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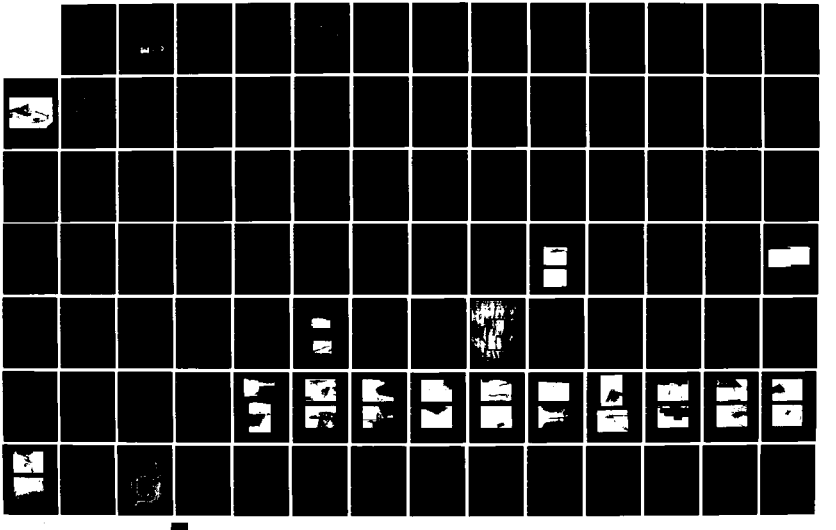

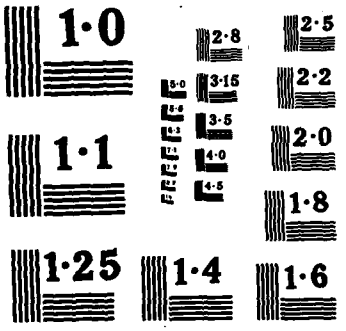

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AD-A156 106

CONNECTICUT RIVER BASIN

CLAREMONT, NEW HAMPSHIRE

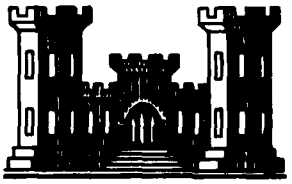
DOLE RESERVOIR DAM & DIKE

NH 00143 & NH 00483

NHWRB NO. 47.17

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



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

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

DAMS, INSPECTION, DAM SAFETY,

Connecticut River Basin
Claremont, New Hampshire

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

The dam is a concrete buttress structure with extensive earthfill at the downstream face. It is 526 ft. long and 43 ft. high. The dam is considered to be in poor condition and the dike is considered to be in fair condition. Major soft, wet area with active seepage discharge at the downstream toe of the dam near the right abutment is among major concerns. It is intermediate in size with a high hazard potential.

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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

APR 2 3 1979

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

Dear Governor Gallen:

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

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Claremont Water and Sewer Department, City Hall, Claremont, New Hampshire 03743.

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

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

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

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DOLE RESERVOIR DAM AND DIKE

NH 00143 & NH 00483

NHWRB 47.17

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CONNECTICUT RIVER BASIN
CLAREMONT, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No: NH 00143 & NH 00483

Name of Dam: Dole Reservoir Dam and Dike

Town: Claremont

County and State: Sullivan, New Hampshire

Stream: Not Applicable

Date of Inspection: November 29, 1979

Dole Reservoir is impounded by two man-made structures, the Dole Reservoir Dam at the eastern end of the reservoir and a dike at the northwestern end. The dam is a concrete buttress structure with extensive earth fill at the downstream face. The overall length of the dam is 526 feet and the height is 43 feet as measured from the dam crest to the toe of the slope. The dike is an earth fill structure with a concrete face. The overall length of the dike is 200 feet including the 30 foot long concrete spillway located at the extreme left end of the dike and the height of the dam is 8.7 feet as measured from the dike crest to the toe of the slope. There is no emergency spillway.

The spillway discharge flows in a northerly direction through an unnamed brook approximately 0.2 miles to Stevens Brook. The dam was originally constructed and is still used to provide a water supply for the city of Claremont. The pond is 850 feet in length with a surface area of about 9.2 acres. The maximum storage capacity is about 133 acre-feet.

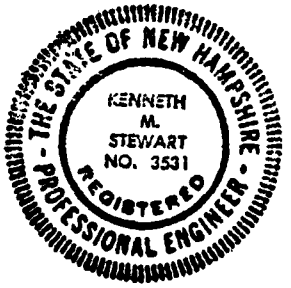
As a result of the visual inspection of this facility, the dam is considered to be in POOR condition and the dike is considered to be in FAIR condition. Major concerns are: major soft, wet area with active seepage discharge at the downstream toe of the dam near the right abutment; and partial undermining by erosion and resulting instability of the right training wall of the dike spillway.

The dam is classified as INTERMEDIATE in size and a HIGH hazard structure in accordance with the recommended guidelines established by the Corps of Engineers. The test flood for this dam is, therefore, the Probable Maximum Flood (PMF). The test flood inflow was estimated to be 189 cfs, and resulted in an outflow discharge equal to 115 cfs which would overtop the dam and dike crests by 0.04 feet. The maximum spillway discharge capacity (stop logs removed) with the water level at the dam/dike crest was estimated to be 92 cfs, or about 80 percent of the test flood discharge. A major breach in the dam with the reservoir surface at the dam/dike crest would result in significant water depths through the residential area located between Winter Street and Green Mountain Road, approximately 2,000 feet below the dam. The depth of flow across Winter Street would be more than 12 feet above the roadway. For the majority of the houses in the residential area,

the water depth would be at least 3 to 6 feet above the sill, while the remainder would experience water depths of less than 3 feet. These flow depths could result in the loss of more than a few lives.

It is recommended that the owner engage a qualified registered engineer to investigate the major soft, wet area and active seepage discharge at the downstream toe of the dam near the right abutment and to design remedial measures for the unstable right training wall of the dike spillway. It is also recommended that the owner repair the cracks and spalling of concrete at the left dam abutment, in the upstream face of the dam at the gate house, and at the upstream end of the right training wall of the dike spillway discharge channel; clear the debris from the spillway discharge channel; clear the embankments and downstream toe of both the dam and the dike of trees and brush; and establish and maintain grassy vegetation on the embankments.

The recommendations and remedial measures are described in Section 7 and should be addressed by the owner within one year after receipt of this Phase I Inspection Report.



Kenneth M. Stewart
Project Manager
N.H.P.E. 3531

S E A Consultants Inc.
Rochester, New Hampshire

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

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Richard J. DiBuono

RICHARD DIBUONO, MEMBER
Water Control Branch
Engineering Division

ARAMAST MAHTESIAN, CHAIRMAN
Geotechnical Engineering Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

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

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

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

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and

rarity of such a storm event, 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 trespassing 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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SECTION 4
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. The Dole Reservoir Dam is used primarily for the retention of the Dole Reservoir which acts as a water supply for the city of Claremont. The normal operating procedure for this dam is to remove the stop log during the winter months. The water level of the reservoir is monitored approximately once each month by a representative of the Claremont Water and Sewer Department.

b. Description of Any Warning System in Effect

No written warning system exists for the dam.

4.2 Maintenance Procedures

a. General. The owner, Claremont Water and Sewer Department, is responsible for the maintenance of the dam. No formal maintenance was discussed.

b. Operating Facilities

No formal plan for maintenance of operating facilities was disclosed.

4.3 Evaluation

The current operation and maintenance procedures for Dole Reservoir Dam are inadequate to ensure that all problems encountered can be remedied within a reasonable period of time. The owner should establish a written operation and maintenance procedure as well as establishing a warning system to follow in event of flood flow conditions or imminent dam failure.

d. Reservoir Area. The slopes of the reservoir appear to be stable. No evidence of significant sedimentation was observed. The approach channel to the spillway is unobstructed.

e. Downstream Channel. The spillway is filled with logs and debris where it crosses the dike. Downstream from the dike, there are many trees overhanging the spillway discharge channel and several trees have blown over across the channel (see Photo No. 22).

3.2 Evaluation

On the basis of the results of the visual inspection, Dole Reservoir Dam is considered to be in poor condition, and the dike is considered to be in fair condition.

The presence of a thick cover of grass, coarse weeds, and brambles on the dam makes it impossible to inspect the dam adequately, although several problems are observable, as described below.

Apparent settlement of the crest of the dam embankment and the downstream slope near the right abutment may be evidence of internal conditions in the embankment or foundation conditions that might lead to long-term seepage or slope-stability problems.

The major, soft, wet areas at the downstream toe of the dam, near the right abutment and near the center of the valley, and the seepage discharge in the soft, wet area near the right abutment are evidence of seepage conditions which might develop into major seepage and erosion problems if not controlled. The uprooted tree near the contact between the downstream slope and the right abutment could be a focus for the development of serious seepage and erosion problems in the near future. The trees which are standing on the right abutment close to the embankment may also cause problems if they blow over and pull out their roots, or if they die or are cut and their roots rot.

With respect to the dike, standing water at the toe may be evidence of a seepage problem which could worsen and endanger the dike. Trees growing on the right abutment, on the downstream slope, and in the area downstream of the toe of the dike may cause serious seepage or erosion problems if they blow over and pull out their roots, or if they die or are cut and their roots rot. The trees that have already blown over in the downstream toe area may have already provided a focus for seepage and erosion which could endanger the dike, if not controlled. An animal burrow in the dike could become a focus for seepage and erosion which would endanger the dike, if not controlled. The concrete retaining wall at the left end of the embankment (which acts as a training wall on the right side of the spillway discharge channel) may topple over if remedial action is not taken, and this could lead to breaching of the dike.

Near the center of the valley, water was standing in two wheel ruts immediately downstream of the toe of the embankment, and there is a wet swampy area a short distance farther downstream (see Plans and Details in Appendix B). No flowing water was observed to be discharging in these two areas.

c. Appurtenant Structures. There is an earth dike at the northwest end of the reservoir (see Photo No. 12). It is about 8.7 feet high, 170 feet long, and 9 feet wide at the crest.

The crest of the dike is covered with grass which is kept mowed (see Photo No. 13). The upstream edge of the crest is retained by a vertical concrete wall which is 12 inches wide at the top. In general, the elevation of the crest of the embankment is approximately the same as the elevation of the top of this concrete wall. It is not possible to determine from the visual inspection the elevation of the bottom of this wall. The left abutment appears to be rock and the right abutment appears to be soil. There is one large tree growing on the right abutment close to the end of the embankment.

The downstream slope of the embankment is inclined at 1 foot vertical to 2.5 feet horizontal and is covered with coarse weeds (see Photo Nos. 18 and 19). A few trees are growing out of the lower portion of the downstream slope. One animal burrow was observed in the downstream slope (see Photo No. 20). Minor subsidence of the downstream slope near the left end of the dike appears to be due to surface sloughing. There is one motorbike track from the toe to the crest of the downstream slope near the right end of the dike.

Immediately downstream of the toe of the dike there are a number of trees growing and several trees that have blown over and pulled out their root masses (see Plans and Details in Appendix B). At the location of two of these uprooted trees, there is a pool of standing water in a small depression that is larger than the depression that resulted from the uprooting of the two trees (see Photo No. 21). No flow of water was observed in or around this standing water. Brush has been cut and dumped immediately downstream of the toe of the dam.

The left end of the embankment is retained by a concrete wall, 15 inches wide and about 7 feet high, which also acts as a training wall along the right side of the spillway discharge channel (see Plans and Details in Appendix B). This wall is partially undermined by erosion at its downstream end and is also about 4.5 inches out-of-plumb because it is tilted toward the west (see Photo No. 15). The embankment immediately adjacent to the wall appears to have subsided about 6-8 inches relative to the top of the wall. There is a 1/4-inch wide crack in the concrete and spalling at the corner where the training wall meets the embankment wall, due to this tilting (see Photo No. 17).

The principal spillway is located on the left abutment of the dike. It is a concrete spillway 14 inches thick, approximately 30 feet long, with a 1.0 foot deep by 3.0 feet long stop log bay. Except for loose brush in the discharge channel, the spillway is in good condition (see Photo Nos. 15 and 16).

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Dole Reservoir Dam impounds a reservoir of small size. The watershed above the dam is small and consists of steeply sloped banks surrounding the reservoir. The drainage basin is heavily wooded and completely undeveloped. The downstream area is predominantly undeveloped until it passes under Winter Street.

The field inspection of Dole Reservoir Dam was made on November 29, 1979. The inspection team consisted of personnel from S E A Consultants Inc. and Geotechnical Engineers, Inc. Inspection checklists, completed during the visual inspection, are included in Appendix A. At the time of inspection, all the stop logs were removed from the stop log bay and water was passing approximately 1/8-inch deep over the 3 foot wide spillway, thus provided. The pool elevation was at approximately 722.00 MSL. The upstream face of the dam could only be inspected above this water level.

b. Dam. Dole Reservoir Dam is a concrete buttress dam with extensive earth fill at the downstream face. The dam is approximately 43 feet high, 526 feet long and 8 feet wide at the crest.

The crest of the dam is mostly covered with unmowed grass and coarse weeds (see Photo Nos. 2 and 3). The upstream edge of the crest is retained by a vertical concrete wall which is 12 inches wide at the top. The cap of this wall is spalling at several locations, and there is a 3-foot long and 1/8-inch wide horizontal crack exposing reinforcing steel on the front face of the wall by the gate house (see Photo Nos. 5, 6, and 7). Near the abutments, the embankment crest is at about the same elevation as the top of this wall, but in the deeper part of the valley, the crest of the embankment is generally 6-12 inches lower than the top of the concrete wall (see Photo No. 7). It is not possible to determine from the visual inspection the elevation of the bottom of this wall. The left abutment appears to be bedrock, and the right abutment appears to be soil (see Photo No. 4).

The downstream slope of the embankment is inclined at 1 foot vertical to 2 feet horizontal and is covered with a thick growth of grass, coarse weeds, and brush, which make it impossible to make an adequate visual inspection of the slope (see photo Nos. 8 and 9). The downstream slope has an irregular surface near the right abutment, possibly due to minor sloughing.

There is a major soft, wet area immediately downstream of the toe of the dam near the right abutment. In this same area, clear seepage discharge water is flowing in rivulets that were hidden beneath the cover of dead grass and weeds at the time of inspection (see Photo No. 10 and Plans and Details in Appendix B). A large tree has blown over and pulled out its root mass at the contact between the downstream slope and the right abutment (see Plans and Details in Appendix B). There are many standing trees on the right abutment close to the end of the embankment (see Photo No. 9).

SECTION 2
ENGINEERING DATA

2.1 Design

A set of plans dated 1913 showing plan, elevation, and section for construction of the dam, dike, and spillway were obtained from Elmer Huntly, Jr. and Associates of North Hampton, Massachusetts. No in-depth engineering calculations, as-built drawings, or specifications were found.

2.2 Construction

No construction records are available for use in evaluating the dam. Records from the state of New Hampshire Water Resources Board indicate construction of the dam began in 1913, and the spillway was rebuilt 1 foot higher in 1914.

2.3 Operation

No engineering operational data were found.

2.4 Evaluation

a. Availability. The Dole Reservoir Dam was designed by E. E. Davis, Civil Engineer, North Hampton, Massachusetts. Other than the plans described above, no additional engineering data were found.

b. Adequacy. Available engineering data and drawings are considered adequate for a Phase I investigation.

c. Validity. The field investigation indicated that the external features of the Dole Reservoir Dam substantially agree with those shown on the furnished plans.

j. Regulating Outlets

(1) Invert - Water intake to distribution system estimated by *Claremont Water and Sewer Department* personnel to be approximately 22 to 23 feet below the dam crest (approximate elevation 701 to 702 feet)

(2) Size - 20 inches in diameter

(3) Description - Water intake to distribution system from reservoir through 20-inch diameter cast iron pipe at gate house on dam.

(4) Control Mechanism - Discharge through the pipe is apparently controlled by a buried gate valve. Also, two blow-off valves are located on this pipe between the dam and Winter Street. These consist of a 4-inch valve and an 8-inch valve.

(5) Other - None identified

(3)	Height - 43 feet maximum	8.7 feet maximum
(4)	Top Width - 8 feet	9 feet
(5)	Side Slopes - Upstream 32V to 1H concrete to reservoir bottom, downstream 1V to 2H earth to toe of slope	Upstream 10V to 1H concrete to reservoir bottom, downstream 1V to 2.5H earth to toe of slope
(6)	Zoning - unknown	Unknown
(7)	Impervious core - unknown	Unknown
(8)	Cutoff - unknown	Unknown
(9)	Grout curtain - unknown	Unknown
(10)	Other - none	None

h. Diversion and Regulating Tunnel

Not applicable (see Section j below)

i. Spillway

(1) Type - The spillway is concrete with a straight drop. Located, near the right training wall is a 3.0 feet long by 1.0 feet deep stop log bay (see Photos No. 14 through 16)

(2) Length of weir - 30.0 feet

(3) Crest elevation - 723.0 (with 12-inch stop log)
722.0 (with stop log removed)

(4) Gates - none

(5) U/S Channel - Dole Reservoir. The banks are treelined. The slopes of the reservoir appear stable. No evidence of significant sedimentation was observed.

(6) D/S Channel. The spillway discharges into an unnamed brook which is tree lined and flows in a northerly direction approximately 0.2 miles to its confluence with Stevens Brook.

(7) Design surcharge (Original Design) - unknown

(8) Top of dam - 724.0

(9) Test flood design surcharge - 724.04

d. Reservoir (length in feet)

(1) Normal pool - 850

(2) Flood control pool - N/A

(3) Spillway crest pool - 850

(4) Top of dam - 850

(5) Test flood pool - 850

e. Storage (acre-feet)

(1) Normal pool - 123

(2) Flood control pool - N/A

(3) Spillway crest pool - 114 (with stop log removed)

(4) Top of dam - 133

(5) Test flood pool - 133

f. Reservoir Surface (acres)

(1) Normal pool - 9.2

(2) Flood control pool - N/A

(3) Spillway crest - 9.2

(4) Test flood pool - 9.6

(5) Top of dam - 9.6

g.	Dam	Dike
(1)	Type - concrete buttress with earthfill	earth fill with upstream concrete wall
(2)	Length - 526 feet	170 feet (dike embankment) 200 feet (overall)

(2) Maximum known flood at damsite - not known

(3) Spillway capacity at top of dam (724.0 NGVD)

a. 12-inch stop log in place - 78 cfs

b. Stop log removed - 92 cfs

(4) Spillway capacity at test flood elevation (724.04 NGVD)

a. 12-inch stop log in place - 83 cfs

b. Stop log removed - 98 cfs

(5) Spillway capacity at normal pool elevation 5.2 cfs at 722.7 elevation upon removal of 9-inch stop logs

(6) Not applicable

(7) Total spillway capacity (stop logs removed) at test flood elevation 98 cfs at 724.04 elevation

(8) Total project discharge at top of dam 101 cfs at 724.0 elevation

(9) Total project discharge at test flood elevation 115 cfs at 724.04 elevation

c. Elevation (feet, NGVD) based on datum information from plans of dam construction by E. E. Davis, Civil Engineer

(1) Streambed

(a) at toe of dam - 681.3

(b) at toe of dike - 716.9

(2) Bottom of cutoff - unknown

(3) Maximum tailwater - unknown

(4) Normal pool - 722.7

(5) Full flood control pool - N/A

(6) Spillway crest

a. With 12-inch stop log- 723.0

b. With stop log removed - 722.0

e. Ownership. The dam and dike were constructed in 1913 and have been continually owned by the Claremont Water and Sewer Department, City Hall, Claremont, New Hampshire 03743. Telephone: (603) 542-6691.

f. Operator. The dam is maintained and operated by William Blaisdell, Superintendent of the Claremont Water and Sewer Department, City Hall, Claremont, New Hampshire 03743. Telephone: (603) 542-6691.

g. Purpose of Dam. The dam was constructed to provide a water supply for the city of Claremont.

h. Design and Construction History. The dam, dike and spillway were designed by E. E. Davis, Civil Engineer of North Hampton, Massachusetts in 1913. Construction began that same year by Osgood Construction Company (address unknown). An inspection report dated January 9, 1925 indicates the spillway was raised 1.0 feet in 1914. The design plans of the dam and dike indicate the concrete foundation of the face wall is constructed on ledge. The construction plans were obtained from Elmer Huntly, Jr. and Associates of North Hampton, Massachusetts. No in-depth design calculations or as-built drawings were disclosed for this dam.

i. Normal Operating Procedure. The Dole Reservoir Dam is used primarily for the retention of the Dole Reservoir which acts as a water supply for the city of Claremont. The normal operating procedure for this dam is to remove a 9-inch high stop log from the spillway stop log bay during the winter months.

1.3 Pertinent Data

a. Drainage Area. The drainage area above the Dole Reservoir Dam covers nearly 0.049 square miles (31.6 acres), consisting of steeply sloped banks surrounding the reservoir. The drainage basin is heavily wooded and completely undeveloped. The topography in the drainage basin ranges from an elevation of 850 feet (NGVD) to 699 feet (NGVD) at the base of the dam.

b. Discharge at Damsite

(1) The outlet works consist of a cast-in-place concrete spillway with a total weir length of approximately 30 feet, with a stop log bay 1.0 feet deep and 3.0 feet long. The reservoir is normally maintained at an elevation of 722.7 feet (NGVD) during the summer months, and the stop log is removed and the reservoir lowered to 722.0 during the winter. The intake structure into Claremont's Water Distribution System is located approximately 125 feet from the left end of the dam and draws water from the gate house chamber into a 20-inch diameter cast iron pipe. The elevation to which this pipe could draw down the water in the reservoir could not be verified, but the invert was estimated to be approximately 22 to 23 feet below the crest of the dam by Claremont Water and Sewer Department personnel.

b. Description of Dam and Appurtenances. Dole Reservoir Dam is a concrete buttress dam with extensive earth fill at the downstream face for stability. The dam is approximately 43 feet high from toe of slope to crest of dam and 526 feet in overall length. The upstream face consists of a reinforced concrete wall which extends downward from the crest of the dam and terminates at a concrete foundation cast on ledge. This concrete wall varies from a minimum of 1' - 0" thickness to a maximum of 1' - 9" thickness and is approximately 26 feet high at its highest point. The wall is supported by 15-inch thick concrete buttresses, 10.0 feet on center throughout most of the length of the dam. The downstream slope of the earthfill stabilizing the dam is approximately 1 foot vertical to 2 feet horizontal to toe of slope. The crest width is approximately 8.0 feet.

