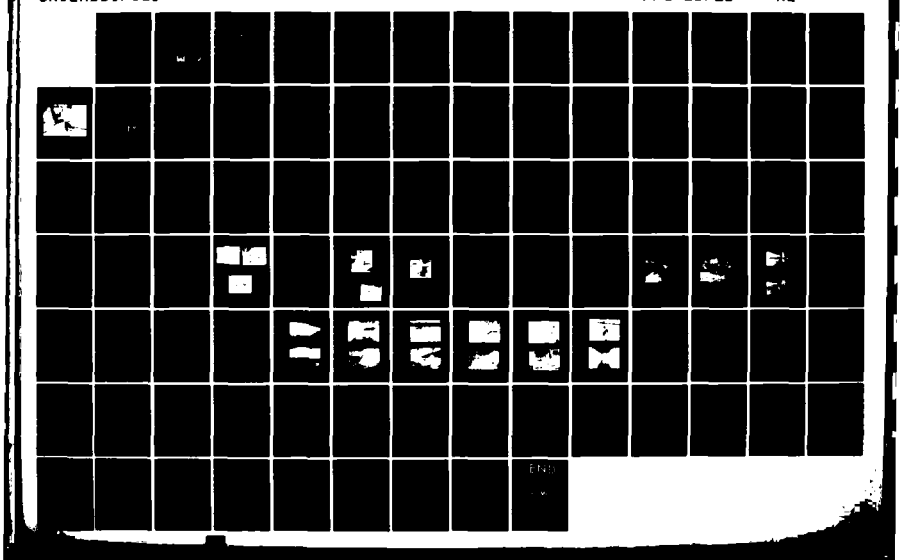
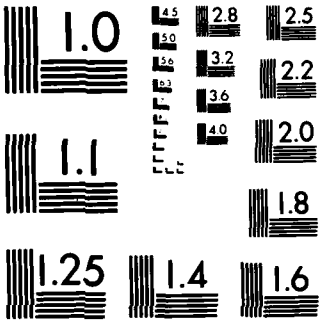
AD-A156 454 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 1/1
UNCANOONUC LAKE DAM N.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV JUN 80

UNCLASSIFIED F/G 13/13 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD-A156 454

MERRIMACK RIVER BASIN

GOFFSTOWN, NEW HAMPSHIRE

UNCANOONUC LAKE DAM #2

NH 00021

NHWRB NO. 93.04

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

Copy available to DTIC does not permit fully legible reproduction

DTIC
ELECTE
JUL 05 1985
S
B
G
D

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

DTIC FILE COPY

JUNE 1980

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution unlimited

85 06 10 085

REPRODUCED AT GOVERNMENT EXPENSE

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NH 00021	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Uncanoonuc Lake Dam #2 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE June 1980 13. NUMBER OF PAGES 60
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

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

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

DAMS, INSPECTION, DAM SAFETY,
Merrimack River Basin
Goffstown, New Hampshire
Dan Little Brook

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

The dam is an earthen embankment structure with a central concrete core wall about 147 ft. in overall length and 9 ft. high from the crest of the dam to downstream toe. The dam is considered to be in fair condition. It is classified as small in size and significant in its hazard classification.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

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

REPLY TO
ATTENTION OF
NEDED

JUL 23 1980

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 Uncanoonuc Lake Dam No. 2 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, Goffstown Conservation Commission, Town Hall, 16 Main Street, Goffstown, New Hampshire.

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

UNCANOONUC LAKE DAM #2
NH 00021
NHWRB 93.04

MERRIMACK RIVER BASIN
GOFFSTOWN, NEW HAMPSHIRE

Accession For
NTIS GRA&I
DTIC TAB
Unannounced
Justification
By
Distribution/
Availability Codes
Dist | Avail and/or Special
A/1 | 24

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No: NH 00021

Name of Dam: Uncanoonuc Lake Dam #2

Town: Goffstown

County and State: Hillsborough, New Hampshire

Stream: Dan Little Brook

Date of Inspection: December 13, 1979

Uncanoonuc Lake Dam #2 is an earthen embankment structure with a central concrete core wall about 147 feet in overall length and 9 feet high from crest of dam to downstream toe. Located approximately in the center of the dam is the principal spillway which consists of a 16.1 feet long by 1.6 feet deep stoplog bay cast into the top of the concrete core wall.

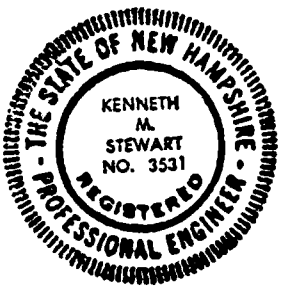
The dam impounds Uncanoonuc Lake and the discharge flows through Dan Little Brook in a northeasterly, then northerly direction approximately 2.0 miles to the Piscataquog River. The dam was originally constructed for, and still serves, recreational purposes. The lake is 0.32 miles in length with a surface area of about 23.9 acres. The maximum storage capacity is about 161 acre feet.

As a result of the visual inspection of this facility, the dam is considered to be in FAIR condition. Major concerns are: downstream tilt of the concrete core wall with large vertical cracks and spalling; lack of erosion protection on the embankment and the right abutment; trees which are partially buried in the earthfill on the downstream slope; seepage at the downstream toe of the dam; and lack of a low level regulating outlet that would allow drawdown of the lake in an emergency.

The dam is classified as SMALL in size and a SIGNIFICANT hazard structure in accordance with the recommended guidelines established by the Corps of Engineers. The test flood for this dam therefore, ranges from a 100-year flood to one-half the Probable Maximum Flood (1/2 PMF). Since the dam falls on the lower end of the small size range, the 100-year flood was utilized for this hydrologic analysis. The test flood inflow was estimated to be 215 cfs and resulted in a routed test flood outflow equal to 86 cfs which would not overtop the dam crest. The maximum spillway discharge capacity with the reservoir surface at the dam crest was estimated to be 85 cfs which is nearly 100 percent of the routed test flood outflow. An assumed breach with the reservoir surface at the dam crest could damage the permanent residence located directly behind the dam and would overtop two town roads located downstream of the dam.

It is recommended that the owner engage a qualified registered professional engineer to: investigate the structural stability of the tilted and cracked concrete core wall; design and specify erosion protection for the upstream and downstream slopes of the embankment and the right abutment; specify and oversee procedures for the removal of trees and their root systems from the downstream slope of the dam and the left abutment; investigate the seepage at the downstream toe of the dam; and assess the need for and means to provide a low level regulating outlet that would allow drawdown of the pond in an emergency.

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 Uncanoonuc Lake Dam No. 2 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.

RICHARD DIBUONO, MEMBER
Water Control Branch
Engineering Division

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, CHAIRMAN
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

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

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

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

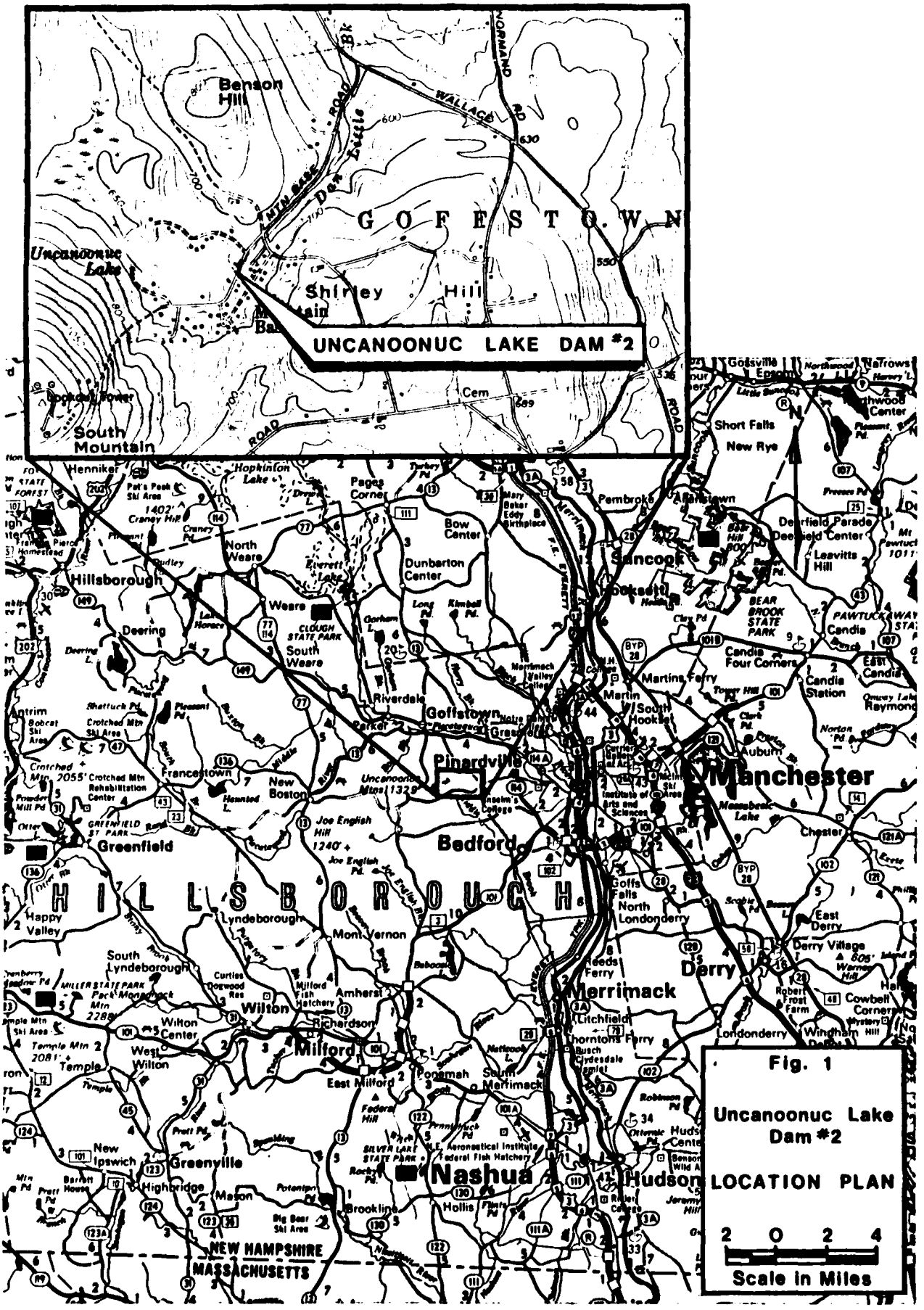
Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because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

rarity of such a storm event, 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.

TABLE OF CONTENTS

OVERVIEW PHOTO - UNCANOONUC LAKE DAM #2


UNCANOONUC LAKE DAM #2
Benson Hill
Uncanoonuc Lake
Shirley Hill
South Mountain
GOFFSTOWN
HILLSBOROUGH
Manchester
Nashua
Bedford
Merrimack
Derry
Londonderry
Hudson
Goffstown
Pinardville
Milford
Amherst
Wilton
Greenville
Mont Vernon
Lyndeborough
Francestown
New Boston
Greenfield
Hillsborough
Weare
Dunbarton Center
Bow Center
Pembroke
Suncook
Allenstown
Short Falls
New Rye
Candia
Auburn
Chester
East Derry
Derry Village
Litchfield
Hollis
Brookline
Mason
Temple
Peterborough
NEW HAMPSHIRE
MASSACHUSETTS
Fig. 1
Uncanoonuc Lake
Dam #2
LOCATION PLAN
2 0 2 4
Scale in Miles

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
UNCANOONUC LAKE DAM #2

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-C-0008 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. Uncanoonuc Lake Dam #2 is located in the Town of Goffstown, New Hampshire, at the east end of Uncanoonuc Lake. The dam impounds water from Uncanoonuc Lake and the spillway discharge flows in a northeasterly, then northerly direction through Dan Little Brook for about 2.0 miles until it discharges into the Piscataquog River. The dam is shown on U.S.G.S. Quadrangle, Pinardville, New Hampshire, with coordinates approximately at N42°59'19", W71°34'41", Hillsborough County, New Hampshire (see Location Plan).

b. Description of Dam and Appurtenances. Uncanoonuc Lake Dam #2 is an earthen embankment structure with a central concrete core wall about 147 feet in overall length and 9 feet high from crest of dam to downstream toe. The upstream face consists of a sand and gravel fill which extends from the top of

the core wall down approximately 1 foot vertical to 10 feet horizontal (1:10) to wood logs at the edge of the lake. The downstream slope consists of a sand and gravel fill that crests about 1.5 feet lower than the top of the core wall and slopes downward approximately 1 foot vertical to 9 feet horizontal (1:9) for about nine feet and then slopes one foot vertical to 2.5 feet horizontal (1:2.5) to old ground. The crest of the core wall is about 22 inches wide.

