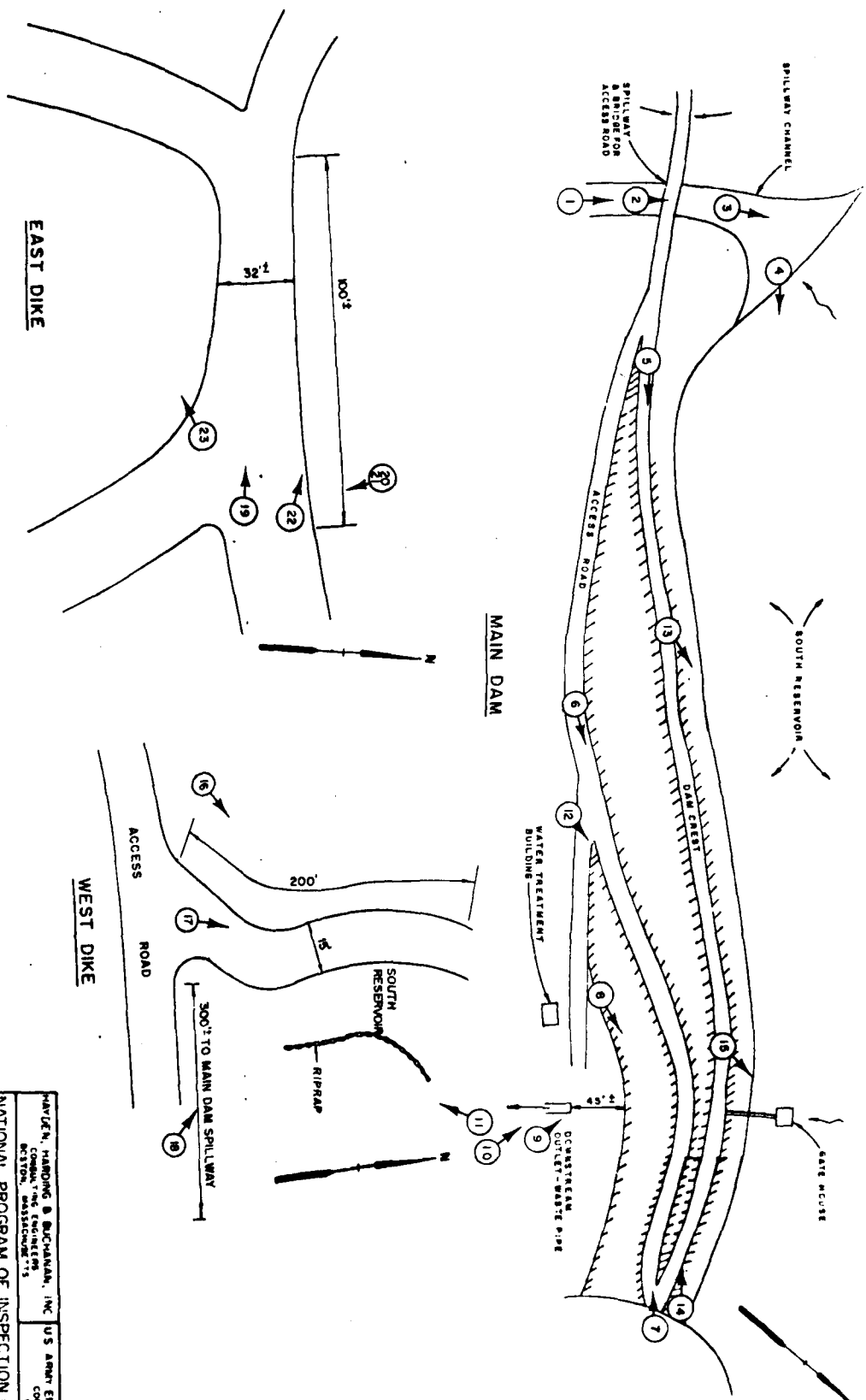


**SECTION AT ACCESS ROAD NATURAL AREA  
SHOWING CROSS CULVERT**

PLAN DEVELOPED FROM ON-SITE INSPECTION

|                                                                                   |  |                                                                             |  |
|-----------------------------------------------------------------------------------|--|-----------------------------------------------------------------------------|--|
| HAYDEN, HARDING & BUCHANAN, INC.<br>CONSULTING ENGINEERS<br>BOSTON, MASSACHUSETTS |  | U.S. ARMY ENGINEER DIV. NEW ENGLAND<br>CORPS OF ENGINEERS<br>WALTHAM, MASS. |  |
| NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS                                   |  |                                                                             |  |
| SOUTH RESERVOIR DAM                                                               |  |                                                                             |  |
| SECTIONS AT ACCESS ROAD DIKE                                                      |  |                                                                             |  |
| WINCHESTER                                                                        |  | MASSACHUSETTS                                                               |  |
|                                                                                   |  | SCALE: NOT TO SCALE                                                         |  |
|                                                                                   |  | DATE: MARCH 1980                                                            |  |

APPENDIX C  
PHOTOGRAPHS



NOTE:  
PLAN DEVELOPED FROM ON-SITE INVESTIGATION

# **SOUTH RESERVOIR DAM** **PHOTO LOCATIONS**

|                                                |  |                                          |  |
|------------------------------------------------|--|------------------------------------------|--|
| HAYDEN, HANCOCK & BUCHANAN, INC.               |  | U.S. ARMY ENGINEER DISTRICT, NEW ENGLAND |  |
| CONSULTING ENGINEERS                           |  | CORPS OF ENGINEERS                       |  |
| BOSTON, MASSACHUSETTS                          |  | BOSTON, MASSACHUSETTS                    |  |
| NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS |  | MASSACHUSETTS                            |  |
| WINCHESTER                                     |  | STATE NO. 10, STATE                      |  |
|                                                |  | JULY 1960                                |  |



PHOTO NO. 3 - Spillway approach channel looking upstream. The channel is about 55 feet long with a gravel base and riprap protection on its sides.



PHOTO NO. 4 - Upstream face of Dam viewed from the spillway approach channel. Gatehouse can be seen in left center of photo. The crest of the Dam is used as an access road for gatehouse. Note riprap protection along face of Dam.



PHOTO NO. 1 - Spillway discharge channel, and access road overpass, looking upstream.



PHOTO NO. 2 - Spillway weir looking upstream.

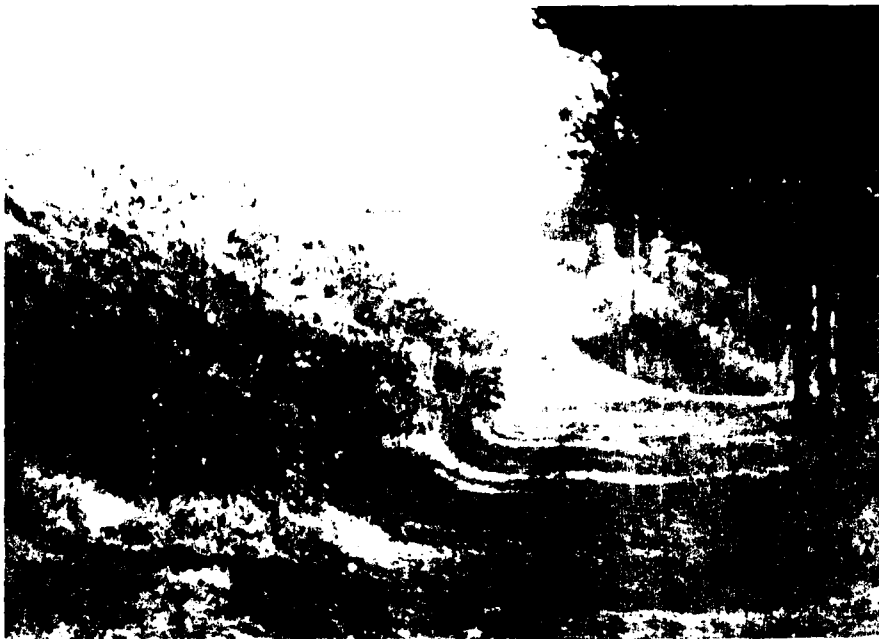


PHOTO NO. 5 - Crest of Dam, viewed from right abutment.



PHOTO NO. 6 - Upper portion of the downstream slope  
of the Dam, looking left along the midslope berm.



PHOTO NO. 7 - Lower portion of the downstream slope, viewed from the left abutment of the Dam. Note water treatment building in middle left portion of photo.



PHOTO NO. 8 - Lower portion of the downstream slope, looking left and slightly upstream from the downstream toe.



PHOTO NO. 9 - Outlet pipe located about 40-50 feet from the downstream toe. Outlet pipe ( 30 inch dia.) is almost completely submerged at head of channel. Function of the small drain pipe (5 inch dia.) that protrudes above the channel is not known. (Scale is open to 1 foot in the photo.)

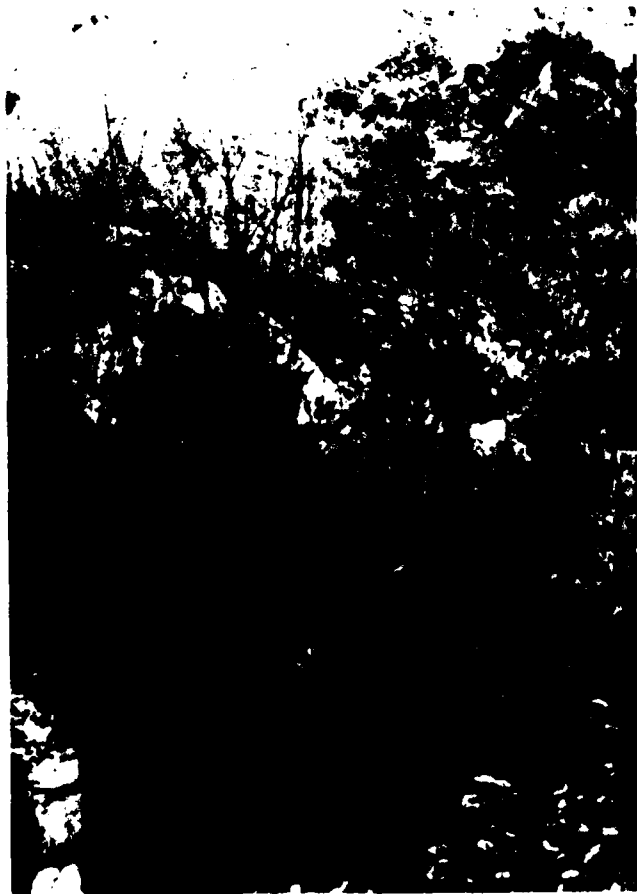


PHOTO NO. 10 - Outlet channel, looking upstream. The water level in the channel is approximately 12 inches deep. The outlet pipe at the head of the channel is almost completely submerged.



PHOTO NO. 11 - Outlet channel,  
looking downstream.



PHOTO NO. 12 - Downstream slope, looking left. Note  
the configuration of the midslope berm separating  
the upper and lower portions of the downstream  
slope.



PHOTO NO. 13 - Reservoir viewed from Dam crest.  
Gatehouse can be seen in right center of  
photo. Tree cover around reservoir is  
typical of drainage area.



PHOTO NO. 14 - Upper portion of the downstream slope,  
viewed from the left abutment of the Dam.



PHOTO NO. 15 - View of the gatehouse. The gate house contains manually operated controls to allow the reservoir to discharge into either a 30 inch waste pipe or a 24 inch pipe on the town water supply system.



PHOTO NO. 16 - This view shows the west dike. The access road is on top of the 6 foot high dike.



PHOTO NO. 17 - View of crest of west dike taken from left abutment.



PHOTO NO. 18 - Upstream slope of the West Dike, viewed from a point upstream of the left abutment.



PHOTO NO. 19 - Crest of the east dike, viewed from the  
left abutment.



PHOTO NO. 20 - View of the erosion gully on the upstream slope of the east dike at the left abutment. The gully is approximately 4 feet wide and 2.5 feet deep. (Rule is open to 4 feet in the photo.)

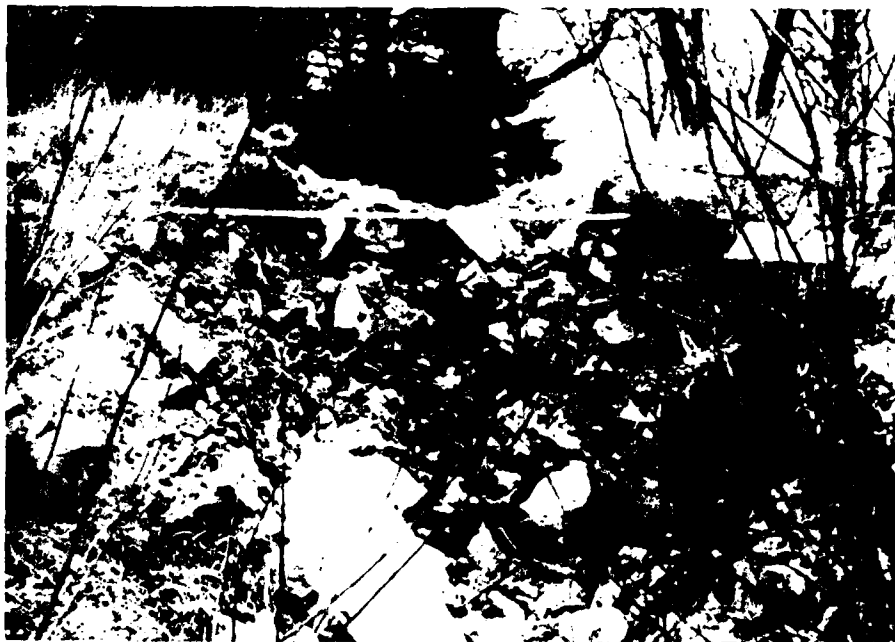


PHOTO NO. 21 - Close up view of Photo No. 20.



PHOTO NO. 22 - Upstream slope of the east dike, viewed from the left abutment.



PHOTO NO. 23 - Downstream slope of the east dike, viewed from the left abutment. The rubble stone wall at the toe of the slope is approximately 2-3 feet high.

APPENDIX D  
HYDROLOGIC AND HYDRAULIC COMPUTATIONS

JOB NO. 79.206.1  
DATE 12/20/79  
BY FDD  
CH'D BY MA



HAYDEN, HARDING & BUCHANAN, INC.  
CONSULTING ENGINEERS  
BOSTON — WEST HARTFORD

SHEET NO. D2  
JOB Dams  
SUBJECT South Res Dam  
CLIENT Corps

South Reservoir Dam : Built 1870's ±

Height of Dam: 38.0'

Outlets: 24" pipe - Town water supply

30" pipe - waste to down-  
stream brook

Spillway & Channel

Earth Embankment Structure with  
stone core wall, used for water  
supply purposes. South & Middle Reservoirs  
separated by natural & man-made embankment

Storage Capacity: 2720. ± ac-ft (includes  
Middle Reservoir)

Size Class : Intermediate (by Storage)

Drainage Area: 0.76 sq. mi (486 acres)

Hazard Potential: High

Corps Guidelines

Require that

Runoff From drain-

age areas of 2

sq mi or less are

developed using

3000. c.s.m.

Test Flood: PMF

PMF Inflow =  $3000 \times .76 \times 1 = 2280 \text{ cfs}$

Volume of runoff =  $19 \times \frac{1}{12} \times 486 = 770 \text{ a-ft}$

PMF Outflow = 265 cfs. (No stoplogs @ Spillway  
waste gate closed)

Dam is not over-topped.

JOB NO. 79.206.1  
 DATE 11/23/90  
 BY FDD  
 CHECKED BY WME



HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D3  
 JOB Dams  
 SUBJECT South Res. Dam  
 CLIENT Corps

## Storage Capacity - South & Middle Reservoirs

| Elev<br>NGVD | South Reservoir |                 |          |                | Middle Reservoir |                 |          |                | Cum.<br>Storage<br>ac-ft. |
|--------------|-----------------|-----------------|----------|----------------|------------------|-----------------|----------|----------------|---------------------------|
|              | Area<br>ac.     | Ave Area<br>ac. | D<br>Ft. | Stor<br>ac-ft. | Area<br>ac.      | Ave Area<br>ac. | D<br>Ft. | Stor<br>ac-ft. |                           |
| 130±         | 0.0             |                 |          |                | 0.0              |                 |          |                |                           |
|              |                 | 36.7            | 28       | 1027.6 ✓       |                  | 27.2            | 28       | 761.6 ✓        | 1789.2 ✓                  |
| 159±         | 73.5            |                 |          |                | 54.4             |                 |          |                |                           |
|              |                 | 82.3            | 2        | 164.6 ✓        |                  | 59.9            | 2        | 119.8 ✓        | 2073.6 ✓                  |
| 160          | 91.0            |                 |          |                | 65.3             |                 |          |                |                           |
|              |                 | 103.1           | 10       | 1031 ✓         |                  | 73.6            | 10       | 736 ✓          | 3840.6 ✓                  |
| 170          | 115.2           |                 |          |                | 81.9             |                 |          |                |                           |

(Elevations assumed using U.S.G.S. map)

Top of dam elev. ≈ 163.5

JOB NO. 79.206.1  
 DATE 12/20/79  
 BY EDD  
 CH'D BY MA



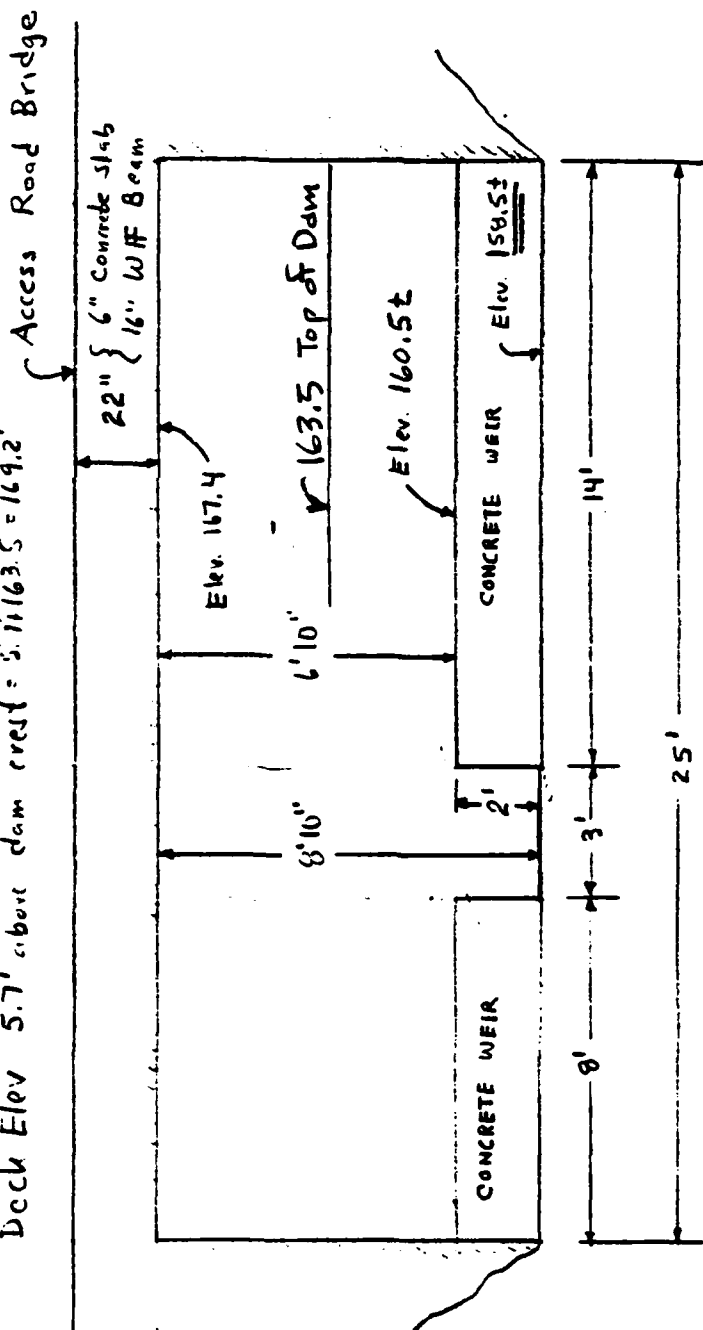
HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. 24