Located approximately 125 feet from the left end of the dam is the principal intake structure which consists of a gate house which inlets water from the reservoir into a 20-inch diameter cast iron pipe that feeds the city of Claremont's water distribution system.

A dike located at the northwest corner of the reservoir consists of an earthfill structure approximately 8.7 feet high from toe of slope to crest of dike and 170 feet in length. The upstream face consists of a reinforced concrete wall which extends downward from the crest of the dike and terminates at a concrete foundation cast on ledge. This concrete wall varies from a minimum of 1' - 1" thickness to a maximum of 2' - 0" thickness, is approximately 10 feet high at its highest point and is not buttressed. The downstream slope of the earthfill is approximately 1 foot vertical to 2.5 feet horizontal to toe of slope. The crest width is approximately 9.0 feet.

Located at the extreme left end of the dike is the principal spillway which consists of a concrete spillway approximately 30 feet long with a 1.0 foot deep by 3.0 feet long stop log bay. The overall length of the dike including the spillway is approximately 200 feet.

At the approximate center of the dike, a 10-inch diameter cast iron pipe runs beneath the concrete wall foundation. When the valves in this pipe are opened, water flows from Rice Reservoir, located approximately 2 miles north, into Dole Reservoir.

c. Size Classification. Intermediate (height 43 feet; storage 133 acre-feet) based on height (greater than or equal to 40 feet and less than 100 feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. High Hazard. Failure of the dam could result in the loss of more than a few lives, damage to as many as 15 homes, and damage to a main town road and five residential streets. The depth of flow was estimated to be more than 12 feet deep as it crosses Winter Street. Through the residential area the depth of flow was estimated to be between 7 and 12 feet above the invert of the "channel". For the majority of the houses this would result in a water depth of at least 3 to 6 feet above the sill of the house, while for the remainder depths of less than 3 feet would be typical.

NATIONAL DAM INSPECTION
PHASE I INSPECTION REPORT
DOLE RESERVOIR DAM AND DIKE

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. S E A Consultants Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to S E A Consultants Inc. under a letter of November 5, 1979 from William Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C0008 has been assigned by the Corps of Engineers for this work.

b. Purpose

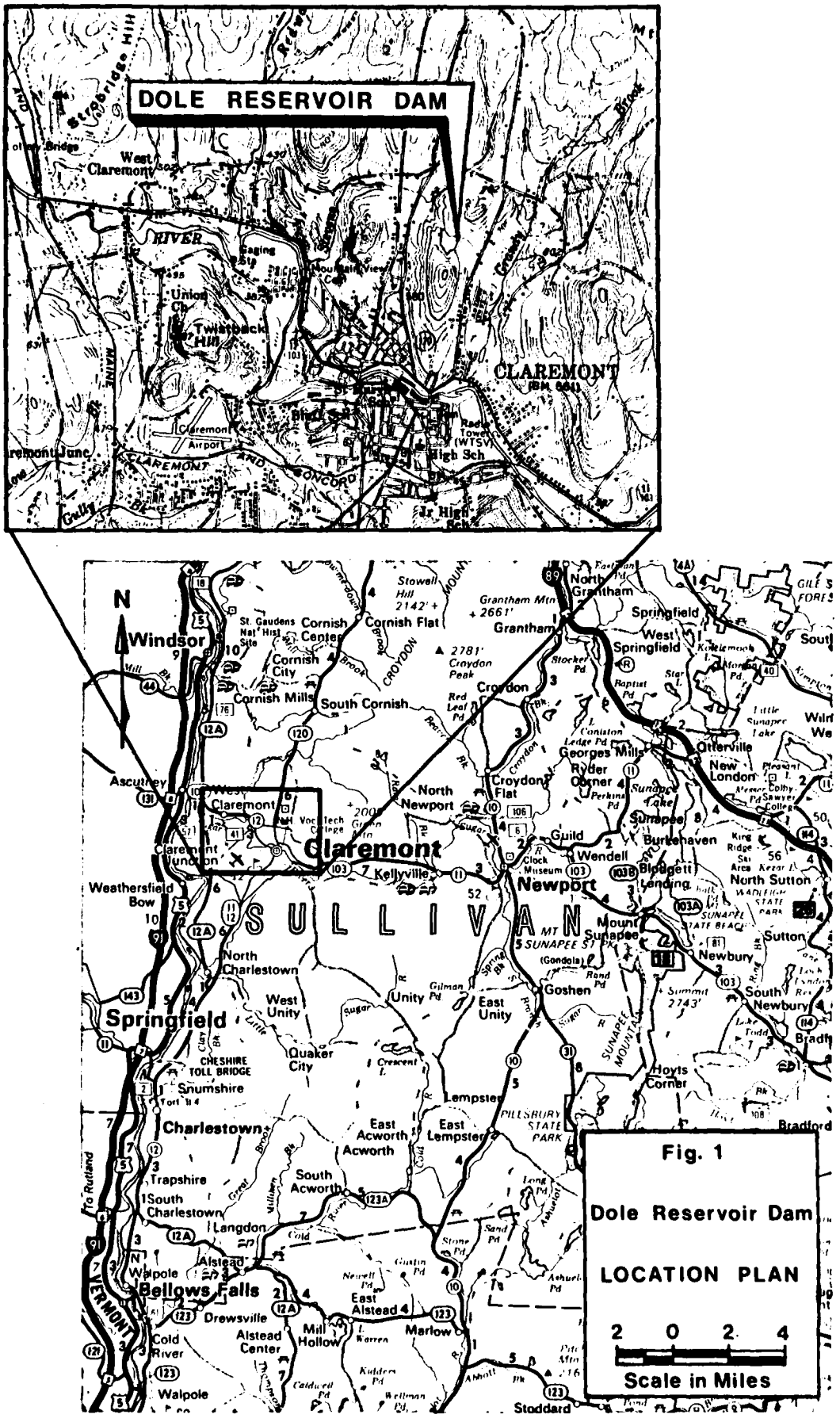
(1) To perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

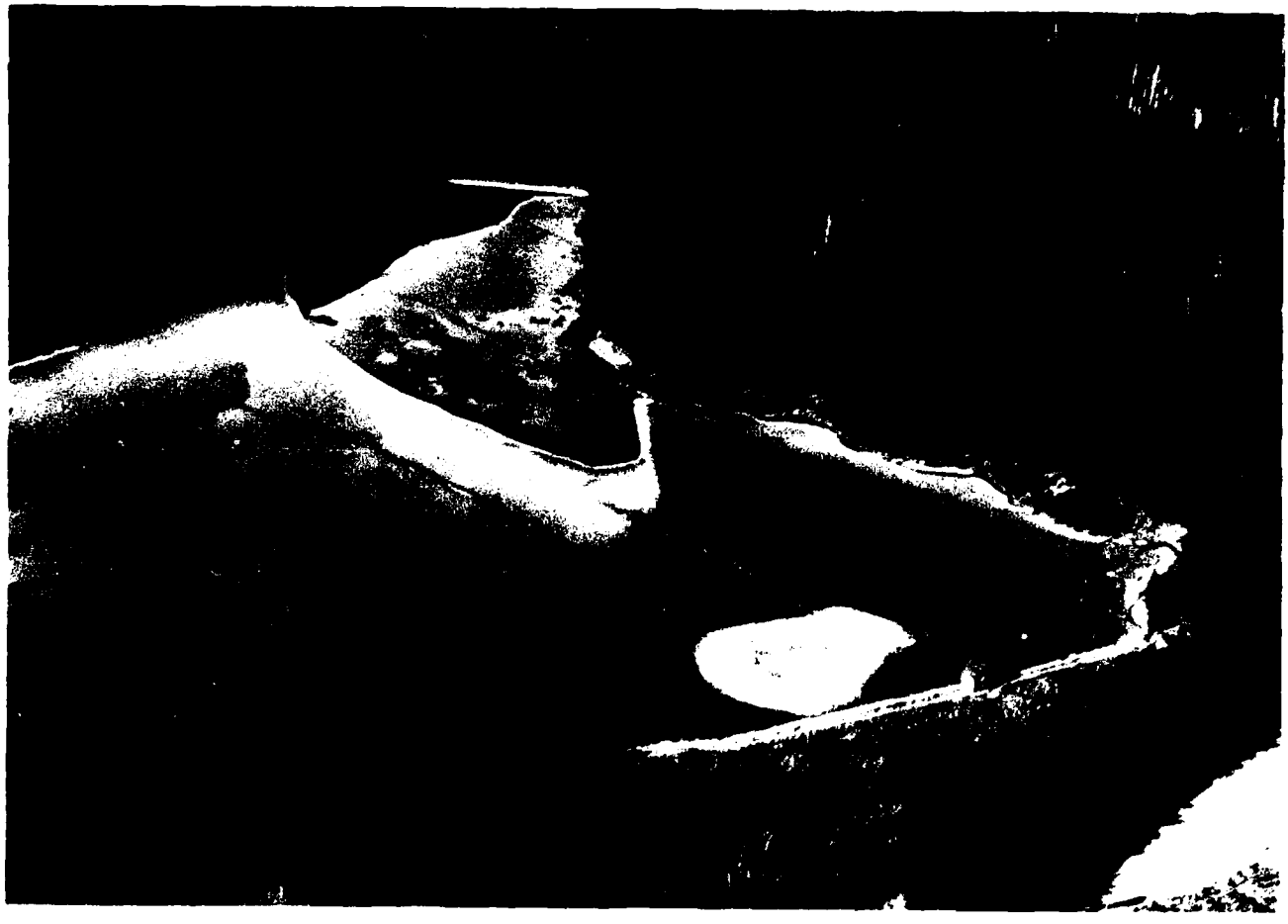
(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The Dole Reservoir Dam is located in the city of Claremont, New Hampshire. Dole Reservoir forms the headwaters of an unnamed brook, which after passing over the spillway, flows in a northerly direction approximately 0.2 mile to its confluence with Stevens Brook in Claremont, New Hampshire. The dam, which is on the east side of the reservoir, is shown on U.S.G.S. Quadrangle, Claremont, New Hampshire, with coordinates approximately at N43°23'20", W72°19'58", Sullivan County, New Hampshire. The dike and spillway, which is on the northwest corner of the reservoir, is also shown on U.S.G.S. Quadrangle, Claremont, New Hampshire, with coordinates approximately N43°23'25", W72°20'07", Sullivan County, New Hampshire. (See Location Plan)


DOLE RESERVOIR DAM
N
Windsor
Claremont
Newport
SULLIVAN
Springfield
Charlestown
Bellows Falls
Walpole
Stoddard
Fig. 1
Dole Reservoir Dam
LOCATION PLAN
2 0 2 4
Scale in Miles



OVERVIEW PHOTO - DOLE RESERVOIR DAM AND DIKE

SECTION 5
EVALUATION OF HYDROLOGIC/HYDRAULIC FEATURES

5.1 General. Dole Reservoir is impounded by two man-made structures, the Dole Reservoir Dam at the eastern end of the reservoir and a dike at the northwestern end. The crest elevations of these two structures are equivalent. The dam is a concrete buttress dam with extensive earth fill at the downstream face. The overall length of the dam is 526 feet, and the height is 43 feet, as measured from the dam crest to the toe of slope. The gate house located in the dam serves as an intake structure that feeds water to the city of Claremont's water distribution system. Dole Reservoir represents the last reservoir in a series of reservoirs supplying water to the city of Claremont. Consequently, water is "continually" flowing into this reservoir from Rice Reservoir through a 10-inch diameter cast-iron pipe and out of the reservoir through a 20-inch diameter pipe to the water distribution system. Upon completion of the new water treatment facility located just downstream from the dam, the water from Dole Reservoir will pass through the new plant and then to the distribution system. Based on the height of the dam, it is classified as intermediate in size, having a maximum storage of approximately 133 acre-feet at the dam crest.

The dike is an earth fill structure with a concrete face. The dike measures 170 feet in length and is approximately 8.7 feet high from toe of slope to crest of dike. The principal spillway structure located at the extreme left end of the dike serves as the control for discharge of water from the reservoir. The spillway is approximately 30 feet long, with a 1.0 foot deep by 3.0 feet long stop log bay located near the center of the spillway. The reservoir level is adjusted seasonally by inserting and removing stop logs.

5.2 Design Data. No hydrological or hydraulic design data were disclosed.

5.3 Experience Data. No experience data for either the dam or dike were disclosed. Maximum flood flows or elevations are unknown.

5.4 Test Flood Analysis. Due to the absence of detailed design and operational information, this hydrologic evaluation was performed utilizing data gathered during field inspection, watershed size and an estimated test flood equal to the Probable Maximum Flood (PMF). The basin characteristics were determined to be mountainous and consequently, the mountainous curve from the Corps of Engineers set of guide curves was used to estimate the Maximum Probable Flood Peak Flow Rate.

Based on a drainage area of 0.049 square miles and a Maximum Probable Flood Peak Flow Rate of 3850 cfs/sq mile, the test flood inflow was estimated to be 189 cfs. The test flood was routed through the dam-dike complex in accordance with the Corps of Engineers procedure for Estimating Effect of Surcharge Storage on Maximum Probable Discharge. The discharge was estimated to be 115 cfs. This analysis indicated that the dam crest would be overtopped by 0.04 feet. The maximum spillway capacity (stop logs removed) with the water level at the dam/dike crest was estimated to be 92 cfs, which is 80 percent of the test flood discharge.

5.5 Dam Failure Analysis. The Dole Reservoir Dam was subjected to detailed dam failure analysis since failure of this structure would be much more critical than failure of the dike. The impact of dam failure with the reservoir surface at the dam crest was assessed utilizing the "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs published by the Corps of Engineers. Based on this analysis the dam has been classified as a high hazard structure. By inspection, the dike has been classified as a low hazard structure.

Based on information derived from U.S.G.S. maps, it appears that failure of the Dole Reservoir Dam would not impact the new water treatment facility which is under construction. The water depth along the reach near the plant was estimated to be nearly 15 to 16 feet above the "channel" invert. However, since the topography around the plant has been altered by the construction work and, therefore, does not conform to the information shown on the U.S.G.S. sheet, it is difficult to evaluate the relationship between the maximum water elevation in the reach and the elevation of the new water treatment facility.

However, the flow emananting from a major break in the dam would impact the residential area located between Winter Street and Green Mountain Road before entering Grandy Brook. As many as fifteen houses could be inundated, and Winter Street, as well as the residential streets in the area, would be impacted. It was estimated that the depth of flow would be more than 12 feet deep as it crosses Winter Street. The water depth, above the invert of the "channel," was estimated to be between 7 and 12 feet deep through the residential area. For the majority of the houses in this area, the water depth would be at least 3 to 6 feet above the sill of the house, while for the remainder depths of less than 3 feet would be typical. These flows could result in the loss of more than a few lives.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual inspection indicates the following potential structural problems:

(1) Apparent settlement of the crest of the dam and irregular settlement of the downstream slope of the dam near the right abutment, which may be evidence of internal conditions in the embankment or foundation conditions that might lead to long-term seepage or slope-stability problems.

(2) Major wet, soft areas and local areas of active seepage discharge at the toe of the dam are evidence of seepage conditions which might develop into major seepage or erosion problems if not controlled.

(3) An uprooted tree near the contact between the downstream slope and the right abutment of the dam and several uprooted trees immediately downstream of the toe of the dike could be a focus for the development of serious seepage and erosion problems in the near future.

(4) Standing trees on the right abutment of the dam, on the right abutment of the dike, and downstream of the dike could cause serious seepage and erosion problems if they blow over and pull out their roots or are cut and their roots rot.

(5) The poor condition of the concrete wall which retains the left end of the dike embankment and also acts as a training wall on the right side of the spillway discharge channel indicates the possibility that the wall may topple over and lead to breaching of the dike.

(6) An animal burrow in the dike embankment could lead to serious seepage and erosion problems.

A thick cover of grass, coarse weeds, and brush makes it impossible to inspect the embankment and downstream toe area adequately.

6.2 Design and Construction Data

The dam, dike and spillway were designed by E. E. Davis, Civil Engineer of North Hampton, Massachusetts in 1913. Construction began that same year by Osgood Construction Company (address unknown). The design plans of the dam and dike indicate the concrete foundation of the face wall is constructed on ledge.

6.3 Post-Construction Changes

An inspection report dated January 9, 1925, on file at the State of New Hampshire Water Resources Board, indicates the spillway was raised 1.0 feet in 1914. Since that time, there is no indication any further construction has been performed.

6.4 Seismic Stability

This dam is located in Seismic Zone 2 and, in accordance with the Phase I guidelines, does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATION, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination indicates that the Dole Reservoir Dam is in poor condition and the dike is in fair condition. The major concerns with respect to the integrity of the dam are:

(1) Apparent settlement of the crest of the dam and of the downstream slope of the dam near the right abutment.

(2) Soft, wet areas at the toe of the dam near the right abutment and near the center of the valley, and seepage discharge at the toe of the dam near the right abutment.

(3) An uprooted tree near the contact between the downstream slope of the dam and the right abutment.

(4) Numerous standing trees on the right abutment close to the embankment.

(5) Inadequacy of blow-off valves for dewatering the reservoir.

The major concerns with respect to the integrity of the dike are:

(1) Standing water in a depression near the downstream toe of the dike.

(2) Uprooted trees in the area immediately downstream of the toe of the dike.

(3) Standing trees on the downstream slope on the right abutment and in the area immediately downstream of the toe of the dike.

(4) Poor condition of the concrete wall which retains the left end of the dike embankment and also acts as a training wall on the right side of the spillway discharge channel.

b. Adequacy of Information. The presence of grass, coarse weeds, and brambles makes it impossible to inspect the downstream slopes of the dam and dike adequately. The information available from the present visual inspection is adequate to identify the problems listed in 7.2. These problems will require the attention of a qualified registered professional engineer who will have to make additional engineering studies to design or specify remedial measures. No other engineering studies are needed for the purpose of this Phase I inspection.

c. Urgency. The owner should implement the recommendations in 7.2 and 7.3 within one year after receipt of this Phase I report.

7.2 Recommendations

The owner should retain a registered professional engineer qualified in the design and construction of dams to:

(1) Inspect the downstream slope of the dam and dike after the grass, weeds and brambles have been cleared.

(2) Investigate the cause of the settlement of the crest of the dam and the irregular settlement of the downstream slope of the dam near the right abutment, and design remedial measures if needed.

(3) Investigate the soft, wet areas and seepage at the toe of the dam and dike, and design remedial measures, if needed.

(4) Design repairs for the areas where trees have been uprooted at the downstream toe of the dam and dike.

(5) Investigate the cause of the tilting of the training wall along the right side of the spillway and design remedial measures.

(6) Specify procedures for the removal of trees and their roots on the downstream slope of the dike, on the right abutment of the dike, on the right abutment of the dam, and in the zone within 25 feet downstream from the toe of the dam and dike.

(7) Specify procedures for filling animal burrows on the downstream slope of the dike, and on the downstream slope of the dam, if any are found there after the slope has been cleared of grass, weeds, and brambles.

(8) Investigate the adequacy of the low level outlet to drain the reservoir and design remedial measures, if necessary.

The owner should carry out the recommendations made by the engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Monitor the soft, wet areas and seepage at the downstream toes of the dam and dike until the recommendation made in 7.2(3) has been carried out.

(2) Keep the dike and dam embankment mowed.

(3) Control trespassing on the dike and dam.

(4) Clear the debris from the spillway discharge channel.

(5) Visually inspect the dam once a month.

(6) Engage a registered professional engineer qualified in the design and construction of dams to make a comprehensive technical inspection of the dam once every year.

(7) Establish a surveillance program for use during and immediately after heavy rainfall, and also a warning program to follow in case of emergency conditions.

7.4 Alternatives

There are no practical alternatives to the recommendations of Section 7.2 and 7.3.