Located approximately in the center of the dam is the principal spillway which consists of a 16.1 feet long by 1.6 feet deep stoplog bay cast into the top of the concrete core wall. A concrete apron equal to the width of the spillway extends downstream from the stoplog bay about 11.0 feet to a riprap slope which extends about 12 feet at a slope of approximately 1 foot vertical to 2 feet horizontal (1:2) to the existing stream channel.

Located at the opposite end of the lake from Uncanoonuc Lake Dam #2 is a second dam (Uncanoonuc Lake Dam #1, NH 00489). Uncanoonuc Lake Dam #1 functions as a dike as there is no apparent point of discharge. Uncanoonuc Lake Dam #1 has been classified low hazard by the New Hampshire Water Resource Board.

c. Size Classification. Small (height - 9 feet, storage 161 acre-feet) based on storage (less than 1,000 acre-feet and greater than or equal to 50 acre-feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant hazard. An assumed breach in Uncanoonuc Lake Dam #2 could result in damage to the permanent residence located directly behind the dam. The discharge emanating from the failed dam would be at the sill level and could undermine the foundation, which is exposed along the stream channel, causing appreciable damage to the structure. The potential for the loss of less than a few lives of residents inhabiting this structure exists. The water surface in the small pond immediately below the dam would rise approximately 9 feet, and the town roads adjacent to this pond would be overtopped. The first roadway below the dam would be overtopped by about 6 feet, and the second by approximately 4 feet.

e. Ownership. The earliest structure of the dam was built in 1921 and owned by the Uncanoonuc Mountain Incline Railway Company. The core wall and upstream face of the dam is presently owned by the town of Goffstown, Conservation Commission, Town Hall, 16 Main Street, Goffstown, New Hampshire 03045. Telephone No. (603) 497-3613. The downstream slope is owned by Fran Blazon, Mountain Base Road, Goffstown, New Hampshire 03045. Telephone No. (603) 497-3681. Also, the town of Goffstown owns a 20 foot wide right-of-way centered on the dam.

f. Operator. The dam is maintained and operated by the town of Goffstown, Town Hall, 16 Main Street, Goffstown, New Hampshire 03045. Telephone No. (603) 497-3613.

g. Purpose of Dam. The dam was originally constructed for, and still serves, recreational purposes.

h. Design and Construction History. A plan dated 1921 showing plan and profiles for dams to be constructed on the lake, prepared by H. W. Sawyer, Professional Engineer, Goffstown, New Hampshire, is on file at the State of New Hampshire Water Resources Board. This plan indicates that the original dam was built of stone with a wood plank apron on the upstream slope. It is not known when the present concrete core wall dam was built to replace the stone dam, but plans on file at the State of New Hampshire Water Resources Board, dated 1936 and prepared by L. H. Shattuck, Inc., Manchester, New Hampshire 03101, for repairs to another dam on the lake use the core wall as a datum and indicate it to be constructed of concrete. Photos on file at the State of New Hampshire Water Resources Board verify the concrete core wall dam to be in existence by 1936.

Records at the State of New Hampshire Water Resources Board indicate that fill around the concrete core wall was washed out during the 1936 flood, and repairs were made shortly thereafter. There are no records of any further construction or repair to the dam since that time.

i. Normal Operating Procedure. Uncanoonuc Lake Dam #2 is used primarily to retain the waters of Uncanoonuc Lake for recreational purposes. There is no written operating procedure for this dam. However, the condition of the stop log slots (See Photo No. 6) shows that installation of stop logs is not part of the normal operating procedure.

1.3 Pertinent Data

a. Drainage Area. The drainage area above Uncanoonuc Lake Dam #2 covers nearly 0.26 square miles (approximately 166 acres), consisting of steeply sloping terrain surrounding Uncanoonuc Lake. The topography in the drainage basin ranges from over 1310 feet (NGVD) on top of South Mountain to approximately 648 feet at the base of the dam. The majority of the basin is heavily wooded and undeveloped. The development which does exist is predominantly located near the lake and consists of a combination of year-round and summer housing.

b. Discharge at Damsite. Discharge at the dam occurs over the 16.1 feet long spillway. Other than the spillway, there are no regulating outlets which would allow the surface of the lake to be lowered below the level of the spillway crest.

(1) Outlet Works - N/A

(2) Maximum known flood at damsite - unknown

(3) The ungated spillway capacity with the water surface elevation at the top of the dam (elevation 656.6 feet) was estimated to be 85 cfs.

(4) The ungated spillway capacity with the water surface elevation at the test flood elevation (elevation 656.6 feet) was estimated to be 85 cfs.

(5) Gated spillway capacity at normal pool elevation - N/A

(6) Gated spillway capacity at test flood elevation - N/A

(7) The total spillway capacity at the test flood elevation (elevation 656.6 feet) was estimated to be 85 cfs.

(8) The total project discharge at the top of the dam (elevation 656.6 feet) was estimated to be 85 cfs.

(9) The total project discharge at the test flood elevation (elevation 656.6 feet) was estimated to be 85 cfs.

c. Elevation. (feet, NGVD) based on an elevation of 655.0 feet, extrapolated from U.S.G.S. quadrangle sheet and assumed to be the pool elevation at the spillway crest.

(1) Streambed at toe of dam - 647.6

(2) Bottom of cutoff - Unknown

(3) Maximum tailwater - Unknown

(4) Normal pool - 655.0

(5) Full flood control pool - N/A

(6) Spillway crest - 655.0 (stoplogs removed)
656.6 (stoplogs in place)

(7) Design surcharge (Original Design) - Unknown

(8) Top of dam - Elevation varies - 656.6 minimum

(9) Test flood surcharge - 656.6

d. Reservoir (Length in feet)

(1) Normal pool - 1680

(2) Flood control pool - N/A

(3) Spillway crest pool - 1680

(4) Top of dam - 1680

(5) Test flood pool - 1680

e. Storage (acre-feet)

(1) Normal pool - 120

(2) Flood control pool - N/A

(3) Spillway crest pool - 120

(4) Top of dam - 161

(5) Test flood pool - 161

f. Reservoir Surface (acres)

(1) Normal pool - 23.9

(2) Flood-control pool - N/A

(3) Spillway crest pool - 23.9

(4) Top of dam - 26.8

(5) Test flood pool - 26.8

g. Dam

(1) Type - earth embankment with central concrete core wall

(2) Length - 147 feet overall

(3) Height - 9 feet (maximum)

(4) Top width - core wall 22 inches wide at crest

(5) Side slopes - Upstream 1V to 10H to edge of lake
downstream 1V to 9H and 1V to 2.5H.

(6) Zoning - Unknown

(7) Impervious core - concrete wall

(8) Cutoff - Unknown

(9) Grout curtain - None

(10) Other - None

h. Diversion and Regulating Tunnel Not applicable (See Section j)

i. Spillway

(1) Type - Concrete stoplog bay

(2) Length of weir - 16.1 feet

(3) Crest elevation - 655.0 (stoplogs removed)
656.6 (stoplogs in place)

(4) Gates - None

(5) U/S Channel - The upstream approach channel to the spillway is wide and unobstructed. The channel slopes are tree covered and appear to be stable.

(6) D/S Channel - The spillway discharges into a natural stream channel at the toe of the dam. Approximately 115 feet downstream from the dam this discharge passes through a roadway culvert into a small pond. This pond is created by a roadway located approximately 530 feet below the dam. A few small trees overhang the portion of the channel between the dam and the first roadway culvert.

j. Regulating Outlets. There is no low level regulating outlet incorporated into the dam that would allow drawdown of the lake in an emergency.

SECTION 2
ENGINEERING DATA

2.1 Design

No design data were found for the existing structure of Uncanoonuc Lake Dam #2.

2.2 Construction

No construction records were found.

2.3 Operation

No engineering operational data were found.

2.4 Evaluation

a. Availability. No engineering data were available for Uncanoonuc Lake Dam #2. A search of the files of the New Hampshire Water Resources Board and direct contact with the owners revealed a limited amount of recorded information.

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

c. Validity. No engineering data were found to validate.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Uncanoonuc Lake Dam #2 impounds a lake of small size. The drainage area above the dam consists of steeply sloped terrain. The majority of the basin is heavily wooded and generally undeveloped. The development which does exist is predominantly located near the lake. The immediate downstream channel is predominantly undeveloped.

The field inspection of Uncanoonuc Lake Dam #2 was made on December 13, 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, no stop logs were in place and water was passing approximately 1-1/4 inches deep over the 16.1 foot wide spillway. The pool elevation was at approximately 655.1 NGVD. The upstream face of the dam could only be inspected above this water level.

b. Dam. Uncanoonuc Lake Dam #2 is an earthen embankment structure with a central concrete core wall about 147 feet in overall length and 9 feet high from crest of dam to downstream toe.

The concrete core wall is tilted downstream on a batter of about 1 foot horizontal to 4 feet vertical (1H:4V) and has three large vertical cracks along its length and is spalled at several locations. From the visual examination alone, it is not possible to determine the cause of the tilting.

The earthfill on the upstream side of the core wall is sand and gravel and its crest is at the same elevation as the top of the concrete core wall. Some logs have been placed along the waterline on the upstream slope at approximately the elevation of the spillway crest, apparently for the purpose of retaining the earthfill above that elevation or providing erosion protection. The logs are not in a regular alignment and do not effectively serve either of these purposes today. One bush is growing on the upstream slope of the earthfill. There is no grassy vegetation, riprap, or other erosion protection on the upstream slope.

The earthfill on the downstream side of the core wall is sand and gravel and its crest is about 1.5 feet lower than the top of the concrete core wall. Most of the downstream slope is bare of vegetation. Some trees are partially buried in the earthfill on the downstream slope. The downstream slope is retained by timbers, supported by trees for a distance of about 15 feet to the left of the edge of the spillway discharge channel. There is a small seepage at the downstream toe of the dam near the left abutment.

There is a home within a few feet of the downstream toe between the spillway and the left abutment. There is evidence of significant trespassing on the dam and the area at the downstream toe.

Both abutments of the dam appear to be soil. The left abutment is covered with trees and brush at the elevation of the crest of the dam. The right abutment is bare of vegetation.

c. Appurtenant Structures. Located approximately in the center of the dam is the principal spillway which consists of a 16.1 feet long by 1.6 feet deep stoplog bay cast into the top of the concrete core wall. At the time of the inspection, no stoplogs were in place. A concrete apron equal to the width of the spillway extends downstream from the stoplog bay about 11.0 feet to a riprap slope which extends about 12 feet to an existing stream channel. Soil has eroded from beneath the downstream edge of this concrete apron.

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

e. Downstream Channel. A few small trees overhang the discharge channel between the dam and the road culvert which is about 115 feet downstream from the dam.