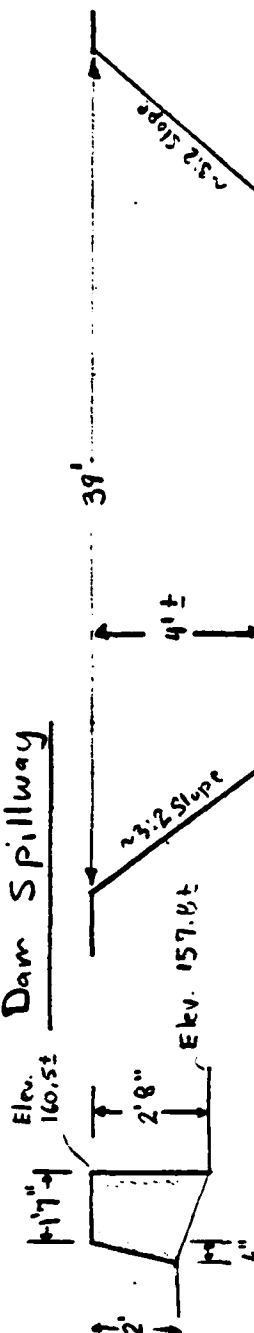
JOB Dam  
 SUBJECT South Reservoir Dam  
 CLIENT Carpi

# South Reservoir Dam

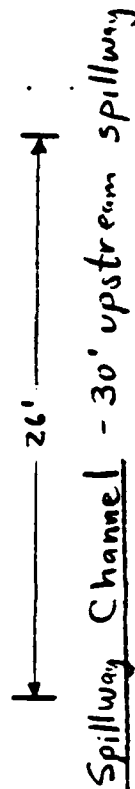
Deck Elev 5.7' above dam crest = 5.7 + 163.5 = 169.2'



## Dam Spillway



## Weir Section



JOB NO. 79.206.1  
 DATE 12/20/79  
 BY FDD  
 CH'D BY WA



HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. DE  
 JOB Dams  
 SUBJECT South Res Dam  
 CLIENT Corps

## Outlet capacity - South Reservoir

Dam Spillway - consists of 2' high weir in 2 sections  
 (not used for discharge graph) & a 3' wide slotted "channel"  
 also has what are apparently pins for up  
 to 6" flash boards on top of weirs.

Check worst condition: stop logs in channel section  
 & 6" flash boards  
 Top elev = 161.0 ±  $Q = CLH^{3/2}$

Spillway Outflow - Stop logs & flashboards in place

| 6" Flashboards<br>in place | H<br>ft | $H^{3/2}$ | C    | L<br>ft | Q<br>cfs | Elev  |
|----------------------------|---------|-----------|------|---------|----------|-------|
|                            | 1.0     | 1.0       | 2.70 | 25      | 67.5     | 162.0 |
|                            | 2.0     | 2.83      | 2.95 | "       | 208.7 ✓  | 163.0 |
|                            | 3.0     | 5.20      | 3.28 | "       | 426.1    | 164.0 |
|                            | 4.0     | 8.0       | 3.32 | "       | 664.0 ✓  | 165.0 |
|                            | 5.0     | 11.18     | 3.32 | "       | 928.0 ✓  | 166.0 |
|                            | 2.5     | 3.95      | 3.20 | "       | 316.0    | 163.5 |

Weir - Spillway Outflow - no (additional) controls at spillway  
 (3' x 2' opening) actual conditions  
 Channel Area use  $Q = CLH^{3/2}$  with  $C = 2.63$ ,  $L = 3$

| H<br>ft | $H^{3/2}$ | CL<br>3 x 2.63 | Q<br>cfs | Elev    |
|---------|-----------|----------------|----------|---------|
| 1       | 1.0       | 7.89           | 7.9      | 159.5 ✓ |
| 2       | 2.83      | "              | 22.3 ✓   | 160.5 ✓ |
| 2.5     | 3.95      | "              | 31.2     | 161.0 ✓ |

JOB NO. 79.206.1  
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SHEET NO. DC  
 JOB Dams  
 SUBJECT South Res Dam  
 CLIENT Corp

# Dam Spillway Outflow - South Reservoir Dam

Weir Sections:  $Q = CLH$   $L = 25'$   
 (Used for graph)

|              | H   | $H^{3/2}$ | C    | L  | Q     | Elev. |
|--------------|-----|-----------|------|----|-------|-------|
|              | ft  |           |      | ft | cfs   |       |
| No flashbrds | 1.0 | 1.0       | 2.70 | 25 | 67.5  | 161.5 |
|              | 2.0 | 2.83      | 2.95 | "  | 208.7 | 162.5 |
|              | 3.0 | 5.20      | 3.28 | "  | 426.4 | 163.5 |
|              | 4.0 | 8.0       | 3.32 | "  | 664.0 | 164.5 |
|              | 4.5 | 9.55      | "    | "  | 792   | 165.0 |
| 100 ft       | 5.5 | 12.9      | "    | "  | 1070  | 166   |

Check Waste Pipe (Ability to use is unknown)

30 inch diameter metal pipe (made from boiler Flanges)

Outflow controlled by sluice gate located within gate house - operation unknown outlet appears blocked.

Discharges to outlet structure & flows to downstream brook

Assume Invert to waste pipe ~ 45' below top of dam, @ elev 120±

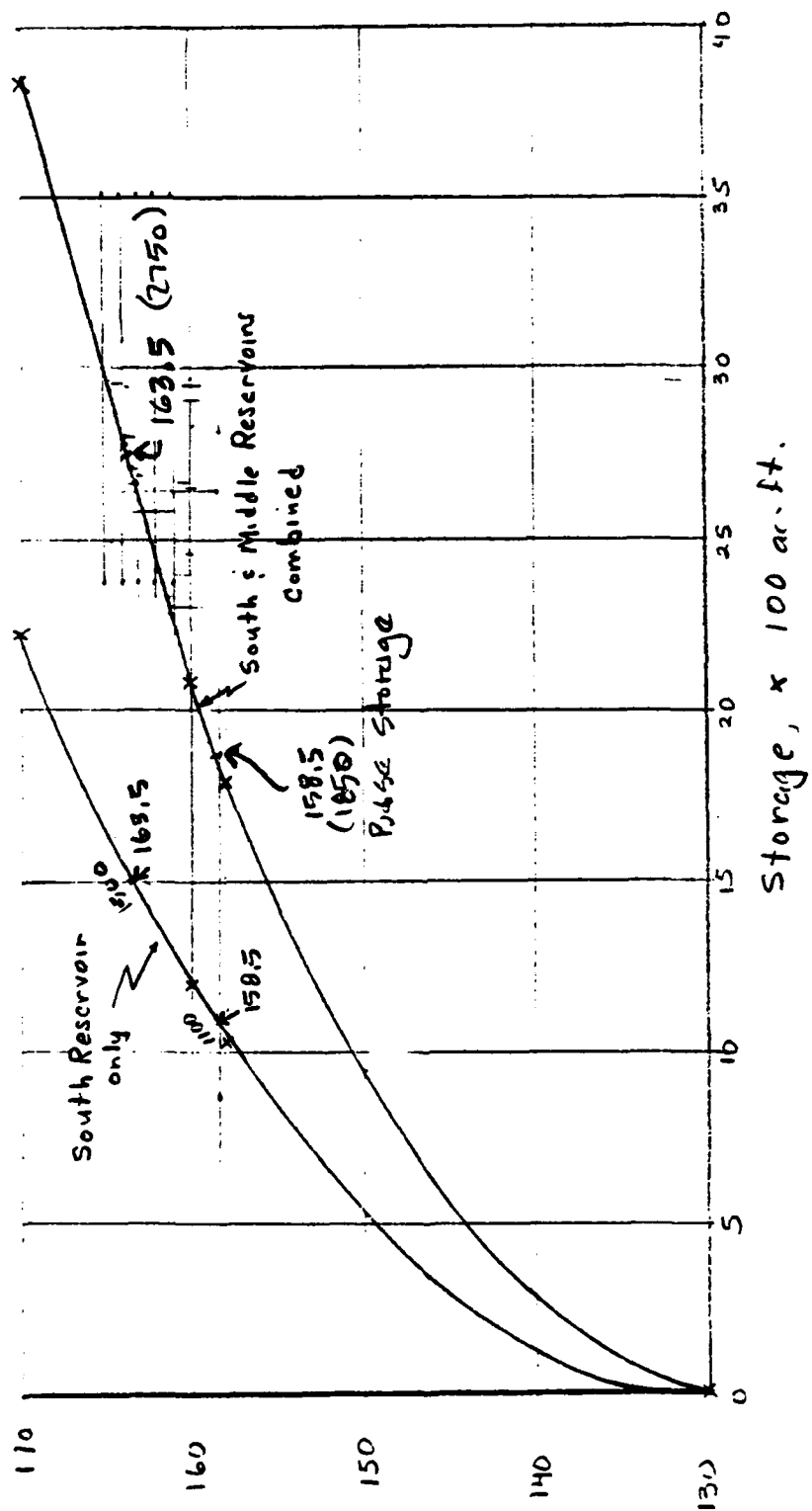
Estimating the outflow with  $h \approx 40'$ ,  $Q = 150 \text{ cfs} \pm$

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SHEET NO. D7  
 JOB Dam  
 SUBJECT South & Middle Reservoirs  
 CLIENT Corps

Elevation vs. Storage - South & Middle Reservoirs



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SHEET NO. 28  
 JOB Dams  
 SUBJECT South Rec. Dam  
 CLIENT Corps

Above elevation 163.5', get weir flow over  
 a portion of the top of dam.

$$Q = CLH^{3/2} \text{ with } C = 2.63 \text{ \&L= 400}$$

| H<br>ft | H <sup>3/2</sup> | CL<br>400x2.63 | Q<br>cfs. | Elev. |
|---------|------------------|----------------|-----------|-------|
| 0.5     | 0.35             | 1052           | 372±      | 164.0 |
| 1.0     | 1.0              | 1052           | 1052±     | 164.5 |
| 1.5     | 1.84             | 1052           | 1933±     | 165.0 |

### OVERFLOW AND

### SPILLWAY DISCHARGE

| ELEV  | 2'x3'<br>Weir | SPILLWAY |          | OVERFLOW | COMBINED |          |
|-------|---------------|----------|----------|----------|----------|----------|
|       |               | NO FLH.  | WITH FLH |          | NO FLH   | WITH FLH |
| 158.5 | 0             | 0        | 0        | 0        | 0        | 0        |
| 159.  | 8             | 0        | 0        | 0        | 8        | 8        |
| 159.5 | -             |          |          |          |          |          |
| 160.0 | -             |          |          |          |          |          |
| 160.5 | 22            |          |          |          | 22       | 22       |
| 161.0 | (31)          |          |          |          |          | 31       |
| 161.5 |               | 68       |          |          | 90       |          |
| 162.0 |               |          | 68       |          |          | 99       |
| 162.5 |               | 209      |          |          | 231      |          |
| 163.0 |               | 316      | 209      |          | 338      | 240      |
| 163.5 |               | 426      | 316      |          | 448      | 347      |
| 164.0 |               | 540      | 426      | 372      | 934      | 829      |
| 164.5 |               | 664      | 540      | 1052     | 1733     | 1631     |
| 165.0 |               | 792      | 664      | 1933     | 2747     | 2628     |

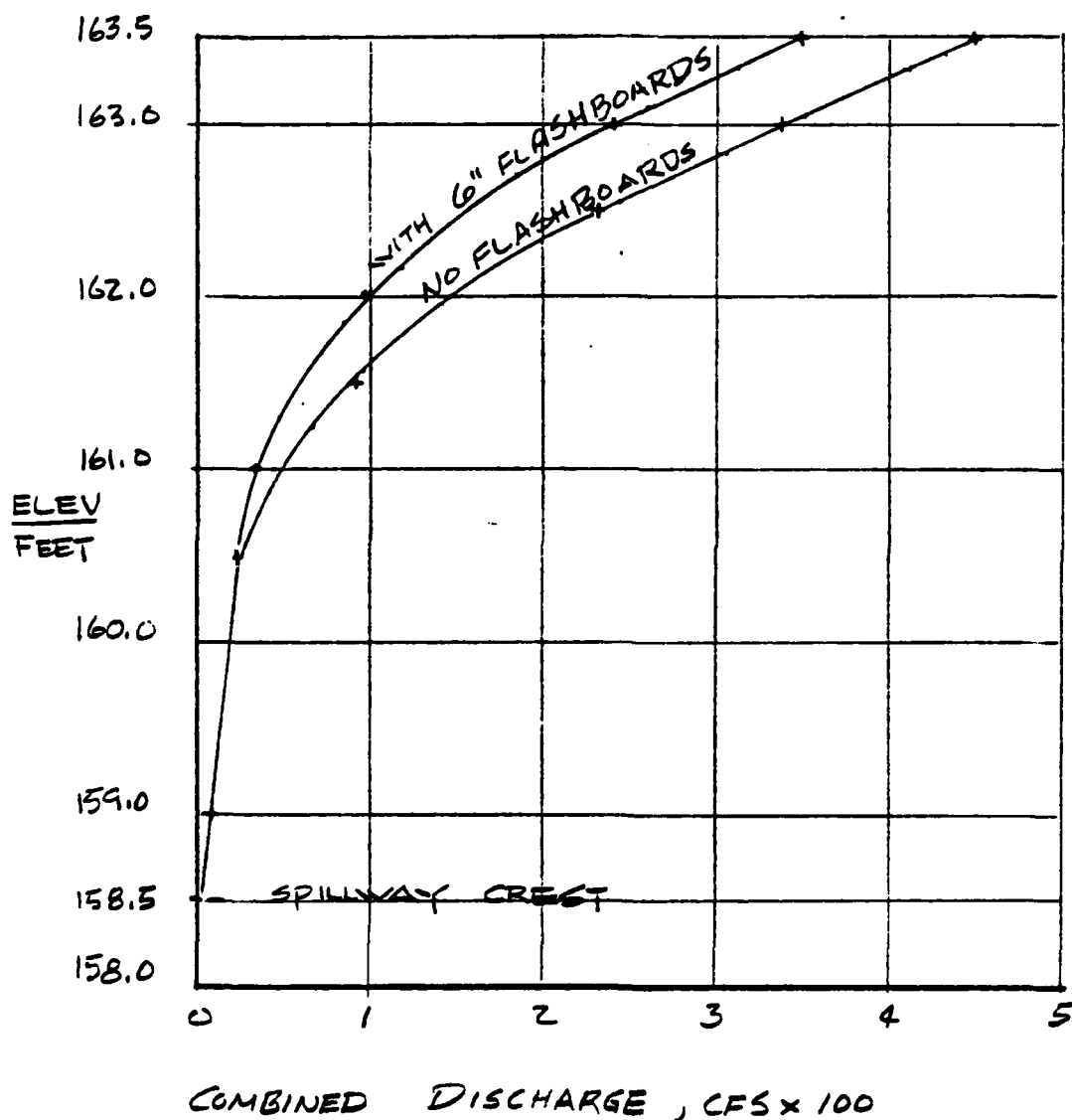
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SHEET NO. D8A  
JOB Dams  
SUBJECT S. Res.  
CLIENT C&E

## STAGE DISCHARGE



COMBINED DISCHARGE, CFS x 100

- continued on page D8B -

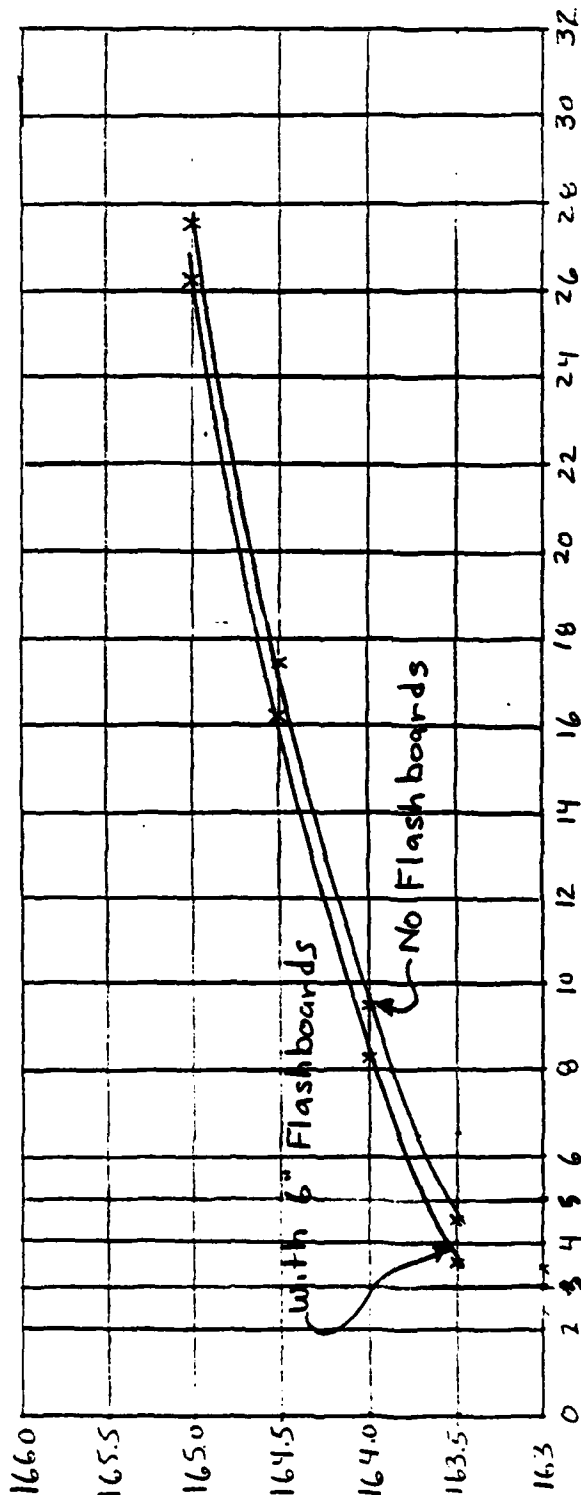
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SHEET NO. DEB  
 JOB Dams  
 SUBJECT So Res  
 CLIENT COE

# STAGE DISCHARGE



Combined OverFlow, cfs x 100

- see page D8A -

see PS D8A

OS NO. 79206.1  
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BOSTON — WEST HARTFORD

SHEET NO. D 9  
JOB Dams  
SUBJECT South Res Dam  
CLIENT Carpa

### Test Flood - South Reservoir Dam

$A = 0.76 \text{ sm.}$  (includes areas to both South & Middle Reservoirs)

assume flow between reservoirs

$$Q_{PMF} = 3000 \times 0.76 \times 1 = 2280 \text{ cfs.}$$

$$\text{Volume} = 19'' \times 486 \text{ ac} \times \frac{1 \text{ ft}}{12 \text{ in}} = 770 \text{ ac-ft}$$

$$\begin{aligned} \text{Elev of Spillway} &= 158.5' \text{ NGVD} \\ \text{Storage Volume} &= 900 \text{ ac-ft (163.5 to 158.5)} \\ (770 \text{ ac-ft} &= 8/163.0\pm) \end{aligned}$$

$$\text{Top of Dam Elev.} = 163.5 \pm$$

$$\text{Top of Natural Dike @ Middle Res.} = 164. \pm$$

$$\text{Storage Volume - Top of Dam} = 2756 \text{ ac-ft.}$$

Stor. avail. > Stor. required for PMF inflow

Determine PMF Outflow: Normal operation  
with waste gate closed & no stop logs or  
flashboards @ spillway.