APPENDIX A

INSPECTION CHECK LIST

INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT: Dole Reservoir Dam and Dike, NH

DATE: November 29, 1979
TIME: 1:00 p.m.
WEATHER: Clear, cold
W.S. ELEV. 722.0 U.S. N/A DN.S.
(U.S.G.S. Datum)

PARTY:

1. Robert Durfee, S E A
2. Bruce Pierstorff, S E A
3. Philip Ricardi, S E A
4. Ronald Hirschfeld, GEI
5. Kenneth Stern, NHWRB
6. Richard DeBold, NHWRB
7. William Binder, Claremont W.W
8. Russ Davis, Claremont W.W
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Structural Stability	R. Durfee	
2.	Hydrology/Hydraulics	B. Pierstorff/P. Ricardi	
3.	Soils and Geology	R. Hirschfeld	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

INSPECTION CHECK LIST

PROJECT: Dole Reservoir Dam, NH DATE: November 29, 1979

PROJECT FEATURE: Dam Embankment NAME:

DISCIPLINE: NAME:

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	724.0
Current Pool Elevation	722.0
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	Not paved
Movement or Settlement of Crest	Embankment appears to have settled 6 to 12 inches below top of concrete retaining wall on upstream edge of crest
Lateral Movement	None observed
Vertical Alignment	Good, except for apparent subsidence of crest noted above
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Good at abutments. Apparent subsidence of about one foot next to gatehouse
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	No evidence observed
Vegetation on Slopes	Coarse growth of weeds and brambles on downstream slope. Coarse grass on crest.
Sloughing or Erosion of Slopes or Abutments	Irregular downstream slope near right abutment may be result of sloughing
Rock Slope Protection - Riprap Failures	No riprap
Unusual Movement or Cracking at or near Toes	None observed
Unusual Embankment or Downstream Seepage	Area about 25 ft downstream from toe of dam on right side of valley is very wet and soft and has small rivulets of running water
Piping or Boils	None observed
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	None observed

INSPECTION CHECK LIST

PROJECT: Dole Reservoir Dam, NH DATE: November 29, 1979

PROJECT FEATURE: Dike Embankment NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
DIKE EMBANKMENT	
Crest Elevation	724.0
Current Pool Elevation	722.0
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	Not paved
Lateral Movement	None observed
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Subsidence next to concrete retaining wall at left end of embankment
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	One motorbike track bare of vegetation on downstream slope
Vegetation on Slopes	Three large trees, two smaller trees on downstream slope. Many trees in area immediately downstream of toe of dam.
Sloughing or Erosion of Slopes or Abutments	Irregular downstream slope near left end of embankment may be due to minor sloughing
Rock Slope Protection - Riprap Failures	No riprap
Unusual Movement or Cracking at or near Toe	None observed
Unusual Embankment or Downstream Seepage	Large area with standing water near downstream toe. Two uprooted trees in this area.
Piping or Boils	None observed
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	None observed

INSPECTION CHECK LIST

PROJECT: Dole Reservoir Dam, NH DATE: November 29, 1979

PROJECT FEATURE: Intake Channel NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	Not visible beneath reservoir surface
Bottom Conditions	Not visible
Rock Slides or Falls	Not visible beneath reservoir surface
Log Boom	None
Debris	None
Condition of Concrete Lining	Not visible beneath reservoir surface
Drains or Weep Holes	None visible
b. Intake Structure	Not visible beneath reservoir surface
Condition of Concrete	
Stop Logs and Slots	

INSPECTION CHECK LIST

PROJECT: Dole Reservoir Dam, NH DATE: November 29, 1979

PROJECT FEATURE: Control Tower NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	BRICK MASONRY STRUCTURE ON DAM EMBANKMENT IS CONTROL TOWER
a. Concrete and Structural	
General Condition	Fair
Condition of Joints	None visible
Spalling	Moderate spalling on top of concrete face wall
Visible Reinforcing	Horizontal bar exposed in 3" wide crack near top of concrete face wall
Rusting or Staining of Concrete	Slight staining of exposed reinforcing bar near top of concrete face wall
Any Seepage or Efflorescence	None
Joint Alignment	Not visible
Unusual Seepage or Leaks in Gate Chamber	Chamber not visible
Cracks	3" wide by 36" long crack near top of concrete face wall
Rusting or Corrosion of Steel	Moderate rusting of exposed reinforcing steel near top of concrete face wall
b. Mechanical and Electrical	
Air Vents	Not visible
Float Wells	Not visible
Crane Hoist	Not visible
Elevator	Not visible
Hydraulic System	Not visible
Service Gates	Not visible
Emergency Gates	Not visible
Lightning Protection System	Not visible
Emergency Power System	Not visible
Wiring and Lighting System	Not visible

INSPECTION CHECK LIST

ROJECT: Dole Reservoir Dam, NH _____ DATE: November 29, 1979

ROJECT FEATURE: Transition and Conduit NAME: _____

ISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
)UTLET WORKS - TRANSITION .ND CONDUIT	Not visible
ieneral Condition of Concrete	
lust or Staining on Concrete	
palling	
:rosion or Cavitation	
:racking	
\lignment of Monoliths	
\lignment of Joints	
Numbering of Monoliths	

Dam No. 47.17

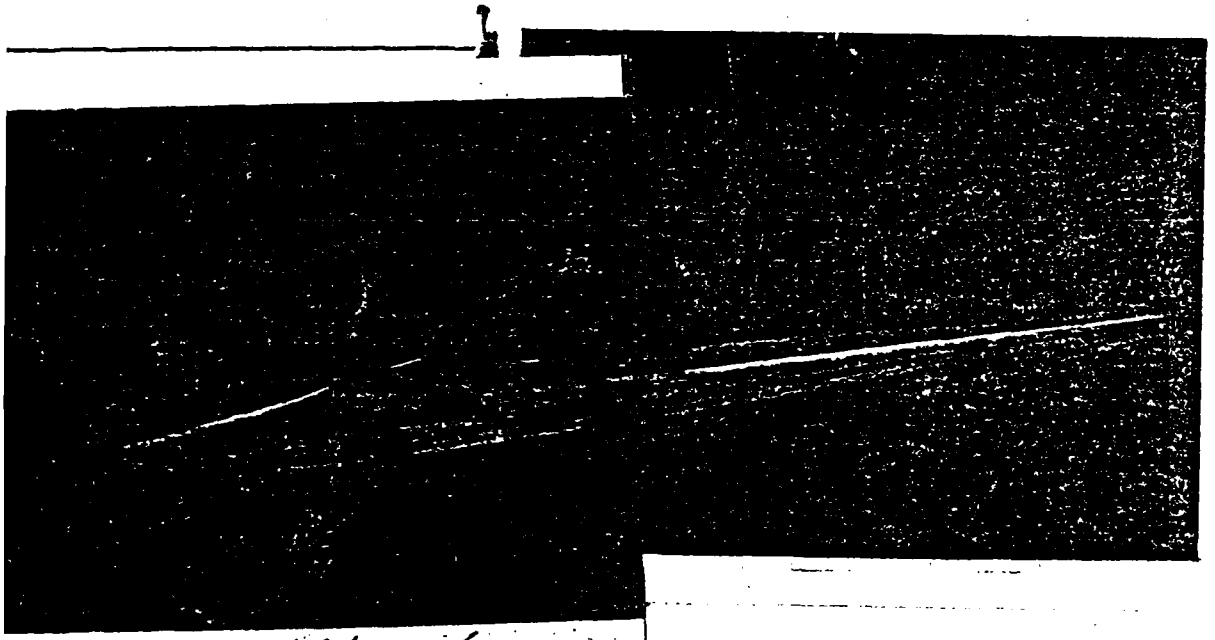
S:

(1) CRACKED + LEANING WALL (2) SPILLWAY

(2) TREES ON EMBANKMENT

(3) WET AREA AT TOE

(4) OLD ANIMAL HOLE



CRACK

Dam No. 47.17

LWAY: Length: 25' 1' FREEBOARD Freeboard: 2' WINTER (STOPLOG)
9" ~~FLASH BOARDS~~ IN SUMMER STOPLOG

AGE: Location, estimated quantity, etc.

WET AREA W/ NO FLOW / COULD BE FROM INLET PIPE

RESERVOIR FED BY PIPE FROM ANOTHER RESERVOIR

PIPE DATES TO ORIGINAL CONSTRUCTION

ges Since Construction or Last Inspection:

Water Conditions:

WOODS

all Condition of Dam: GOOD

act With Owner: YES

of Inspection: 11/29/79 Suggested Reinspection Date

s of Dam: NON-MENACE

Signature Kenneth Stern

Date

Size Sizing, Condition and detailed description for each item, if applicable.

NEW HAMPSHIRE WATER RESOURCES BOARD

INSPECTION REPORT

: CLAREMONT Dam Number: 47.17

of Dam, Stream and/or Water Body: DOLE RESERVOIR - OUTLET DAM

r: CITY OF CLAREMONT Telephone Number:

ing Address:

Height of Dam: 9' Pond Area: SEE USGS Length of Dam: 125'±

DATION: LEDGE - SHALEY DECOMPOSES INTO SMALL PLATELETTES

ET WORKS: 25' CONCRETE SPILLWAY W/3' STOPLOG BAY 1' DEEP WATER FEED TO CITY SERVICE

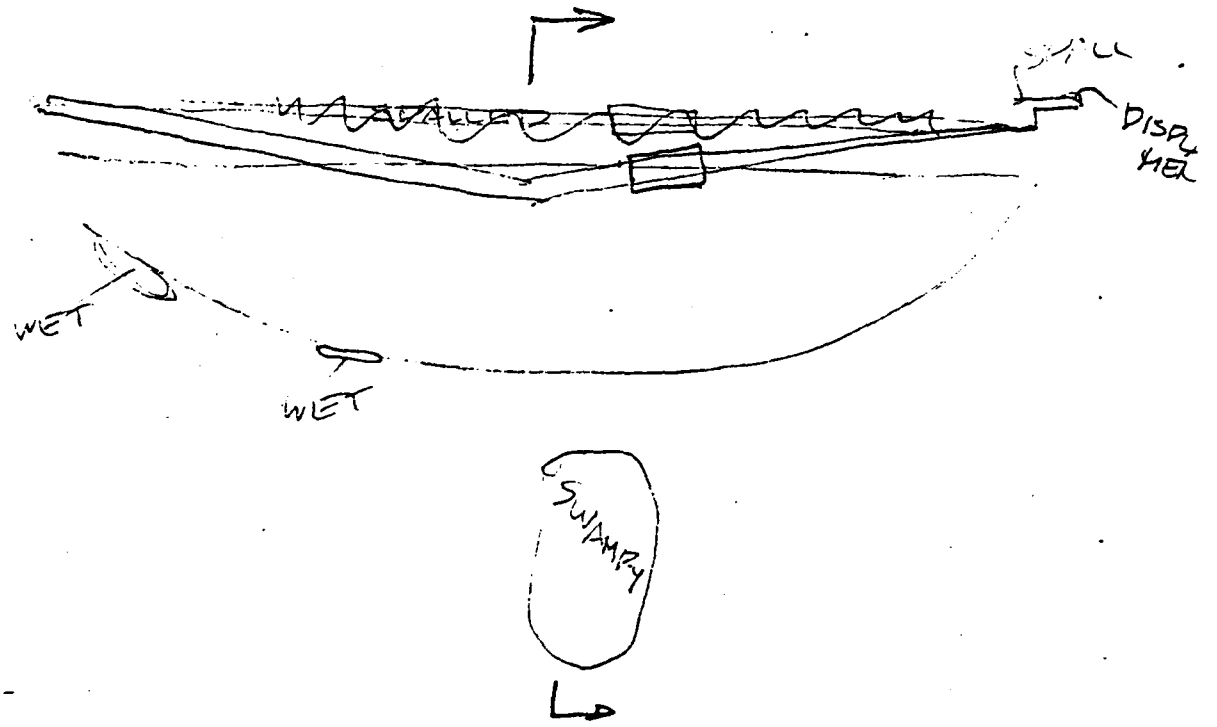
MENTS: @ SPILLWAY RT ABUT CRACK @ CORNER D/S WALL LEANING, MINOR SPALLING @ D/S END FROST? FOUNDATION

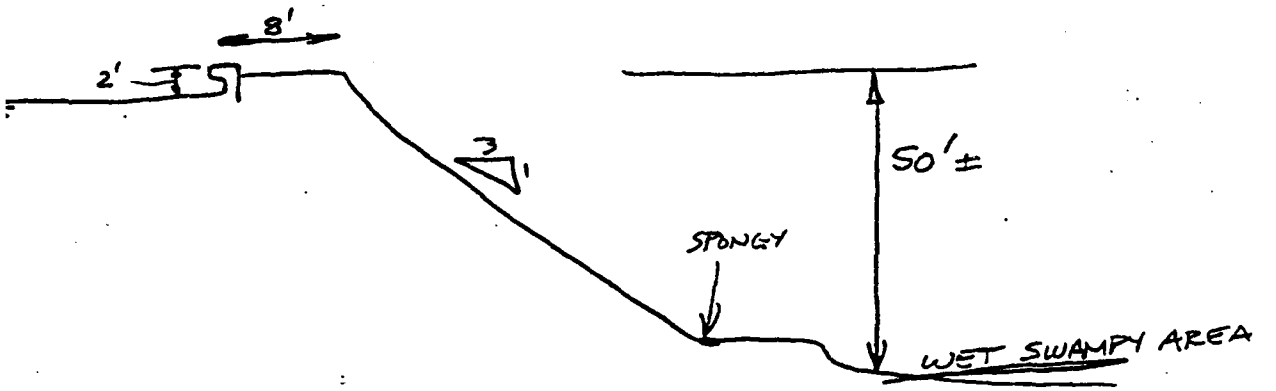
NKMENT: 1 ABANDONED ANIMAL HOLE 6' TOP WIDTH U/S CONCRETE WALL SOME MINOR CRACKS 2 LARGE PINES 1 SMALL HARDWOOD

Give Sizing, Condition and detailed description for each item, if applicable.

Dam No. 47.17

TCH OF DAM (Show Plan, Elevation & Cross Sections)





SECTION

Dam No. 47.17

MMENTS:

(1) CUT TREES & BUSHES

(2) MOW SLOPE

(3) REPAIR SPALLING

(4) " FOUNDATION @ LT ABUT

(5) MONITOR SEEPAGE - TOE DRAIN OR BLANKET

Dam No. 47.17

PILLWAY: NONE Length: _____ Freeboard: 2'±

EEPAGE: Location, estimated quantity, etc.

SPONGY DAMP AREA @ RT. END WHERE EMB MEETS OLD GROUND / WET BUT NO FLOW

WET AREA AT TOE - SWAMPY BUT NO FLOW

hanges Since Construction or Last Inspection:

EMBANKMENT HAS SETTLED 1'I

ail Water Conditions:

NEW TREATMENT PLANT SEVERAL HOUSES IN VALLEY

verall Condition of Dam: ~~FAIR~~ FAIR-SEEPAGE spalling

ontact With Owner: YES

ate of Inspection: 11/29/79 Suggested Reinspection Date _____

lass of Dam: MENACE

Signature Kenneth Hall

Date _____

te: Give Sizing, Condition and detailed description for each item, if applicable.

NEW HAMPSHIRE WATER RESOURCES BOARD

INSPECTION REPORT

Town: CLAREMONT Dam Number: 47.17

Name of Dam, Stream and/or Water Body: DOLE RES MAIN DAM

Owner: CITY OF CLAREMONT Telephone Number:

Mailing Address:

Max. Height of Dam: 50 Pond Area: SEE USGS Length of Dam:

FOUNDATION: LT LEDGE RT UNKNOWN
LEDGE IS SHALEY EXPOSED AREAS DECOMPOSE INTO SMALL PLATES. AT LT END THERE IS A VOID DUE TO FOUNDATION DETERIORATION

OUTLET WORKS: PIPE TO WATER SUPPLY

ABUTMENTS: EMBANKMENT 8' TOP WIDTH MANY THORNS A FEW BUSHES

EMBANKMENT: U/S CONC WALL SPALLED @ LT END (SEE PHOTO)
LEDGE DETERIORATED @ LT END 2" DISPLACEMENT OF JOGGED WALL
MINOR BRUSH GROWTH
SPALLING @ WATER LINE JUST RT OF INTAKE HOUSE
TOP OF WALL SPALLED NEEDS PATCH OR REFACE 4" DEEP IN SOME LOCATIONS

Note: Give Sizing, Condition and detailed description for each item, if applicable.

M E M O

Date: November 30, 1979

To: Vernon A. Knowlton,
Chief Engineer

From: Ken Stern,
Water Resources Engineer

Subject: Dole Reservoir, Dam No. 47.17, Claremont

On November 29, 1979 Dick DeBold and I accompanied the inspection team from SEA Consultants. Representatives from the Claremont Water Department were present. There are two structures maintaining the reservoir.

Outlet Dam

This is an earth dam with an upstream concrete wall, founded on ledge. The maximum height is about 9'. There is a 25' concrete spillway with one foot of freeboard and a 3' wide 1' deep stoplog bay. The dam is in fair condition. It is a non-menace structure. The items in need of attention are:

1- The downstream wingwall at the spillway is cracked and leaning, probably due to frost action and deterioration of the foundation.

2- There are two large pines and one small hardwood which should be cut.

3- There is an abandoned animal hole which should be filled.

4- There is a wet area at the toe.

Main Embankment

This is a combination earth fill and concrete buttress dam about 50 ft. high and several hundred feet long. It is in fair condition. It is a menace dam due to the height, storage and the location of homes in the path of breach flows. The items in need of attention are:

1- The concrete has extensive surface spalling.

2- The foundation ledge at the left abutment has deteriorated.

3- There are bushes and small trees growing on the embankment.

4- The embankment needs mowing.

5- The toe is spongy.

6- Just downstream of the toe is a swampy area. No seeps, boils or flow were observed, but there is standing water.

I believe any action on our part can wait until receipt of the Corps' report.

KS:paf
Enc.

PAST INSPECTION REPORTS

AVAILABLE ENGINEERING DATA

A set of plans dated 1913, by E. E. Davis, Civil Engineer, showing plan, elevation, and section for construction of the dam, dike, and spillway were obtained from Elmer Huntly, Jr. and Associates of North Hampton, Massachusetts. No in-depth engineering calculations, as-built drawings, or specifications were found.

APPENDIX B

ENGINEERING DATA

INSPECTION CHECK LIST

PROJECT: Dole Reservoir Dam, NH DATE: November 29, 1979

PROJECT FEATURE: Service Bridge NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE	No Service Bridge
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

INSPECTION CHECK LIST

PROJECT: Dole Reservoir Dam, NH DATE: November 29, 1979

PROJECT FEATURE: Spillway Weir NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Not visible beneath reservoir surface
b. Weir and Training Walls	
General Condition of Concrete	Cracking and overturning of right training wall
Rust or Staining	None
Spalling	Slight
Any Visible Reinforcing	None
Any Seepage or Efflorescence	Undermining of right training wall at toe of slope
Drain Holes	None
c. Discharge Channel	
General Condition	Poor
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Many trees overhanging and in channel
Floor of Channel	Soil
Other Obstructions	Debris, logs, fallen trees in channel

INSPECTION CHECK LIST

PROJECT: Dole Reservoir Dam, NH DATE: November 29, 1979

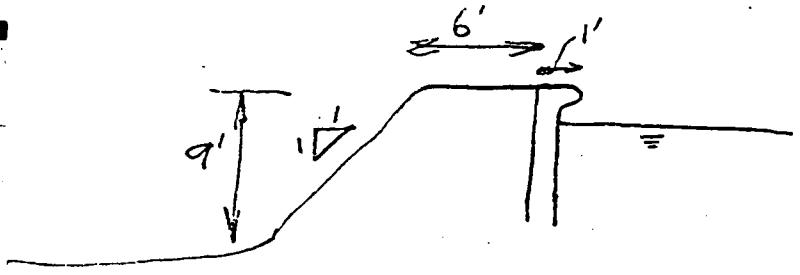
PROJECT FEATURE: Outlet Structure NAME: _____

DISCIPLINE: _____ NAME: _____

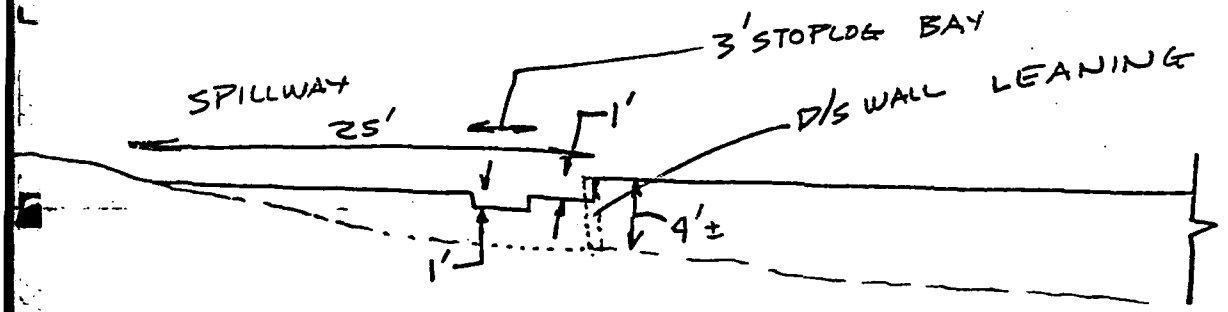
AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	Not visible - underground
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	

Dam No. 47.17

SKETCH OF DAM (Show Plan, Elevation & Cross Sections)



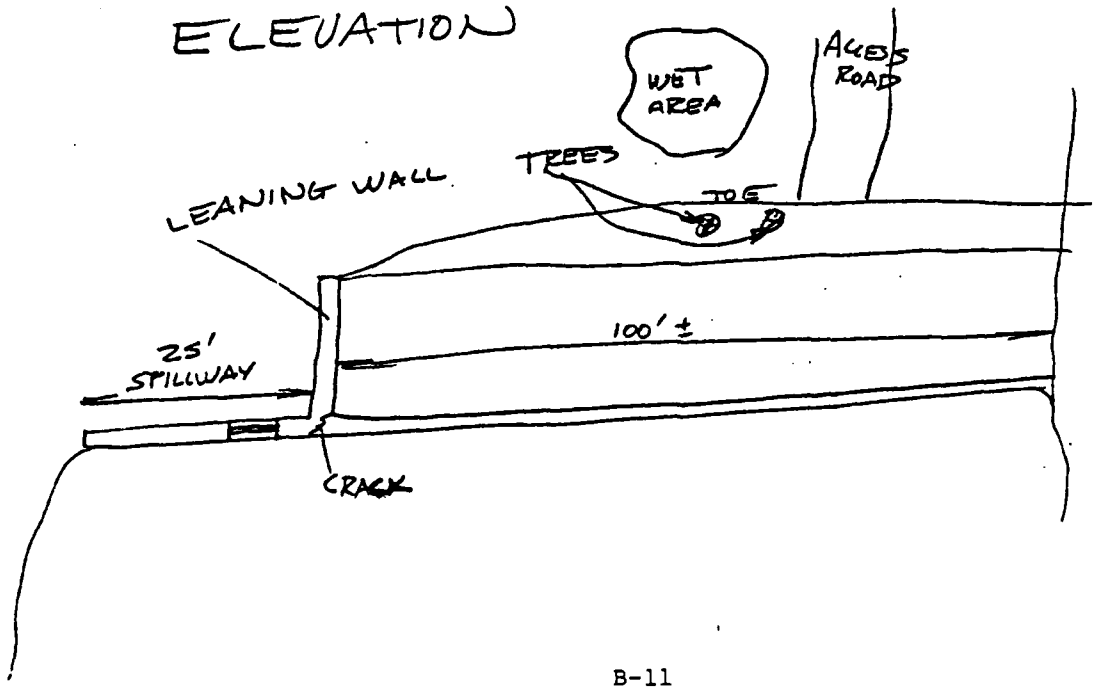
SECTION



9" STOP LOG REMOVED FOR WINTER

ALMOST NO CONTRIBUTING DRAINAGE AREA

ELEVATION



FORM E2 8253

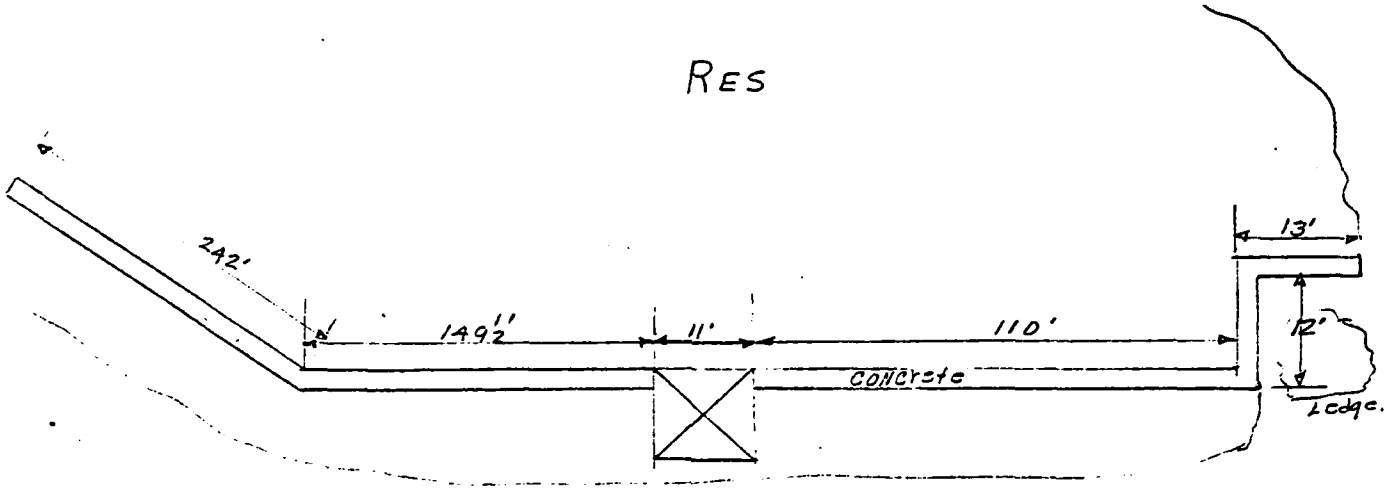
NEW HAMPSHIRE WATER RESOURCES BOARD CONCORD, N. H.