3.2 Evaluation

On the basis of the visual inspection, Uncanoonuc Dam #2 is considered to be in fair condition.

The downstream tilt of the concrete core wall with large vertical cracks and spalling indicates that it has been unstable at one time. On the basis of the visual inspection alone, it is not possible to determine if the remedial measures taken in the past are adequate to ensure the present stability of the wall.

The lack of erosion protection on the upstream and downstream slopes of the embankment and the right abutment leaves the embankment susceptible to erosion by rainfall runoff or, if the dam should be overtopped, by overflowing water.

Trees which are partially buried in the downstream slope and trees growing on the left abutment could cause seepage and erosion problems if a tree blows over and pulls out its roots, or if a tree dies, or is cut and its roots rot.

Seepage at the downstream toe of the dam near the left abutment, if not controlled, could result in long-term instability.

The construction of the house which is located close to the downstream toe and continuing trespassing on the embankment may result in long-term seepage or erosion problems.

SECTION 4
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. Uncanoonuc Lake Dam #2 is used primarily to create Uncanoonuc Lake. There are no written or routine operational procedures.

b. Description of any Warning Systems in Effect. No written warning system exists for the dam.

4.2 Maintenance Procedures

a. General. The part owner, the town of Goffstown, is responsible for the maintenance of the dam. No formal maintenance plan exists.

b. Operating Facilities. No formal plan for maintenance of operating facilities exists.

4.3 Evaluation

The current operation and maintenance procedures for Uncanoonuc Lake Dam #2 are inadequate to ensure that all problems encountered can be remedied within a reasonable period of time. The owners should establish a written operation and maintenance procedure, as well as establish a warning system to follow in event of flood flow conditions or imminent dam failure.

SECTION 5
EVALUATION OF HYDROLOGIC/HYDRAULIC FEATURES

5.1 General. Uncanoonuc Lake Dam #2 consists of an earthen embankment structure with a central concrete core wall. The dam is approximately 9 feet high from the crest of the dam to the downstream toe, with an overall length of 147 feet. Discharge from the dam occurs through the spillway located near the center of the dam. Other than this spillway, no other outlets exist. Located at the opposite end of the lake from Uncanoonuc Lake Dam #2 is a second dam (Uncanoonuc Lake Dam #1, NH00489). The crest of Uncanoonuc Lake Dam #1 is approximately 4 feet higher than the crest of Uncanoonuc Lake Dam #2. There is no apparent discharge from Uncanoonuc Lake Dam #1.

The drainage area above the dam consists of steeply sloped terrain which is heavily wooded. No other impoundments, which would delay the arrival of runoff to Uncanoonuc Lake are located in the drainage area. The dam impounds a lake which functions as a recreational facility. The dam is classified as small in size, having a maximum storage of approximately 161 acre-feet.

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

5.3 Experience Data. No experience data were disclosed. Maximum flood flows or elevations are unknown.

5.4 Test Flood Analysis. Due to the absence of detailed design and operational information, the hydrologic evaluation was performed utilizing data gathered during field inspection, watershed size and an estimated test flood determined from the Corps of Engineers guide curves. For this dam (small size and significant hazard) the test flood ranges from the 100-year flood to one-half the Probable Maximum Flood (1/2 PMF). Since the dam falls on the lower end of the small size range, the 100-year flood was utilized for this hydrologic analysis. The drainage area consists of steeply sloping terrain, so 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 an estimated maximum probable flood peak flow rate of 3,300 cfs per square mile and a drainage area of 0.26 square miles, the test flood inflow was estimated to be 215 cfs. The test flood was routed through the reservoir in accordance with the Corps of Engineers procedure for Estimating Effect of Surcharge Storage on Maximum Probable Discharge. The reservoir water surface was assumed to be at elevation 655.0 prior to the flood routing. The routed test flood outflow was estimated to be 86 cfs. This analysis indicated that the dam crest would not be overtopped. The maximum spillway discharge capacity with the water level at the dam crest was estimated to be 85 cfs, which is nearly 100 percent of the routed test flood outflow.

5.5 Dam Failure Analysis. The impact of dam failure was assessed utilizing the "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs published by the Corps of Engineers. The analysis covered a reach extending approximately 0.7 miles downstream to beyond Wallace Road. The prefailure flow is negligible (about 3 percent of the peak failure outflow from an assumed breach), so prefailure tailwater conditions were not included in the calculations and the dam failure analysis was conducted with the water surface at the dam crest. Based on this analysis, Uncanoonuc Lake Dam #2 has been classified as a significant hazard.

An assumed breach in Uncanoonuc Lake Dam #2 with the water surface at the dam crest would increase the stage of the immediate downstream channel to nearly 9 feet and could result in damage to the permanent residence located directly behind the dam. The discharge emanating from the failed dam would be at the sill level and could undermine the foundation, which is exposed along the stream channel, causing appreciable damage to the structure. The potential for the loss of less than a few lives of residents inhabiting this structure exists. The water surface in the small pond immediately below the dam would rise approximately 9 feet, and the town roads adjacent to this pond would be overtopped. The first roadway below the dam would be overtopped by about 6 feet, and the second roadway by about 4 feet. Further downstream, the stage would be considerably reduced, to 3 to 4 feet, and additional damage to town roads is not likely. There are no other structures in the reach that would be impacted.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Examination

The visual examination indicates the following potential structural problems:

(1) The downstream tilt of the concrete core wall with large vertical cracks and spalling indicates that it has been unstable at one time. On the basis of the visual inspection alone, it is not possible to determine if the remedial measures taken in the past are adequate to ensure the present stability of the wall.

(2) The lack of erosion protection on the upstream and downstream slopes of the embankment and the right abutment leaves the embankment susceptible to erosion by rainfall runoff or, if the dam should be overtopped, by overflowing water.

(3) Trees which are partially buried in the downstream slope and trees growing on the left abutment could cause seepage and erosion problems if a tree blows over and pulls out its roots, or if a tree dies or is cut and its roots rot.

(4) Seepage at the downstream toe of the dam, if not controlled, could result in long-term instability.

6.2 Design and Construction Data. The original stone dam was designed by H.W. Sawyer, Professional Engineer, Goffstown, New Hampshire and was built by the Uncanoonuc Mountain Incline Railway Company in 1921.

6.3 Post-Construction Changes. It is not known when the present concrete core wall dam was built to replace the original stone dam, but records indicate it to be in existence by 1936, and the last known repairs were made to the dam in the same year.

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, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection indicates that Uncanoonuc Dam #2 is in fair condition. The major concerns with respect to the integrity of the dam are:

(1) Downstream tilt of the concrete core wall with large vertical cracks and spalling

(2) Lack of erosion protection on the embankment and the right abutment

(3) Trees which are partially buried in the earthfill on the downstream slope

(4) Seepage at the downstream toe of the dam

(5) Presence of a house close to the downstream toe of the dam and extensive trespassing on the embankment.

(6) Lack of a low level regulating outlet that would allow drawdown of the lake in an emergency

b. Adequacy of Information. The information available from the visual inspection and hydraulic computations 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 additional information is needed for the purposes of this Phase I investigation.

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

7.2 Recommendations

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

(1) Investigate the structural stability of the tilted and cracked concrete core wall and design remedial measures if needed.

(2) Design and specify erosion protection for the upstream and downstream slopes of the embankment, the right abutment and the spillway apron.

(3) Specify and oversee procedures for the removal of trees and their root systems from the downstream slope of the dam and the left abutment.

(4) Investigate the seepage at the downstream toe of the dam and design remedial measures if needed.

(5) Assess the need for and means to provide a low level regulating outlet that would allow drawdown of the pond in an emergency.

The owner should implement the recommendations made by the engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owners should:

(1) Visually inspect the dam and appurtenant structures once each month.

(2) Establish written maintenance and operating procedures, especially stipulating that stoplogs not be installed in the spillway.

(3) 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.

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

(5) Ideally, there should be no structures located within the immediate vicinity of the dam, such as the existing house near the left abutment. Although it is not reasonable to recommend that the house be removed, the residents should be made aware of the effects that trespassing (vandalism and restricting vegetation growth) and landscaping (planting and digging up trees and shrubs) have on the structural integrity of the dam. The residents should take measures to restrict these activities.

7.4 Alternatives

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

APPENDIX A

INSPECTION CHECKLIST

INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT: Uncanoonuc Lake Dam #2, NH

DATE: December 13, 1979

TIME: 9:30 a.m.

WEATHER: Cold, cloudy

W.S. ELEV. 655.1 U.S. 647.9 DN.S.
(NGVD)

PARTY:

1. Kenneth Stewart, S E A
2. Robert Durfee, S E A
3. Bruce Pierstorff, S E A
4. Philip Ricardi, S E A
5. Ronald Hirschfeld, GEI
6. Kenneth Stern, N.H.W.R.B.
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Structural Stability	K. Stewart/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: Uncanoonuc Lake Dam #2, NH DATE: December 13, 1979

PROJECT FEATURE: Dam Embankment NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	656.6
Current Pool Elevation	655.1
Maximum Impoundment to Date	Unknown
Surface Cracks	Three large vertical cracks through top of concrete core wall
Pavement Condition	Not paved
Movement or Settlement of Crest	None observed
Lateral Movement	Concrete core wall is tilted downstream
Vertical Alighment	Good
Horizontal Alignment	Poor alignment of concrete core wall
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	One footpath on downstream slope
Vegetation on Slopes	One bush on upstream slope. Trees on downstream slope
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection - Riprap Failures	No riprap
Unusual Movement or Cracking at or near Toe	None observed
Unusual Embankment or Downstream Seepage	One minor seepage at downstream toe halfway between spillway and left abutment
Piping or Boils	None observed
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	None observed

INSPECTION CHECK LIST

PROJECT: Uncanoonuc Lake Dam #2, NH DATE: December 13, 1979

PROJECT FEATURE: Dike Embankment NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
DIKE EMBANKMENT	No Dike
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Vegetation on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	

INSPECTION CHECK LIST

PROJECT: Uncanoonuc Lake Dam #2, NH DATE: December 13, 1979

PROJECT FEATURE: Intake Channel NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	No outlet works
a. Approach Channel	
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	
Stop Logs and Slots	

INSPECTION CHECK LIST

PROJECT: Uncanoonuc Lake Dam #2, NH DATE: December 13, 1979

PROJECT FEATURE: Control Tower NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	No control tower
a. Concrete and Structural	
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

INSPECTION CHECK LIST

PROJECT: Uncanoonuc Lake Dam #2, NH DATE: December 13, 1979

PROJECT FEATURE: Transition and Conduit NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	None
General Condition of Concrete	
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

INSPECTION CHECK LIST

PROJECT: Uncanoonuc Lake Dam #2, NH DATE: December 13, 1979

PROJECT FEATURE: Outlet Structure NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	None
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	

INSPECTION CHECK LIST

PROJECT: Uncanoonuc Lake Dam #2, NH DATE: December 13, 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	Sand and gravel
b. Weir and Training Walls	
General Condition of Concrete	Poor
Rust or Staining	None observed
Spalling	Extensive
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None observed
Drain Holes	None
c. Discharge Channel	
General Condition	Fair
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Trees overhanging channel
Floor of Channel	Soil
Other Obstructions	None

INSPECTION CHECK LIST

PROJECT: Uncanoonuc Lake Dam #2, NH DATE: December 13, 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	

APPENDIX B

ENGINEERING DATA

AVAILABLE ENGINEERING DATA

No engineering data, other than past inspection reports from the State of New Hampshire Water Resources Board, were available for the existing structure of Uncanoonuc Lake Dam #2.