Assume initial reservoir level @ Spillway Invert  
elev. = 158.5' NGVD



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SHEET NO. D10

JOB Dams

SUBJECT S. Per

CLIENT COE

NO FLASHBOARDS AT SPILLWAY  
TEST FLOOD ROUTED OUTFLOW D.A. = 0.76 sm  
486 m

$Q_{P_1} = 2280 \text{ cfs Inflow } EI_1 = 1648$   
 $Str_1 = 2950 - 1850 = 1100 \text{ d-f or } 27.2" > 19$   
 $strave = \frac{27.2 + 0}{2} = 13.6$

$$Q_{P_3} = 2280 \left(1 - \frac{13.6}{19}\right) = 648 \text{ cfs} \quad E_{I_3} = 163.7$$

$$S_{t_3} = 2800 - 1850 = 950 \text{ ft} \quad \text{or } 23.4''$$

$$S_{\text{trave}} = \frac{13.6 + 23.4}{2} = 18.5''$$

$$Q_{Pa} = 2280 \left(1 - \frac{18.5}{19}\right) = 60 \text{ cfs} \quad E|_4 = 161.2$$

$$S_{tra} = 22.40 - 18.50 = 4.90 \text{ ft at } 12.1''$$

$$S_{tra} = \frac{18.5 + 12.1}{2} = 15.3''$$

$$G_{p_5} = 2280 \left(1 - \frac{15.3}{19}\right) = 444 \text{ cfs} \quad E_{p_5} = 163.5$$

$$G_{tr_5} = 2700 - 1850 = 850 \text{ cfs at } 21"$$

$$S_{trave} = \frac{21 + 15.3}{2} = 18.2"$$

$$\begin{aligned} Q_{r6} &= 2260 \left( 1 - \frac{18.2}{19} \right) = 96 \text{ cfs} \quad E|_6 = 161.6 \\ C_{t6} &= 2360 - 1850 = 510 \text{ or } 12.6'' \\ S_{tave} &= \frac{12.6 + 18.2}{2} = 15.4 \end{aligned}$$

$$Q_{p2} = 2280 \left(1 - \frac{15.4}{19}\right) = 432 \text{ cfs } EI = 16\% \cdot 4'$$

$$S_{tr} = 2670 - 1850 = 820 \text{ ft}^2 \text{ on } 20.2''$$

$$S_{trave} = \frac{20.2 + 15.4}{2} = 17.8 \pm ''$$

$$Q_{pg} = 2280 \left(1 - \frac{17.8}{19}\right) = 144 \quad EI_g = 162.0$$

$$St_g = 2400 - 1850 = 550 \text{ or } 13.6''$$

$$St_{aver} = \frac{13.6 + 17.8}{2} = 15.7''$$

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SHEET NO. D11  
JOB Dams  
SUBJECT So. Res.  
CLIENT COE

$$Q_{10} = 2280 \left(1 - \frac{15.7}{19}\right) = 396 \quad El_q = 163.3$$

$$Str_q = 2620 - 1850 = 770 \quad \text{or } 19''$$

$$Str_{ave} = \frac{19 + 15.7}{2} = 17.4$$

$$Q_{p10} = 2280 \left(1 - \frac{17.4}{19}\right) = 192 \quad El_q = 162.3$$

$$Str_{10} = 2550 - 1850 = 700 \quad \text{or } 17.3$$

$$Str_{ave} = \frac{17.3 + 17.4}{2} = 17.35$$

$$Q_{p11} = 2280 \left(1 - \frac{17.35}{19}\right) = 198 \quad El_{10} = 162.3$$

$$Q_{out} = 200^{\pm} \text{ cfs} \quad Elev = 162.3^{\pm}$$

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 DATE 4-20-50  
 BY MA  
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SHEET NO. D12  
 JOB Dam 5  
 SUBJECT Sg. Res  
 CLIENT CEE

TEST FLOOD ROUTED OUTFLOW  
WITH 6" FLASHBOARDS AT SPILLWAY

$$Q_{P_1} = 2280 \quad E1_1 = 164.8 \quad S_{r_1} = 2950 - 1850 = 1100 \quad 27.2''$$

$$S_{ave} = \frac{27.2 + 0}{2} = 13.6''$$

$$Q_{P_2} = 2280 \left(1 - \frac{13.6}{19}\right) = 650 \text{ cfs} \quad E1_2 = 163.7$$

$$S_{r_2} = 2775 - 1850 = 925 \text{ or } 22.8''$$

$$S_{ave} = \frac{22.8 + 13.6}{2} = 18.2''$$

$$Q_{P_3} = 2280 \left(1 - \frac{18.2}{19}\right) = 96 \text{ cfs} \quad E1_3 = 162.0$$

$$S_4 = 2450 - 1850 = 600 = 14.8''$$

$$S_{ave} = \frac{14.8 + 18.2}{2} = 16.5''$$

$$Q_{P_4} = 2280 \left(1 - \frac{16.5}{19}\right) = 300 \text{ cfs} \quad E1_4 = 163.3$$

$$S_5 = 2630 - 1850 = 780 = 19.3''$$

$$S_{ave} = \frac{16.5 + 19.3}{2} = 17.4''$$

$$Q_{P_5} = 2280 \left(1 - \frac{17.4}{19}\right) = 192 \text{ cfs} \quad E1_5 = 162.8$$

$$S_6 = 2580 - 1850 = 730 = 18.0''$$

$$S_{ave} = \frac{17.4 + 18.0}{2} = 17.7''$$

$$Q_{P_6} = 2280 \left(1 - \frac{17.7}{19}\right) = 156 \text{ cfs} \quad E1_6 = 162.5$$

$$S_7 = 2530 - 1850 = 680 \text{ ac. ft} = 16.8''$$

$$S_{ave} = \frac{17.7 + 16.8}{2} = 17.3''$$

$$Q_{P_7} = 2280 \left(1 - \frac{17.3}{19}\right) = 204 \text{ cfs} \quad E1_7 = 162.8$$

$$S_8 = 730 = 18.0''$$

$$S_{ave} = 17.3 + 18 = 17.65''$$

$$Q_{P_8} = 2280 \left(1 - \frac{17.65}{19}\right) = 162 \text{ cfs} \quad E1_8 = 162.5$$

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SHEET NO. 12A  
JOB Dams  
SUBJECT S. R.  
CLIENT COE

$$Q_{p_9} = 162 \text{ cfs.} \quad \text{Elev} = 162.5$$

$$S_9 = 2530 - 1850 = 680 = 16.8''$$

$$S_A = \frac{16.8 + 17.65}{2} = 17.23''$$

$$Q_{p,0} = 2280 \left(1 - \frac{17.23}{19}\right) = 212 \text{ cfs} \quad \text{Elev.} = 162.8$$

Elev. varies between 162.5 and 162.8

$$\text{Let Elev} = \frac{162.5 + 162.8}{2} = 162.65 \sim 162.7$$

$$Q = 190^+ \text{ cfs}$$

$$\text{Elev} = 162.7 \quad Q = 190 \text{ cfs.}$$

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BOSTON — WEST HARTFORD

SHEET NO. D 13

JOB Dams  
SUBJECT South Res Dam  
CLIENT Corps

Failure Outflow - South Reservoir Dam

Breach width = 40% of 260' length of dam measured at midheight, at "original stream" location.

$$\text{Failure Discharge, } Q_F = \frac{8}{27} (0.4 \times B_w) (\sqrt{g}) (H)^{3/2}$$

$$Q_F = \frac{8}{27} (0.4 \times 260) (\sqrt{32.2}) (38.0)^{3/2}$$

$$Q_F = 40,930 \pm \text{cfs.}$$

Breach width limited by downstream channel - see Section 6+00  
Assume Dam Fails with pool at top of dam

Storage at time of failure = S

$$S = 1500 \text{ ac-ft (el=163.5)}$$

Max. Base Flow just prior to failure of dam  
is on the order of 450 cfs± assuming  
gate to waste pipe is closed and  
no additional controls (i.e. stop logs and  
flash boards) in place at spillway.

Combined Failure Discharge & Base Flow =

$$40,930 + 450 = 41,380 \text{ cfs. , say } 41,400 \pm$$

$$Q_P = 41,400 \text{ cfs.}$$

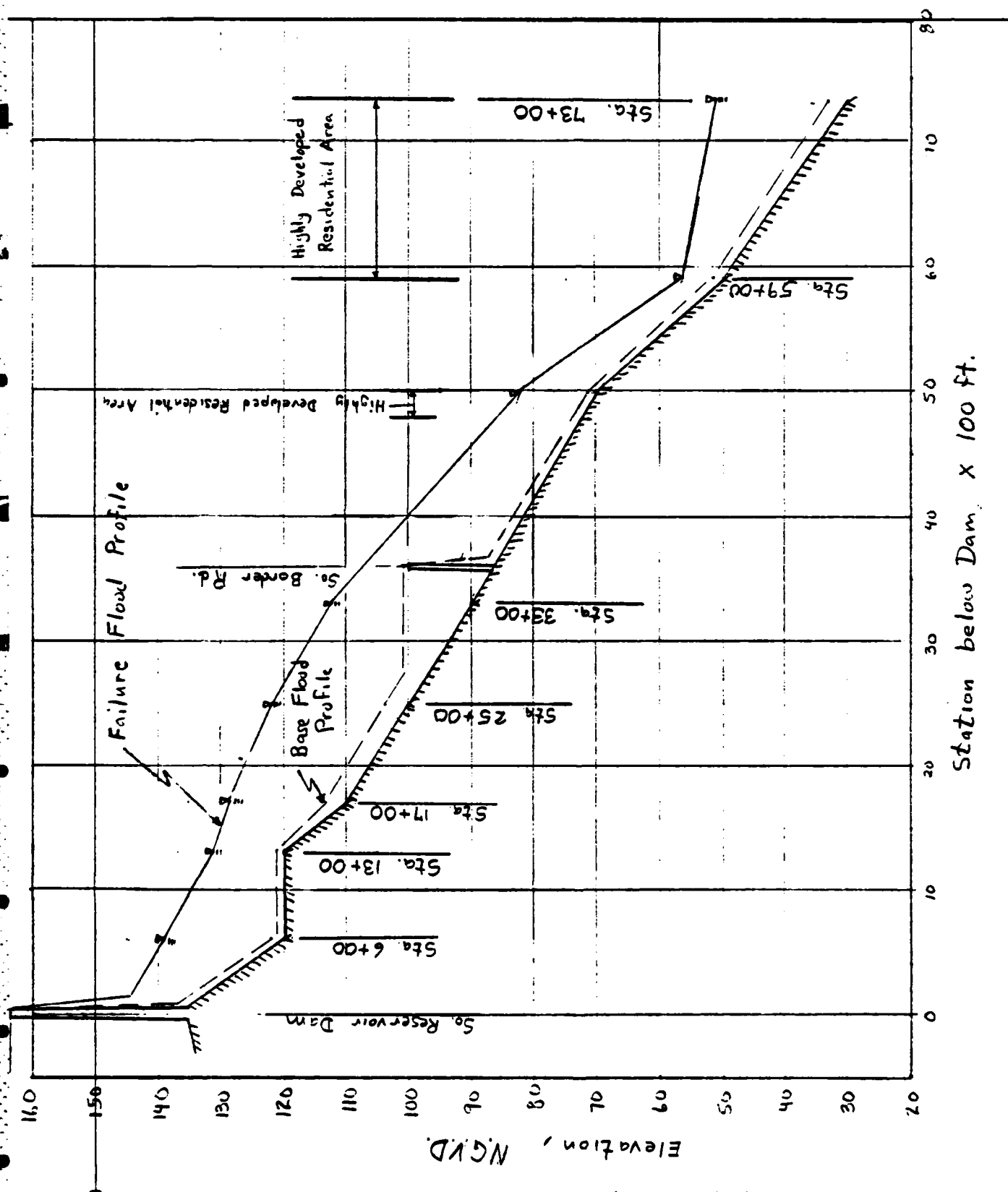
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SHEET NO. D14

JOB Dams  
 SUBJECT So. Res. Dam  
 CLIENT Corps



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SHEET NO. D 15  
 JOB Dams  
 SUBJECT So. R.R.  
 CLIENT CIE

| Sta   | Elev | Base Flow         |        | Failure Flow       |                |
|-------|------|-------------------|--------|--------------------|----------------|
|       |      | Elev<br>(500±cfs) | Damage | Elev<br>(4100±cfs) | Damage         |
| 6+00  | 120  | 121               | —      | 139.3              | So. Border Rd. |
| 13+00 | 120  | 121               | —      | 131.1              | S.B.R.         |
| 17+00 | 110  | 111               | —      | 129                | S.B.R.         |
| 25+00 | 100  | 101               | —      | 122                | SBR            |
| 33+00 | 90   | 91                | —      | 112                | SBR            |
| 35+00 |      |                   |        |                    | Residential    |
| 50+00 | 70   | 71                | —      | 85                 | 10± homes      |
| 60+00 |      |                   |        |                    | Residential    |
| 59+00 | 50   | 51                | —      | 56                 |                |
| 73+00 | 30   | 31                | —      | 41                 |                |

At least 150 to 250 homes in this area.

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SHEET NO. D16  
JOB Dam  
SUBJECT South Res. Dam  
CLIENT Corps

## South Reservoir Dam

### Impact Areas - Failure Flood Routing

Sta. 0+00 to 33+00: No homes or other inhabitable structures inundated. Approximately 3000 ft of So. Border Rd flooded by 1-10' of water.

Sta 33+00 to 59+00: Possibly a number of houses by 1-6' of water. Flood limits impact a "pink tint" (on USGS) highly developed area around Sta 50+00 and along Lawrence Rd near Sta 59+00. Damage could be significant.

Sta. 59+00 to 73+00 and beyond  
Large number of houses inundated by 1-11' of floodwater in thickly settled (highly developed "pink tint" on USGS) area. Extensive Damages could occur in this area from the failure Flood. 250<sup>±</sup> homes

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SHEET NO. D18

JOB Dams  
 SUBJECT South Res Dam  
 CLIENT Corps

Dam Failure Flood Routing - So. Res. Dam

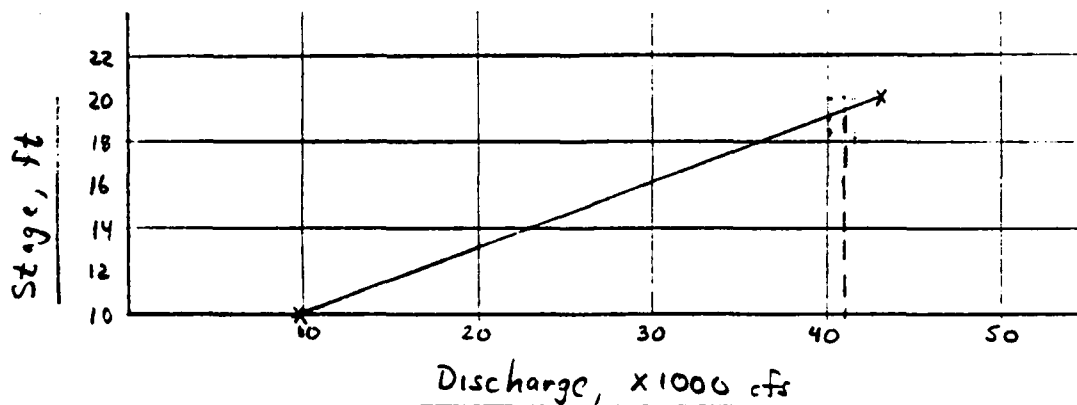
$$Q_F = 41,400 \text{ cfs.}$$

Sta. 6+00

$$S = 0.05 \quad n = 0.12$$

$$V = f' R^{2/3} \quad V = 2.77 R^{2/3}$$

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^{2/3}}$ | $\frac{f'}{}$ | $\frac{V}{fps}$ | $\frac{Q}{cfs}$ | <u>Elev.</u> |
|----------------|-----------------|----------------|------------------|---------------|-----------------|-----------------|--------------|
| 10             | 150             | 1000           | 3.56 ✓           | 2.77          | 9.87 ✓          | 9874 ✓          | 130          |
| 20             | 600             | 4250           | 3.71 ✓           | "             | 10.28 ✓         | 43,705. ✓       | 140          |



$$Q_{P_1} = 41,400 \text{ cfs} \quad d_1 = 19.6' \quad \checkmark$$

$$V_{d_1} = \frac{2785 + 4004}{2} \times \frac{400}{43560} = 31.17 \text{ ac-ft} \quad \checkmark$$

$$Q_{P_2} = 41,400 \left(1 - \frac{31.17}{1500}\right) = 40,540 \text{ cfs.} \quad \checkmark$$

$$d_2 = 19.3'$$

UNCLASSIFIED

SOUTH RESERVOIR DAM A. (U) CORPS OF ENGINEERS WALTHAM  
MA NEW ENGLAND DIV APR 80

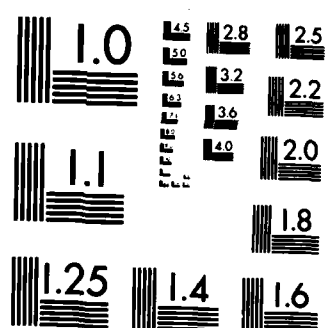
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BOSTON — WEST HARTFORD

SHEET NO. D17  
JOB Dams  
SUBJECT South Res Dam  
CLIENT Corps

### South Reservoir Dam

#### Check: Impact of Base Flood Flows

$$Q_{\text{Base}} = 450 \text{ cfs.}$$

Sta. 0+00 to 59+00 - No effect on man-made structures

Sta. 59+00 - No effect on adjacent developed areas  
( $Q = 26,942$ ,  $d = 6.1'$ ; no development below  $d = 5'$ )

$$\text{for } Q = 450 \text{ cfs. } d \approx 1.0' \pm \quad V \approx 5 \pm \text{ fps}$$