PROJECT FILE 47.17

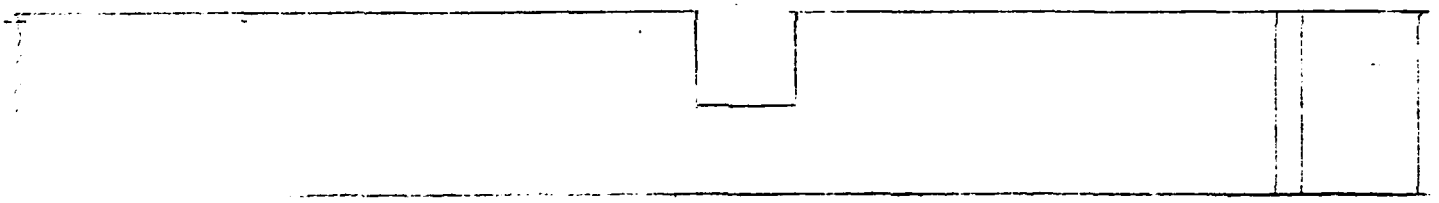
SUBJECT DOLE RESERVOIR. CLAREMONT ACC.

CONN. R. SUGAR R. Claremont WATER Works

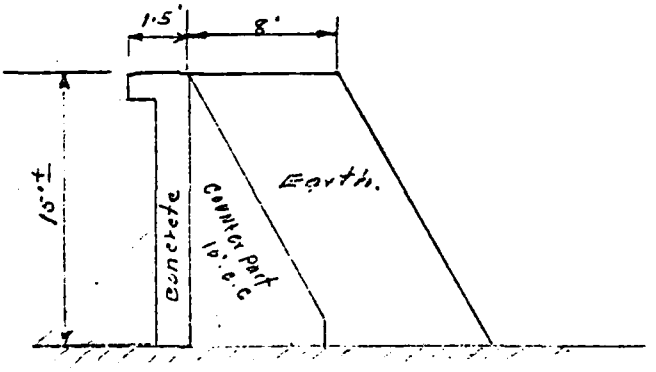
COMPUTER G.S.W. CHECKER CONT. FROM ACC. CONT. ON ACC. SUMMARY ON ACC. DATE 9/26/39



PLAN scale. 1"=40'-0"



ELEVATION



X-Section.

7204

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 47.17

Town Claremont : County Sullivan

Stream

Basin-Primary Conn R. : Secondary Sugar R.

Local Name Pole Reservoir ✓

Coordinates—Lat. 43° 25' -9600 ✓ : Long. 72° 20' +400 ✓

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 0.17 Sq. Mi.

Overall length of dam 550 ✓ ft.: Date of Construction 1913

Height: Stream bed to highest elev. 30 ✓ ft.: Max. Structure 29' and 27' - 11' ✓ ft.

Cost—Dam : Reservoir

DESCRIPTION

Waste Gates

Type

Number : Size ft. high x ft. wide

Elevation Invert : Total Area sq. ft.

Hoist

Waste Gates Conduit

Number 1 : Materials 30" Cast Iron Pipe ✓

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on : Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction

Length—~~Total~~ ~~ft.~~ ~~Net~~ 24' high - 5' low ✓ ft.

Height of permanent section—max. 27' ft.: Min. 27' ft.

Flashboards—Type : Height ft.

Elevation—Permanent Crest 736 : Top of Flashboard

Flood Capacity cfs.: cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 2' 1" ✓ ft.: Min. 1.0' ✓ ft.

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

OWNER Claremont Water Works Claremont N.H.

REMARKS Use- Water Supply Pond Area (?.5) 7 A. ?

Tabulation By W.P.A. Date November 9, 1938

Return to	
Filed	
File No.	

WATER CONTROL COMMISSION

STATE OF NEW HAMPSHIRE

Concord, New Hampshire
October 13, 1938.

Claremont Water Works,
Claremont N H

RE: Dole Dale Res. Dam. W. C. C. No. 47.17

Gentlemen:

In order that we may determine the magnitude and extent of the flood of September 21-24 just passed, we are requesting the various dam owners in the State to supply us with the following information:

1. Was this dam injured? Ans. No

2. If so, to what extent? Ans.

3. Did all flashboards go out? Ans. No.

4. What was the maximum height of water over the permanent crest of spillway? Ans. Do not Know

5. At what day and hour did the maximum flood height reach your dam? Ans.

6. Any other interesting information regarding the flood or rain fall may be given on the back of this sheet, or attach sheets.

Will you please return this letter with as much information as you can give us as promptly as possible. A self-addressed envelope is attached hereto.

We thank you for your cooperation.

Very truly yours,

Richard S. Holmgren

Richard S. Holmgren
Chief Engineer

CDC:GMB
Enc.

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Connecticut NO. 17 417a 47.17
RIVER Dole Reservoir MILES FROM MOUTH ____ D.A.SQ.MI ____
TOWN Claremont OWNER Town of Claremont
LOCAL NAME OF DAM
BUILT 1913 DESCRIPTION Concrete wall buttressed Earth fill

POND AREA-ACRES 2.5± DRAWDOWN FT. 23 POND CAPACITY-ACRE FT. 115.5
HEIGHT-TOP TO BED OF STREAM-FT. 30 MAX. MIN.
OVERALL LENGTH OF DAM-FT. 550 MAX.FLOOD HEIGHT ABOVE CREST-FT.
PERMANENT CREST ELEV.U.S.G.S. 776± LOCAL GAGE
TAILWATER ELEV.U.S.G.S. LOCAL GAGE
SPILLWAY LENGTHS-FT. 15. 24 high 5.0 low FREEBOARD-FT. 1.0' + 2.1"
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST
WASTE GATES-NO. WIDTH MAX.OPENING DEPTH SILL BELOW CREST

2H REMARKS Condition Good 1 A 15' Dike 10 ft high 20' long some pon
This Reservoir receives water thru 10" pipe from Rice Reservoir and feeds town distribution system thru 20" C.I. Pipe. Water comes from Whitewater Bk. Dole Reservoir is connected to Straw reservoir on Grandy Bk by 8" equalizing pipe.

POWER DEVELOPMENT

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

USE Water Supply

REMARKS Information from Supt. Claremont Water Works 6/15/37
Says 475' long spillway 15" capacity 3,055,246 gal. Does not mention dike. Raised 1 ft. in 1914
Built by F E Davis C.E. Northampton, Mass.

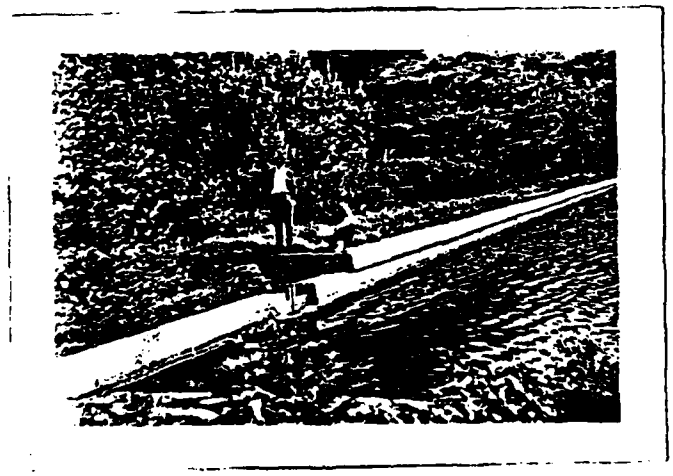
Shown by Chas. Easter Supt.

Top foot 2,665,425 92%
" 5ft 13,398,974 "
2d " 10,149,402 "
3d " 6,619,443 "
4th " 3,546,952 "
remainder 357,953 "

DATE 1925 Est.
12/1/37

NO.

DOLE RESERVOIR IN CLAREMONT
Claremont Water Works
September 30,1937



Spillway

Claremont (Sullivan) Inspected June 30, 1930.

Claremont Water Company

This is a concrete dam, the general construction of which is shown by two sketches. Consists of a cement front wall, mostly earth dam, and on ledge. Capacity is 37,000,000 gallons. This is known as the Dole reservoir. Built in 1913. Interviewed Mr. Rice, superintendent, who accompanied me on inspection trip,

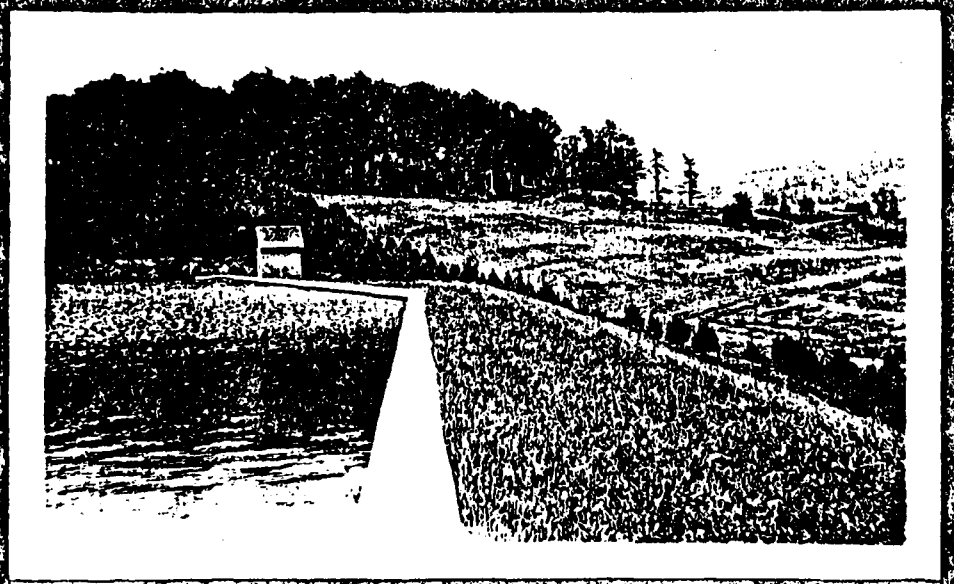
DIVI-79.

Claremont (Sullivan) Inspected June 30, 1930.

Claremont Water Company

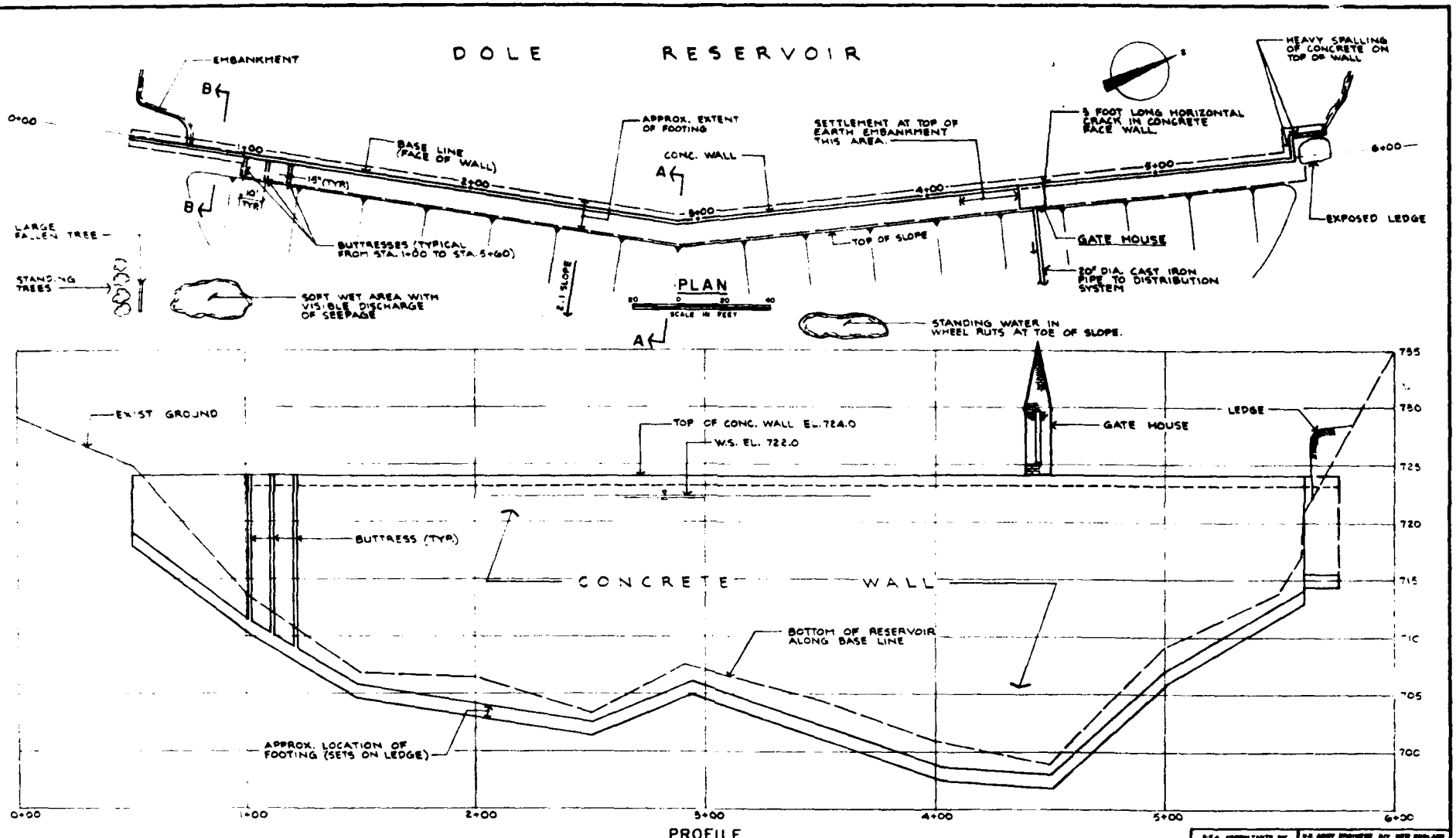
On the upper part of the reservoir there is a retaining wall which helps raise the elevation of the water. Is also used as a spillway, and the water is also brought in at this end from White Water Brook.

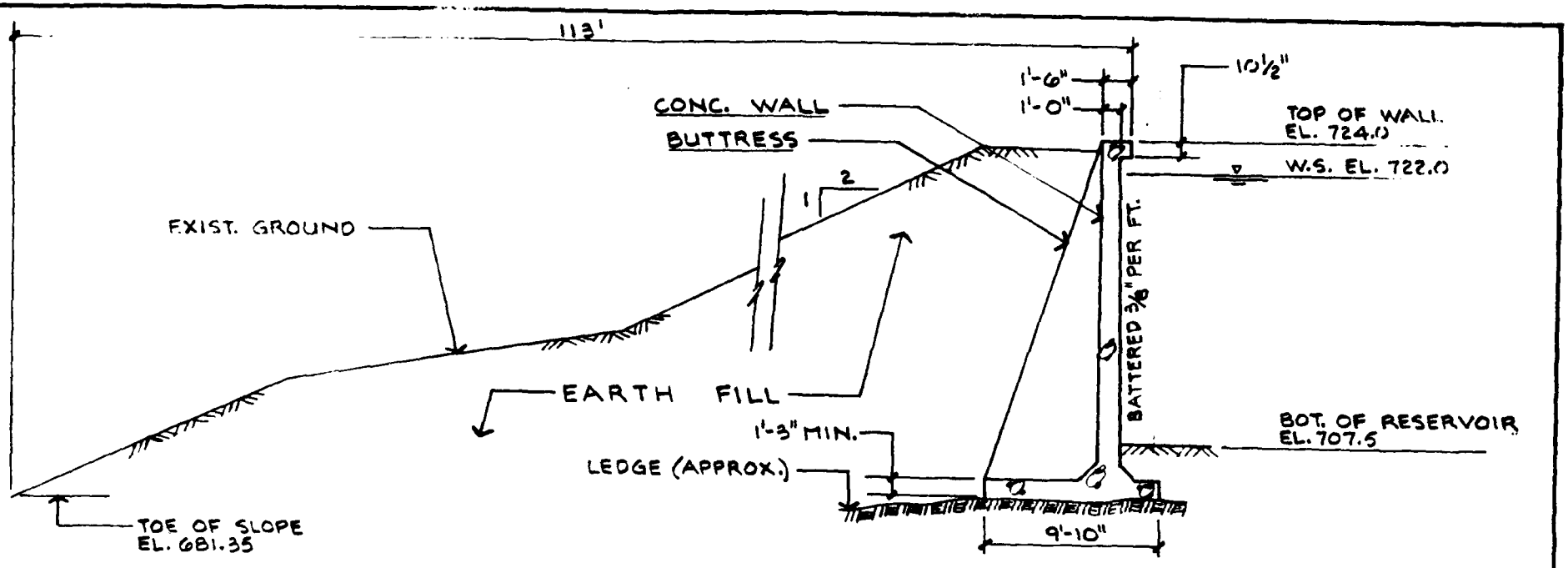
DIVI-80.



DIVI-793 Taken from along the top of the earth dam.