PAST INSPECTION REPORTS

Date: December 20, 1979

To: Vernon A. Knowlton,
Chief Engineer

From: Ken Stern,
Water Resources Engineer KS

Subject: Corps Inspection of Uncanoonuc Lake No. 2, Dam No. 93.03

On December 13, 1979 I accompanied the inspection team from SEA consultants. Their contract called for the inspection of No. 93.04 which is an earth dike upstream of a vast, undeveloped, swamp area. The Corps inventory photographs in file No. 93.04 were of dam No. 93.03 which is the outlet structure for the impoundment. There is a house directly downstream of No. 93.03 making this dam a menace structure. After considerable discussion the consultants decided to inspect the more hazardous structure.

This dam, No. 93.03, is in fair to poor condition. It is an earth dam with a concrete core wall. The spillway is 16 ft. long with 1.5 ft. of freeboard. There is a concrete apron, which leads to mortared stone slope protection, downstream of the spillway. The major items worthy of note are:

1- The concrete core is leaning, cracked, spalled and has a poor alignment,

2- The top of the dam is erodible gravel with no vegetative cover,

3- There are several large trees on the downstream slope. These trees are stabilizing the slope. There is a combination of various wood planks between some of these trees,

4- There is slight seepage coming out of the downstream right toe. The area was wet but there was very little if any discernable flow.

The house just downstream is owned by:

Fran Blazon
Mountain Base Road
Goffstown, NH

According to her deed her land is bounded by the concrete core wall but makes no mention of the dam or water rights. The dam apparently is owned by the Town.

Dam No. 93.04 is an earthen dike built out of very sandy material. The upstream slope has stone riprap in areas. The dike is used as a bathing area and has very little vegetative cover. Several large seeps were observed at the downstream toe but a thorough inspection was not performed due to the lack of threat to life or property should the dam fail.

I believe any action on these structures can wait until receipt of the Corps' reports.

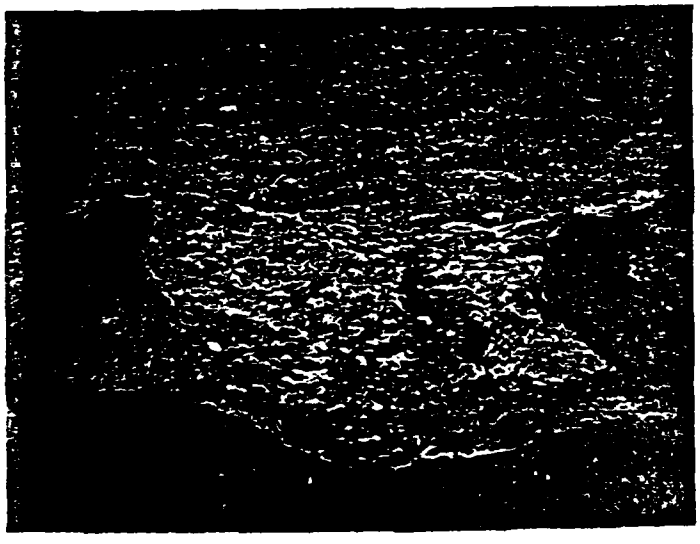
KS:paf
Enc.

Dam No. 93.03 inspected by Ken Stern on December 13, 1979

View of crest from right side

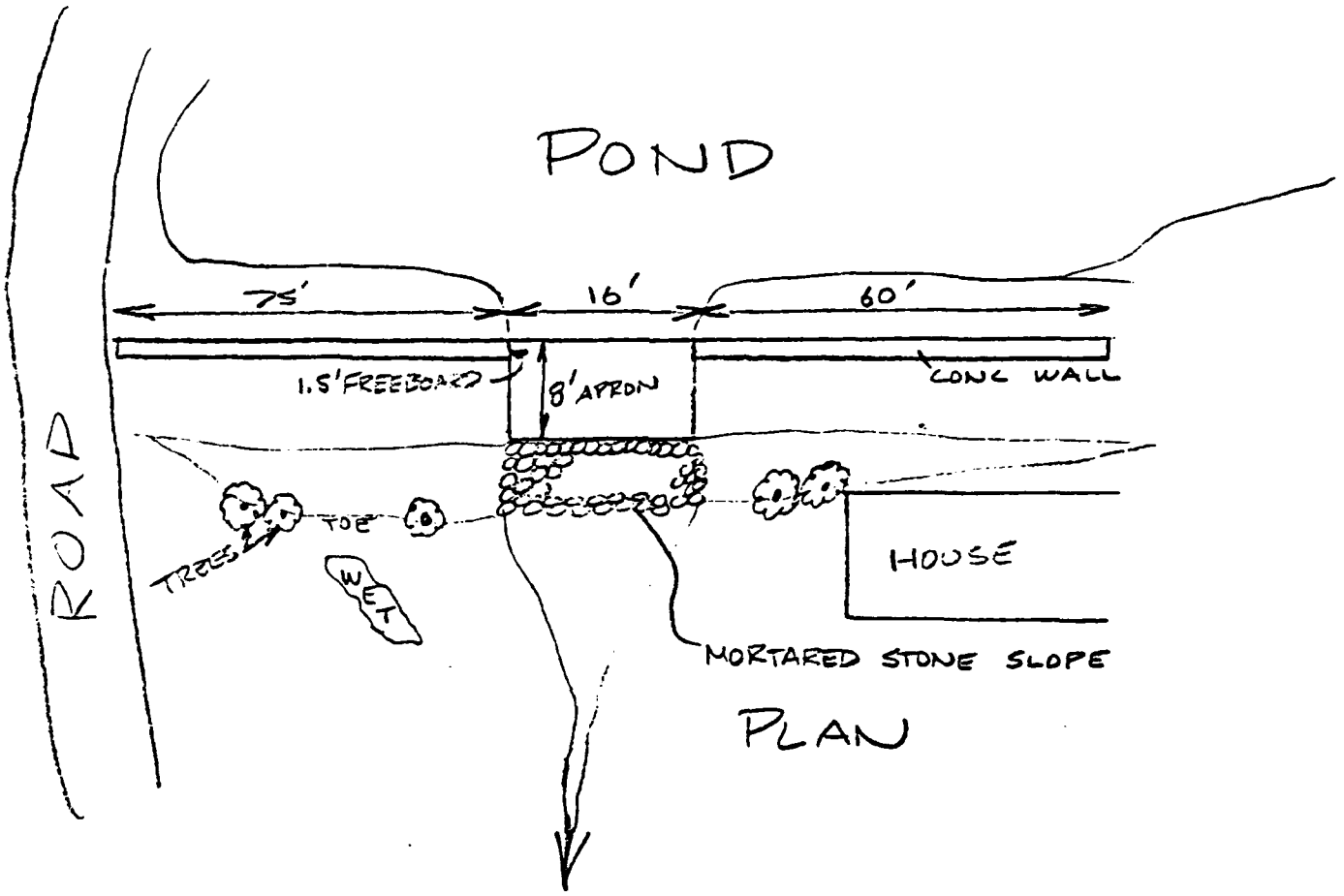
View of downstream slope and house from right side

View of Spalled Concrete

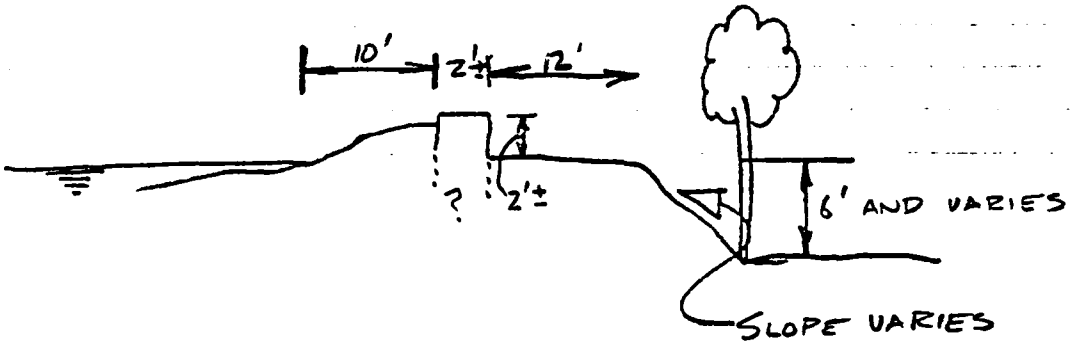


UNCANOONUC LAKE DAM 93.03

STETN 12/17/:



PLAN



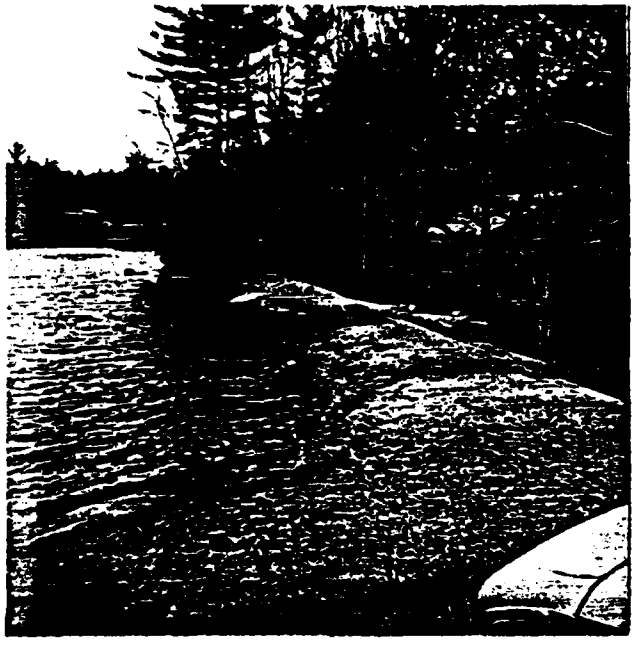
SECTION

Army Corps of Engineers Dam Inventory Program

Dam # 93.04

Date 4/22/74

Corps # 21-93.04-28.4



Description: View along dam from right side near road.

Dam # 93.04

Corps # 21-93.04-28.5

Description: View of IT spillway from 75'± downstream

Army Corps of Engineers Dam Inventory Program

Dam # 9304 Date 4/22/74

Corps # 21-9304-28.6

Description: View of dam from 125'± upstream

MEMORANDUM

Case No. C35-C

93.03

TO: Water Control Commission

RE: Uncanoonuc Brook in Goffstown, N. H.

This dam has been constructed in accordance with our directions and I recommend that final approval be given.

It is our intention to watch this dam rather closely and see that the flashboards are removed during the flood season.

Richard S. Holmgren
Chief Engineer

1/11/39

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 93.03

Town Goffstown : County Hillsboro

Stream Uncanoonuc Brook

Basin-Primary Merrimack River : Secondary Piscataquog River

Local Name [illegible] #1

Coordinates—Lat. 43° 00' -3,600 : Long. 71° 35' -900'

GENERAL DATA

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

Overall length of dam 131 ft.: Date of Construction

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

Cost—Dam : Reservoir

DESCRIPTION Gravity— Earth— Rock— on Timber crib— Concrete

Waste Gates

Type

Number : Size ft. high x ft. wide

Elevation Invert : Total Area sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

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

Embankment

Type

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 (no spill way)

Length—Total ft.: Net ft.

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

Flashboards—Type : Height ft.

Elevation—Permanent Crest : Top of Flashboard

Flood Capacity 180 cfs.: cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. ft.: Min. ft.

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

OWNER Uncanoonuc Incline Ry- Development

REMARKS Went out in 1936 (under construction)

Tabulation By A A N & R L T B-9 Date December 5, 1938.

B&B21284

File C35-C

MEMORANDUM

TO: Richard S. Holmgren, Chief Engineer

RE: Dam at Uncanoonuc Mountain. (Henry A. Laxson)

Visited the dam at Uncanoonuc Mountain and found eight inches of flash boards on the spill. The water was one inch below the top of the flash boards.