Sta. 73+00 - minor-moderate flooding of adjacent developed areas.

$$\text{for } Q = 450 \quad d \approx 1.0' \pm \quad V \approx 1.5 \pm \text{ fps}$$

#### Comparison of Impact Areas: Base Flood & Failure Flood

|                     | <u>Base Flood</u>                                                                                                        | <u>Failure Flood</u>                                                                                               |
|---------------------|--------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Sta. 0+00 to 59+00  | So. Border Rd<br>overtopped by 1'±<br>for 200'±                                                                          | So. Border Rd overtopped by<br>5-10' for ~3000'<br>Several houses flooded by<br>1-5'                               |
| Sta. 59+00 to 73+00 | Hwy. developed residential<br>area flooded by 1-2'± for<br>width up to 250 ft±<br>Expected damage - minor<br>to moderate | Hwy. developed residential<br>area flooded by 6-11'±<br>for width up to 1150 ft±<br>Expected damage -<br>extensive |

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SHEET NO. D19  
 JOB Dams  
 SUBJECT South Res Dam  
 CLIENT Corps

# Failure Flood Routing - So. Res. Dam

$$Vol_2 = \frac{2785 + 3861}{2} \times \frac{400}{43560} = 30.52 \text{ ac-ft}$$

$$Q_{p2} = 41,400 \left(1 - \frac{30.52}{1500}\right) = 40,558 \text{ cfs. } d_2 = 19.3 \pm'$$

$$Q_{out} = 40,558 \text{ cfs. } Elev = 139.3' \pm$$

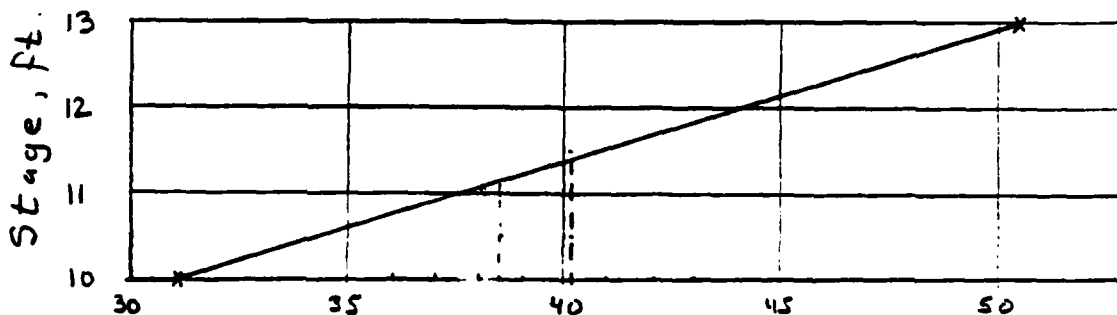
Sta. 13 + 00 "Swampy" Area

$$s = 0.0083', n = 0.10$$

$$V = f' R^{2/3} \quad f' = \frac{1.486}{0.10} (0.0083)^{1/2} = 1.35$$

$$V = 1.35 R^{2/3}$$

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^{2/3}}$ | $\frac{f'}{}$ | $\frac{V}{fps}$ | $\frac{Q}{cfs}$ | $\frac{Elev.}{'}$ |
|----------------|-----------------|----------------|------------------|---------------|-----------------|-----------------|-------------------|
| 10             | 650             | 5500           | 4.18             | 1.35          | 5.65            | 31,052          | 130               |
| 13             | 680             | 7495           | 4.99             | "             | 6.74            | 50,515          | 133               |



Discharge, x1000 cfs.

$$Q_{p1} = 40,558 \text{ cfs} \quad d_1 = 11.5' \checkmark$$

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SHEET NO. 120  
 JOB Dams  
 SUBJECT South Res Dam  
 CLIENT Corps

# Failure Flood Routing - So. Res. Dam

$$Q_{P_1} = 40,558 \text{ cfs} \quad d_1 = 11.5$$

$$Vol_1 = \frac{3880 + 6492}{2} \times \frac{700}{43,560} = 83.33 \checkmark \text{ ac-ft}$$

$$Q_{P_2} = 40,558 \left(1 - \frac{83.33}{1500}\right) = 38,307 \checkmark \text{ cfs} \quad d_2 = 11.1' \pm$$

$$Vol_2 = \frac{3880 + 6111}{2} \times \frac{700}{43,560} = 80.28 \checkmark \text{ ac-ft}$$

$$Vol_{ave} = \frac{83.33 + 80.28}{2} = 81.82 \pm \text{ ac-ft}$$

$$Q_{P_2} = 40,558 \left(1 - \frac{81.52}{1500}\right) = 38,356 \checkmark \text{ cfs} \quad d_2 = 11.1'$$

$$Q_{out} = 38,356 \text{ cfs} \quad Elev = 131.1'$$

Sta 17+00

$$S = 0.0083$$

$$n = 0.10$$

$$V = f R^{2/3}$$

$$V = 1.35 R^{2/3}$$

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^{2/3}}$ | $\frac{f'}{}$ | $\frac{V}{fps}$ | $\frac{Q}{cfs}$ | $\frac{Elev}{}$ |
|----------------|-----------------|----------------|------------------|---------------|-----------------|-----------------|-----------------|
| 10             | 350             | 1750           | 2.94 ✓           | 1.35          | 3.97 ✓          | 6945 ✓          | 120             |
| 15             | 400             | 3625           | 4.38 ✓           | "             | 5.91 ✓          | 21,429 ✓        | 125             |
| 20             | 450             | 5750           | 5.51 ✓           | "             | 7.44 ✓          | 42,788 ✓        | 130             |

JOB NO. 79.206.1  
 DATE 12/21/79  
 BY FDD  
 CH'D BY MR

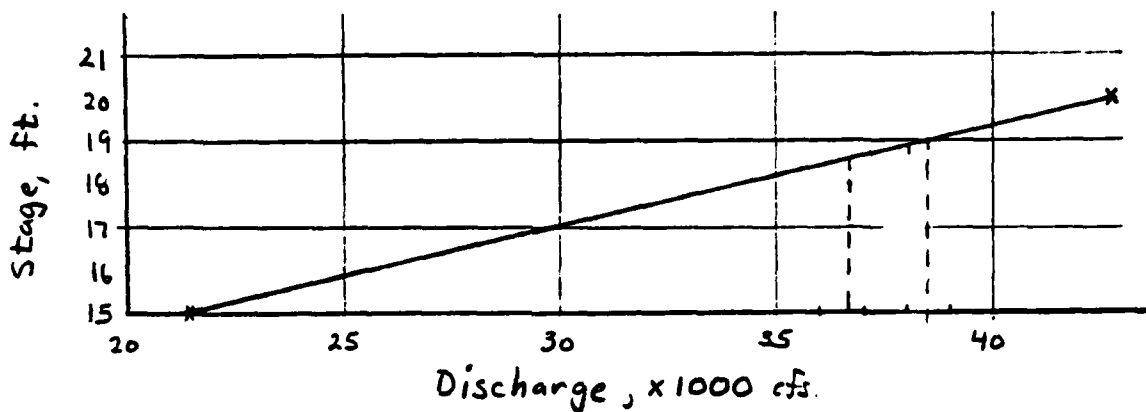


HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO D21

JOB Dams  
 SUBJECT South Res. Dam  
 CLIENT Corps

# Failure Flood Routing - So. Res. Dam



$$Q_{P_1} = 38,356 \text{ cfs} \quad d_1 = 19.0'$$

$$Vol_1 = \frac{6300 + 5305}{2} \times \frac{400}{43,560} = 53.28 \text{ ac-ft}$$

$$Q_{P_2} = 38,356 \left(1 - \frac{53.28}{1500}\right) = 36,994 \text{ cfs} \quad d_2 = 18.8'$$

$$Vol_2 = \frac{6300 + 5212}{2} \times \frac{400}{43,560} = 52.88 \text{ ac-ft}$$

$$Vol_{ave} = \frac{53.28 + 52.88}{2} = 53.08 \text{ ac-ft}$$

$$Q_{P_3} = 38,356 \left(1 - \frac{53.08}{1500}\right) = 36,998 \text{ cfs} \quad d_2 = 18.8'$$

$$Q_{out} = 36,998 \text{ cfs} \quad Elev. = 128.8'$$

Sta 25+00

$$S = 0.0125\%$$

$$n = 0.11$$

$$V = F' R^{2/3} \quad F' = \frac{1.486}{0.11} (0.0125)^{1/2} = 1.51$$

$$V = 1.51 R^{2/3}$$

JOB NO. 79.206.1  
 DATE 12/2/79  
 BY FDD  
 CH'D BY MA

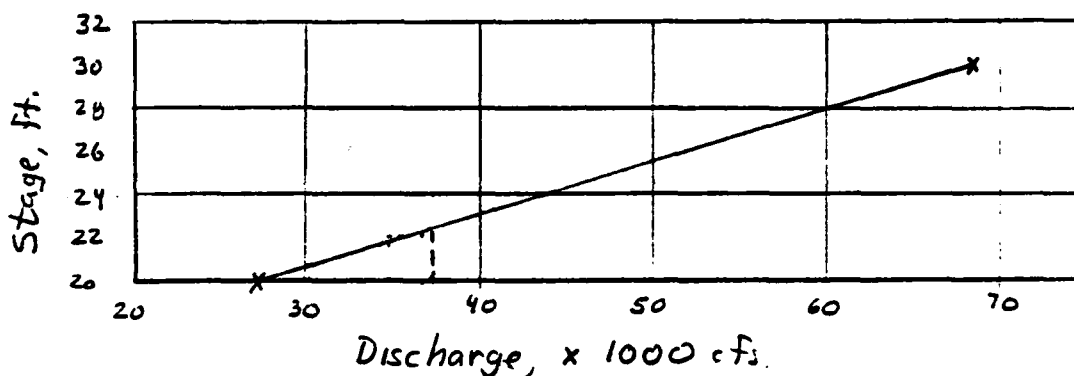


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 BOSTON — WEST HARTFORD

SHEET NO. D22  
 JOB Dam  
 SUBJECT So. Res. Dam  
 CLIENT Corp.

## Failure Flood Routing - So. Res. Dam

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^{2/3}}{ft^{2/3}}$ | $\frac{F'}{ft}$ | $\frac{V}{fps}$ | $\frac{Q}{cfs}$ | Elev |
|----------------|-----------------|----------------|----------------------------|-----------------|-----------------|-----------------|------|
| 10             | 200             | 1000           | 2.94 ✓                     | 1.51            | 4.44 ✓          | 4,439 ✓         | 110  |
| 20             | 275             | 3350           | 5.34 ✓                     | "               | 8.06 ✓          | 27,005 ✓        | 120  |
| 30             | 400             | 6800           | 6.67 ✓                     | "               | 10.08 ✓         | 68,531 ✓        | 130  |



$$Q_{P1} = 36,998 \text{ cfs} \quad d_1 = 22.4'$$

$$Vol_1 = \frac{5240 + 4030}{2} \times \frac{800}{43,560} = 85.13 \text{ ac-ft}$$

$$Q_{P2} = 36,998 \left(1 - \frac{85.13}{1500}\right) = 34,897 \text{ cfs} \quad d_2 = 21.9'$$

$$Vol_2 = \frac{5240 + 3880}{2} \times \frac{800}{43,560} = 83.75 \text{ ac-ft}$$

$$Vol_{ave} = \frac{85.13 + 83.75}{2} = 84.44 \text{ ac-ft}$$

$$Q_{P3} = 36,998 \left(1 - \frac{84.44}{1500}\right) = 34,901 \text{ cfs} \quad d_2 = 21.9'$$

$$Q_{out} = 34,901 \text{ cfs} \quad Elev. = 121.9'$$

JOB NO. 79.206.1  
 DATE 12/21/79  
 BY FDD  
 CH'D BY M4



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 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D23  
 JOB Dams  
 SUBJECT South Res Dam  
 CLIENT Corps

## Failure Flood Routing - So. Res. Dam

Sta 33+00

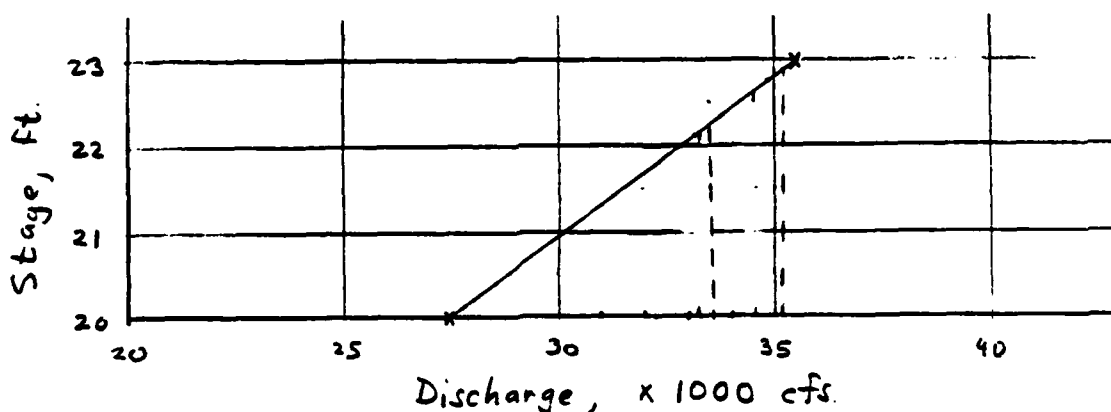
$$S = 0.0125$$

$$n = 0.11$$

$$V = f' R^{2/3}$$

$$V = 1.51 R^{2/3}$$

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^{2/3}}$ | $\frac{f'}{}$ | $\frac{V}{fps}$ | $\frac{Q}{cfs}$ | $\frac{Elev}{}$ |
|----------------|-----------------|----------------|------------------|---------------|-----------------|-----------------|-----------------|
| 10             | 200             | 1006           | 2.93 ✓           | 1.51          | 4.44            | 4439 ✓          | 100             |
| 20             | 350             | 3750           | 4.90 ✓           | "             | 7.40 ✓          | 27739 ✓         | 110             |
| 23             | 760             | 5940           | 3.97 ✓           | "             | 5.99 ✓          | 35,568 ✓        | 113             |



$$Q_P = 34,901 \text{ cfs} \quad d_1 = 22.75' \checkmark$$

$$Vol_1 = \frac{3475 + 5710}{2} \times \frac{700}{43,560} = 77.82' \text{ ac-ft}$$

$$Q_{P_2} = 34,901 \left(1 - \frac{77.82}{1500}\right) = 33,090 \text{ cfs} \quad d_2 = 22.25'$$

$$Vol_2 = \frac{3475 + 5314}{2} \times \frac{700}{43,560} = 74.66' \text{ ac-ft}$$

$$Vol_{ave} = \frac{77.82 + 74.66}{2} = 76.24' \text{ ac-ft}$$

JOB NO. 79.706.1  
 DATE 12/2/79  
 BY FDD  
 CH'D BY MA



HAYDEN, HARDING & BUCHANAN, INC.  
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 BOSTON — WEST HARTFORD

SHEET NO. D24

JOB Dams  
 SUBJECT South Res Dam  
 CLIENT Corps

# Failure Flood Routing - So. Res. Dam

$$Q_{P_3} = 34,901 \left(1 - \frac{76.24}{1500}\right) = 33,127 \text{ cfs. } d_2 = 22.2' \pm$$

$$Q_{out} = 33,127 \text{ cfs } Elev. = 112.2' \pm$$

Sta. 50+00

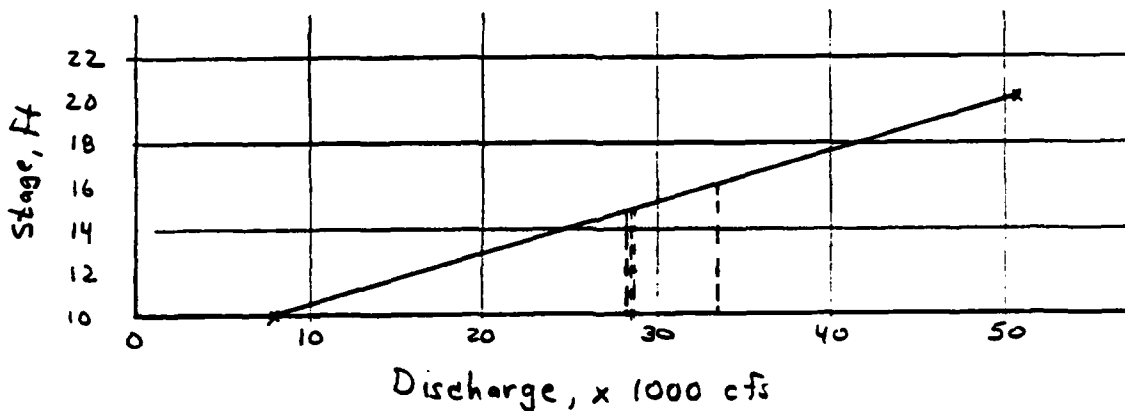
$$S = 0.00588$$

$$n = 0.12$$

$$V = F' R^{2/3} \quad F' = \frac{1.486}{.12} (0.00588)^{1/2} = 0.950'$$

$$V = 0.95 R^{2/3}$$

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^3}{\checkmark}$ | $\frac{F'}{\checkmark}$ | $\frac{V}{fps}$ | $\frac{Q}{cfs}$ | $\frac{Elev}{\checkmark}$ |
|----------------|-----------------|----------------|--------------------------|-------------------------|-----------------|-----------------|---------------------------|
| 10             | 270             | 2100           | 3.93                     | 0.95                    | 3.73            | 7833            | 90                        |
| 20             | 1200            | 11,700         | 4.56                     | "                       | 4.33            | 50,661          | 100                       |



$$Q_{P_1} = 33,127 \text{ cfs. } d_1 = 16'$$

$$Vol_1 = \frac{5550 \times 7204}{2} \times \frac{1700}{43560} = 250.43 \text{ ac-ft.}$$

$$Q_{P_2} = 33,127 \left(1 - \frac{250.43}{1500}\right) = 27,596 \text{ cfs. } d_2 = 14.7'$$

JOB NO. 79.206.1  
 DATE 12/26/79  
 BY EDD  
 CH'D BY MD



HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D25

JOB Dam  
 SUBJECT South Res. Dam  
 CLIENT Corps

# Failure Flood Routing - So. Res. Dam

$$Q_{P2} = 27,596 \quad d_2 = 14.7$$

$$Vol_2 = \frac{5550 + 6000}{2} \times \frac{1700}{43560} = 225.38 \text{ ac-ft}$$

$$Volume = \frac{250.43 + 225.38}{2} = 237.91 \text{ ac-ft}$$

$$Q_{P3} = 33,127 \left(1 - \frac{237.91}{1500}\right) = 27,886 \text{ cfs} \quad d_2 = 14.8'$$

$$Q_{P3} \approx 28000 \pm \quad El = 95 \pm$$

Sta. 59+00

$$S = 0.333$$

$$n = 0.12$$

$$V = P' R^{2/3}$$

$$V = 7.14 R^{2/3}$$

$$P' = \frac{1.486}{.12} (.333)^{4/2} = 7.14$$

| D  | WP  | A    | R <sup>2/3</sup> | P'   | V     | Q       | El (v.) |
|----|-----|------|------------------|------|-------|---------|---------|
| ft | ft  | sq   |                  |      | fps   | cfs     |         |
| 10 | 780 | 3900 | 2.93             | 7.14 | 20.92 | 81599 ± | 60      |
| 5  | 390 | 975  | 1.84             | "    | 13.14 | 12812 ± | 55      |