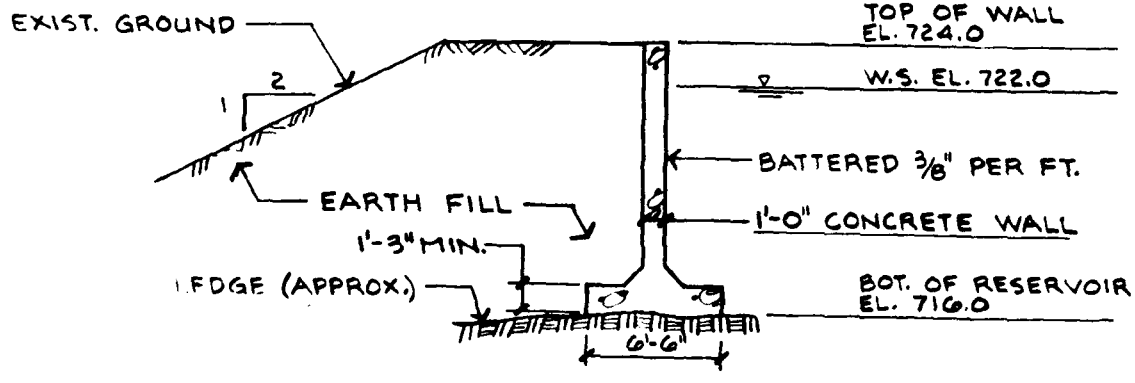
PLANS AND DETAILS


DOLE RESERVOIR
EMBANKMENT
B
0+00
1+00
2+00
3+00
4+00
5+00
6+00
BASE LINE (FACE OF WALL)
APPROX. EXTENT OF FOOTING
CONC. WALL
A
SETTLEMENT AT TOP OF EARTH EMBANKMENT THIS AREA.
3 FOOT LONG HORIZONTAL CRACK IN CONCRETE FACE WALL
HEAVY SPALLING OF CONCRETE ON TOP OF WALL
EXPOSED LEDGE
GATE HOUSE
TOP OF SLOPE
20" DIA. CAST IRON PIPE TO DISTRIBUTION SYSTEM
15" (TYP.)
10' (TYP.)
BUTTRESSES (TYPICAL FROM STA. 1+00 TO STA. 5+60)
LARGE FALLEN TREE
STANDING TREES
SOFT WET AREA WITH VISIBLE DISCHARGE OF SEEPAGE
2:1 SLOPE
PLAN
SCALE IN FEET
STANDING WATER IN WHEEL RUTS AT TOE OF SLOPE.
EXIST GROUND
TOP OF CONC. WALL EL. 724.0
W.S. EL. 722.0
LEDGE
GATE HOUSE
BUTTRESS (TYP.)
CONCRETE WALL
BOTTOM OF RESERVOIR ALONG BASE LINE
APPROX. LOCATION OF FOOTING (SETS ON LEDGE)
PROFILE
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
DOLE RESERVOIR
DAM-PLAN & PROFILE



SECTION A-A

SCALE: 3/16"=1'

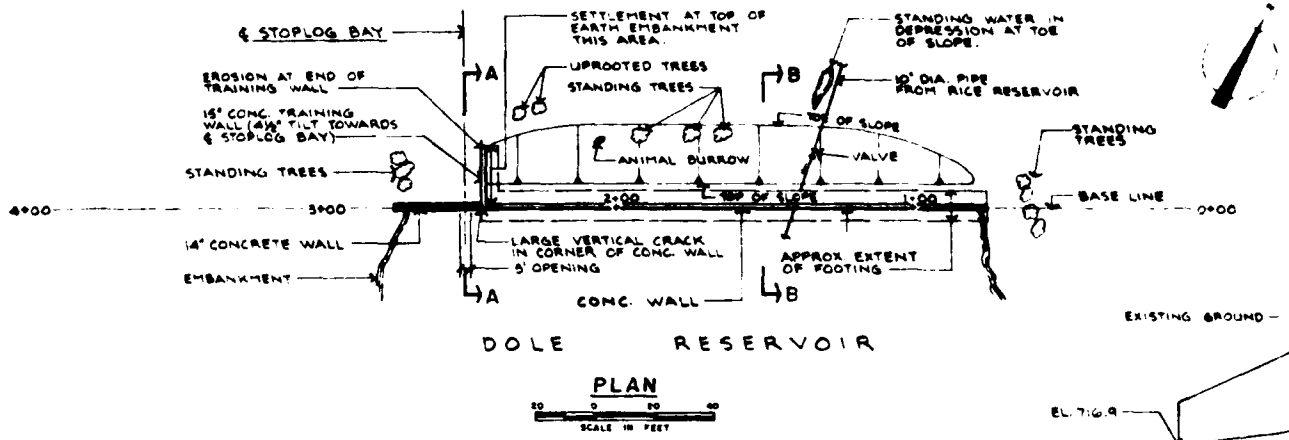


SECTION B-B

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

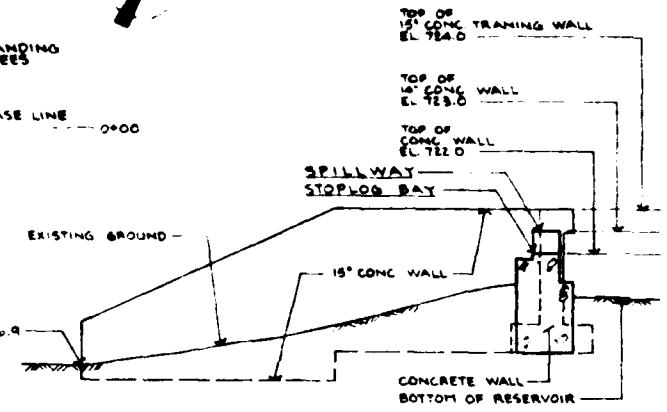
DOLE RESERVOIR
DAM – SECTIONS

REPRODUCED AT GOVERNMENT EXPENSE



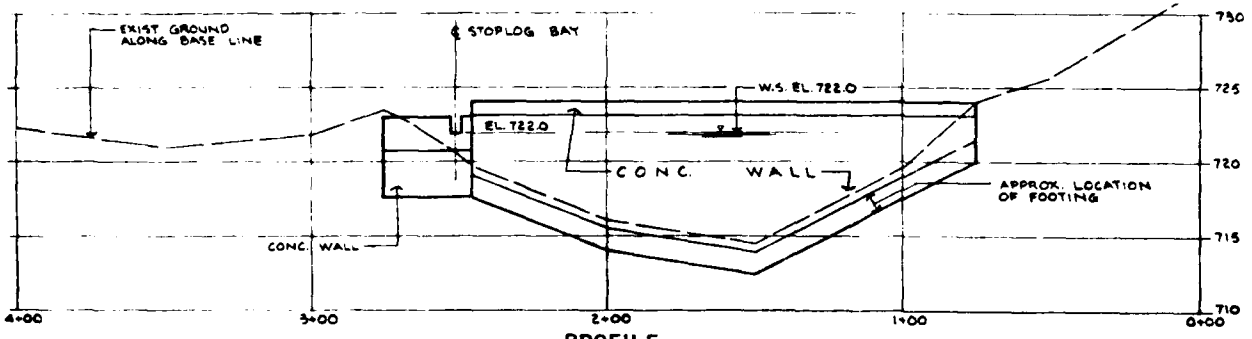
DOLE RESERVOIR

PLAN

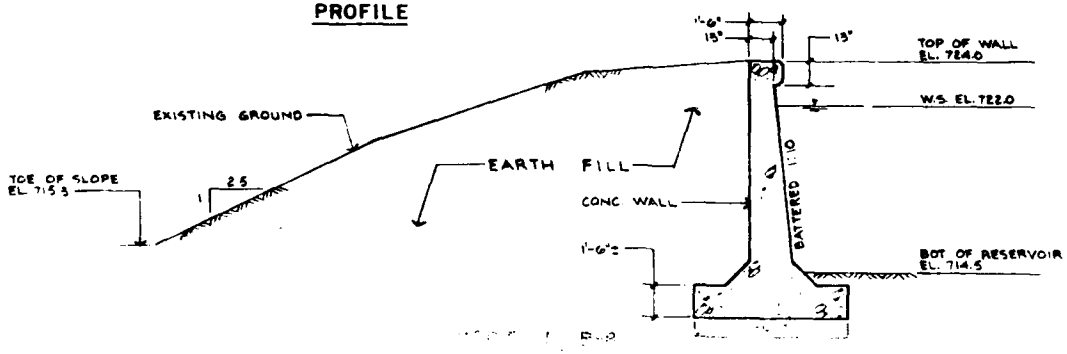


SECTION A-A

SCALE: 3/16"=1'



PROFILE



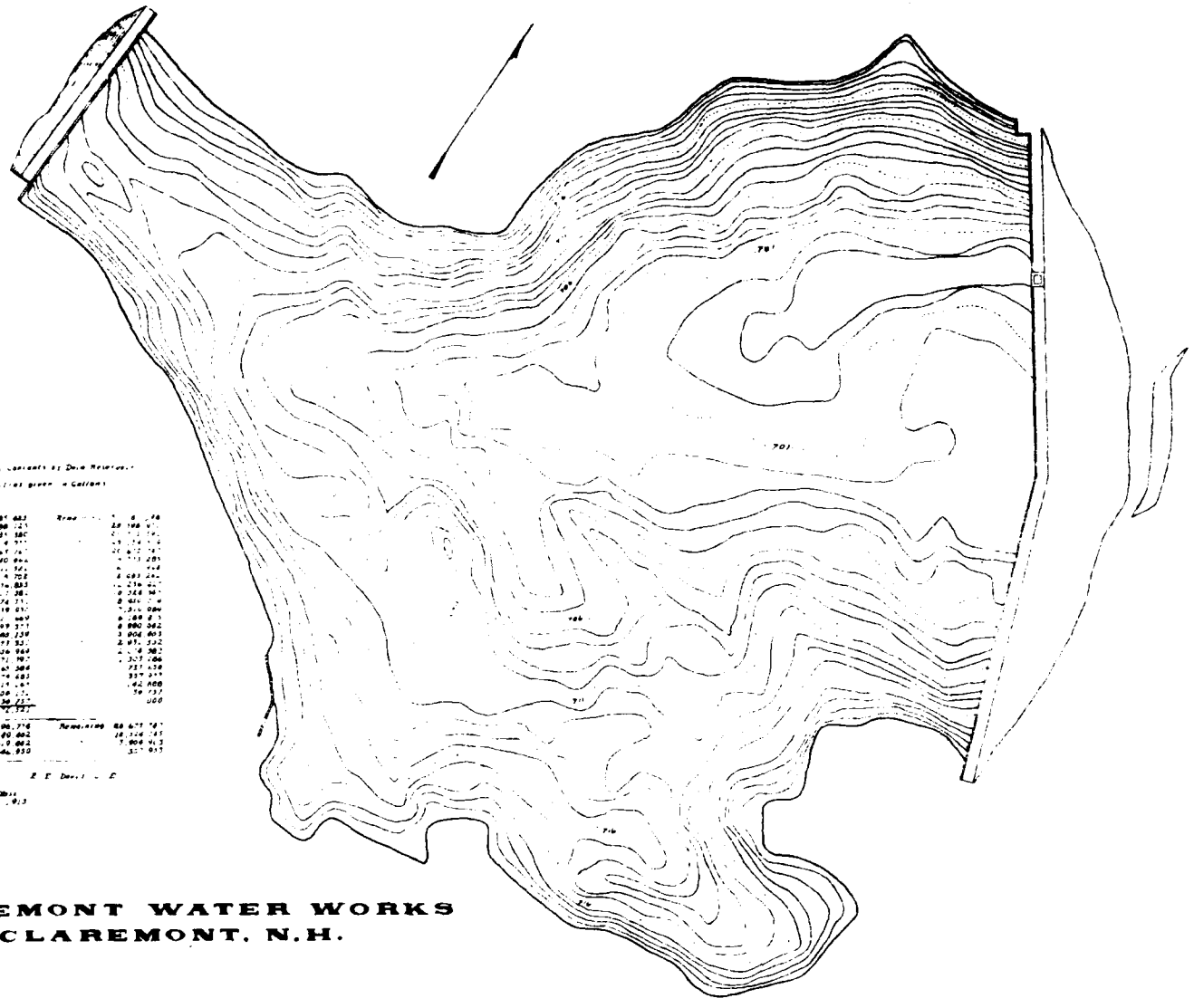
GENERAL NOTES:

1) THE ELEVATIONS SHOWN ARE BASE ON USGS DATUM. FROM INFORMATION OBTAINED FROM THE 1913 DAM CONSTRUCTION PLANS, BY E.E. DAVIS, CIVIL ENGINEER.
2) THE INFORMATION SHOWN ON THESE DRAWINGS ARE BASED ON THE EXISTING CONSTRUCTION PLANS & VISUAL OBSERVATIONS MADE DURING THE FIELD INSPECTION. DIMENSIONS OR MATERIALS INDICATED ON THESE DRAWINGS WHICH WERE BELOW GRADE OR WATER DURING THE TIME OF INSPECTION WERE NOT VERIFIED.

[illegible] CONSULTANTS, INC.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

DOLE RESERVOIR DIKE - PLAN, PROFILE & SECTIONS



CLAREMONT WATER WORKS
CLAREMONT, N.H.

Photo No. 19 - Downstream slope of dike looking from right abutment toward left abutment.

Photo No. 20 - Animal Burrow in downstream slope of dike.

Photo No. 17 - Crack and spalling of upstream end of right training wall of spillway discharge channel.

Photo No. 18 - Downstream slope of dike looking from spillway discharge channel toward right abutment.

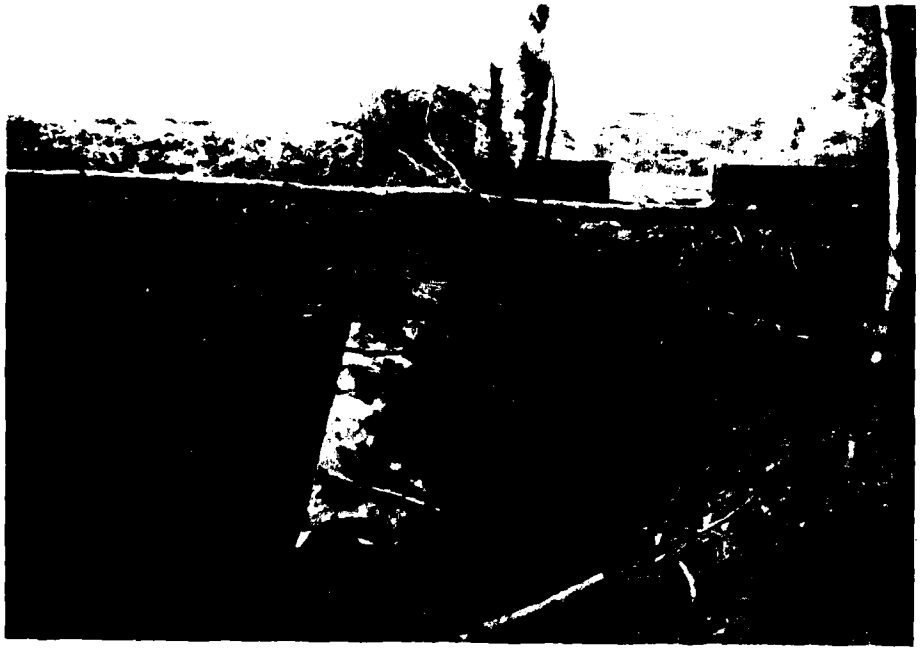


Photo No. 15 - View upstream along right training wall of spillway discharge channel.

Photo No. 16 - Closeup view of spillway stoplog section.

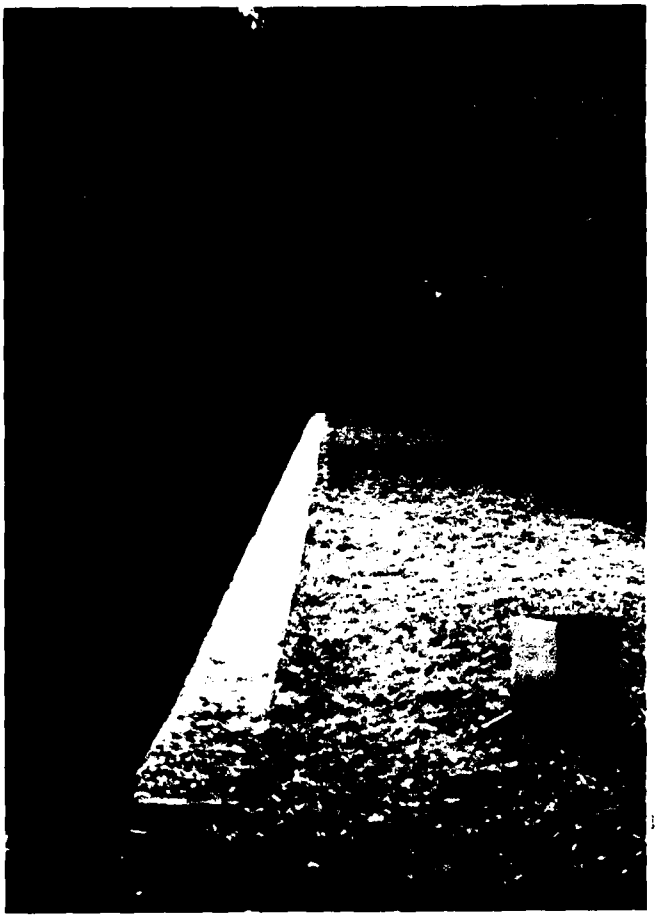


Photo No. 13 - View of crest of dike from right embankment.

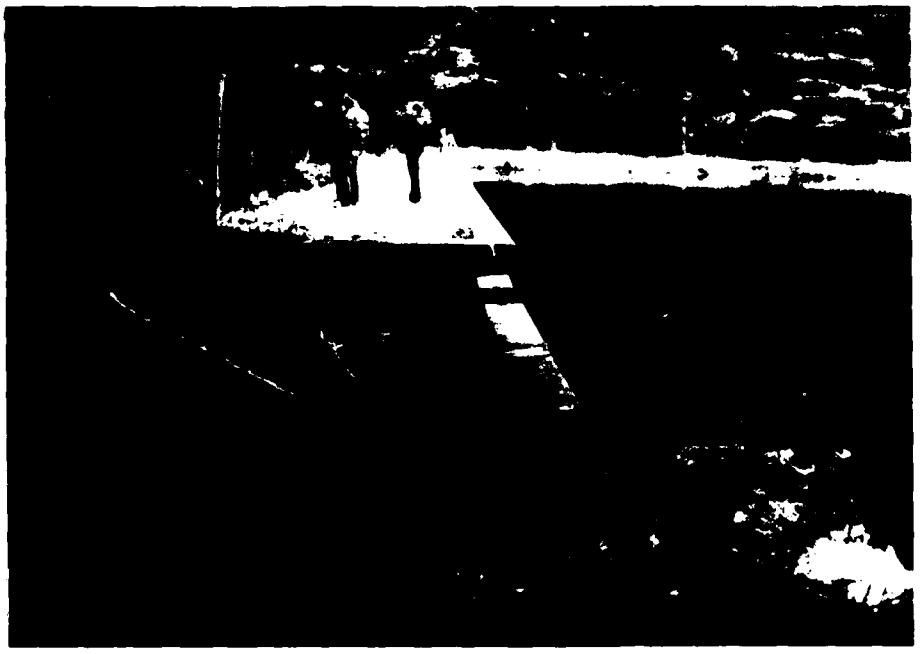


Photo No. 14 - View of crest of dike from left embankment.

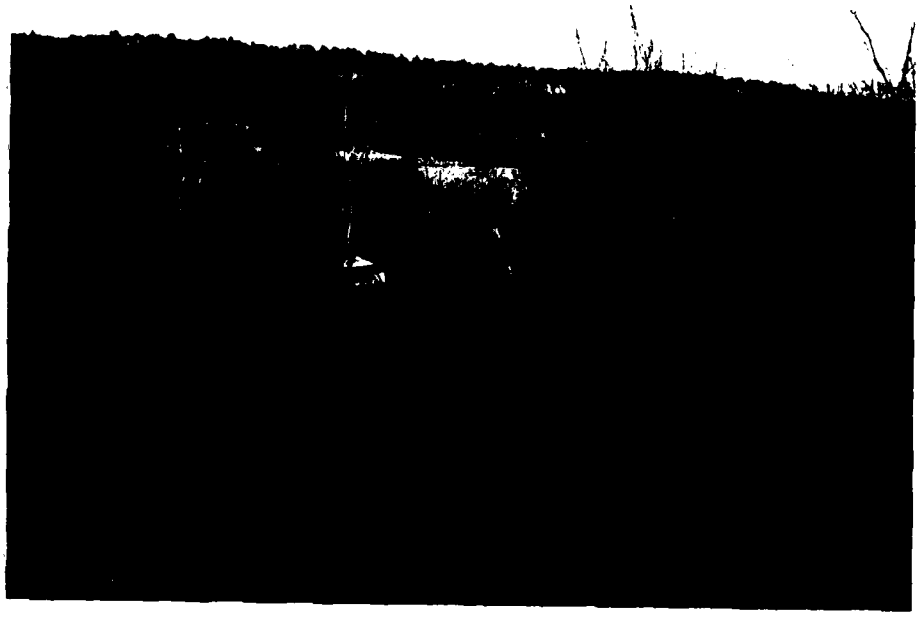


Photo No. 11 - General view of downstream area from top center of dam.

Photo No. 12 - General view of dike from reservoir.

Photo No. 9 - Downstream slope of dam looking from left abutment toward right abutment.

Photo No. 10 - Running water at toe of downstream slope of dam.

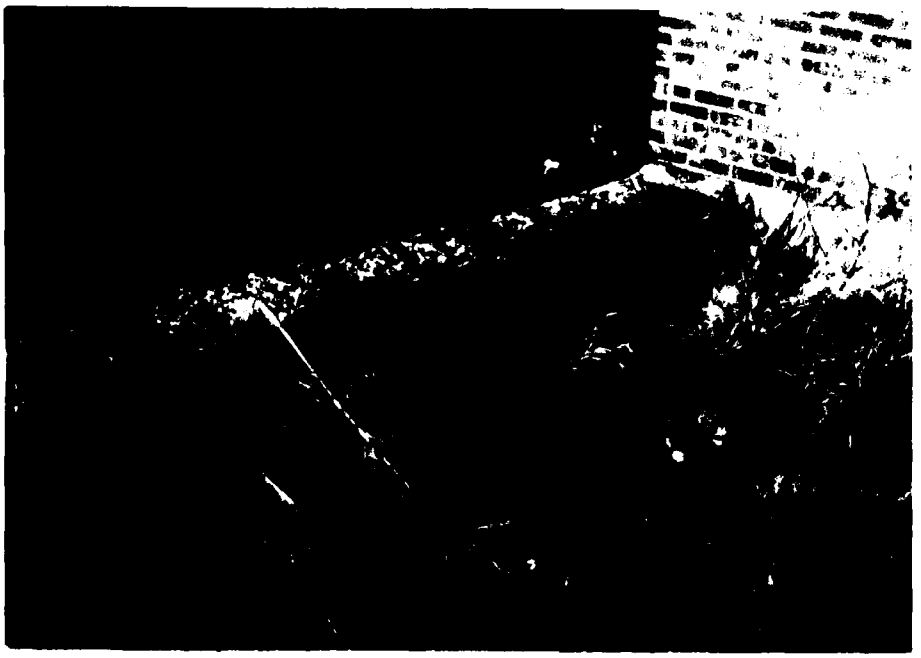


Photo No. 7 - Spalling of concrete cap at gatehouse and settlement of embankment structure.

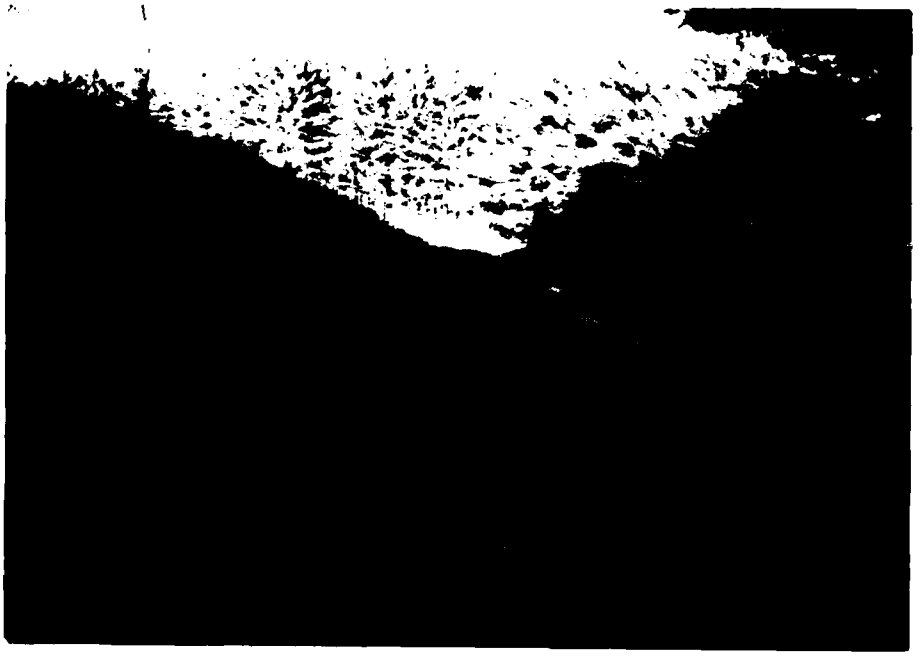


Photo No. 8 - Downstream slope of dam looking from right abutment toward left abutment

Photo No. 5 - Spalling of concrete cap at left abutment of dam.