I should say the pond is about at its maximum capacity, the water being up to the road as you approach the pond from the upper dam. There is no water being spilled at the upper dam, either over the flash boards or through the gate and the gate is closed at the lower dam. There seems to be very little leakage at the lower dam.

An extra quantity of fill has been dumped in on the up.. stream face of the lower dam and also considerable on the down stream face on the east side. The holes abutting the dam on the west side where fill was taken out have been filled up as you ordered.

I believe this dam can now be given approval such as it is, but I do believe that in case of prolonged rains or high water that flash boards should be pulled on both dams and controll gates opened, as I still question the stability of the structure.

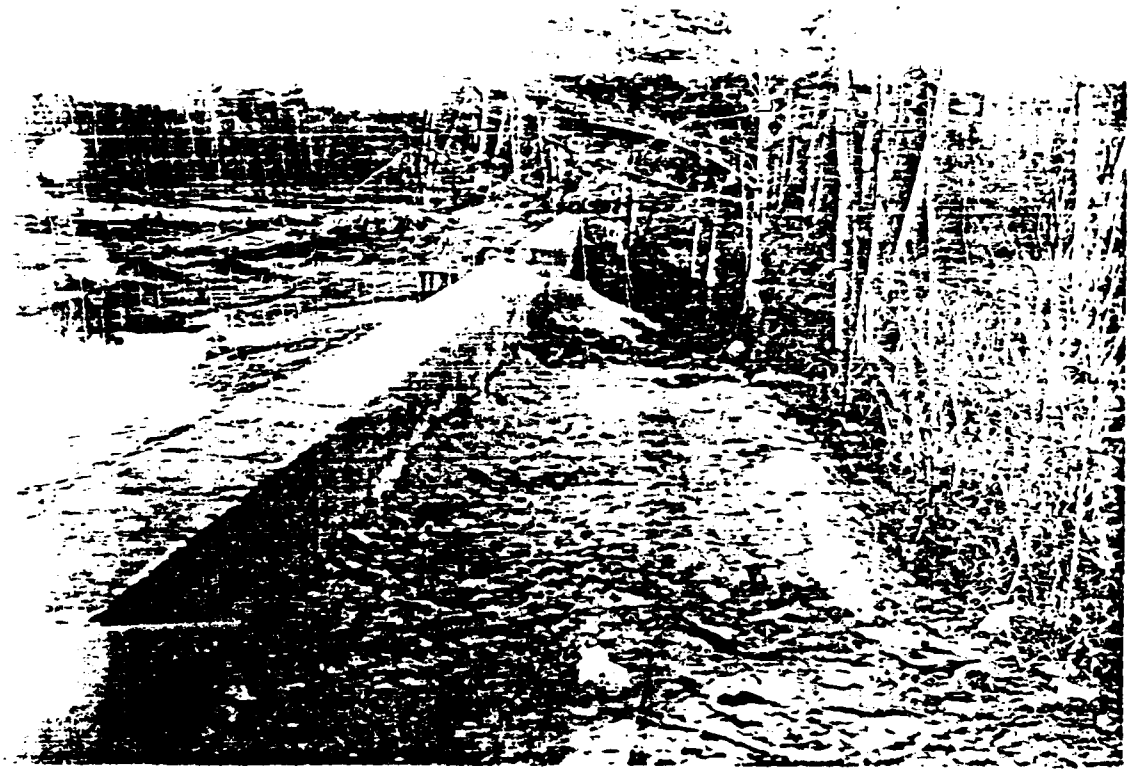
Respectfully submitted,

Charles D. Colman
Assistant Engineer

9/13/38

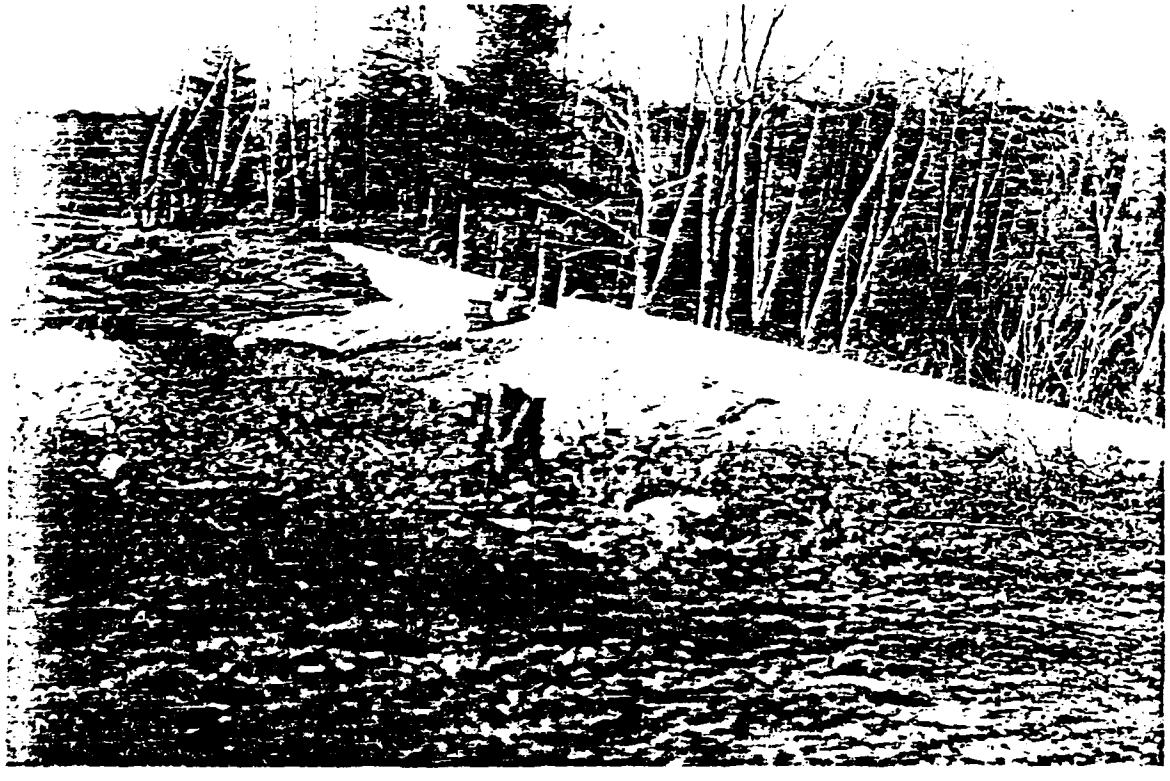
No. 93.03
93.04

SAM CRR BROOK IN GOFFSTOWN
Uncanoonuc Incline Railway & Development Co.
April 1930

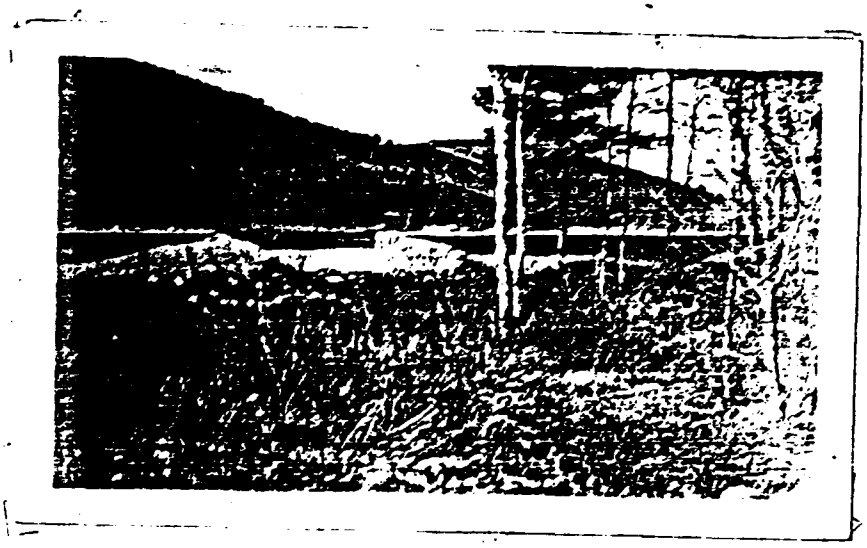


No. 93.03
93.04

SAM ORR BROOK IN GOFFSTOWN
Uncanoonuc Incline Railway & Development Co.
April 1936



UNCANOONUC BROOK IN GOFFSTOWN
Uncanoonuc Incline Railway and Development Company



Looking at Downstream Face of Overflow Dam at Southeast End of Pond

Upstream Face Looking North - Overflow Dam Southeast of Pond

Manchester Union, October 18, 1921.

START ARTIFICIAL LAKE AT BASE OF UNCANOONUC MTS.

The building of two dams to keep back the waters of the Sam Orr brooks at the base of Uncanoonuc mountain, in Goffstown, which will flood 50 acres of land at the mountain base, will give that summer resort a lake for bathing and boating purposes, which is expected to be ready by next summer. Work has already started on one of the dams and it is expected that both structures will be well on the way to completion before the weather interferes.

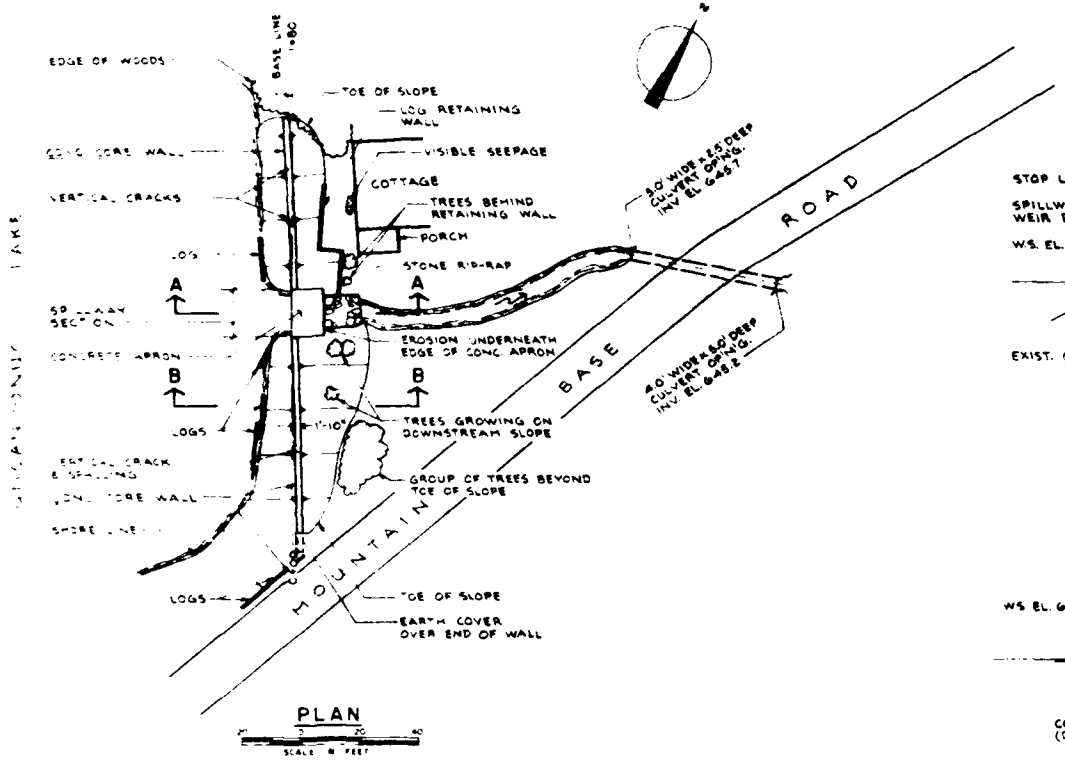
Papers were passed last week transferring a strip of land to H. A. Laxson, manager of the incline railway, which gives him possession of land upon which to build the bigger of the two dams, which will be 200 ft. long and 25 feet high. The second dam will be of these letters have been returned to land which will be flooded and the work is being rushed with two large gangs of men working, as the weather has been dry and suited for the work.