JOB NO. 79.206.1  
 DATE 12/26/79  
 BY FDD  
 CHECKED BY           

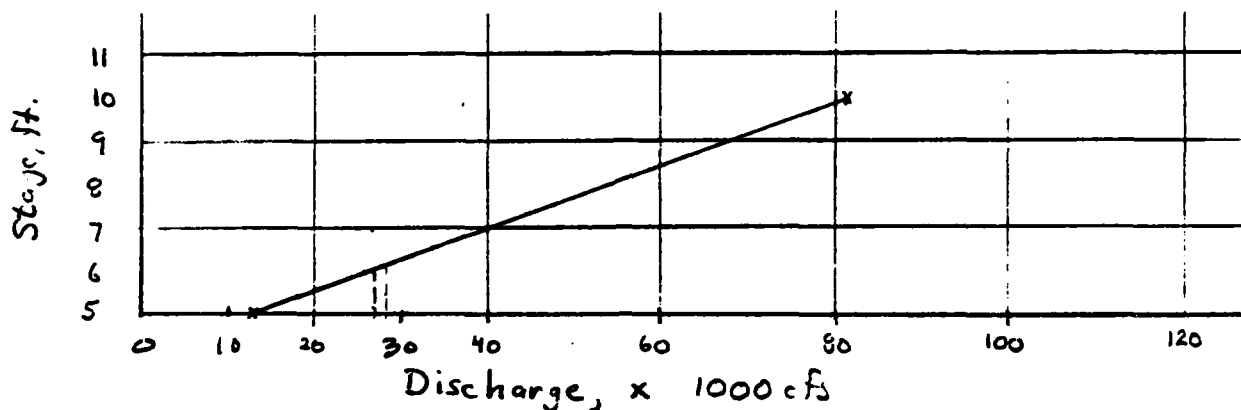


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 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D-6

JOB Dams  
 SUBJECT South Res. Dam  
 CLIENT Coeur

## Failure Flood Routing - So. Res. Dam



$$Q_{p1} = 28,000 \text{ cfs} \quad d_1 = 6.1'$$

$$Vol_1 = \frac{6250 + 1342}{2} \times \frac{900}{43560} = 78.43 \text{ ac-ft}$$

$$Q_{p2} = 28,000 \left(1 - \frac{78.43}{1500}\right) = 26,560 \text{ cfs} \quad d_2 = 6.0'$$

$$Vol_2 = \frac{6250 + 1240}{2} \times \frac{900}{43560} = 77.38 \text{ ac-ft}$$

$$Vol_{ave} = \frac{77.38 + 78.43}{2} = 77.91 \text{ ac-ft}$$

$$Q_{p3} = 28,000 \left(1 - \frac{77.91}{1500}\right) = 26,571 \text{ cfs} \quad d_2 = 6.0'$$

$$Q_{out} = 26,571 \text{ cfs} \quad E/ev = 56.0'$$

Sta. 73+00

$$S = 0.0143$$

$$n = 0.15$$

$$V = F' R^{2/3}$$

$$V = 1.19 R^{2/3}$$

$$F' = \frac{1.486}{0.15} (0.0143)^{1/2} = 1.19 \checkmark$$

JOB NO. 79.206.1  
 DATE 12/26/79  
 BY FDD  
 CH'D BY WJA



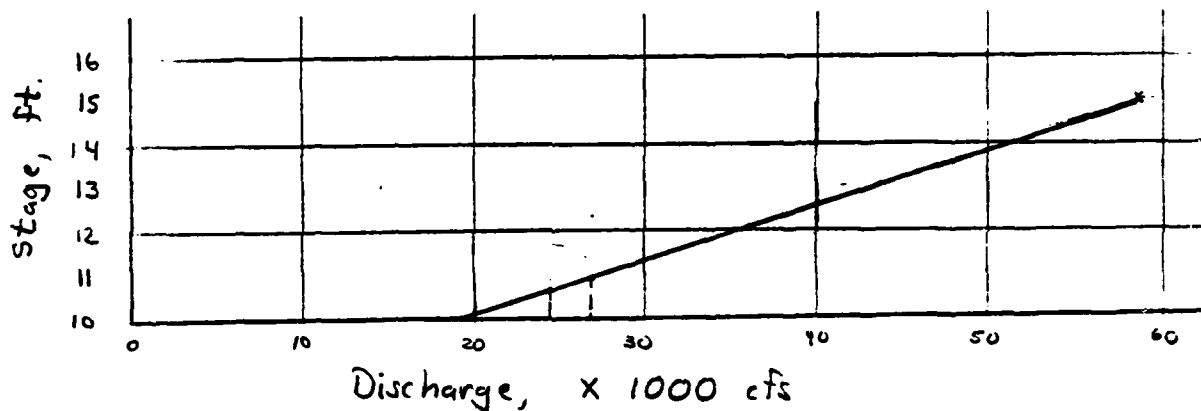
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 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D27

JOB Dams  
 SUBJECT South Res Dams  
 CLIENT Corps

Failure Flood Routing - So. Res. Dam

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{P^{2/3}}{ft}$ | $\frac{f'}{ft}$ | $\frac{V}{fps}$ | $\frac{Q}{cfs}$ | Elev |
|----------------|-----------------|----------------|----------------------|-----------------|-----------------|-----------------|------|
| 10             | 1100            | 5500           | 2.93                 | 1.19            | 3.49            | 19,195          | 40   |
| 15             | 1300            | 11,500         | 4.28                 | "               | 5.09            | 58,535          | 45   |



$$Q_p = 26,571 \text{ cfs} \quad d_1 = 10.9'$$

$$Vol_1 = \frac{1425 + 5660}{2} \times \frac{1400}{43560} = 113.85 \text{ ac-ft}$$

$$Q_{p2} = 26,571 \left(1 - \frac{113.85}{1500}\right) = 24,554 \text{ cfs} \quad d_2 = 10.7'$$

$$Vol_2 = \frac{1425 + 5610}{2} \times \frac{1400}{43560} = 113.08 \text{ ac-ft}$$

$$Vol_{ave} = \frac{113.85 + 113.08}{2} = 113.47 \text{ ac-ft}$$

$$Q_{p2} = 26,571 \left(1 - \frac{113.47}{1500}\right) = 24,561 \text{ cfs} \quad d_2 = 10.7'$$

$$Q_{out} = 24,561 \text{ cfs} \quad Elev. = 40.7'$$

JOB NO. 79.206.1  
 DATE 12/20/79  
 BY FDD  
 CND BY WV



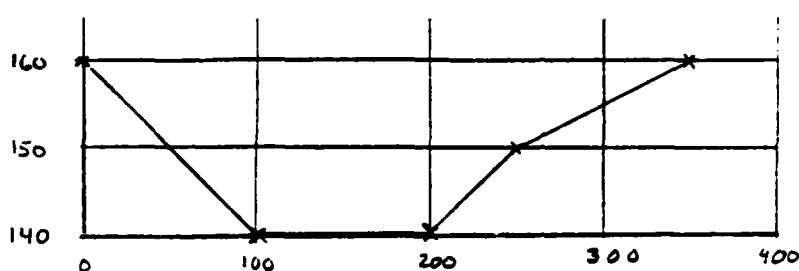
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 BOSTON — WEST HARTFORD

SHEET NO. D28  
 JOB Dams  
 SUBJECT South Res  
 CLIENT Corps

## Cross Sections - So. Res. Dam

Sections taken looking upstream

Sta. 3+00 (below Spillway)

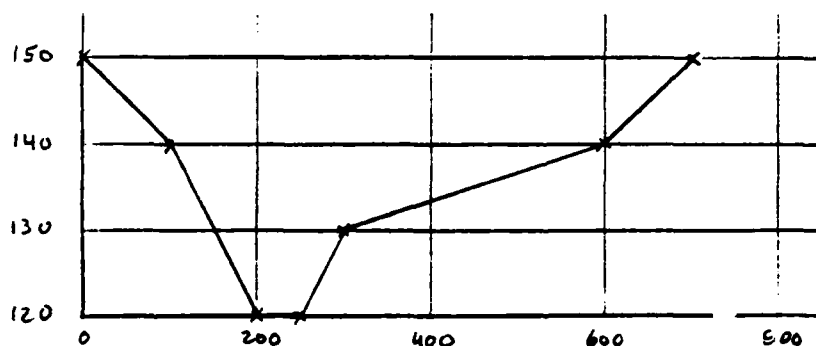


| Elev.<br>NGVD | Area<br>sf |
|---------------|------------|
| 150           | 1500       |
| 160           | 4250       |

$$S = 30/600' = 0.05'$$

$$n = 0.12 \text{ - med. - hvy. brush \& trees.}$$

Sta. 6+00 (below Dam)

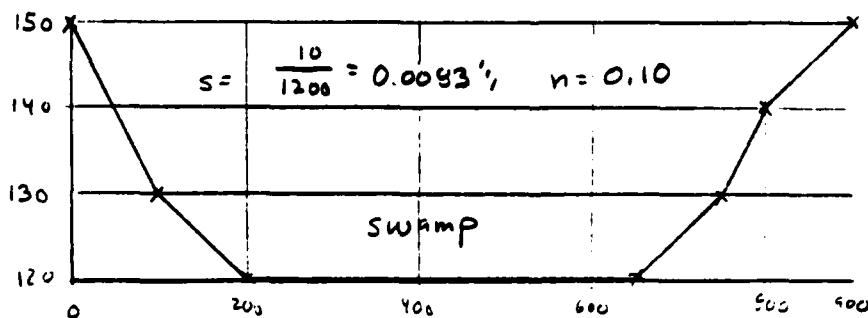


| Elev. | Area<br>sf |
|-------|------------|
| 130   | 1000       |
| 140   | 4250       |
| 150   | 10250      |

$$S = 0.05$$

$$n = 0.12$$

Sta. 13+00



$$S = \frac{10}{1200} = 0.0083', \quad n = 0.10$$

SWAMP

| Elev. | Area<br>sf |
|-------|------------|
| 130   | 5500       |
| 140   | 12500      |
| 150   | 20750      |

JOB NO. 79.206.1  
 DATE 12/20/79  
 BY FDD  
 CH'D BY WLR



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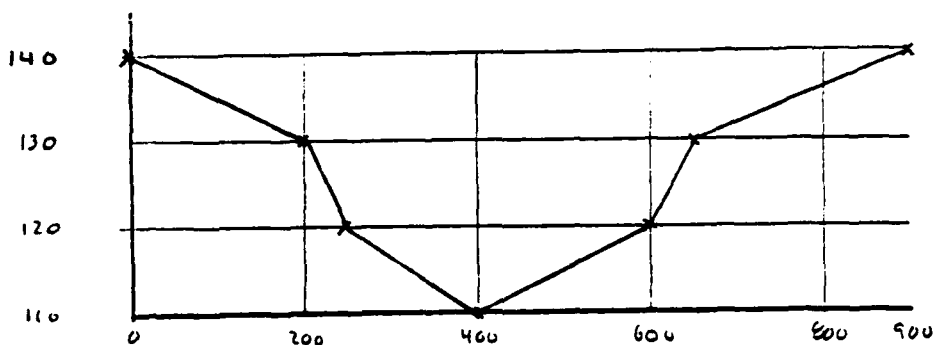
SHEET NO. D29

JOB Dams  
 SUBJECT South Res  
 CLIENT Corps

## Cross Sections - South Res Dam

Sections taken looking upstream

Sta 17+00

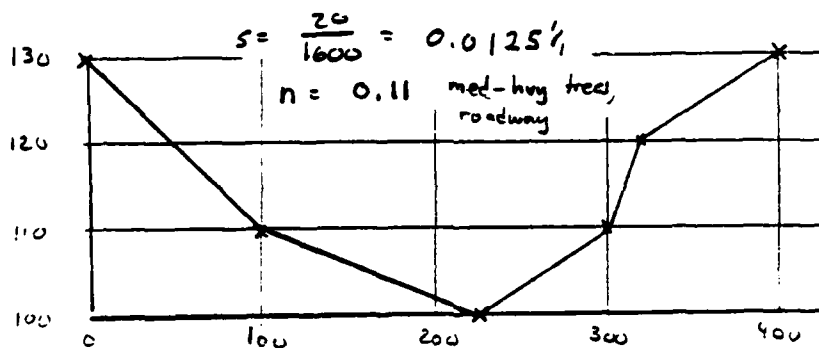


| Elev | Area<br>sf |
|------|------------|
| 120  | 1750       |
| 130  | 5750       |
| 140  | 12,000     |

$$S = 0.0083\%$$

$$n = 0.10$$

Sta 25+00

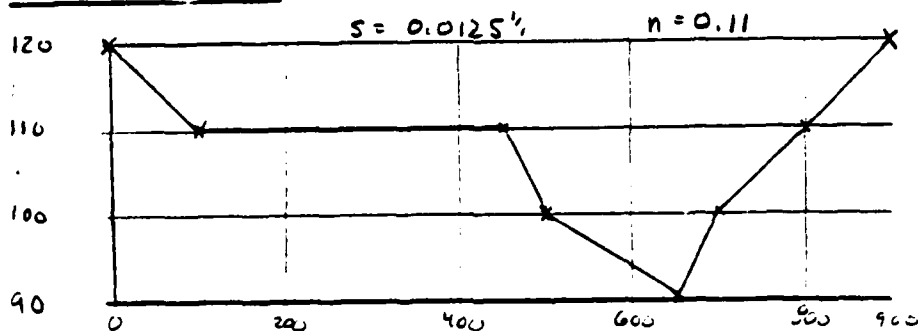


$$S = \frac{20}{1600} = 0.0125\%$$

$$n = 0.11 \text{ med-hvy trees, roadway}$$

| Elev | Area<br>sf |
|------|------------|
| 110  | 1000       |
| 120  | 3350       |
| 130  | 6800       |

Sta 33+00



$$S = 0.0125\%$$

$$n = 0.11$$

| Elev | Area<br>sf |
|------|------------|
| 100  | 1000       |
| 110  | 3750       |
| 120  | 10,000     |

JOB NO. 79 206.1  
 DATE 12/26/79  
 BY FDD  
 CH'D BY MA



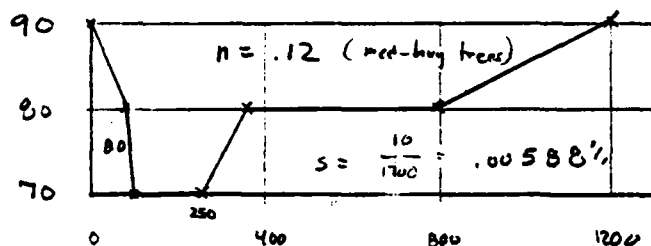
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 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D30  
 JOB Dams  
 SUBJECT South Res Dam  
 CLIENT Corps

## Cross Sections - South Res. Dam

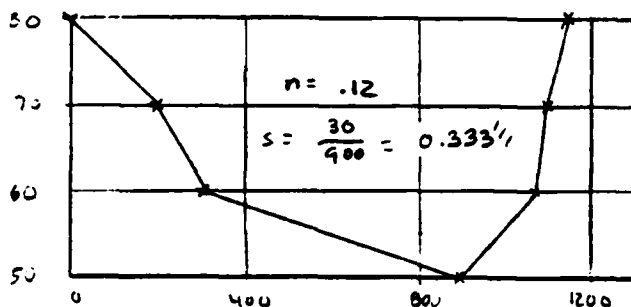
Sections taken looking upstream

Sta. 50+00 (below Dam)



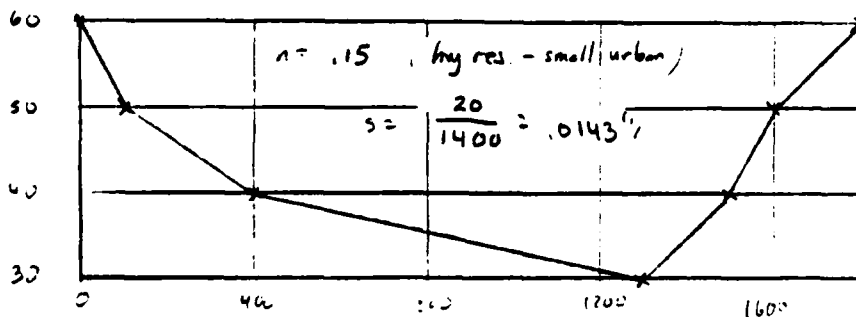
| Elev. | Area (sf) |
|-------|-----------|
| 90    | 2100      |
| 100   | 11,700    |

Sta. 59+00



| Elev. | Area (sf) |
|-------|-----------|
| 60    | 3900      |
| 70    | 12,300    |
| 80    | 22,550    |

Sta. 73+00



| Elev | Area sf |
|------|---------|
| 40   | 5500    |
| 50   | 14500   |
| 60   | 35,000  |

JOB NO. 79.206.1  
 DATE 11/5/80  
 BY FDD  
 CH'D BY MA



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 BOSTON — WEST HARTFORD

SHEET NO. E31  
 JOB Dam  
 SUBJECT South Res. Dike  
 CLIENT Corps

West Dike - located at southwest corner of  
 South Reservoir

has length approx. 200'  
 height: effective height = 3' as dike crest is  
 about 3' above South Border Rd.  
 (assume this road doesn't wash out).