Photo No. 6 - View of gatehouse from left shoreline.

Photo No. 3 - General view of dam from left abutment

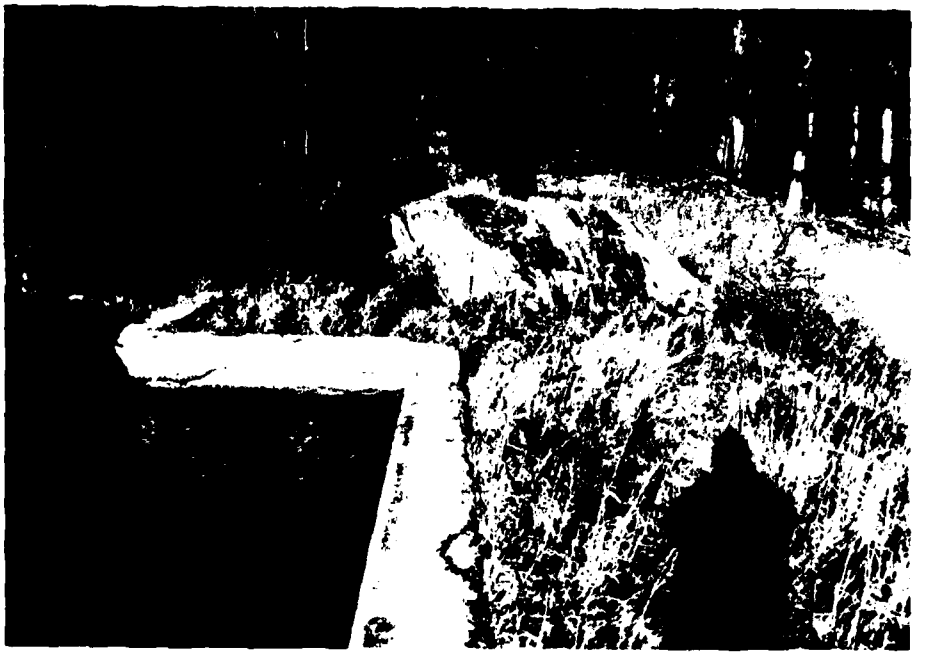


Photo No. 4 - View of left abutment from dam

Photo No. 1 - General view of center section of dam from reservoir

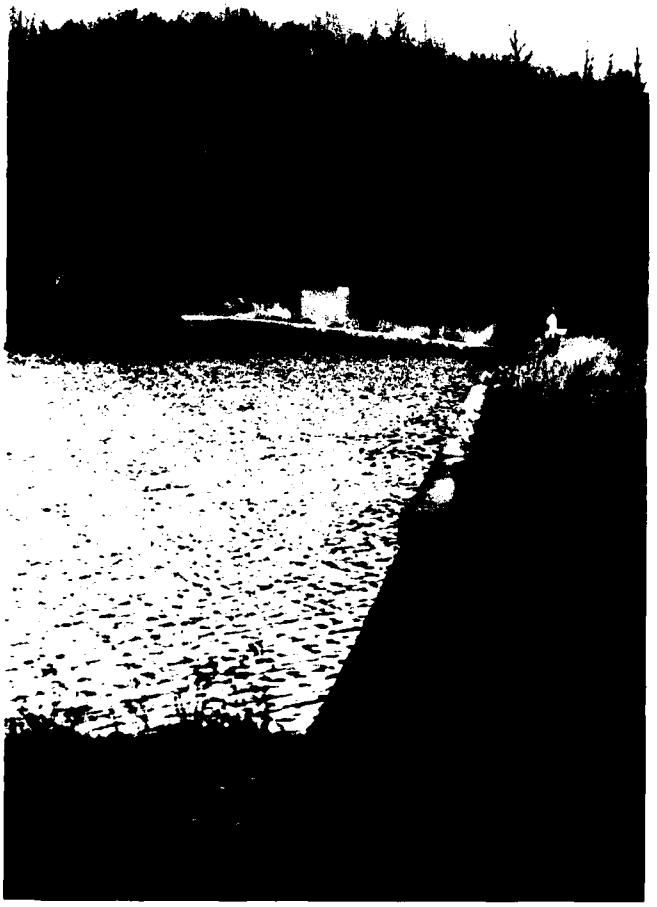
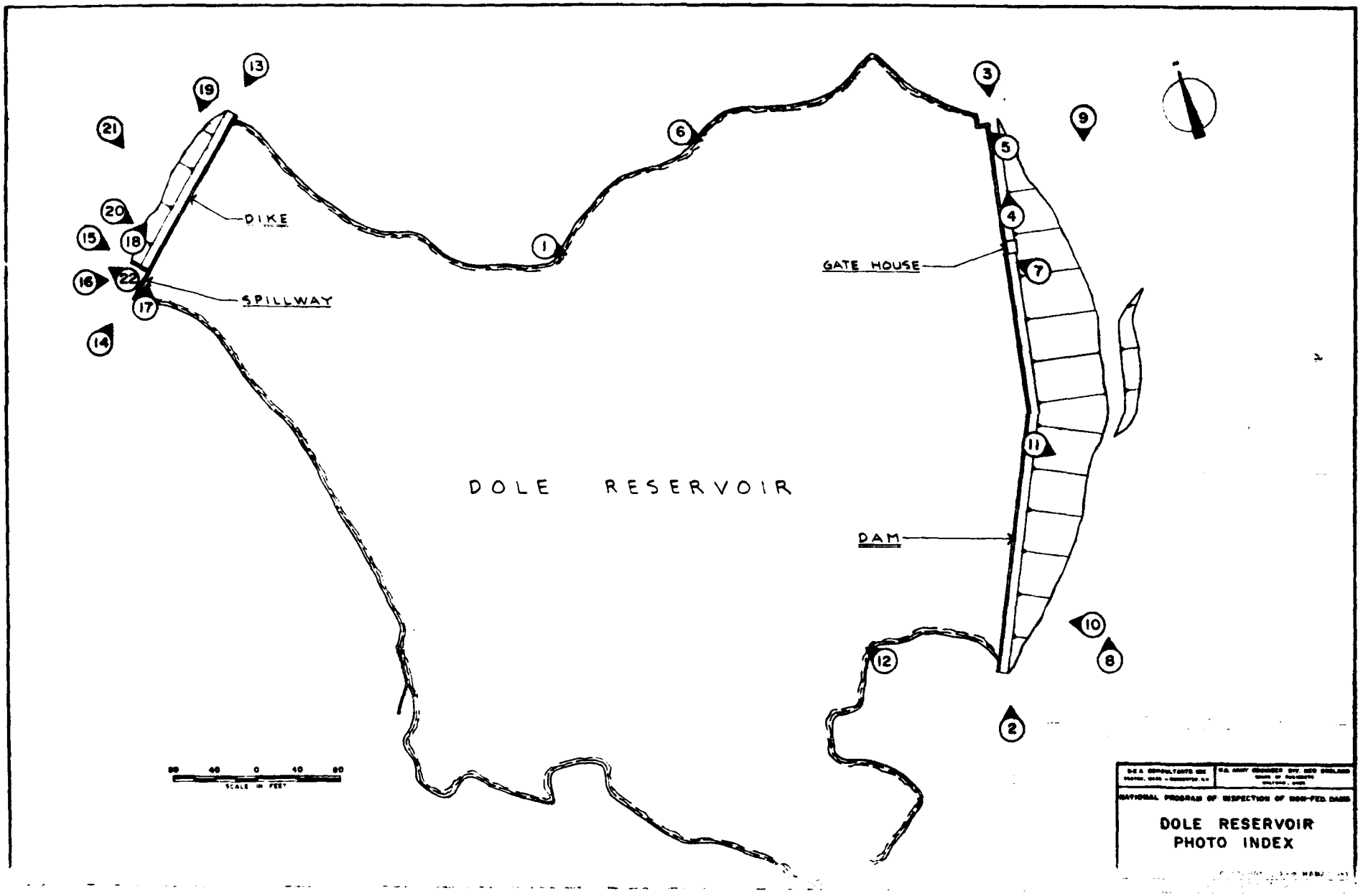


Photo No. 2 - General view of dam from right abutment

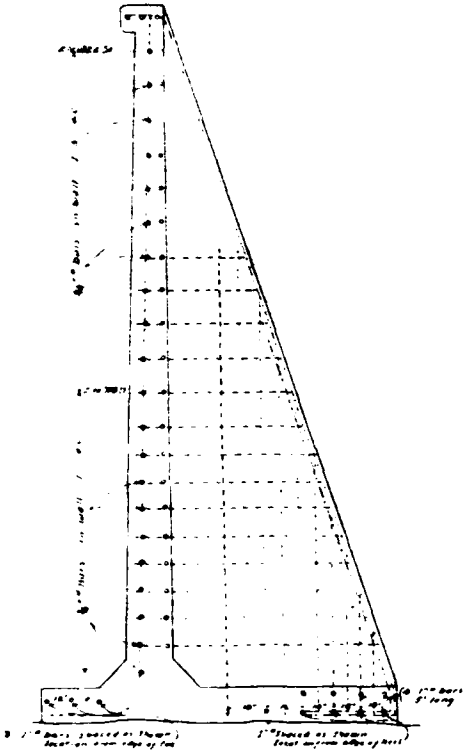
APPENDIX C

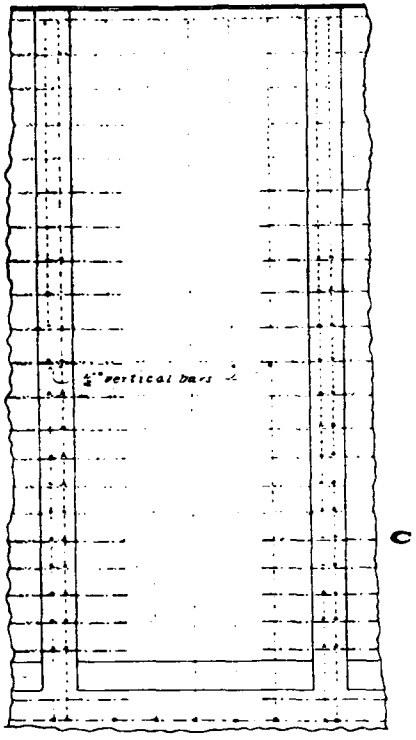
SELECTED PHOTOGRAPHS

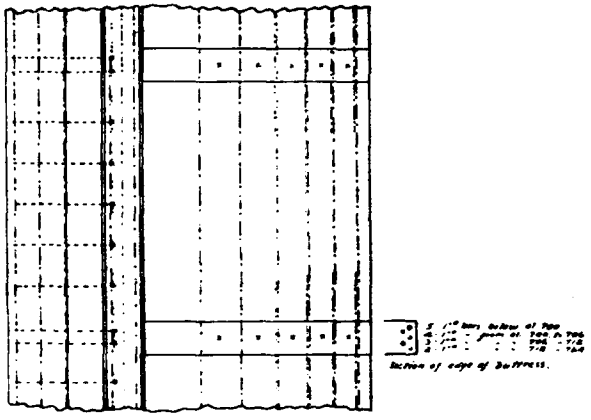


NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

DOLE RESERVOIR
PHOTO INDEX







CLAREMONT WATER WORKS
CLAREMONT, N.H.

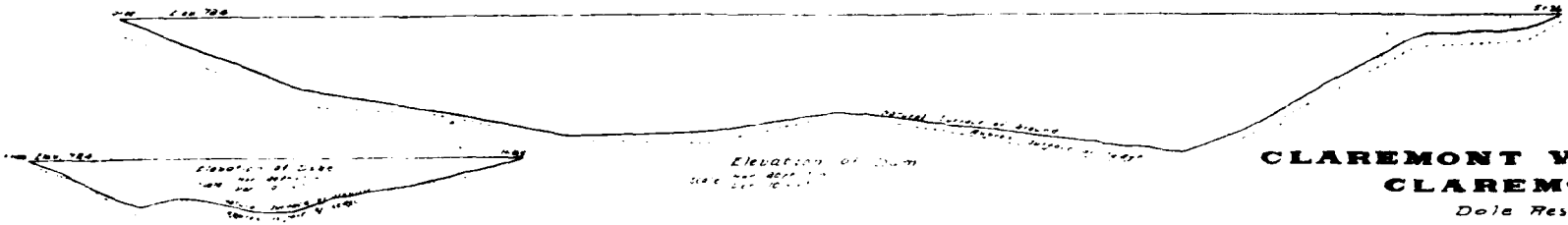
Location of Steel in Dole Reservoir Dam

Scale 8 feet = 1 inch Northampton, Mass. April 1913
E.E. Davis C.E.

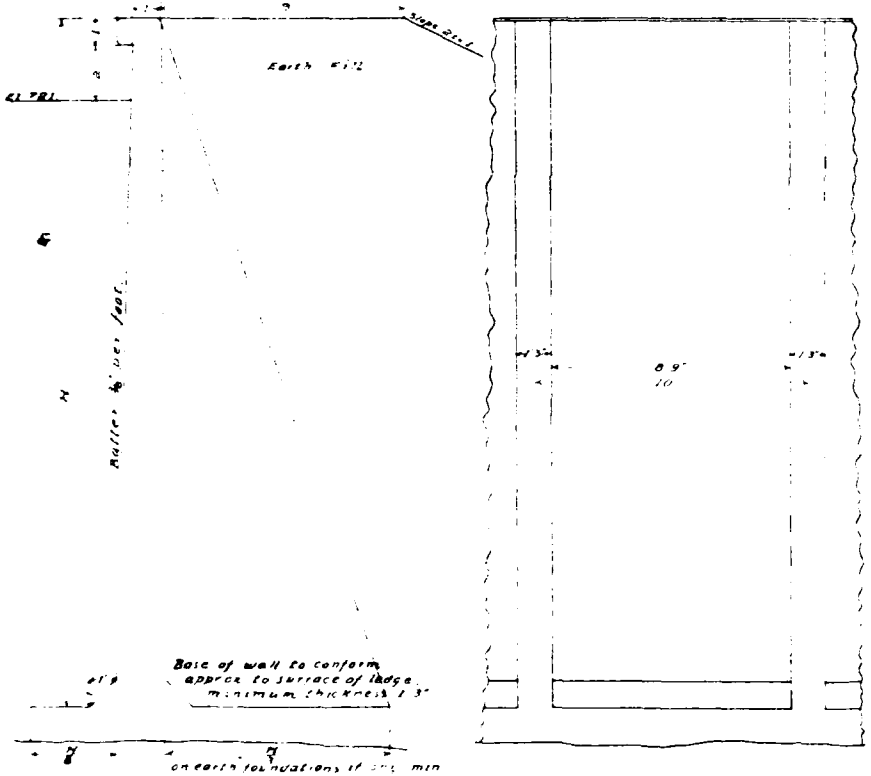
CLAREMONT WATER WORKS
CLAREMONT, N.H.

Dole Reservoir Dam

Northampton, Mass. April 1913
E. E. Davis, Eng.



Elevation of Dam

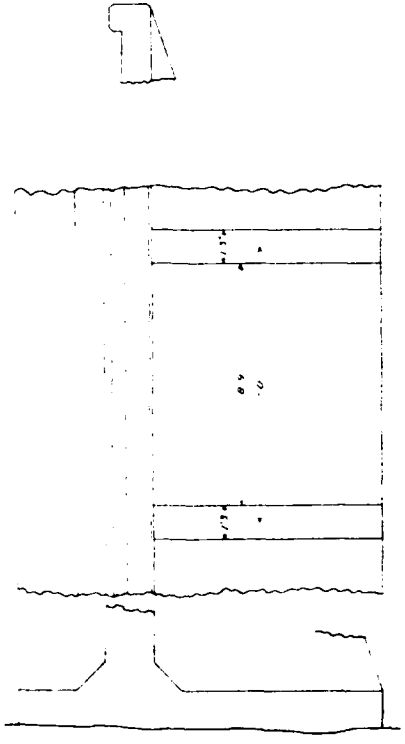


Base of wall to conform approx to surface of ledge minimum thickness 1'-3"

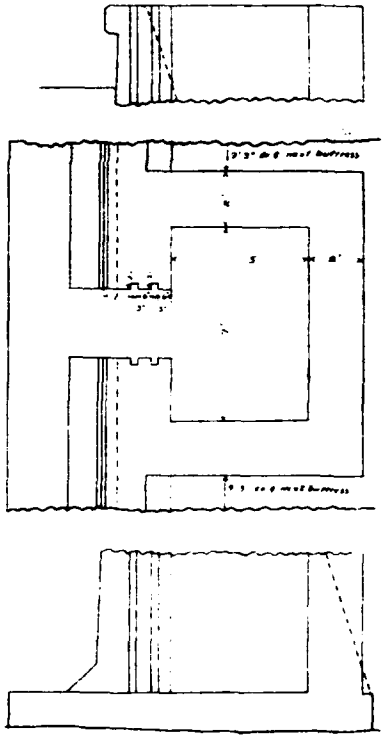
on earth foundations if any min thickness of base & extend main wall as directed

Typical section of counter fort

Elevation of back of wall showing Buttresses



Plan of a section of wall showing Buttresses



Plan of Gate and Screen Wall

REPRODUCED BY GOVERNMENT EXPENSE

Photo No. 21 - View of downstream slope of dike showing standing water in rut at toe of slope.

Photo No. 22 - View of downstream discharge channel from spillway stoplog section.

APPENDIX D
HYDROLOGIC AND HYDRAULIC COMPUTATIONS

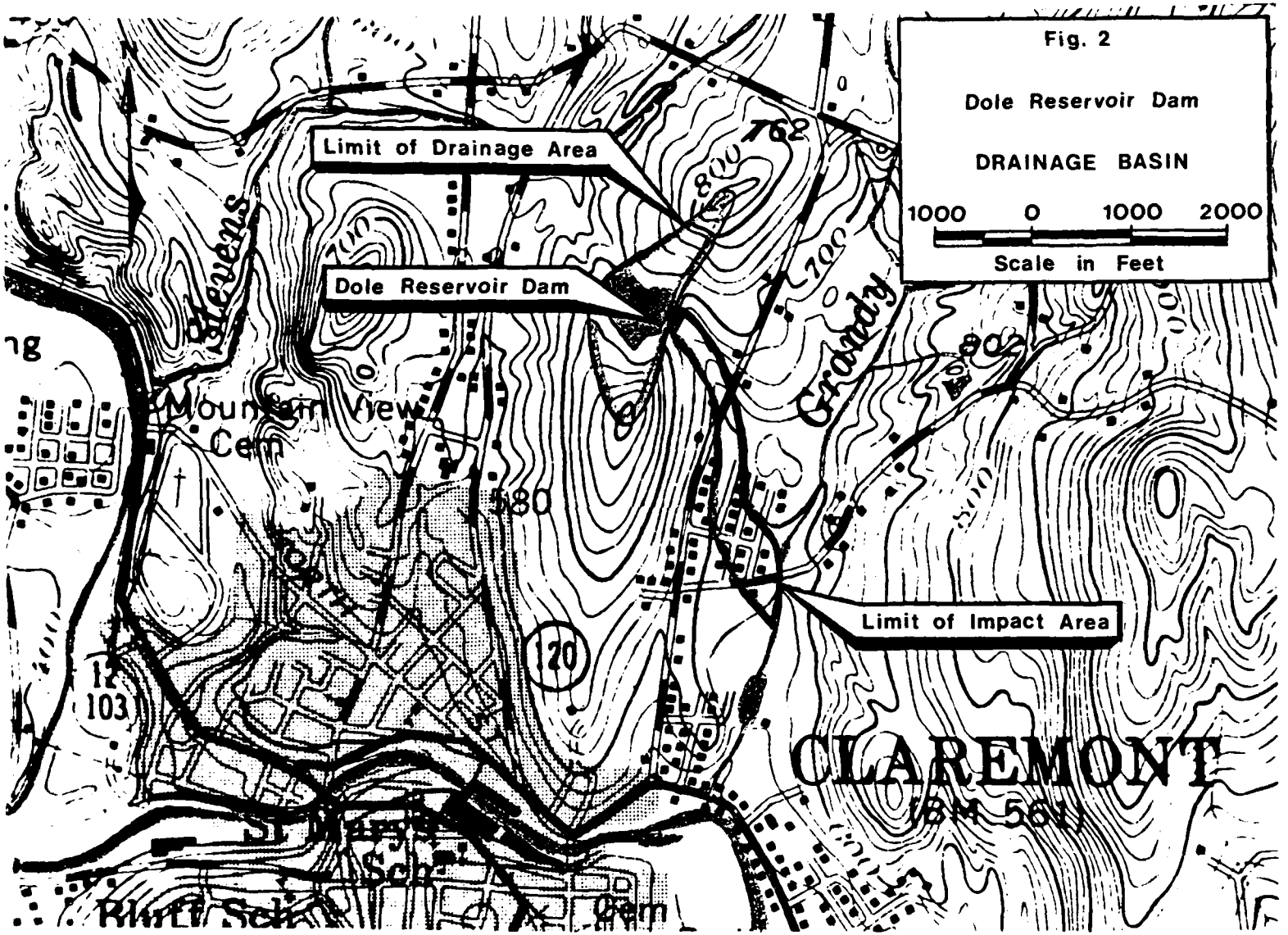


Fig. 2
Dole Reservoir Dam
DRAINAGE BASIN
1000 0 1000 2000
Scale in Feet
Limit of Drainage Area
Dole Reservoir Dam
Limit of Impact Area
Stevens
Mountain View
Cem
Grandy
CLAREMONT
(BM 561)
120
103
580
800
762
700

I. Basic Data

A. Drainage Area

1. 0.049 sq. mi – as defined on U.S.G.S. [illegible] and then planimetered

2. drainage would classify as mountainous for estimating PMF Peak Flow Rates

B. Dam and Storage Information

1. Size Classification: INTERMEDIATE by Height (≥ 40 and < 100)
   Elevation difference between top of dam and downstream toe ≈ 43 feet

2 Hazard Potential: SIGNIFICANT

   a failure of dam could result in extensive destruction of up to 15 homes in residential area below dam, with numerous lives lost, and possible destruction of portions of 6 town streets

3. Storage Information

   Storage vs. depth data for Dole Reservoir was obtained from The Town of Claremont. (Data was included below.) The data looks good, except for the final figure given in the table for "Full to top of Flashboards". To arrive at the storage = sum of 39,000,000 gallons the surface area of the pond would have to decrease as the elevation increases from the top of the new overflow to the top of the flashboards. Consequently, in order to develop storage for elevations above the new spillway, information was extrapolated from the data given for the "Top foot" and the "2nd foot".

a. Photo copy of storage information

Schedule of contents of Dole Reservoir.