The new lake, which will be named by the public, will be twice as large as Pine Island or Crystal lake, according to the survey made by Engineer H. A. Sawyer of this city, who has mapped out the site of the new lake. The land on the lake shore is owned by H. A. Laxson, Ferson brothers, Shirley Johnson of the Shirley Hill house and the Uncanoonuc Mt. Incline railway. The four land owners expect to develop their property for camp sites and the Shirley Hill house management expects to use some of its land this winter for winter sports as the hotel will open for the winter season on Dec. 10.

Besides building two dams and cutting down the timber on the area to be flooded, which investment means an outlay of several thousand dollars, the incline railway people are building a new automobile road which will bring the mountain base half a mile nearer to Manchester as it will cut off the treacherous hill at Cram's crossing. The new road will bear towards the right at Cram's crossing, alongside of the surface line of the mountain electric road to the base. Frank A. Hebert is superintendent of construction in charge of the two crews building the dams and clearing the brush.

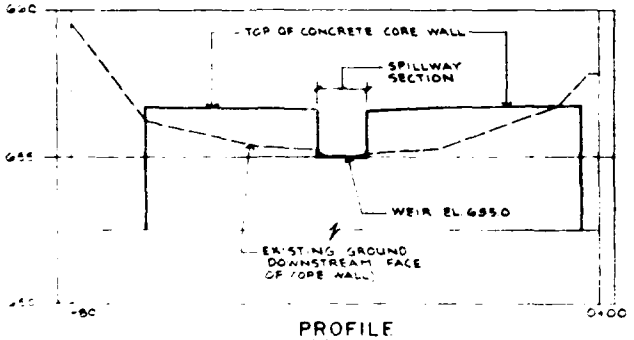
The incline railway intends to build an amusement park on the shore of the new lake, right at the foot of the mountain. There willl be a bath house as well as all the attractions that go to make a summer park popular.

PLANS AND DETAILS



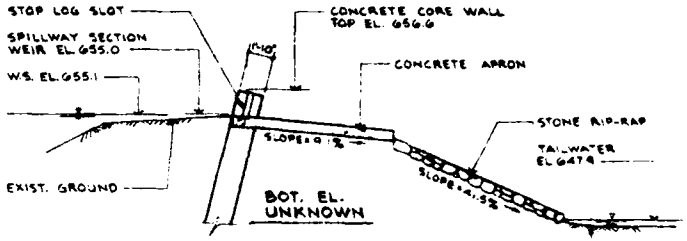
PLAN

SCALE IN FEET



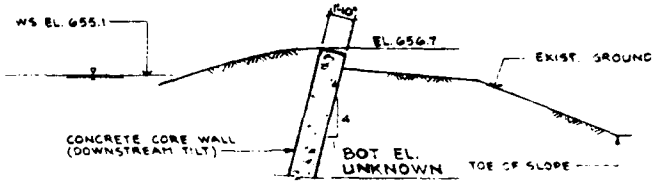
PROFILE

(LOOKING DOWNSTREAM)



SECTION A-A

SCALE 1/8"=1'-0"



SECTION B-B

SCALE 1/8"=1'-0"

NOTES:

1) THE ELEVATIONS SHOWN ARE BASED ON AN ELEVATION OF 655.0 EXTRAPOLATED FROM USGS QUADRANGLE SHEET ASSUMED TO BE POOL ELEVATION AT PERMANENT SPILLWAY CREST.

2) THE INFORMATION SHOWN ON THIS DRAWING IS BASED ON EXISTING SKETCHES AND VISUAL OBSERVATIONS MADE DURING THE FIELD INSPECTION. DIMENSIONS OR MATERIALS INDICATED ON THIS DRAWING WHICH WERE BELOW GRADE OR WATER DURING THE TIME OF INSPECTION WERE NOT VERIFIED.

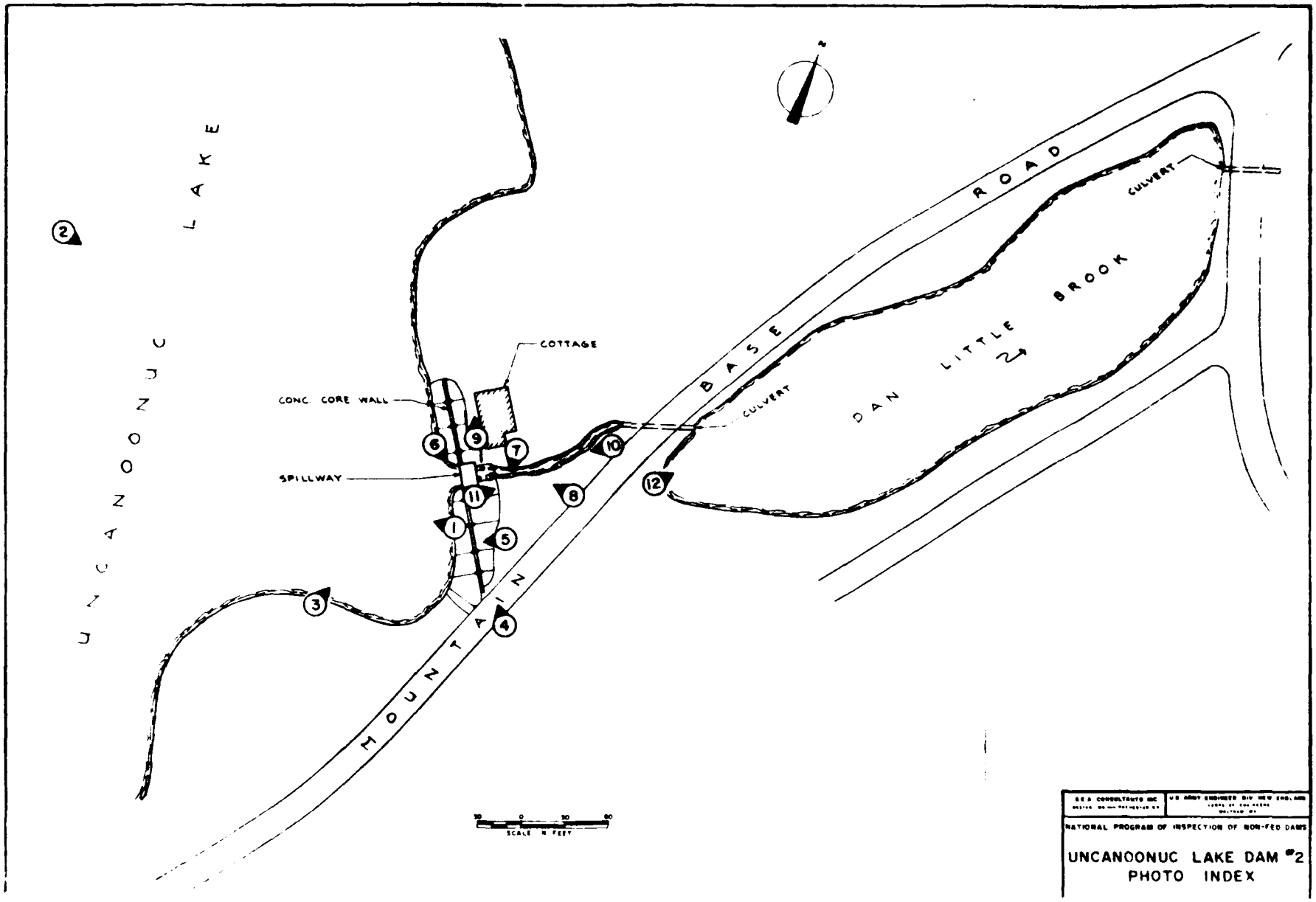
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

UNCANOONUC LAKE DAM #2

GOFFSTOWN, NEW HAMPSHIRE

APPENDIX C

SELECTED PHOTOGRAPHS



NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

UNCANOONUC LAKE DAM #2
PHOTO INDEX

REPRODUCED AT GOVERNMENT EXPENSE

Photo No. 1 - General view of lake from dam.

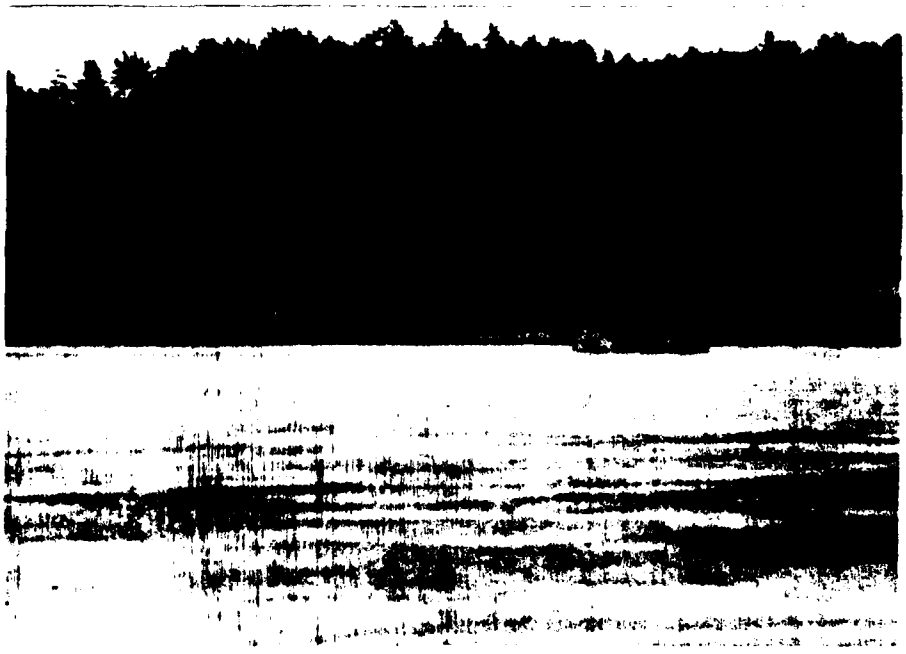


Photo No. 2 - General view of dam from lake.

REPRODUCED AT GOVERNMENT EXPENSE

Photo No. 3 - View of upstream face of left side of dam from right shoreline.

Photo No. 4 - View of crest of dam and left abutment from right abutment.

REPRODUCED AT GOVERNMENT EXPENSE

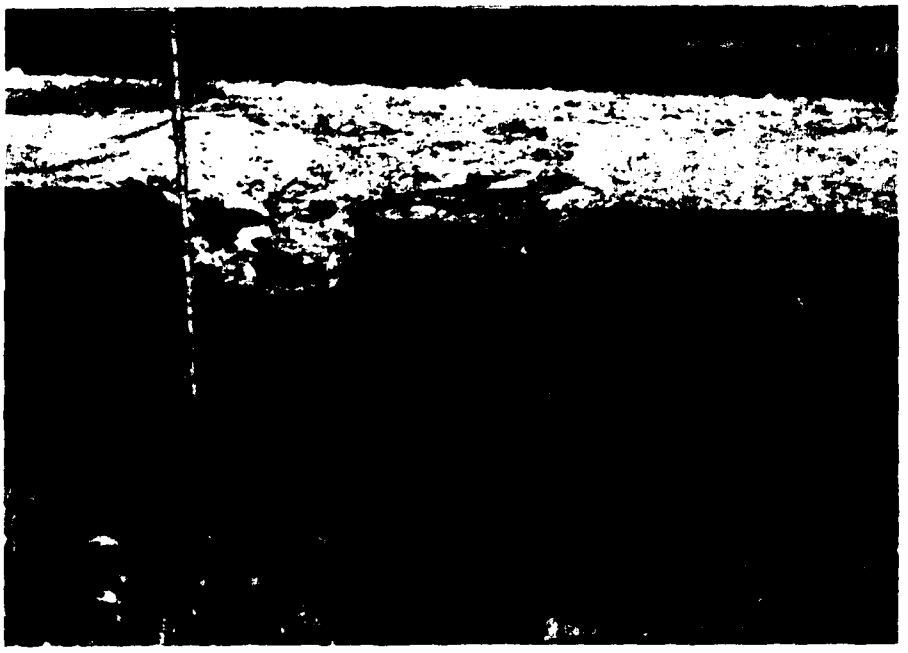


Photo No. 5 - Closeup view of spalling at top of concrete core wall.