Failure Discharge (from Corps Guidelines):

$$Q_F = \frac{8}{27} \times (0.4 \times 200) (\sqrt{2g}) (3)^{1.5} = 698 \text{ cfs}$$

say  $Q_F = 700 \text{ cfs}$ .

$$Stor = Stor_{163.5} - Stor_{160.2} = 300 \text{ ac-ft} \pm$$

$\uparrow$  top of dam       $\uparrow$  Failure Depth

Sta 5+00

$$S = 0.006'$$

$$n = 0.10$$

$$V = F' R^{2/3}$$

$$V = 1.15 R^{2/3}$$

$$F' = \frac{1.486}{0.10} \times (0.006)^{1/2} = 1.15 \checkmark$$

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^{2/3}}$ | $\frac{F'}$ | $\frac{V}{fps}$ | $\frac{Q}{cfs}$ | Elev. |
|----------------|-----------------|----------------|------------------|-------------|-----------------|-----------------|-------|
| 3              | 180             | 270            | 1.31 ✓           | 1.15 ✓      | 1.51 ✓          | 407 ✓           | 163   |
| 4              | 240             | 480            | 1.59 ✓           | "           | 1.93 ✓          | 878 ✓           | 164   |
| 2              | 120             | 120            | 1.0              | "           | 1.15            | 138 ✓           | 162   |

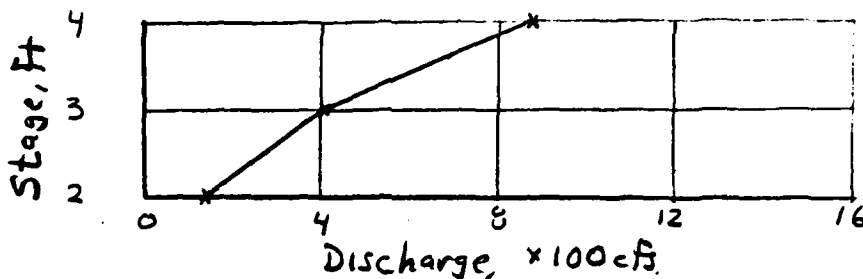
JOB NO. 79.206.1  
 DATE 11/5/80  
 BY FDD  
 CH'D BY MA



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 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D32  
 JOB Dams  
 SUBJECT South Res. Dike  
 CLIENT Corps

Sta. 5+00



$$Q_F = 700 \text{ cfs}$$

$$d = 3.5'$$

$$\text{Elev} = 163.5' \pm$$

$$Q_{P_1} = 700 \quad d_1 = 3.5' \quad \text{Star}_1 = \frac{389 \times 500}{43560} = 4.47' \text{ ft}$$

$$Q_{P_2} = 700 \left(1 - \frac{4.47}{300}\right) = 690 \text{ cfs} \quad d_2 = 3.5'$$

$$Q_{out} = 690 \text{ cfs} \quad \text{Elev} = 163.5' \pm$$

JOB NO. 79.206.1  
 DATE 1/15/80  
 BY FDD  
 CH'D BY MD



HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D33

JOB Dams  
 SUBJECT South Res. Dike  
 CLIENT Corps

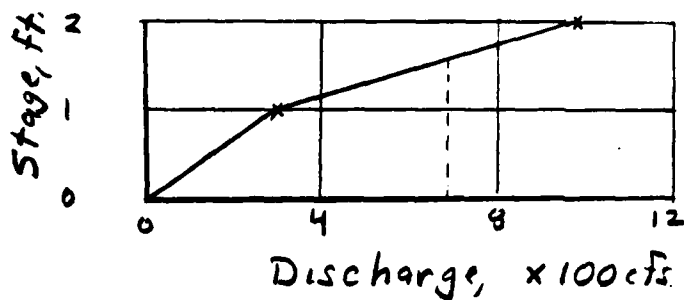
Sta 39+00

$$S = 0.018', \quad n = 0.10$$

$$V = f' R^{2/3} \quad f' = \frac{1.486}{0.10} (0.018)^{1/2} = 1.99'$$

$$V = 1.99 R^{2/3}$$

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sq}$ | $\frac{R^{2/3}}$ | $\frac{f'}{}$ | $\frac{V}{fps}$ | $\frac{Q}{cfs}$ | $\frac{Elev}{}$ |
|----------------|-----------------|----------------|------------------|---------------|-----------------|-----------------|-----------------|
| 1              | 165             | 157.5          | 0.97✓            | 1.99          | 1.93✓           | 304✓            | 91              |
| 2              | 180             | 330            | 1.50             | "             | 2.99✓           | 986✓            | 92              |



$$Q_{P_1} = 690 \text{ cfs} \quad d_1 = 1.6' \pm$$

$$Stor. = \frac{389 + 259}{2} \times \frac{3400}{43560} = 25.29 \text{ ac-ft}$$

$$Q_{P_2} = 690 \left(1 - \frac{25.29}{300}\right) = 632 \text{ cfs} \quad d_2 = 1.5' \pm$$

$$Q_{out} = 632 \text{ cfs} \quad Elev = 91.5' \pm$$

JOB NO. 79.206.1  
 DATE 1/15/80  
 BY FDD  
 CH'D BY W A



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 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D34  
 JOB Dams  
 SUBJECT South Res. Dike  
 CLIENT Corps

Sta. 52+00

$$S = 0.02^{1/2}$$

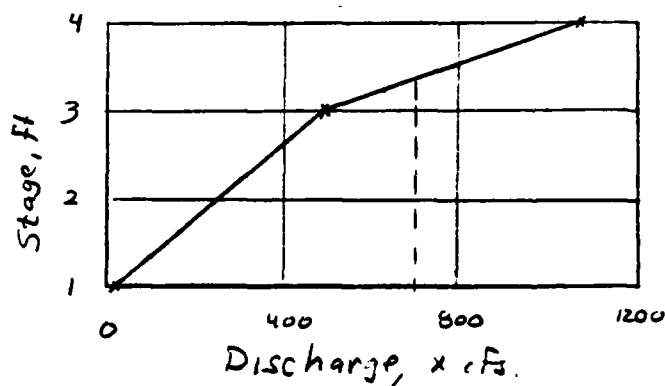
$$V = f' R^{2/3}$$

$$V = 2.10 R^{2/3}$$

$$n = 0.10$$

$$f' = \frac{1.486}{0.1} (0.02)^{1/2} = 2.10$$

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^{2/3}}$ | $f'$ | $\frac{V}{fps}$ | $\frac{Q}{cfs}$ | Elev. |
|----------------|-----------------|----------------|------------------|------|-----------------|-----------------|-------|
| 1.0            | 40              | 20             | .63 ✓            | 2.10 | 1.32 ✓          | 26 ✓            | 61    |
| 3.0            | 120             | 180            | 1.31 ✓           | "    | 2.76 ✓          | 496 ✓           | 63    |
| 4.0            | 160             | 320            | 1.59 ✓           | " ✓  | 3.34 ✓          | 1069 ✓          | 64    |



$$Q_{P1} = 632 \text{ cfs} \quad d_1 = 3.25'$$

$$Stor_1 = \frac{250 + 211}{2} \times \frac{1300}{4380} = 6.88 \text{ ac-ft}$$

$$Q_{P2} = 632 \left(1 - \frac{6.88}{300}\right) = 618 \text{ cfs} \quad d_2 = 3.2' \pm$$

$$Q_{out} = 618 \text{ cfs} \quad Elev = 63.2' \pm$$

JOB NO. 79.206.1  
 DATE 11/5/90  
 BY FDD  
 CH'D BY WA



HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D35  
 JOB Dam  
 SUBJECT South Res. Dike  
 CLIENT Corps

Sta. 60+00

$$S = 0.014'$$

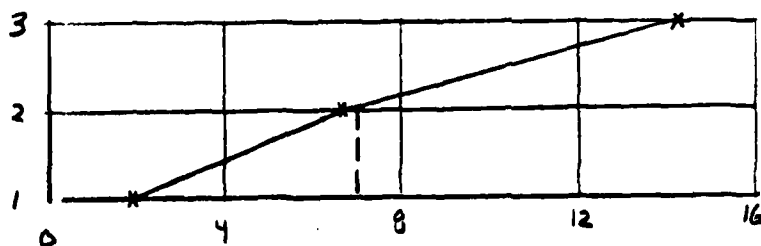
$$V = F' R^{2/3}$$

$$V = 1.76 R^{2/3}$$

$$F' = \frac{1.486}{0.1} (0.014)^{1/2} = 1.76$$

$$n = 0.10$$

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^{2/3}}$ | $\frac{F'}{}$ | $\frac{V}{ft^3/s}$ | $\frac{Q}{cf}$ | Elev |
|----------------|-----------------|----------------|------------------|---------------|--------------------|----------------|------|
| 2              | 180             | 280            | 1.34 ✓           | 1.76          | 2.37 ✓             | 663 ✓          | 52   |
| 3              | 220             | 480            | 1.69 ✓           | " ✓           | 2.97 ✓             | 1425 ✓         | 53   |
| 1              | 140             | 120            | 0.90 ✓           | "             | 1.59 ✓             | 190 ✓          | 51   |



$$Q_{P_1} = 618 \text{ cfs} \quad d_1 = 1.9'$$

$$Stor_1 = \frac{210 + 262}{2} \times \frac{800}{43560} = 4.33$$

$$Q_{P_2} = 618 \left( 1 - \frac{4.33}{300} \right) = 609 \text{ cfs} \quad d_2 = 1.9' \pm$$

$$Q_{out} = 609 \text{ cfs} \quad \text{Elev} = 51.9' \pm$$

JOB NO. 79.206.1  
 DATE 11/5/80  
 BY FDD  
 CH'D BY WJA



HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D36  
 JOB Dams  
 SUBJECT South R. Dike  
 CLIENT Corps

Sta. 70+00

$$S = 0.02$$

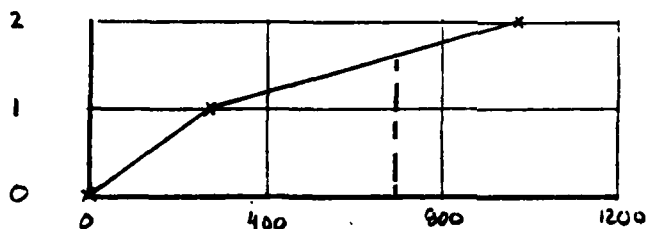
$$n = 0.12$$

$$V = f' R^{2/3}$$

$$V = 1.75 R^{2/3}$$

$$f' = \frac{1.486}{0.12} (0.02)^{1/2} = 1.75 \checkmark$$

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^{2/3}}$  | $f'$ | $\frac{V}{fps}$   | $\frac{Q}{cfs}$  | Elev. |
|----------------|-----------------|----------------|-------------------|------|-------------------|------------------|-------|
| 2              | 260             | 410            | 1.36 $\checkmark$ | 1.75 | 2.37 $\checkmark$ | 974 $\checkmark$ | 32    |
| 1              | 205             | 177.5          | 0.91 $\checkmark$ | "    | 1.59 $\checkmark$ | 283 $\checkmark$ | 31    |



$$Q_{P_1} = 609 \text{ cfs} \quad d_1 = 1.5'$$

$$S_{for_1} = \frac{262 + 287}{2} \times \frac{1000}{43560} = 6.30' \text{ ac-ft}$$

$$Q_{P_2} = 609 \left(1 - \frac{6.30}{300}\right) = 596 \text{ cfs} \quad d_2 = 1.45' \pm$$

$$Q_{out} = 596 \text{ cfs} \quad \text{Elev} = 31.5' \pm$$

JOB NO. 79.226.1  
DATE 11/5/80  
BY FDD  
CHK'D BY WJA



HAYDEN, HARDING & BUCHANAN, INC  
CONSULTING ENGINEERS  
BOSTON — WEST HARTFORD

SHEET NO. D37

JOB Dam  
SUBJECT Santa Rosa Dam  
CLIENT Corpor

### Summary of Failure Flood Elevations

| Sta.  | Ground Elev. | Flood Elev. | Flood Depth |
|-------|--------------|-------------|-------------|
| 5+00  | 160 ±        | 163.5       | 3.5' ±      |
| 39+00 | 90 ±         | 91.5        | 1.5' ±      |
| 52+00 | 60 ±         | 63.2        | 3.2' ±      |
| 60+00 | 50 ±         | 51.9        | 1.9' ±      |
| 70+00 | 30 ±         | 31.5        | 1.5' ±      |

In residential areas, Flooding  
3' to 2' or less deep.

Estimate 5-10 houses in impact area.

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 DATE 1/15/80  
 BY EDD  
 CHECKED BY MMH

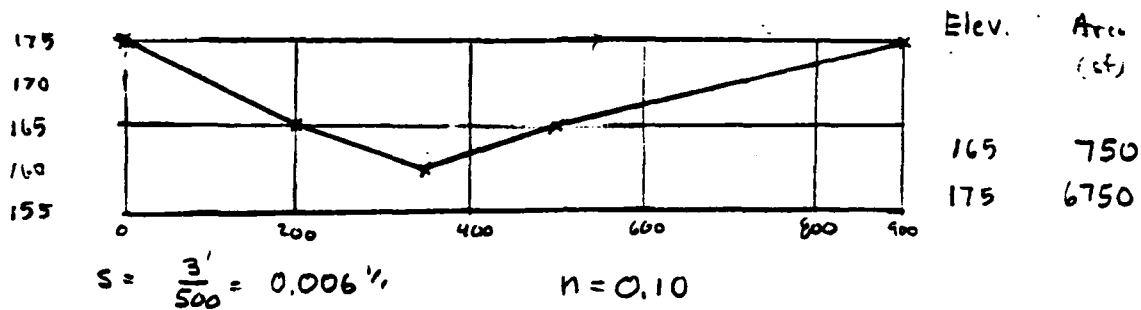


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 BOSTON — WEST HARTFORD

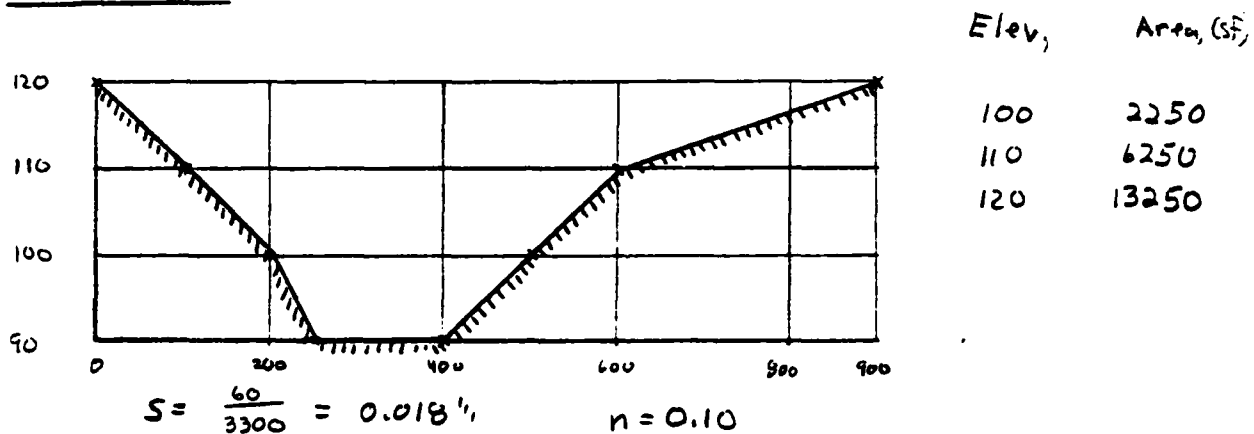
SHEET NO. D38  
 JOB Dams  
 SUBJECT South Res. Dam  
 CLIENT Cooper

## Cross Sections - West Dike (taken looking upstream)

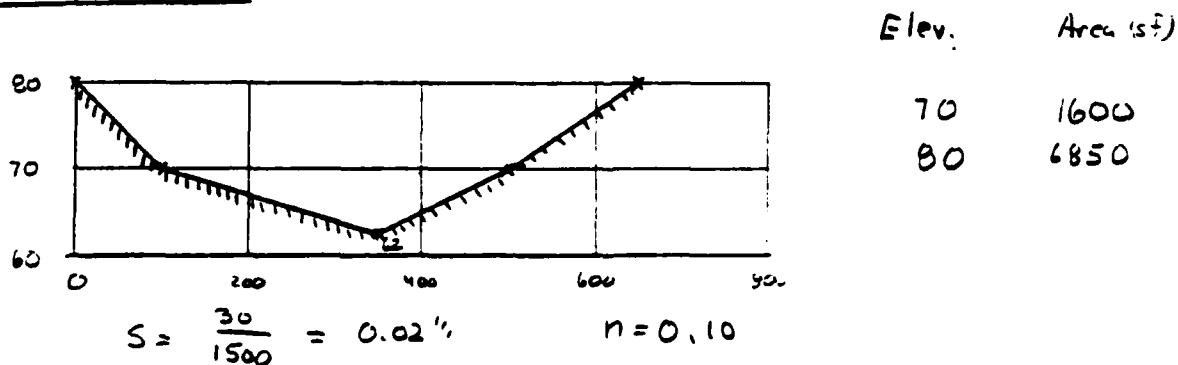
### Sta. 5+00



### Sta. 39+00



### Sta. 52+00



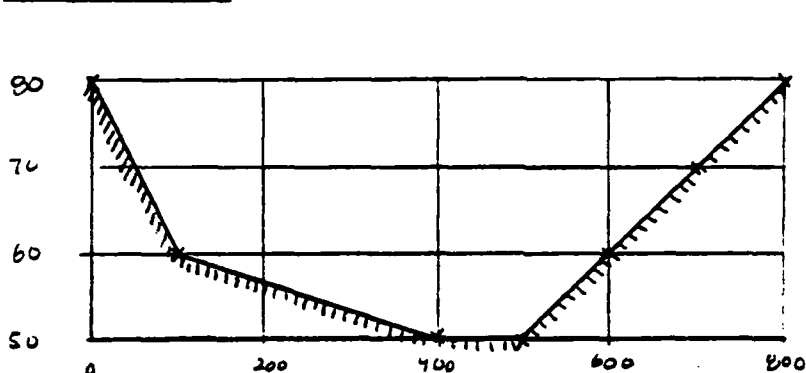
JOB NO. 79.206.1  
 DATE 1/15/80  
 BY FDD  
 CH'D BY MC



HAYDEN, HARDING & BUCHANAN, INC.  
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 BOSTON — WEST HARTFORD

SHEET NO. D39  
 JOB Dam  
 SUBJECT South Res. Dike  
 CLIENT Corps

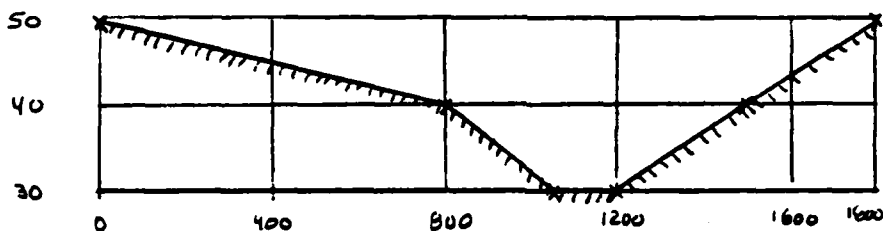
Sta 60+00



| Elev | Area (sf) |
|------|-----------|
| 60   | 3000      |
| 70   | 6750      |

$$S = \frac{10}{700} = 0.014', \quad n = 0.10$$

Sta 70+00



| Elev | Area (sf) |
|------|-----------|
| 40   | 4250      |
| 50   | 16750     |

$$S = \frac{20}{1000} = 0.02', \quad n = 0.12$$

JOB NO. 74.206.1  
 DATE 125162  
 BY EDD  
 CHECKED BY MA



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 BOSTON — WEST HARTFORD

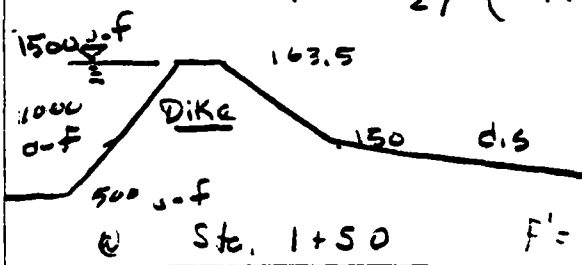
SHEET NO. D40  
 JOB Dams  
 SUBJECT South Res. Dike  
 CLIENT Corps

## East Dike

Assume dike between South & Middle Res. does not fail.