Quantities given in Gallons.

Full to top of Flashboards					**38,000,000 galls**
Full to top of new overflow					**37,055,246 "**
Top foot	**2,982,725**	**galls. Down**	**1**	**foot**	**34,072,521 "**
2d	**2,885,425**	**" "**	**2**	**feet**	**31,187,096 "**
3d	**2,788,125**	**" "**	**3**	**"**	**28,398,971 "**
4th	**2,685,380**	**" "**	**4**	**"**	**25,713,591 "**
5th	**2,574,077**	**" "**	**5**	**"**	**23,139,514 "**
6th	**2,465,767**	**" "**	**6**	**"**	**20,673,747 "**
7th	**2,340,462**	**" "**	**7**	**"**	**18,333,285 "**
8th	**2,221,321**	**" "**	**8**	**"**	**16,111,964 "**
9th	**2,018,702**	**" "**	**9**	**"**	**14,093,262 "**
10th	**1,856,832**	**" "**	**10**	**"**	**12,236,427 "**
11th	**1,712,086**	**" "**	**11**	**"**	**10,524,345 "**
12th	**1,574,331**	**" "**	**12**	**"**	**8,950,014 "**
13th	**1,439,930**	**" "**	**13**	**"**	**7,510,084 "**
14th	**1,320,669**	**" "**	**14**	**"**	**6,189,415 "**
15th	**1,199,374**	**" "**	**15**	**"**	**4,990,042 "**
16th	**1,085,139**	**" "**	**16**	**"**	**3,904,903 "**
17th	**973,351**	**" "**	**17**	**"**	**2,931,552 "**
18th	**856,969**	**" "**	**18**	**"**	**2,074,583 "**
19th	**771,387**	**" "**	**19**	**"**	**1,303,196 "**
20th	**565,584**	**" "**	**20**	**"**	**737,612 "**
21st	**307,685**	**" "**	**21**	**"**	**357,957 "**
22d	**215,065**	**" "**	**22**	**"**	**142,892 "**
23d	**108,131**	**" "**	**23**	**"**	**34,757 "**
24th	**34,757**	**" "**	**24**	**"**	**000 "**

b Estimated storage above new spillway (located at dike)

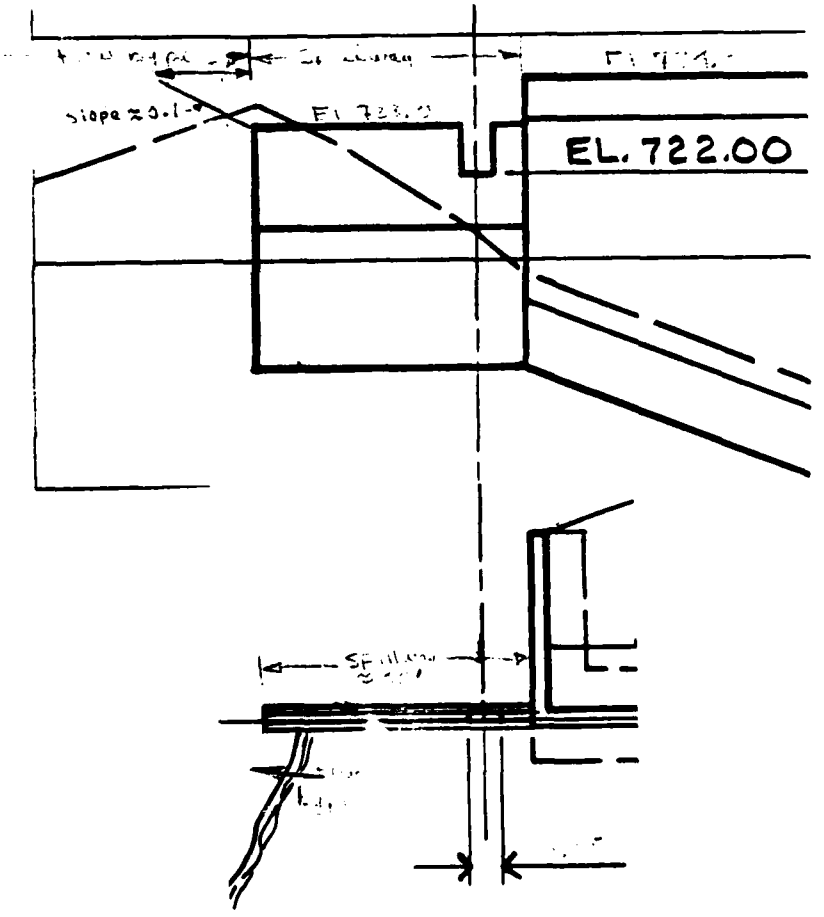
spillway elev. = 722.0 feet (above MSL)

(1) Storage increases by 97,300 gal. from "2nd foot" to "Top foot". Therefore, assume that same increase occurs for each additional foot of depth. Estimated storage as follows:

	Elevation, feet above MSL	Additional Storage, gal	STORAGE gallons	STORAGE acre-ft
	726.0	3,371,925	49,959,146	153
	725.0	3,274,625	46,587,221	143
Top of dam + dike →	724.0	3,177,325	43,312,596	133
	723.0	3,080,025	40,135,271	123
new Spillway crest →	722.0	2,982,725	37,055,246	114
9" stoplogs in place	722.75	3,055,700	40,110,946	123

C Spillway Information

1. Spillway located in dike
2. Permanent spillway consists of a concrete wall approximately 30 feet long (elevation = 723.0 feet - MSL), with a 1.0 ft deep by 3.05' wide stoplog bay (invert elevation 722.0 feet MSL). Above elevation 723.0 water may bypass the end of the spillway structure, thereby increasing the effective weir length of the spillway above elevation 723.0.



Above Elevation 724.0 discharge will occur over both the dam and the dike.

will assume that stoplogs have been removed for surcharge analysis

3. Discharge over spillway given by (broad crest weir formula) – same formula will apply to flow over dike + flow

$$Q = C L H^{3/2}$$ (from Standard Handbook for CE's, Merritt)

where: Q = discharge cfs
C = discharge coeff = 2.6
L = weir length, feet
H = head over weir, feet

II Estimate Surcharge Storage in Maximum Discharge

A. Develop stage-discharge curve for outflow from dike and dam

1. define sources of outflow

a. elevation 722.0 to 723.0 – flow through stoplog bay portion of spillway in dike – assuming stoplogs removed

b. elevation 723.0 to 724.0 – flow over entire spillway in dike including flow bypassing west end of spillway.

c. above elevation 724.0 – flow will occur over crest of the dike and dam.

– stoplog bay outflow –

Elev.	Q cfs	Elev.	Q cfs	Elev.	Q cfs
722.0	0	724.0	22	725.5	52
723.0	8	724.5	31	726.0	65
723.5	15	725.0	41		

3. Spillway outflow

Elevation (feet)	C	L (feet)	H (feet)	Q (cfs)
723.0	—	—	—	0
723.5	2.6	avg 24	0.5	22
724.0	↓	27	1.0	70
724.5	↓	27	1.5	129
725.0	↓	27	2.0	199
725.5	↓	27	2.5	277
726.0	↓	27	3.0	365

4. Flow bypassing spillway

Elevation (feet)	C	L (feet)	H (avg) (feet)	Q (cfs)
723.0	—	—	—	0
723.5	2.6	5	0.25	2
724.0	↓	10	0.5	9
724.5	↓	15	0.75	25
725.0	↓	20	1.0	52
725.5	↓	25	1.25	91
726.0	↓	30	1.5	143

5. Flow over dike and dam

Determination of outflow will be with a single calculation in which L represents the combined length of the dam and dike

4. Flow over dike and dam (continued)

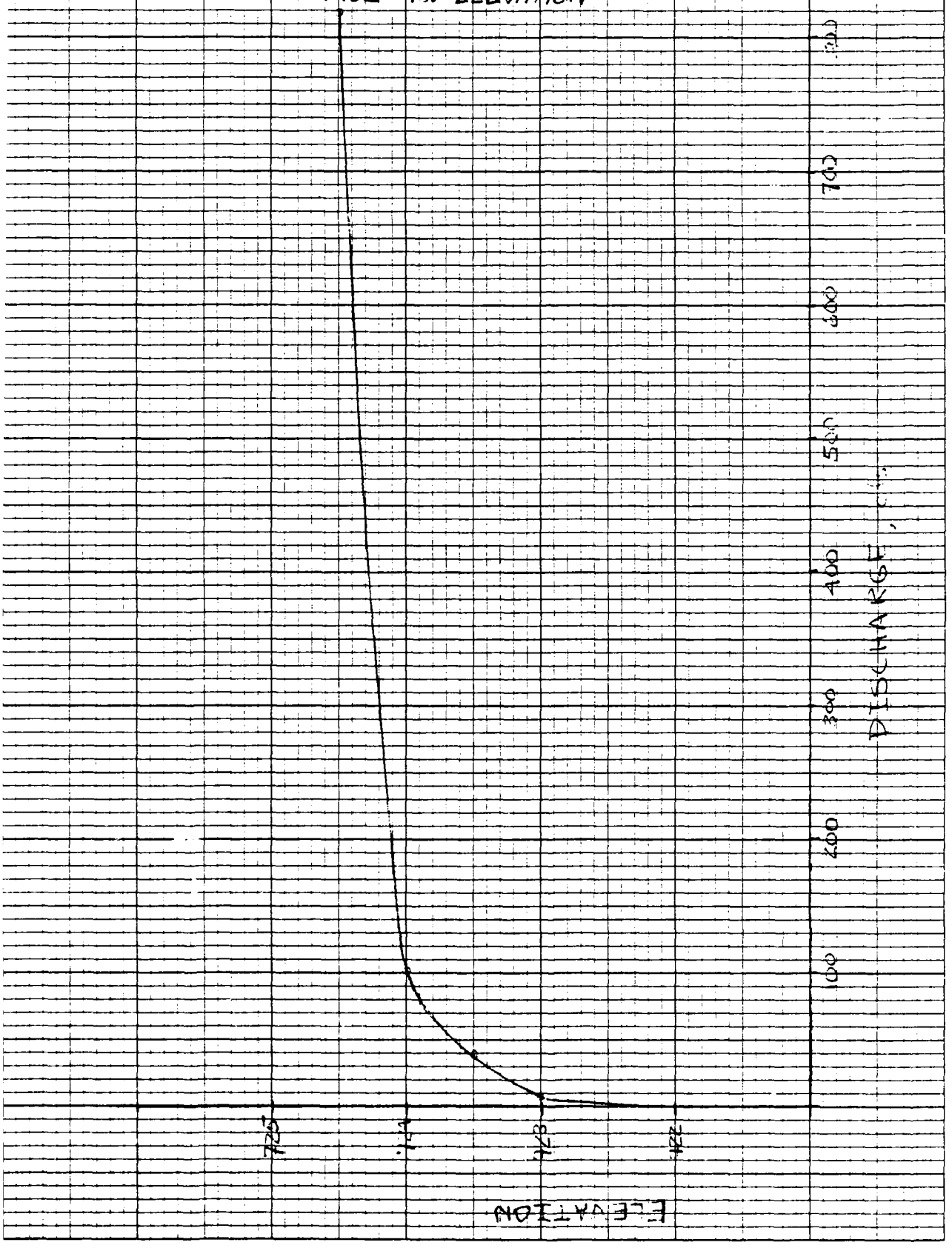
Elevation (feet)	C	Total L (of dam + dike) (feet)	H (feet)	Q (cfs)
724.0	—	—	—	0
724.5	2.6	690	0.5	634
725.0	↓	700	1.0	1820
725.5		710	1.5	3390
726.0		725	2.0	5330

5. Total Outflow - Discharge vs elevation

Elevation	Q stoplog bay	Q Spillway	Q by passing Spillway	Q dike and dam	Q (3 sig. digits) TOTAL
722.0	0	0	0	0	0
723.0	8	0	0	0	8
723.5	15	22	2	0	39
724.0	22	70	9	0	101
724.5	31	129	25	634	819
725.0	41	199	52	1820	2110
725.5	52	277	91	3390	3910
726.0	63	365	113	5330	5900

FIGURE 1

DISCHARGE VS. ELEVATION



Effect of surcharge storage on max. prob. discharge

1. Pertinent Data

   a. Drainage area = 0.049 sq. mi.
   b. Characteristics of basin - mountainous
   c. Test flood = PMF (intermediate size and high hazard)
   d. Follow Army Corps' procedure

2. STEP 1: Determine Peak Inflow Q_{P1} from Guide Curve

   a. the maximum probable discharge was estimated to be 3850 cfs/sq.mi (by extrapolation of Guide Curve)

$$\therefore \text{PMF} = (3850 \text{ cfs/sq.mi})(0.049 \text{ sq.mi})$$

$$= 189 \text{ cfs}$$

3. STEP 2: Determine surcharge height to pass Q_{P1}, $STOR_1$, and Q_{P2}

   a. from Figure 1 determine surcharge height to pass $Q_{P1} = 189$ cfs

surcharge elevation = 724.10

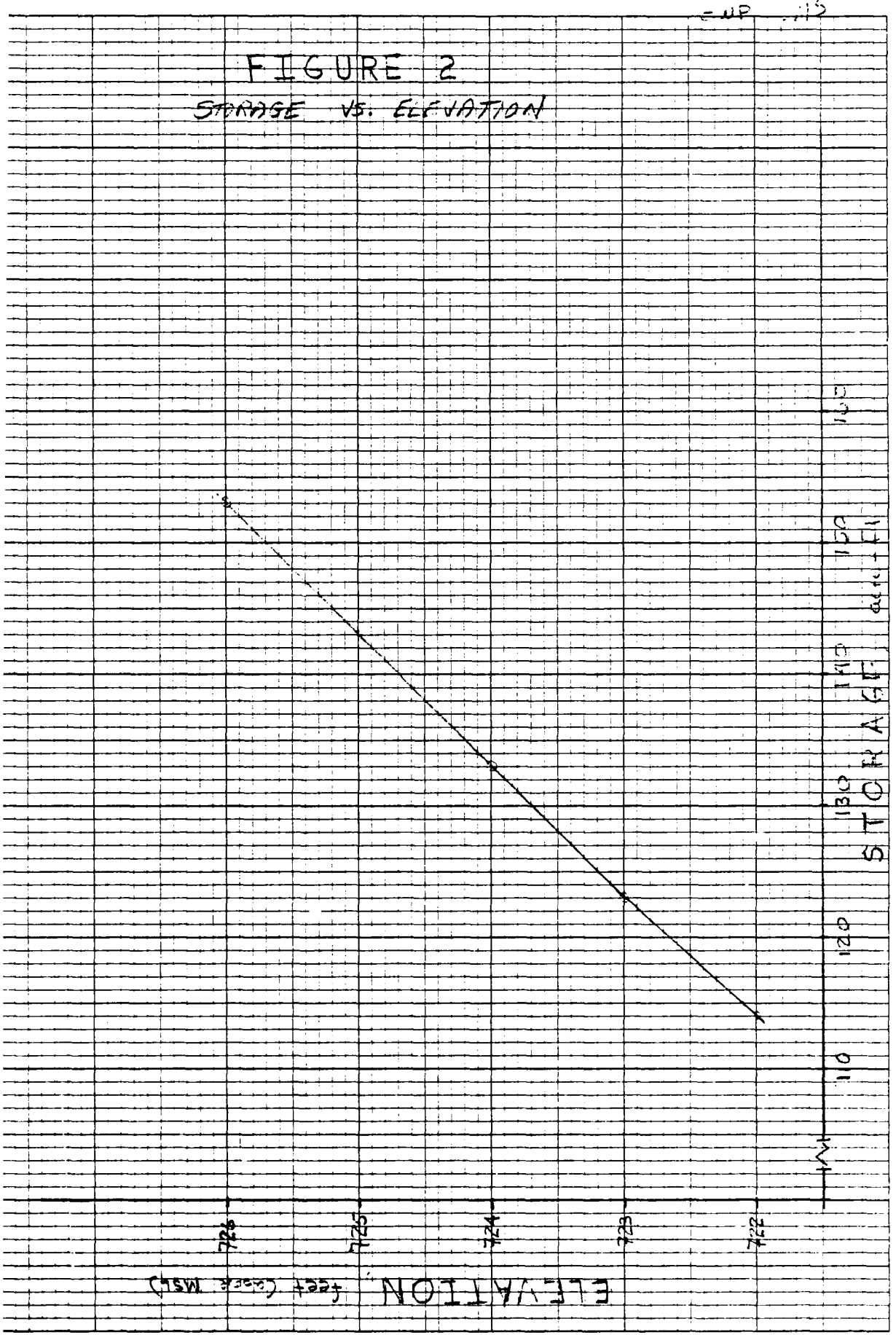
   b. determine volume of surcharge $STOR_1$ in inches of runoff

(1) obtain storage from Figure 2 for surcharge elevation

Reservoir Dam Job # 274-7701

FIGURE 2

STORAGE VS. ELEVATION



(2) storage between elevation 722.0 and 724.10 = difference between storage at elev. 722.0 and 724.10

$$STOR_1 = \frac{\text{Volume of storage (as acre-inches)}}{\text{drainage area}}$$

$$STOR_1 = \frac{(134 \text{ ac-ft} - 114 \text{ ac-ft})(12"/\text{ft})}{(0.049 \text{ sq. mi})(640 \text{ acres/sq. mi})}$$

$$STOR_1 = 7.65 \text{ inches}$$

c. determine Q_{P2}

$$Q_{P2} = Q_{P1}\left(1 - \frac{STOR_1}{19}\right)$$

$$Q_{P2} = (189 \text{ cfs})\left(1 - \frac{7.65}{19}\right)$$

$$Q_{P2} = 113 \text{ cfs}$$

4. STEP 3: Determine surcharge height and $STOR_2$ to pass Q_{P2} and then Q_{P3}

a. From Figure 1 determine surcharge height to pass Q_{P2} =

surcharge elevation = 724.02

Storage at 724.02 is 133.3 acre-ft

b. determine $STOR_2$

$$STOR_2 = \frac{(133.3 \text{ ac-ft} - 114 \text{ ac-ft})(12"/\text{ft})}{(0.049 \text{ sq. mi.})(640 \text{ acres/sq. mi.})}$$

$$= 7.39 \text{ inches}$$

c. Average $STOR_1$ and $STOR_2$

$$STOR_{AVG} = \frac{STOR_1 + STOR_2}{2}$$

$$STOR_{AVG} = \frac{7.65" + 7.39"}{2}$$

$$STOR_{AVG} = 7.52 \text{ inches}$$

d. determine Q_{P3}

$$Q_{P3} = (189 \text{ cfs})\left(1 - \frac{7.52"}{19}\right)$$

$$Q_{P3} = 114 \text{ cfs}$$

5. STEP 4: Determine surcharge height for Q_{P3} and $STOR_3$

a. from Figure 1 surcharge height for Q_{P3} = 112 cfs

surcharge elevation = 724.03

storage at 724.03 is 133.4 acre-ft

b. determine $STOR_3$

$$STOR_3 = \frac{(133.4 \text{ ac-ft} - 114 \text{ ac-ft})(12"/\text{ft})}{(0.049 \text{ sq. mi.})(640 \text{ acres/sq. mi.})}$$

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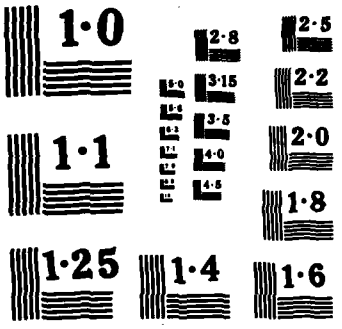

NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

$STOR_3$ = 7.42 inches

c. determine $STOR_{AVG}$

$$STOR_{AVG} = \frac{7.52'' + 7.42''}{2}$$

$STOR_{AVG}$ = 7.47 inches

d. determine Q_{P4}

$$Q_{P4} = (189\ cfs)\left(1 - \frac{7.47}{19}\right)$$

Q_{P4} = 115 cfs

6. STEP 5: Determine surcharge height for Q_{P4} and $STOR_4$

a. From Figure 1 surcharge height for Q_{P4} = 115 cfs

surcharge elevation = 724.04

Storage at 724.04 is 133.5 ac-ft

b. determine $STOR_4$

$$STOR_4 = \frac{(133.5\ ac\text{-}ft - 114\ ac\text{-}ft)(12''/ft)}{(0.049\ sq.\ mi.)(640\ acres/sq.\ mi.)}$$

$STOR_4$ = 7.46 inches

c. determine $STOR_{AVG}$

$$STOR_{AVG} = \frac{7.47'' + 7.46}{2}$$

= 7.47 inches

$STOR_4$ and $STOR_{AVG}$ agree within 1%
Therefore accept $Q = 115$ cfs

7. In Conclusion

a. Test Flood discharge = 115 cfs and will overtop the dam and dike crest by less than 0.1 feet

b. Spillway capacity (stoplogs removed)

(1) at dike (+ dam) crest - elevation 724.0

$Q \approx 92$ cfs

3. at test flood elevation - 724.04

$Q \approx 98$ cfs.