Photo No. 6 - View of upstream face of spillway.

REPRODUCED AT GOVERNMENT EXPENSE

Photo No. 7 - View of downstream face of right side of dam.

Photo No. 8 - View of downstream face of left side of dam.

REPRODUCED AT GOVERNMENT EXPENSE

Photo No. 9 - Closeup view of seepage between toe of dam and dwelling.

Photo No. 10 - View of downstream face of spillway.

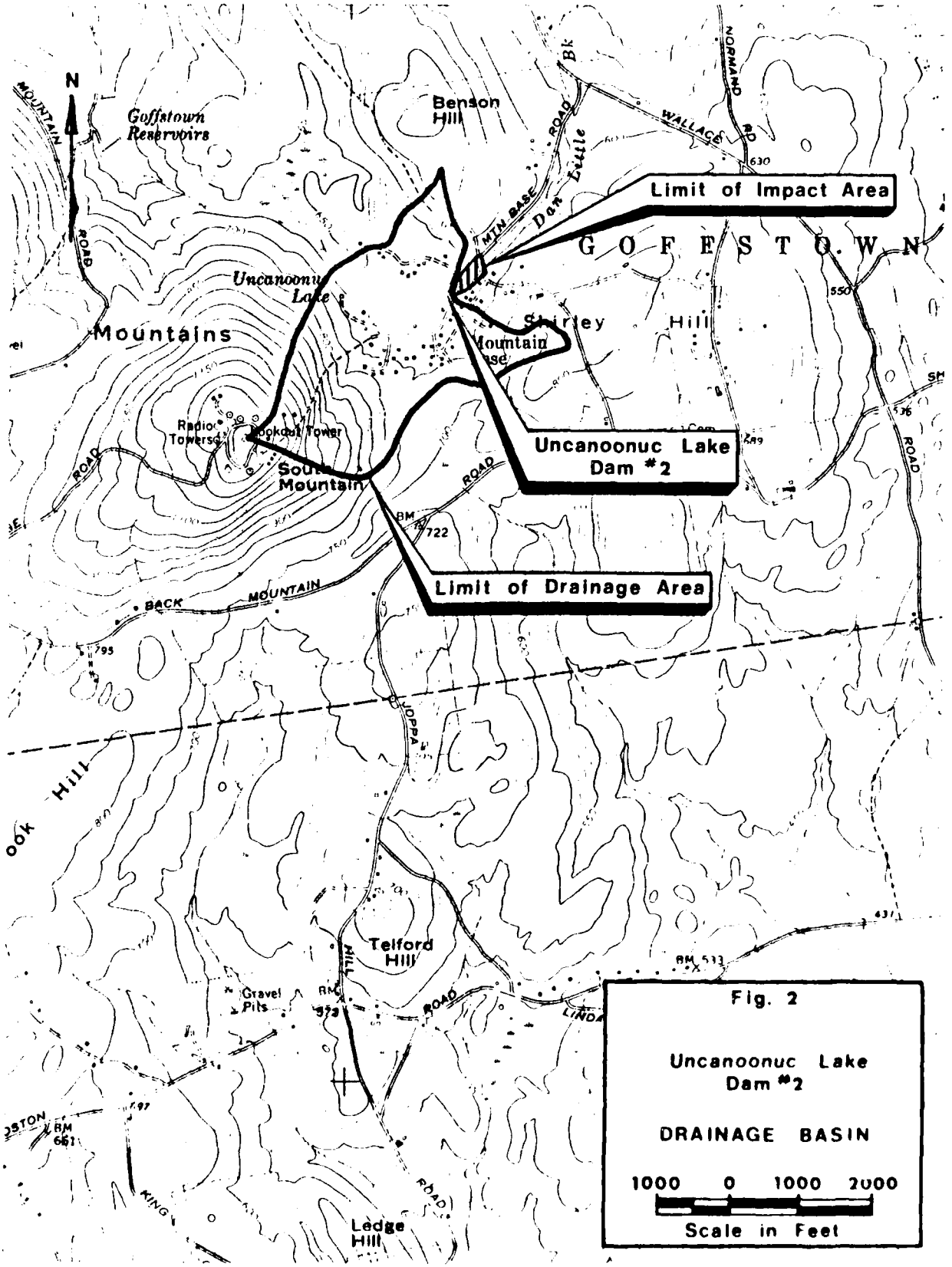
REPRODUCED AT GOVERNMENT EXPENSE

Photo No. 11 - View of downstream channel from top of dam.

Photo No. 12 - View of downstream ponding area and outlet culvert from roadway below dam.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS


N
Goffstown Reservoirs
Benson Hill
Limit of Impact Area
GOFFSTOWN
Uncanoonuc Lake
Mountains
Shirley Hill
Mountain
Radio Towers
Lookout Tower
South Mountain
Uncanoonuc Lake Dam #2
Limit of Drainage Area
BM 722
BACK MOUNTAIN
Telford Hill
Gravel Pits
Ledge Hill
Fig. 2
Uncanoonuc Lake Dam #2
DRAINAGE BASIN
1000 0 1000 2000
Scale in Feet

I. Basic Data

A. Drainage Area

1. 0.26 sq mi. - as defined on U.S.G.S. sheets and then planimetered.

2. Drainage area would be classified as mountainous, but since reservoir large compared to drainage area use rolling curve for estimating MPF.

B. Dam and Storage Information

1. Size Classification: Small based on storage (≥ 50 and < 1,000 acre-ft)

... indicated below, storage at crest of dam estimated to be 161 acre-ft.

2. Hazard Potential: SIGNIFICANT

May impact 1 house and 2 town roads

3. Storage Information

Descriptive Information	Elevation* ft	Surface Area (Acres)	Storage (acre-ft)
660 contour	660.0	33.1	255
test flood	657.1	27.3	174
crest of dam	650.0	20.3	161
spillway crest	655.0	25.7	203

* Note: 1. elevations [illegible]

(2) Normal pool elevation is based on an elevation of 655.0 extrapolated from U.S.G.S. Quadrangle sheet assumed to be pool elevation at permanent spillway crest.

C. Site Information

1. Emergency spillway, located approximately in the center of the earthfilled structure, consists of a 16.1 foot wide by 1.8 foot deep stoplog bay through the top of the concrete core wall.

a. At the time of inspection, all the stoplogs had been removed. Therefore, for the subsequent calculations of spillway capacity it was assumed that the stoplogs would not be in place.

2. Discharge over the spillway given by broad-crested weir formula:

$Q = CLH^{3/2}$ (Standard Handbook for CE's, Merritt

Where: Q = discharge, cfs
C = discharge coefficient, use 2.6
L = weir length, feet
H = head across weir, feet

II Estimate Effect of Surcharge Storage in Maximum Probable Discharge

A. Develop stage discharge curve for spillway discharge

1. define sources of outflow

a. flow over emergency spillway - stoplogs removed

b. flow over dam - above spillway crest elevation 655.7

use broad-crested weir equation, C = 2.6

c. flow through low level outlet - above average elevation of

1) use broad-crested weir equation, C = 3.0

d. discharge over embankment -

1) use broad-crested weir equation, C = 3.0

S|E|A CONSULTANTS INC. BOSTON, MASS.
ENGINEERS / PLANNERS ROCHESTER, N.H.

CLIENT Army Corps of Engineers JOB NO. [illegible] PAGE [illegible]
PROJECT [illegible] COMPTD. BY [illegible] DATE [illegible]
DETAIL [illegible] CK'D. BY [illegible] DATE [illegible]

2. Discharge through spillway

Elevation (feet)	C	L (feet)	H (feet)	Q (cfs)
655.0	—	—	—	—
655.5	2.6	3[illegible]	0.5	2
656.0	2.6	1[illegible]	1.0	12
656.6			1.6	35
657.0			2.0	[illegible]3
658.0			3.0	218
659.0			4.0	335
660.0	▼	▼	5.0	[illegible]

3. Discharge over left concrete core wall

Elevation (feet)	C	L (feet)	avg H (feet)	Q (cfs)
656.7	—	—	—	0
657.0	[illegible]	66	[illegible]	28
658.0			1.[illegible]	254
659.0			2.3	5[illegible]
660.0	▼	▼	3.3	[illegible]

4. Discharge over right concrete core wall

Elevation (feet)	C	L (feet)	avg H (feet)	Q (cfs)
[illegible]	—	—	—	—
[illegible]	[illegible]	63	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]
[illegible]			[illegible]	[illegible]
[illegible]	▼	▼	[illegible]	[illegible]

5. Discharge over right abutment -
break into two segments: 1) between concrete wall and roadway - 2) roadway and abyond

a. First segment

Elevation (feet)	C	L (feet)	avg H (feet)	Q cfs
656.8	2.6	0	0	0
657.0		2	0.1	3
658.0		10	0.6	12
659.0		10	1.6	53
660.0		10	2.6	109

b. Second segment

Elevation (feet)	C	L (feet)	avg H (feet)	Q cfs
657.8	2.6	0	0	0
658.0		9	0.1	7
659.0		55	0.6	66
660.0		100	1.1	200

6 Discharge over left abutment

Elevation (feet)	C	L (feet)	avg H (feet)	Q cfs
656.8	2.6	0	0	-
657.0		2	0.1	1
658.0		9	0.6	11
659.0		10	1.1	31
660.0		15	1.6	61