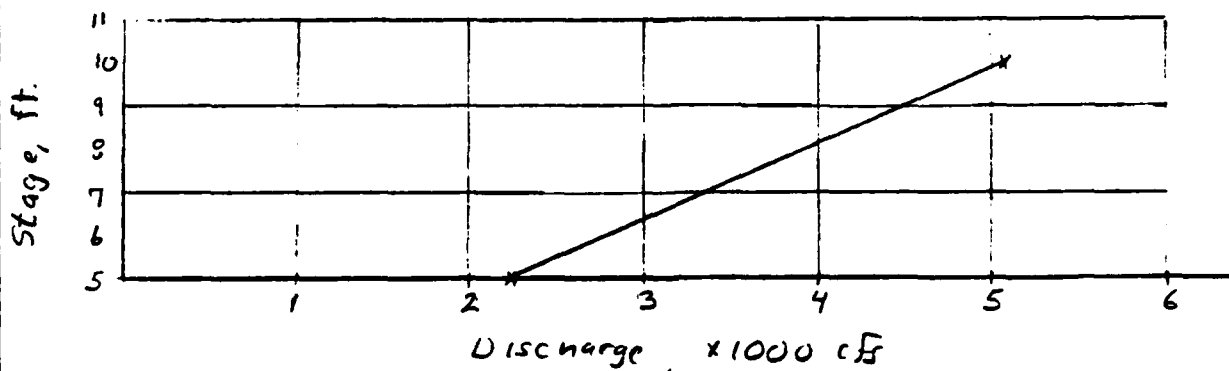
### Failure outflow

$$Q = \frac{E}{27} \times (0.4 \times 100) (5.67) (13.5)^{3/2} = 3333 \text{ cfs} \checkmark$$



$$F' = \frac{1.466}{0.12} (0.007)^{1/2} = 1.04 \checkmark$$

| $\frac{D}{\text{ft.}}$ | $\frac{WP}{\text{ft.}}$ | $\frac{A}{\text{sf.}}$ | $\frac{R^{2/3}}{\text{ft.}}$ | $\frac{F'}{\text{ft.}}$ | $\frac{V}{\text{ft.}}$ | $\frac{Q}{\text{cfs}}$ | $\frac{\text{Elev.}}{\text{NGVD}}$ |
|------------------------|-------------------------|------------------------|------------------------------|-------------------------|------------------------|------------------------|------------------------------------|
| 20                     | 290                     | 3725                   | 5.53                         | 1.04                    | 5.75                   | 21,419                 | 170                                |
| 5                      | 95                      | 613                    | 3.49                         | "                       | 3.63                   | 2,223                  | 155                                |
| 10                     | 190                     | 1325                   | 3.67                         | "                       | 3.82                   | 5,062                  | 160                                |



$$Q_{p1} = 3333 \text{ cfs} \quad d_1 = 7.0 \pm \quad EI = 157.0$$

$$\text{Stor}_1 = \frac{991 \times 150}{43560} = 3.4 \text{ ac-ft}$$

$$Q_{p2} = 3333 \left( 1 - \frac{3.4}{1000} \right) = 3322 \pm \text{cfs}$$

JOB NO. 79-206-1  
 DATE 1/25/50  
 BY FDD  
 CH'D BY WMB



HAYDEN, HARDING & BUCHANAN, INC.  
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SHEET NO. D41  
 JOB Dams  
 SUBJECT South Rec. Dike  
 CLIENT Corps

$$Q_{P_2} = 3322 \text{ cfs} \quad d_2 = 7.0 \quad E1 = 157.0$$

$$Stor_2 = 3.4 \text{ ac-ft}$$

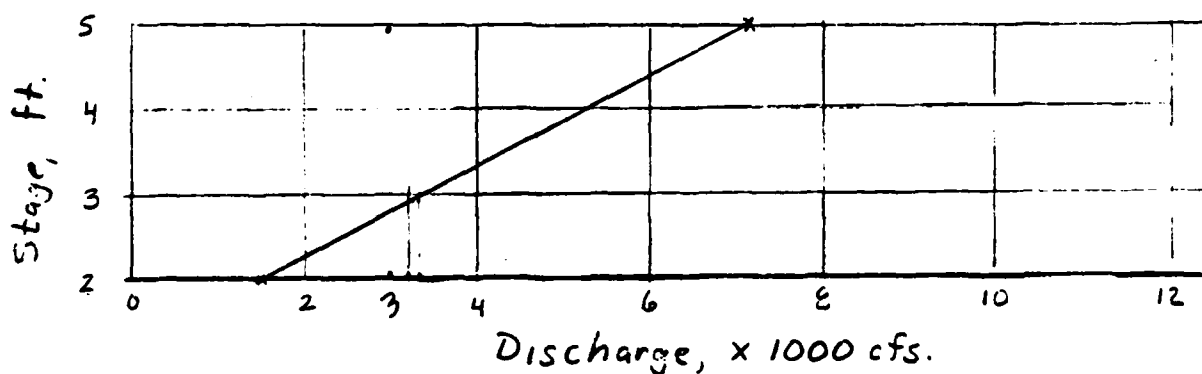
$$Stor_{avr} = 3.4$$

$$Q_{out} = 3322 \text{ cfs} \quad E1 = 157.0$$

@ Sta. 15+00

$$F1 = 1.04$$

| <u>D</u> | <u>WP</u> | <u>A</u>  | <u>R<sup>2/3</sup></u> | <u>F'</u> | <u>V</u>   | <u>Q</u>   | <u>Elev.</u> |
|----------|-----------|-----------|------------------------|-----------|------------|------------|--------------|
| <u>4</u> | <u>F</u>  | <u>sf</u> |                        |           | <u>Fps</u> | <u>cfs</u> | <u>NGVD</u>  |
| 10       | 650       | 5500      | 4.18                   | 1.04      | 4.34       | 23970      | 160          |
| 2        | 490       | 940       | 1.55                   | "         | 1.61       | 1513       | 152          |
| 5        | 550       | 2500      | 2.76                   | "         | 2.97       | 7171       | 155          |



$$Q_{P_1} = 3322 \text{ cfs} \quad d_1 = 3.0' \quad E1 = 153.0' =$$

$$Stor_1 = \frac{941 + 1440}{2} \times \frac{1350}{43560} = 37.7 \text{ ac-ft}$$

$$Q_{P_2} = 3322 \left(1 - \frac{37.7}{1000}\right) = 3197 \text{ cfs}$$

DB NO. 79.206.1  
 DATE 1/25/60  
 BY FDD  
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 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D42  
 JOB Dams  
 SUBJECT South Re. Dike  
 CLIENT Corps

$$Q_{P2} = 3197 \text{ cfs} \quad d_2 = 2.9' \quad \text{Elev} = 152.9' \pm$$

$$\text{Stor}_2 = \frac{991 + 1415}{2} \times \frac{1350}{43560} = 37.3 \text{ ac-ft}$$

$$\text{Stor}_{\text{ave}} = \frac{37.7 + 37.3}{2} = 37.5 \text{ ac-ft}$$

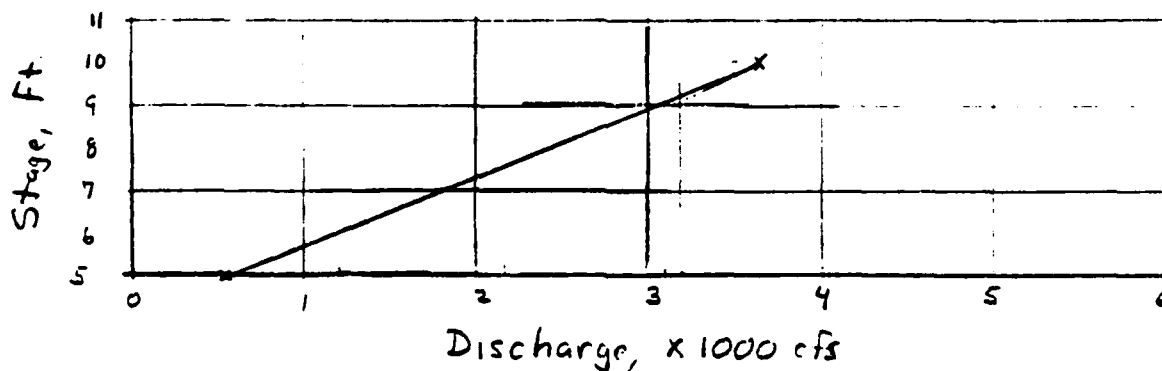
$$Q_{P3} = 3322 \left(1 - \frac{37.5}{1000}\right) = 3197 \text{ cfs}$$

$$Q_{\text{out}} = 3197 \text{ cfs} \quad \text{Elev} = 152.9' \pm$$

@ Sta 25+00

$$F' = \frac{1.466}{0.12} (.01)^{1/2} = 1.24$$

| D<br>ft | WP<br>ft | A<br>sq ft | R <sup>2/3</sup> | F'   | V<br>fps | Q<br>cfs | Elev<br>NGVD |
|---------|----------|------------|------------------|------|----------|----------|--------------|
| 10      | 200      | 1000       | 2.94             | 1.24 | 3.65     | 3650     | 150          |
| 5       | 100      | 250        | 1.87             | "    | 2.3      | 572      | 145          |
| 15      | 380      | 2900       | 3.90             | "    | 4.84     | 14,034   | 155          |



$$Q_{P1} = 3197 \text{ cfs} \quad d_1 = 9.2' \quad \text{Elev} = 149.2' \pm$$

$$\text{Stor}_1 = \frac{1425 + 846}{2} \times \frac{1000}{43560} = 26.1 \text{ ac-ft}$$

JOB NO. 79-206.1  
 DATE 11-25-60  
 BY FDD  
 CH'D BY WVA



HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D43  
 JOB Dam  
 SUBJECT South Res. Dike  
 CLIENT Corpi

$$Q_{P_2} = 3197 \left(1 - \frac{26.1}{1000}\right) = 3114 \text{ cfs}$$

$$Q_{P_2} = 3114 \text{ cfs} \quad d_2 = 9.1 \quad \text{Elev} = 149.$$

$$\text{Stor}_2 = \frac{1425 + 637}{2} \times \frac{1000}{43560} = 26.0 \text{ ac-ft}$$

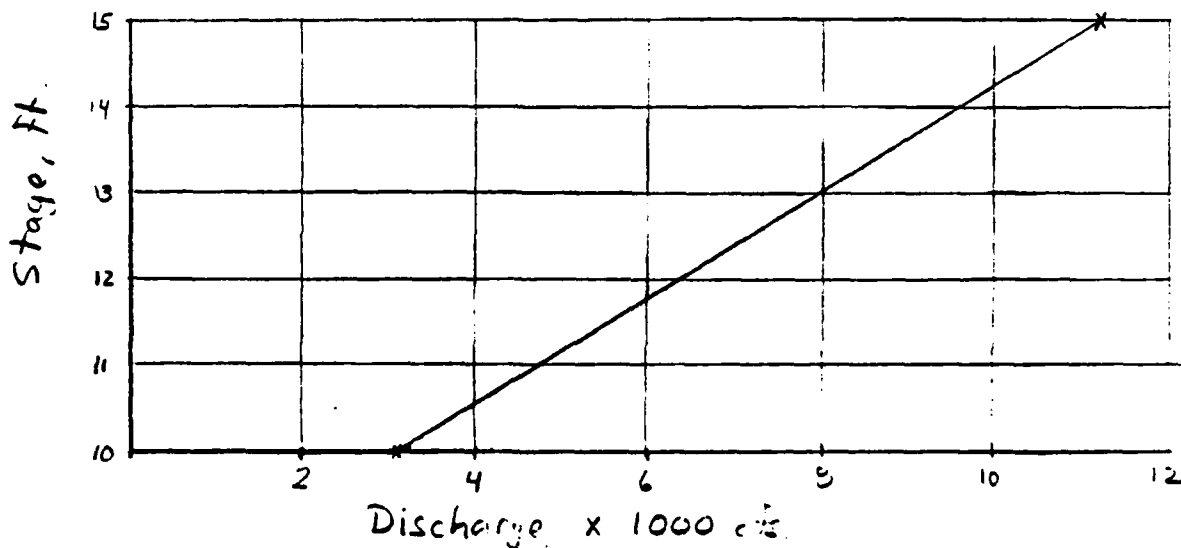
$$\text{Stor}_{ave} = \frac{26.0 + 26.1}{2} = 26.05 \text{ ac-ft}$$

$$Q_{P_3} = 3197 \left(1 - \frac{26.05}{1000}\right) = 3113 \text{ cfs}$$

$$Q_{out} = 3113 \text{ cfs} \quad \text{Elev.} = 149. \pm$$

@ Sta. 33+00  $f' = \frac{1.486}{0.12} (0.013)^{1/2} = 1.41$

| <u>D</u>  | <u>WP</u> | <u>A</u>  | <u>R<sup>2/3</sup></u> | <u>f'</u> | <u>V</u>   | <u>Q</u>   | <u>Elev</u> |
|-----------|-----------|-----------|------------------------|-----------|------------|------------|-------------|
| <u>ft</u> | <u>ft</u> | <u>sq</u> |                        |           | <u>Fps</u> | <u>cfs</u> | <u>NGVD</u> |
| 20        | 300       | 3000      | 4.68                   | 1.41      | 6.60       | 19,796     | 140         |
| 15        | 275       | 2063      | 3.86                   | "         | 5.44       | 11,220     | 135         |
| 10        | 150       | 750       | 2.94 ✓                 | "         | 4.15 ✓     | 3109 ✓     | 130         |



OS NO. 79.206.1  
 DATE 125190  
 BY FDD  
 W'D BY MA



HAYDEN, HARDING & BUCHANAN, INC.  
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 BOSTON — WEST HARTFORD

SHEET NO. D44  
 JOB Dams  
 SUBJECT Santa Rosa Lake  
 CLIENT Corp.

$$Q_{P_1} = 3113 \text{ cfs} \quad d_1 = 10. \pm \quad \text{Elev} = 130. '$$

$$\text{Stor}_1 = \frac{840 + 765}{2} \times \frac{800}{43560} = 14.7 \text{ ac-ft.}$$

$$Q_{P_2} = 3113 \left(1 - \frac{14.7}{1000}\right) = 3067 \text{ cfs}$$

$$Q_{P_2} = 3067 \text{ cfs} \quad d_2 = 10 \pm \quad \text{Elev} = 130$$

$$\text{Stor}_2 = \text{Stor}_1 = \text{Storage} = 14.7 \text{ ac-ft.}$$

$$Q_{\text{out}} = 3067 \text{ cfs.} \quad \text{Elev} = 130. 1' \pm$$

@ Sta. 41+00

$$F' = \frac{1.486}{0.12} (0.025)^{1/2} = 1.96 \checkmark$$

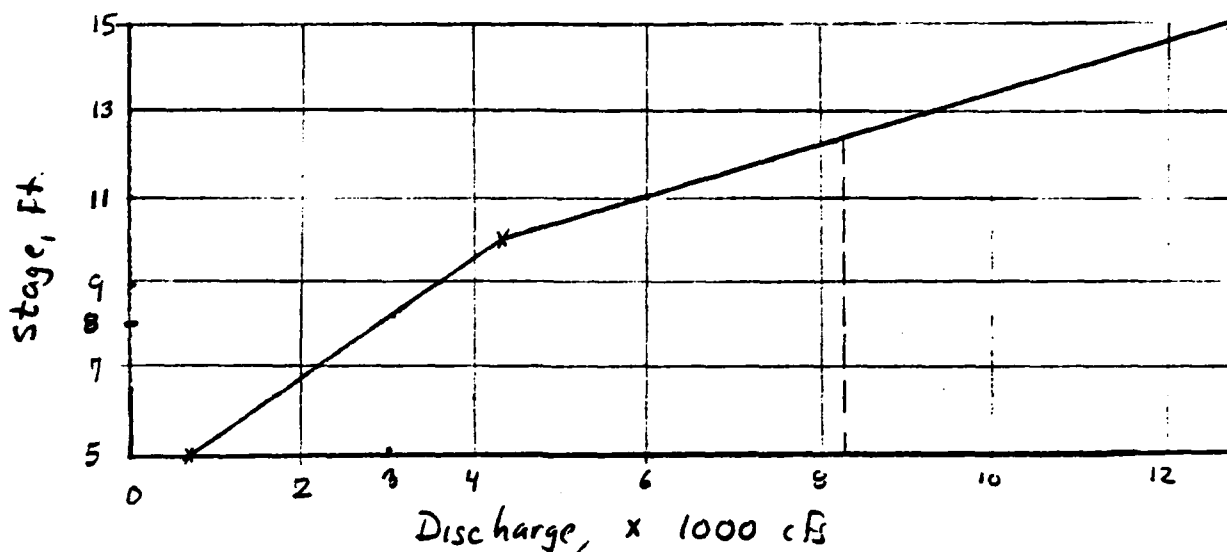
| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^{2/3}}{ft}$ | $\frac{F'}{ft}$ | $\frac{V}{fps}$ | $\frac{Q}{cfs}$ | $\frac{\text{Elev}}{NGVD}$ |
|----------------|-----------------|----------------|----------------------|-----------------|-----------------|-----------------|----------------------------|
| 10             | 150             | 750            | 2.94 ✓               | 1.96            | 5.76 ✓          | 4322 ✓          | 110                        |
| 20             | 300             | 3000           | 4.68                 | "               | 9.17            | 27,518          | 120                        |
| 15             | 225             | 1688           | 3.86                 | "               | 7.56            | 12,762          | 115                        |
| 5              | 75              | 187.5          | 1.85                 | "               | 3.62            | 679             | 105                        |

JOB NO. 79.206.1  
 DATE 11/5/80  
 BY EDD  
 CH'D BY WAK



HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D45  
 JOB Dam  
 SUBJECT South Res. Dike  
 CLIENT Coops



$$Q_{P_1} = 3067 \text{ cfs} \quad d_1 = 8.2 \quad \text{Elev} = 108.2'$$

$$Star_1 = \frac{765 + 529}{2} \times \frac{8.00}{43560} = 11.9' \text{ ac-ft}$$

$$Q_{P_2} = 3067 \left( 1 - \frac{11.9}{1000} \right) = 3030 \text{ cfs}$$

$$Q_{P_3} = 3030 \text{ cfs} \quad d_2 = 8.2 \quad \text{Elev} = 108.2'$$

$$Q_{P_3} = 3030 \text{ cfs} \quad \text{Elev} = 108.2'$$

OS NO. 79.206.1  
 DATE 11/25/40  
 BY FOD  
 M'D BY MAA



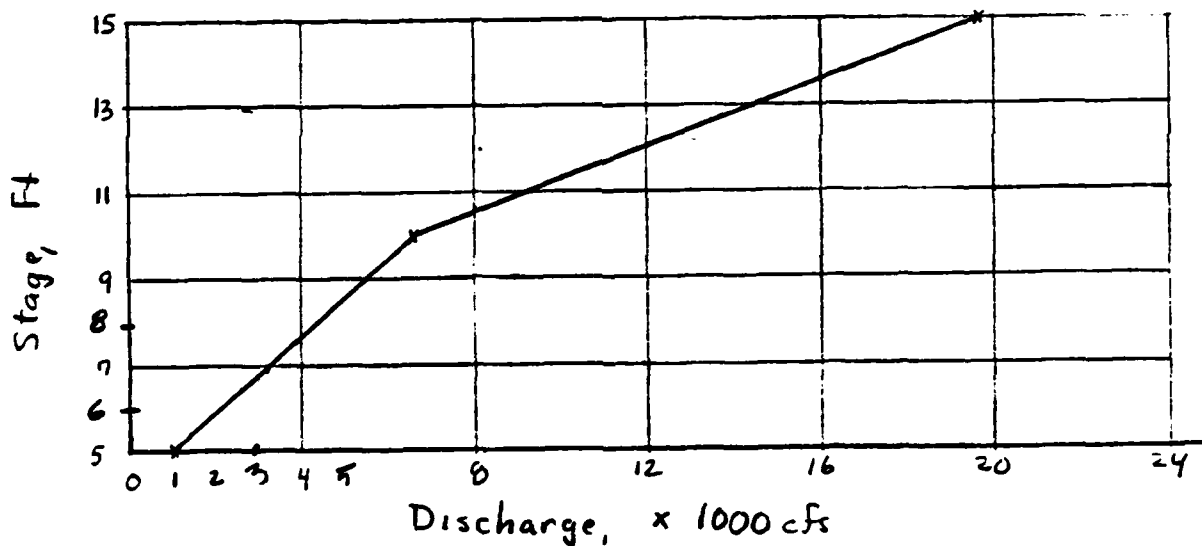
HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D46  
 JOB Dams  
 SUBJECT South Rec. Dike  
 CLIENT Corpor