III. Using "Rule of Thumb" Guidance for Estimating Downstream Dam Failure hydrographs examine impact of dam failure

1. Pertinent Data

a. Failure occurs when reservoir level at crest of dam - elevation = 724.0

b. Storage at crest elevation estimated to be approximately 133 acre-ft.

A. Reach 1

1. STEP 1: Determine reservoir storage at time of failure

from previous calcs. storage = 133 acre-ft

2. STEP 2: Determine Peak Failure Outflow (Q_{P_1})

$$Q_{P_1} = 8/27 \; W_b \sqrt{g} \; Y_o^{3/2}$$

where: W_b = Breach width (use 40% of total length)

$= (0.40)(526 \text{ feet})$

≈ 210 feet

Y_o = Total height from channel bed to peak level at failure

≈ 25 feet

$$Q_{P_1} = (8/27)(210 \text{ feet})(32.2)^{1/2}(25 \text{ feet})^{3/2}$$

$$Q_{P_1} = 44,100 \text{ cfs} \checkmark$$

3. STEP 3. Prepare stage-discharge curve for Reach 1

a. Pertinent Data (see Figure 4 for Channel Profile)
(1) Reach length - 500 feet
(2) channel slope - 0.069
(3) Manning n = 0.08
(4) Channel shape - trapezoidal
(5) base width ≈ 20 feet

b. see Figure 3 for stage-discharge curve

4. STEP 4: Estimate Reach Outflow

a. Determine Stage for Q_{P1} = 44,100 cfs from Figure 3 and find volume in reach

(1) Stage (depth of flow) = 16 feet

(2) Volume in reach = (reach length)(cross-sectional area of channel)

$$\text{X-area} = (0.5)(16\text{ ft})(20\text{ ft} + 250\text{ ft})$$
$$= 2160\text{ ft}^2$$

$$\text{Volume} = V_1 = \frac{(500\text{ ft})(2160\text{ ft}^2)}{43{,}560\text{ ft}^2/\text{acre}}$$

$$= 24.8\text{ acre-ft}$$

$V_1 < \frac{S}{2}$ ∴ reach length OK

b determine $Q_{P2(TRIAL)}$

$$Q_{P2(TRIAL)} = Q_{P1}\left(1 - \frac{V_1}{S}\right)$$
$$= 44{,}100\text{ cfs}\left(1 - \frac{24.8\text{ acre-ft}}{133\text{ acre-ft}}\right)$$

$$= 35{,}900\text{ cfs}$$

c. Compute V_2 using $Q_{P2\,(TRIAL)}$

From Figure 3 determine stage for $Q_{P2\,(TRIAL)}$

Stage = 14.7 feet

$$X\text{-area} = (0.5)(14.7\text{ft})(20\text{ft} + 228\text{ft})$$
$$\approx 1823\ \text{ft}^2$$

$$V_2 = \frac{(500\text{ft})(1823\ \text{ft}^2)}{43{,}560\ \text{ft}^2/\text{acre}}$$

$$V_2 = 19.9\ \text{acre-ft.}$$

d. Average V_1 and V_2 and compute Q_{P2}

(1) $$V_{avg} = \frac{V_1 + V_2}{2}$$

$$= \frac{24.8\ \text{acre-ft} + 20.9\ \text{acre-ft}}{2}$$

$$V_{avg} \approx 22.9\ \text{acre-ft}$$

(2) $$Q_{P2} = Q_{P1}\left(1 - \frac{V_{avg}}{S}\right)$$

$$= 44{,}100\ \text{cfs}\left(1 - \frac{229\ \text{acre-ft}}{133\ \text{acre-ft}}\right)$$

$$Q_{P2} = 36{,}500\ \text{cfs}$$

B. Reach 2

1. STEP 3: Prepare stage-discharge curve for Reach 2

a. Pertinent Data
(1) Reach Length - 780 feet
(2) channel slope - 0.069
(3) Manning n = 0.08
(4) channel shape - trapezoidal

(5) base width ≈ 20 feet

b. see Figure 3 for stage-discharge curve
*note stage-discharge curve for Reach 2 is same as for Reach 1

2. STEP 4:

a Determine Stage for Q_{P2} = 36,500 cfs from Figure 3 and volume in reach

(1) Stage = 14.8 feet

(2) Volume in reach

$$V_1 = \frac{(790\,ft)\left[(0.5)(14.8\,ft)(20\,ft + 230\,ft)\right]}{43{,}560\,ft^2/acre}$$

$$V_1 = 33.1 \text{ acre-ft}$$

$V < \frac{S}{2}$ ∴ reach length ok

b. Determine $Q_{P3\,(TRIAL)}$

$$Q_{P3(TRIAL)} = Q_{P2}\left(1 - \frac{V_1}{S}\right)$$

$$= (36{,}500\,cfs)\left(1 - \frac{33.1}{133}\right)$$

$$Q_{P3(TRIAL)} = 27{,}400\,cfs$$

c. Compute V_2 using $Q_{P3(TRIAL)}$

from Figure 3 determine stage for $Q_{P3(TRIAL)}$

Stage ≈ 13.3 feet

$$V_2 = \frac{(790\,feet)\left[(0.5)(13.3\,ft)(20\,ft + 210\,ft)\right]}{43{,}560\,ft^2/acre}$$

V_2 = 27.4 acre-ft

d. Average V_1 and V_2 and compute Q_{P3}

(1) $V_{avg} = \frac{33.1 + 27.4}{2}$

V_{avg} = 30.3 acre-ft

(2) $Q_{P3} = Q_{P2}\left(1 - \frac{V_{avg}}{S}\right)$

$Q_{P3} = (36{,}500 \text{ cfs})\left(1 - \frac{30.3}{133}\right)$

Q_{P3} = 28,200 cfs

C. Reach 3

1. STEP 3: Prepare stage - discharge curve for Reach 3

a. Pertinent Data
(1) Reach Length = 420 feet
(2) Channel Slope ≈ 0.0104
(3) Manning's "n" = 0.08
(4) Channel slope = trapezoidal - side slope channel at channel depth ≈ 6
(5) base width ≈ 20 feet

b. see Figure 3 for stage - discharge curve

2. STEP 4:

a. Determine stage for Q_{P3} = 28,200 cfs from Figure 3 and volume in reach

(1) Stage ≈ 13.1 feet

(2) Volume in reach

$$V_1 = \frac{(420\,ft)\left[(0.5)(6ft)(20ft + 305ft) + (0.5)(7.1ft)(305ft + 430')\right]}{43,560\ ft^2/acre}$$

$$V_1 = 34.6 \text{ acre - ft}$$

$V_1 < \frac{S}{2}$ ∴ reach length ok

b. Determine $Q_{P4\,(TRIAL)}$

$$Q_{P4(TRIAL)} = Q_{P3}\left(1 - \frac{V_1}{S}\right)$$

$$= (28,200\,cfs)\left(1 - \frac{34.6}{133}\right)$$

$$Q_{P4(TRIAL)} = 20,900\ cfs$$

c. Compute V_2 using $Q_{P4(TRIAL)}$

from Figure 3 determine stage for $Q_{P4(TRIAL)}$

Stage ≈ 11.4 feet

$$V_2 = \frac{(420\,ft)\left[(0.5)(6')(20' + 305') + (0.5)(5.4')(305' + 400')\right]}{43,560\ ft^2/acre}$$

$$V_2 = 27.8 \text{ acre-ft.}$$

d. Average V_1 and V_2 and compute Q_{P4}

(1) $V_{avg} = \frac{34.6 + 27.8}{2}$

$V_{avg} = 31.2$ acre-ft

(2) $Q_{P4} = Q_{P3}\left(1 - \frac{V_{avg}}{S}\right)$

$= (28,300\,cfs)\left(1 - \frac{31.2}{133}\right)$

$Q_{P4} = 21,700\ cfs$

D. Reach 4

1. STEP 3 Prepare stage - discharge curve for Reach 4

a. Pertinent Data
(1) Reach Length = 500 feet
(2) Channel cross-section, slope, etc same as Reach 3

b. see Figure 3 for stage - discharge curve - which is same as curve for Reach 3

2. STEP 4

a. Determine stage for Q_{P4} = 21,700 cfs from Figure 3 and volume in reach

(1) stage ≈ 11.6 feet

(2) Volume in reach

$$V_1 = \frac{(500\,ft)\left[(0.5)(6')(20' + 305') + (0.5)(5.6')(305' + 404')\right]}{43{,}560\ ft^2/acre}$$

$$V_1 = 34.0\ acre\text{-}ft$$

$V_1 < \frac{S}{2}$ ∴ reach length OK

b. Determine $Q_{P5(TRIAL)}$

$$Q_{P5(TRIAL)} = Q_{P4}\left(1 - \frac{V_1}{S}\right)$$

$$= (21{,}700\ cfs)\left(1 - \frac{34.0}{133}\right)$$

$$Q_{P5(TRIAL)} = 16{,}200\ cfs$$

c. Compute V_2 using $Q_{P5(TRIAL)}$

from Figure 3 determine Stage for $Q_{P5(TRIAL)}$

stage ≈ 10.3 feet

$$V_2 = \frac{(500\text{ft})\left[(0.5)(4')(20'+305') + (0.5)(4.3')(305'+333')\right]}{43{,}560\ \text{ft}^2/\text{acre}}$$

$V_2 = 28.2$ acre-ft

d. Average V_1 and V_2 and compute Q_{p5}

(1) $V_{avg} = \frac{34.0 + 28.2}{2}$

$V_{avg} = 31.1$ acre-ft

(2) $Q_{p5} = Q_{p4}\left(1 - \frac{V_{avg}}{S}\right)$

$= (21{,}700\text{cfs})\left(1 - \frac{31.6}{133}\right)$

$Q_{p5} = 16{,}600$ cfs

E Reach 5

1. STEP 3 Prepare stage-discharge curve for Reach 5

a. Pertinent Data
(1) Reach Length = 500 feet
(2) Channel slope = 0.0104
(3) Manning n = 0.08
(4) channel shape - trapezoidal
(5) base width ≈ 20 feet

b. see Figure 3 for stage-discharge curve

2. STEP 4

a. Determine stage for Q_{p5} = 16,600 cfs from Figure 3 and volume in reach

(1) stage ≈ 8.5 feet

(2) Volume in reach

$$V_1 = \frac{(500\,ft)\left[(0.5)(8.5\,ft)(20\,ft + 763\,ft)\right]}{43{,}560\ ft^2/acre}$$

$$V_1 = 33.2\ acre\text{-}ft$$

$V_1 < \frac{S}{2}$ ∴ [illegible]

b. Determine $Q_{P6\,(TRIAL)}$

$$Q_{P6\,(TRIAL)} = Q_{P5}\left(1 - \frac{V_1}{S}\right)$$

$$= (16{,}600\ cfs)\left(1 - \frac{33.2}{132}\right)$$

$$Q_{P6\,(TRIAL)} = 11{,}800\ cfs$$

c. Compute V_2 using $Q_{P6\,(TRIAL)}$

from Figure 3 determine stage for $Q_{P6(TRIAL)}$

Stage ≈ 7.5 feet

$$V_2 = \frac{(500\,ft)\left[(0.5)(7.5\,ft)(20\,ft + 563\,ft)\right]}{43{,}560\ ft^2/acre}$$

$$V_2 = 26.2\ acre\text{-}ft$$

d. Average V_1 and V_2 and compute Q_{P6}

(1) $V_{avg} = \frac{33.2 + 26.2}{2}$

$V_{avg} = 32.2\ acre\text{-}ft$

(2) $Q_{P6} = Q_{P5}\left(1 - \frac{V_{avg.}}{S}\right)$

$$Q_{P6} = (16,700 \text{ cfs})\left(1 - \frac{32.3}{133}\right)$$

$$Q_{P6} = 12,700 \text{ cfs}$$

Reach 6

1. STEP 3 Prepare stage - discharge curve for reach

a. Pertinent Data
   (1) Reach length = 500 feet
   (2) channel cross-section, slope, etc same as Reach 5

b see Figure 3 for stage - discharge curve - same as that for reach 5

2. STEP 4

a Determine stage for $Q_{P6} = 12,700$ cfs from Figure 3 and volume in reach

   (1) stage ≈ 7.7 feet

   (2) Volume in reach

$$V_1 = \frac{(500 \text{ ft})\left[(0.5)(7.7 \text{ ft})(20 \text{ ft} + 69.3 \text{ ft})\right]}{43,560 \text{ ft}^2/\text{acre}}$$

$$V_1 = 31.5 \text{ acre-ft}$$

$V < \frac{S}{2}$ ∴ reach length OK

b. Determine $Q_{P7\,(TRIAL)}$

$$Q_{P7(TRIAL)} = Q_{P6}\left(1 - \frac{V_1}{S}\right)$$

$$Q_{P7\,(TRIAL)} = (12{,}700\ cfs)\left(1 - \frac{31.5}{133}\right)$$

$$Q_{P7\,(TRIAL)} = 9{,}690\ cfs$$

c. Compute V_2 using $Q_{P7\,(TRIAL)}$

from Figure 3 determine stage for $Q_{P7(TRIAL)}$

Stage ≈ 6.9 feet

$$V_2 = \frac{(500\ ft)\left[(0.5)(6.9\ ft)(20\ ft. + 622\ ft.)\right]}{43{,}560\ ft^2/acre}$$

$$V_2 = 25.4\ acre\text{-}ft$$

d. Average V_1 and V_2 and compute Q_{P7}

(1) $V_{avg} = \frac{31.5 + 25.4}{2}$

$V_{avg} = 28.5\ acre\text{-}ft$

(2) $Q_{P7} = Q_{P6}\left(1 - \frac{V_{avg}}{S}\right)$

$$Q_{P7} = (12{,}700\ cfs)\left(1 - \frac{28.5}{133}\right)$$

$$Q_{P7} = 9{,}980\ cfs$$

FIGURE 3
STAGE-DISCHARGE CURVES

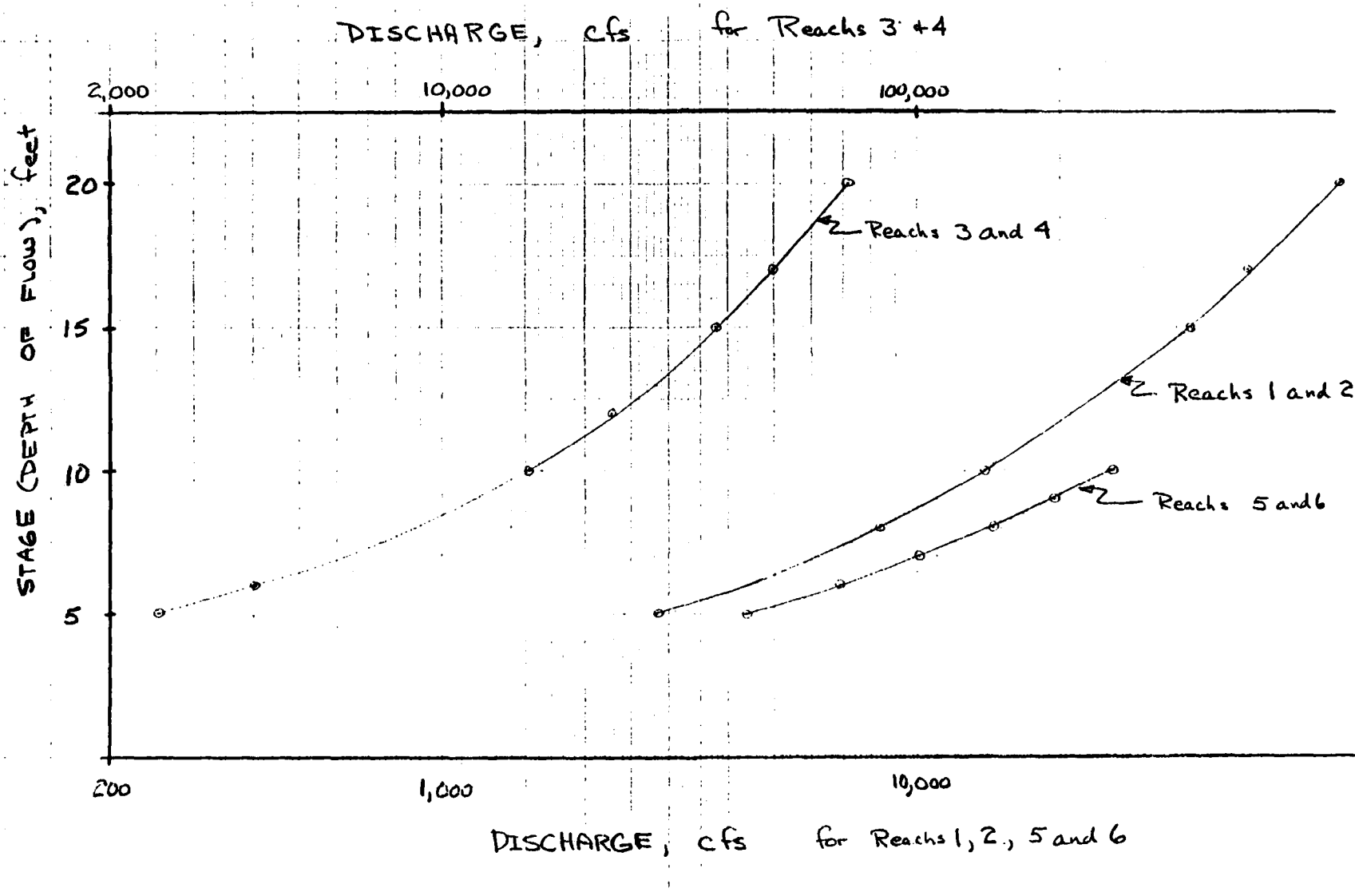

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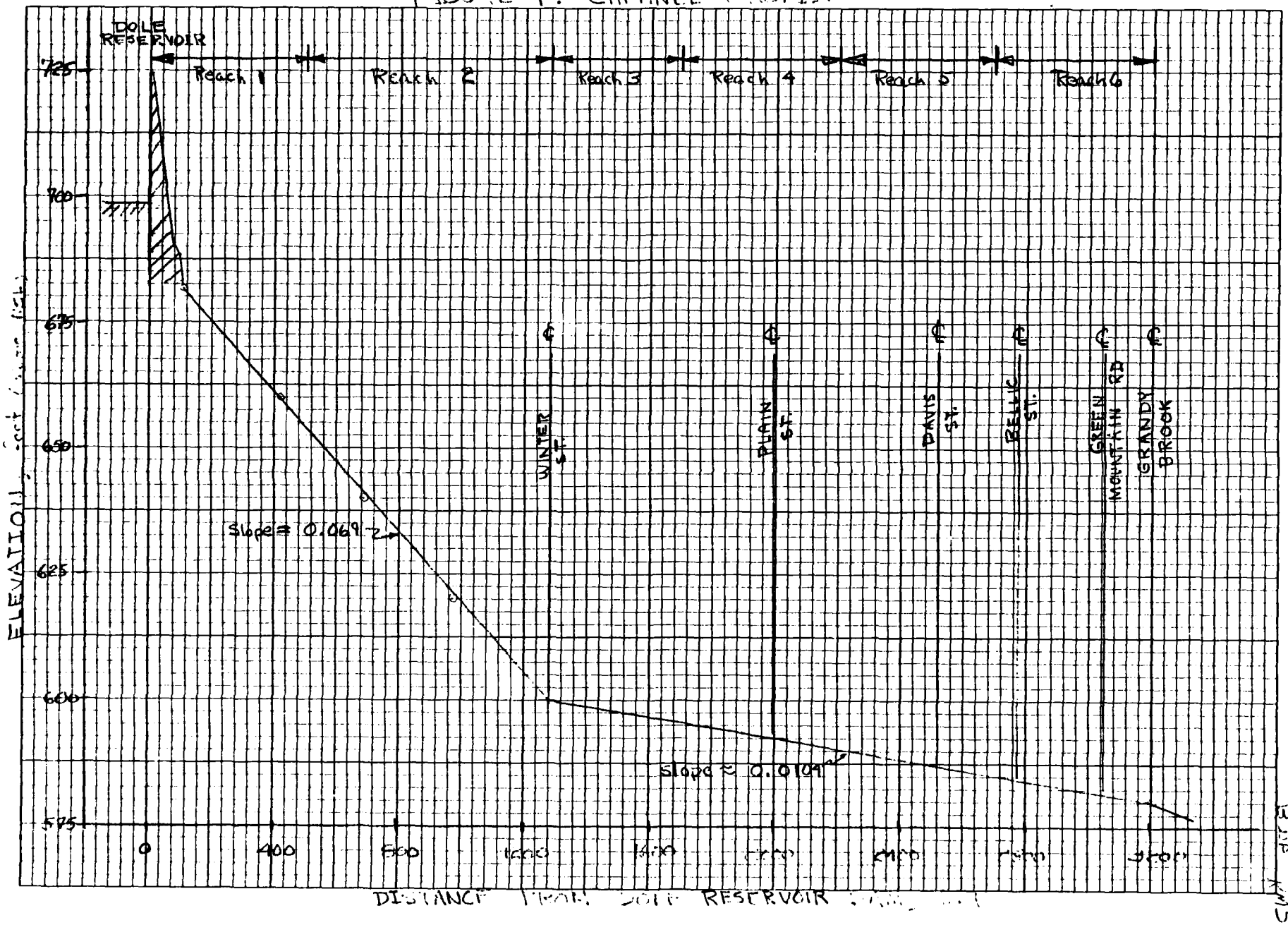
FIGURE 4: CHANNEL PROFILE



DOME RESERVOIR DAM Job # 274-7901

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