@ Sta. 50+00

$$F' = \frac{1.486}{a^{1/2}} (0.033)^{1/2} = 2.25 \checkmark$$

| $\frac{D}{ft}$ | $\frac{WP}{ft}$ | $\frac{A}{sf}$ | $\frac{R^{2/3}}{ft}$ | $\frac{F'}{ft}$ | $\frac{V}{fps}$   | $\frac{Q}{cfs}$    | $\frac{Elev}{NGVD}$ |
|----------------|-----------------|----------------|----------------------|-----------------|-------------------|--------------------|---------------------|
| 10             | 200             | 1000           | 2.94 $\checkmark$    | 2.25            | 6.61 $\checkmark$ | 6,614 $\checkmark$ | 80                  |
| 5              | 100             | 250            | 1.85                 | "               | 4.16              | 1,039              | 75                  |
| 15             | 275             | 2188           | 4.01                 | "               | 9.03              | 19,753             | 85                  |



$$Q_{p1} = 3030 \text{ cfs} \quad d_1 = 6.9 \quad Elev = 76.9'$$

$$Stor_1 = \frac{526 \times 476}{2} \times \frac{900}{43560} = 10.4 \checkmark \text{ ac-ft}$$

$$Q_{p2} = 3030 \left(1 - \frac{10.4}{1000}\right) = 2998 \text{ cfs} \quad d_1 = 6.9' \pm$$

$$Stor_2 = Stor_1 = Stor_{ave} = 10.4 \text{ ac-ft}$$

$$Q_{out} = 3000 \pm \text{cfs} \quad Elev = 76.9' \pm$$

JOB NO. 75.206.1  
 DATE 11/24/62  
 BY MD  
 CH'D BY MD



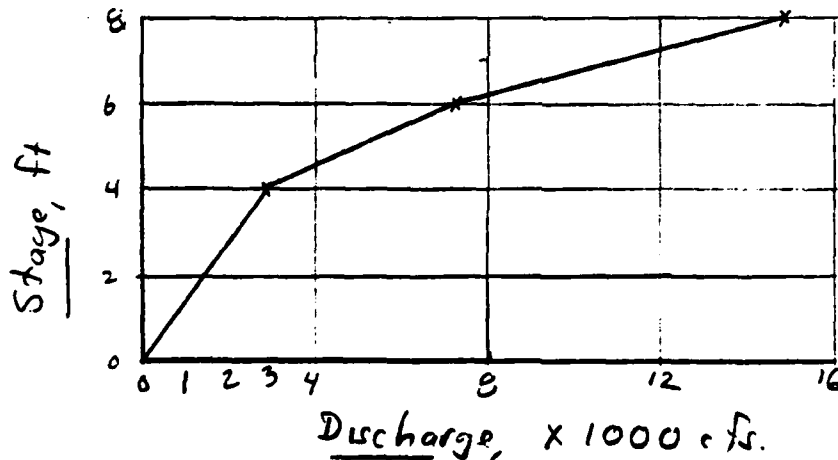
HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. 247  
 JOB Dam  
 SUBJECT Re. Duke  
 CLIENT Corp.

@ Sta. 55+00

$$F' = \frac{1.486}{0.10} \times (0.01)^{1/2} = 1.49$$

| D   | WP  | A    | $R^{2/3}$ | $F'$ | V    | Q     | Elev |
|-----|-----|------|-----------|------|------|-------|------|
| ft. | ft. | sf   |           |      | fps  | cfs   | NGVD |
| 4   | 430 | 1060 | 1.83      | 1.49 | 2.73 | 2891  | 68   |
| 6   | 600 | 2100 | 2.31      | "    | 3.45 | 7243  | 70   |
| 8   | 660 | 3360 | 2.98      | "    | 4.43 | 14896 | 72   |



$$Q_{p1} = 3,000 \text{ cfs. } d_1 = 4.2' \text{ Elev} = 68.2'$$

$$Stor_1 = \frac{476 + 1155}{2} \times \frac{500}{43500} = 9.4' \text{ ac-ft}$$

$$Q_{p2} = 3000 \left(1 - \frac{9.4}{1000}\right) = 2972 \text{ cfs. } d_2 = 4.2'$$

$$Stor_2 = Stor_1 = Stor_{ave} = 9.4 \text{ ac-ft.}$$

$$Q_{out} = 2972 \text{ cfs Elev} = 68.2$$

OS NO. 79.206.1  
DATE 1/29/60  
BY MA  
H'D BY MA



HAYDEN, HARDING & BUCHANAN, INC.  
CONSULTING ENGINEERS  
BOSTON — WEST HARTFORD

SHEET NO. D49

JOB Dem  
SUBJECT South River Dike  
CLIENT Coops

### Impact Area:

Sta. 0+00 to 41+00. No development,  
No damage to any man-made  
structures

Sta. 41+00 to 55+00. Overtops South Border  
Road by 2-3 feet. Could get houses  
across road from stream by say  
2-3 feet.

Beyond Sta. 55+00: Drainage path leads to  
densely settled residential area with  
some small businesses. Depth of  
failure outflow on order 1-2'  
(slight ridge around Sta. 60+00)  
Minor to moderate damage to at  
least 10-20 houses (estimated)

JOB NO. 79.206.1  
 DATE 11/25/80  
 BY FDD  
 CH'D BY WAA



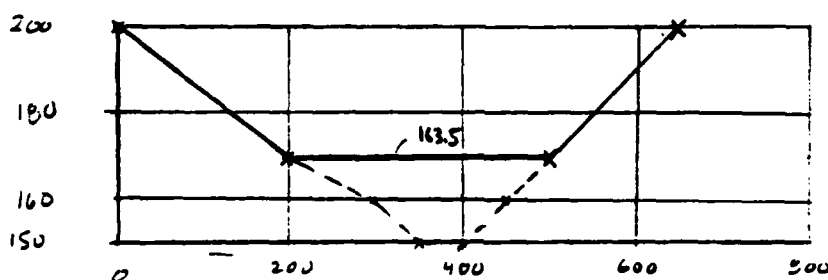
HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D49  
 JOB Dams  
 SUBJECT Santa Rosa Dihe  
 CLIENT Corpor

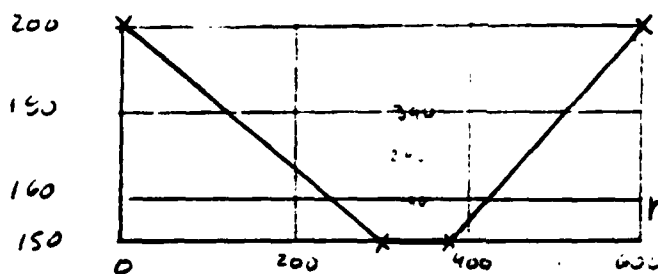
# East Dihe

X-sections (looking U/S)

Dike



Sta 1+50' downstream



| Elev<br>NGVD | Area<br>sq |
|--------------|------------|
| 160          | 1325       |
| 170          | 3725       |
| 180          | 7125       |

$S = \frac{10}{1500} = .007$   
 $n = 0.12$  (swampy forested)

OS NO. 79.206.1  
 DATE 1125180  
 V EDD  
 M'D BY W

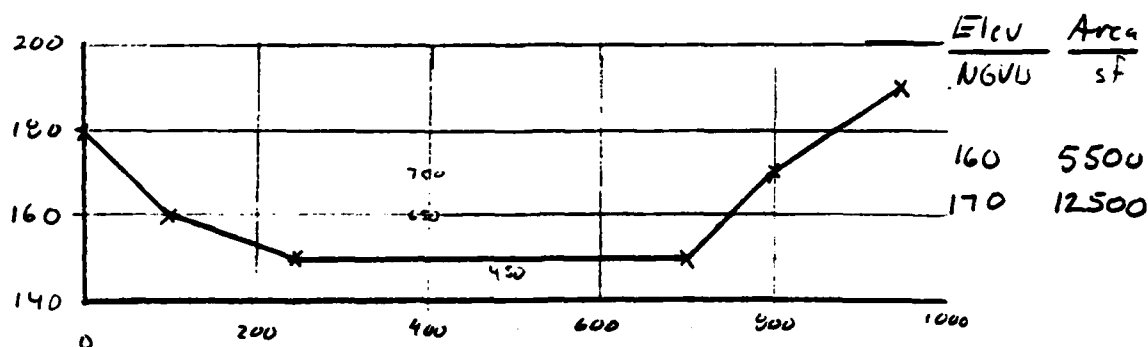


HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. D50  
 JOB Dams  
 SUBJECT South Res. Dike  
 CLIENT Corps

### X-Sections (looking U/S)

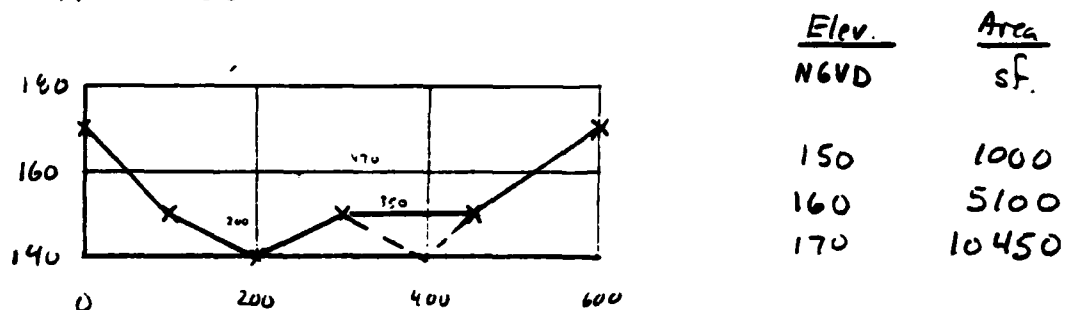
Sta. 15+00' downstream



$$S = 0.007'$$

$$n = 0.12$$

Sta. 25+00



$$S = \frac{10}{1000} = 0.01'$$

$$n = 0.12$$

JOB NO. 79-206-1  
 DATE 11-25-80  
 BY EDD  
 CH'D BY WHA

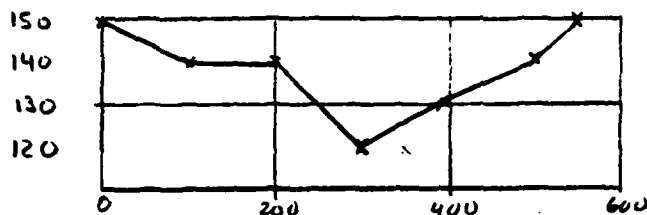


HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

SHEET NO. 251

JOB Dams  
 SUBJECT South Res. Dike  
 CLIENT Carps

@ 33+00 ' downstream

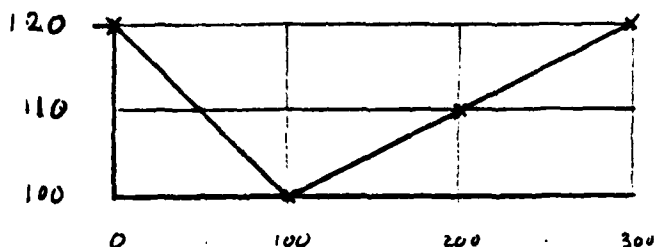


$$S = \frac{10}{800} = 0.013$$

$$n = 0.12$$

| Elev.<br>NGVD | Area<br>sf |
|---------------|------------|
| 130           | 750        |
| 140           | 3000       |
| 150           | 7750       |

@ 41+00 ' downstream

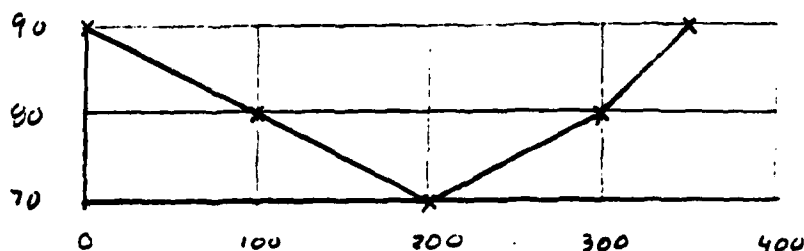


$$S = \frac{20}{800} = 0.025$$

$$n = 0.12$$

| Elev.<br>NGVD | Area<br>sf |
|---------------|------------|
| 110           | 750        |
| 120           | 3000       |

@ 50+00 ' downstream



$$S = \frac{20}{900} = 0.033$$

$$n = 0.12$$

| Elev.<br>NGVD | Area<br>sf |
|---------------|------------|
| 80            | 1000       |
| 90            | 3500       |

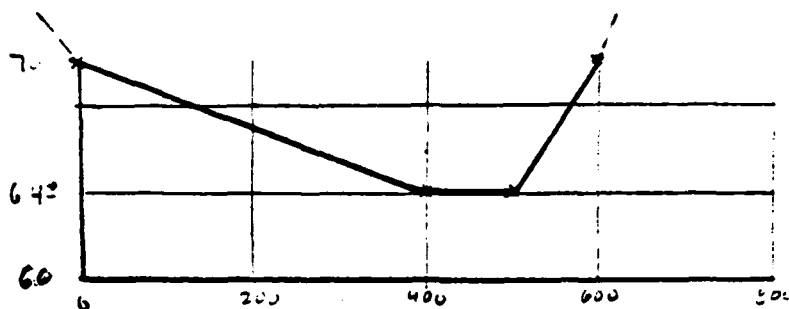
OS NO. 79.206.1  
 DATE 11/25/80  
 BY FDD  
 CH'D BY WVA



HAYDEN, HARDING & BUCHANAN, INC.  
 CONSULTING ENGINEERS  
 BOSTON — WEST HARTFORD

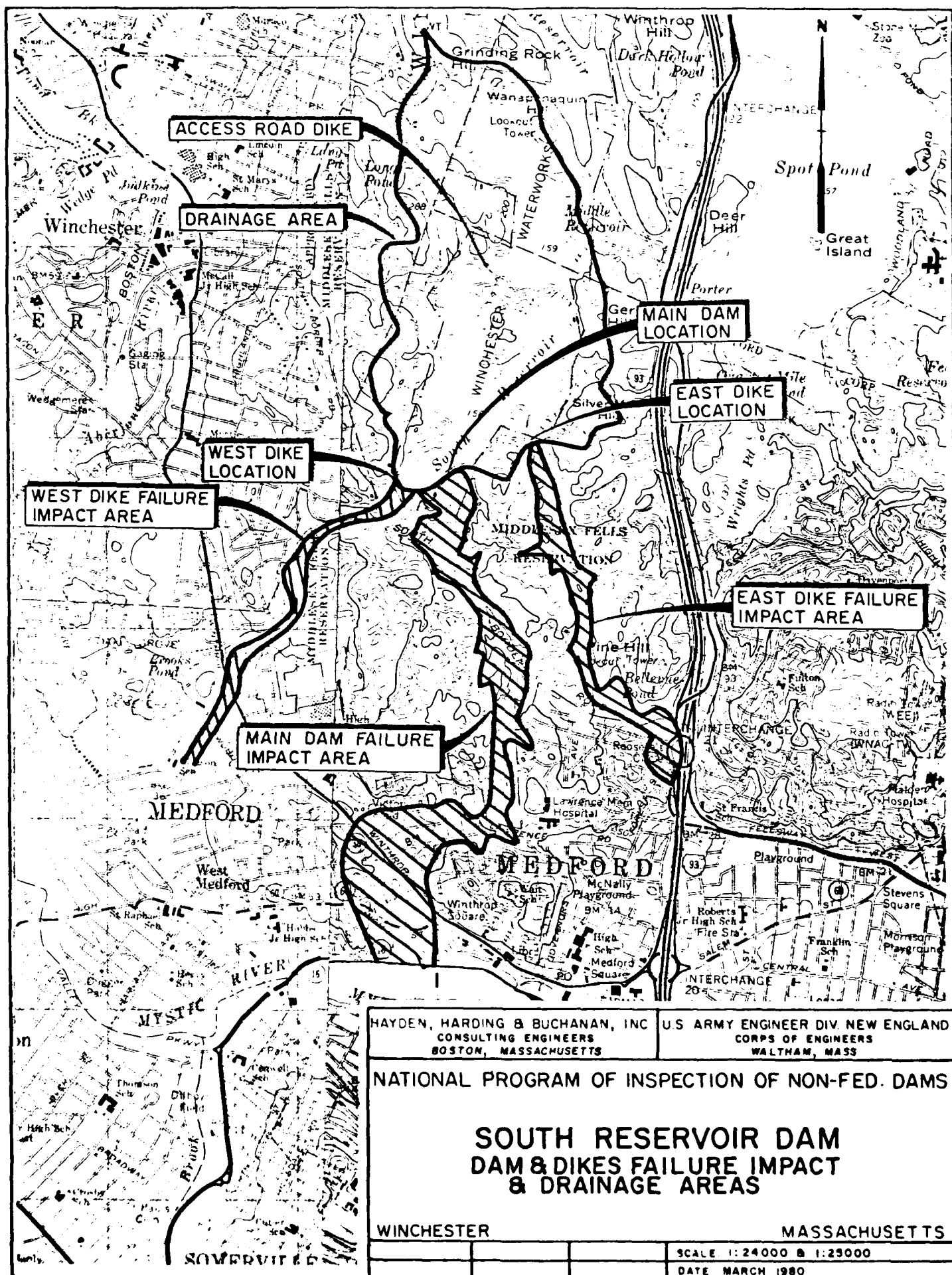
SHEET NO. D52  
 JOB Dams  
 SUBJECT South R. Dike  
 CLIENT Corps

Sta. 55+00



| Elev | Area |
|------|------|
| NGVD | sf   |
| 68   | 1060 |
| 70   | 2100 |
| 72   | 3360 |

$$S = \frac{10}{1000} = 0.01\% \quad n = 0.10$$



APPENDIX E

INFORMATION AS CONTAINED IN THE  
NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME

**END**

**FILMED**

7-85

**DTIC**