7. Total Discharge from dam site

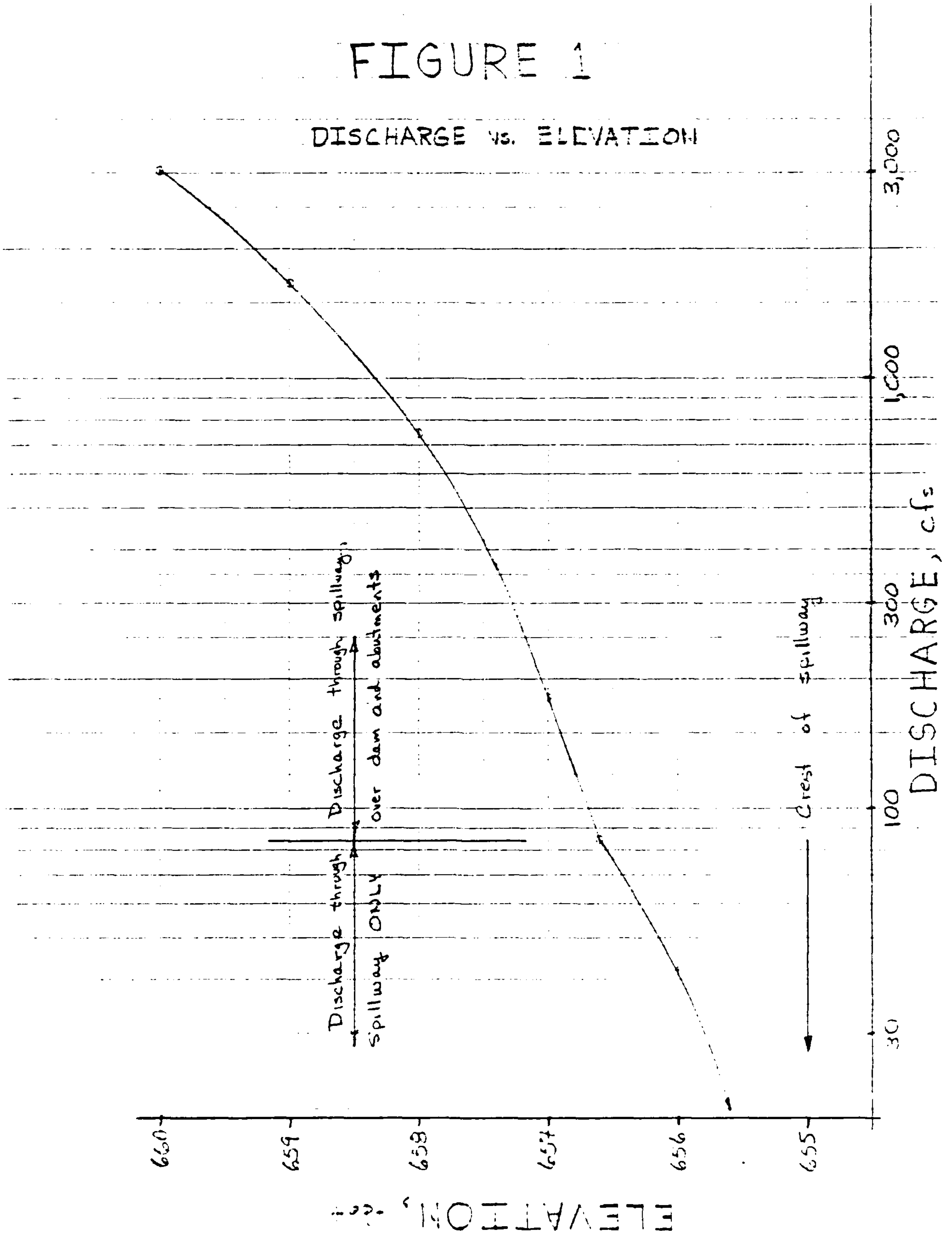
Elevation (feet)	Spillway	Left Earth Wall	Right Earth Wall	Total Right Abutment	Left Concrete Wall	TOTAL
655.0	0	0	0	0	0	0
655.5	15	0	0	0	0	15
656.0	42	0	0	0	0	42
656.6	85	0	0	0	0	85
657.0	118	28	27	9	41	223
658.0	218	254	243	19	11	745
659.0	335	599	571	119	55	1679
660.0	468	1030	932	409	82	2921

Discharge vs Elevation Curve [illegible]

Figure 1

FIGURE 1

DISCHARGE vs. ELEVATION



B. Effect of surcharge storage on max. prob. discharge

1. Pertinent Data

a. Drainage area = 0.26 square miles
b. Characteristics of basin - mountainous
c. Test flood = 100-Yr ≈ 1/4 PMF
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 3,300 cfs/sq.mi

$\therefore$ PMF = (3,300 cfs/sq.mi)(0.26 sq.mi)

= 858 cfs

1/4 PMF ≈ 100 yr. flood ≈ 215 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} = 215 cfs

Surcharge height = [illegible]
elev spillway weir crest = [illegible]
surcharge height = 2.1 ft

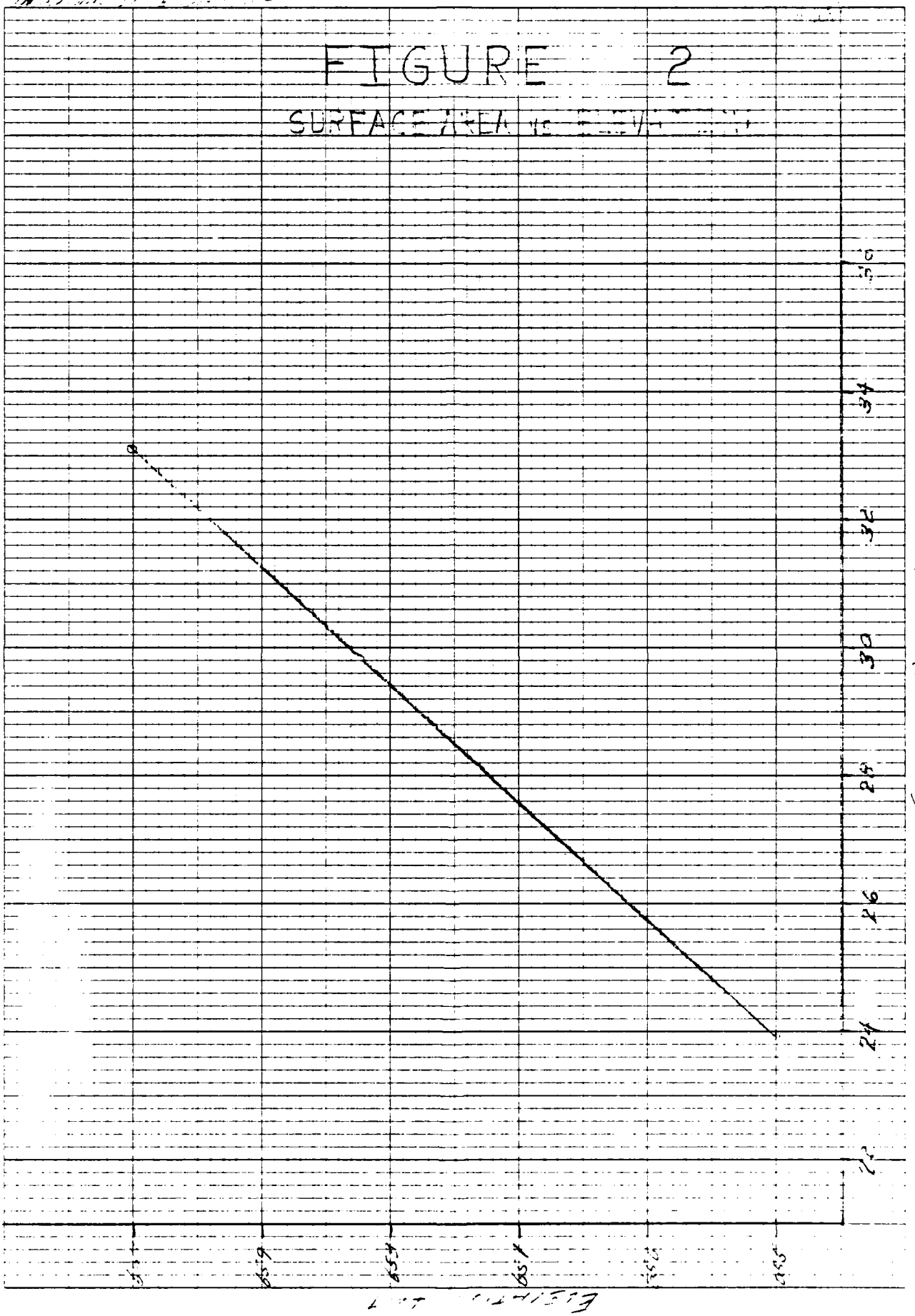
b. determine volume of surcharge [illegible] in inches of runoff

- determine volume in surcharge = surface area of pond x surcharge height

(1) determine surface area of pond

[illegible]

FIGURE 2



DIETZGEN CORPORATION
MADE IN U.S.A.
NO. 341-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

2. average surface area [illegible] and [illegible]

3. multiply average surface area by [illegible] height in [illegible]

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

$$STOR_1 = \frac{\left(\frac{23.9\ \text{acres} + 27.8\ \text{acres}}{2}\right)(2.1\ \text{ft})(12''/\text{ft})}{(0.26\ \text{sq.mi})(640\ \text{acres/sq.mi})}$$

$$STOR_1 = 3.91\ \text{inches}$$

c. determine Q_{P2}

$$Q_{P2} = Q_{P1}\left(1 - \frac{STOR_1}{4.75''}\right)$$

[illegible] 1/4 PMF [illegible] 1/4 of 19 inches

$$Q_{P2} = (215\ \text{cfs})\left(1 - \frac{3.91''}{4.75''}\right)$$

$$Q_{P2} = 38\ \text{cfs}$$

4. STEP 3: Determine surcharge height and [illegible] to pass Q_{P2} and then Q_{P3}

a. From Figure 1 determine surcharge height to pass Q_{P2} = 38 cfs

surcharge elevation ≈ [illegible]
elev. spillway [illegible] 555.0'

surcharge height = [illegible]

[illegible] surface area @ surcharge [illegible] ≈ [illegible]

b. determine $STOR_2$

$$STOR_2 = \frac{\left(\frac{23.9\,ac + 25.5\,ac}{2}\right)(0.9+)\left(12\,\frac{in}{ft}\right)}{(0.26\ sq.mi)\left(640\,\frac{ac}{sq.mi}\right)}$$

$$= 1.60 \text{ inches}$$

c. Average $STOR_1$ and $STOR_2$

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

$$STOR_{AVG} = \frac{3.91\,in + 1.60\,in}{2}$$

$$STOR_{AVG} = 2.75 \text{ inches}$$

d. determine Q_{P3}

$$Q_{P3} = (215\,cfs)\left(1 - \frac{2.75}{4.75}\right)$$

$$Q_{P3} = 91\ cfs$$

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

a. from Figure 1 surcharge height for Q_{P3} = 91 cfs

Surcharge elevation ≈ 656.0'
elev. Spillway weir crest 650.0'
Surcharge height = 6.0 ft

Pond surface area at surcharge elev ≈ 26.3 acres

b. determine $STOR_3$

$$STOR_3 = \frac{\left(\frac{23.9\,ac + 26.3\,ac}{2}\right)(1.6\,in)\left(12\,\frac{in}{ft}\right)}{0.26\ sq.mi\left(640\,\frac{ac}{sq.mi}\right)}$$

$STOR_3$ = 2.93 inches

c. determine $STOR_{AVG}$

$$STOR_{AVG} = \frac{2.75 \text{ in} + 2.93 \text{ in}}{2}$$

$STOR_{AVG}$ = 2.84 inches

d. determine Q_{P4}

$$Q_{P4} = (215 \text{ cfs})\left(1 - \frac{2.84}{4.75}\right)$$

Q_{P4} = 86 cfs

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

a. From Figure 1 surcharge height for Q_{P4} = 86 cfs

Surcharge elevation ≈ 556.2'
Elev spillway crest [illegible] = 554.6'
Surcharge height = 1.6 ft
Pond surface at surcharge elev ≈ 23.3 ac

b. determine $STOR_4$

$$STOR_4 = \frac{\left(\frac{23.3 \text{ ac} + 26.3 \text{ ac}}{2}\right)(1.6 \text{ ft})(12''/\text{ft})}{(0.26 \text{ sq.mi})(640 \text{ ac/sq.mi})}$$

$STOR_4$ = 2.93 inches

c. determine $STOR_{AVG}$

$STOR_{AVG}$ = [illegible]

= [illegible]

D-2

STOR 1 and STOR A15 [illegible] accept routed [illegible] outflow equal to 36 cfs at an elevation of 656.6 feet

7 In Conclusion

a. Routed [illegible] is almost exactly equal to the calculated spillway capacity with [illegible] at the crest of dam (see below).

b. Spillway capacity - stoplog(s) removed

(1) water level at crest of dam - elevation 656.6'

$$Q = (2.6)(16.1\text{ ft})(656.6' - 655.0')^{3/2} \approx 95\text{ cfs}$$

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 = 656.6 feet

b. Storage at crest elevation estimated to be approximately 161 acre-feet

A. Reach 1

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

from previous calcs. storage = 161 acre-feet

2. STEP 2: Determine Peak Failure Outflow Q_{P1}

$$Q_{P1} = (8/27)\, W_b \sqrt{g}\, Y_o^{3/2}$$

where: W_b = Breach width (use 40% of total length)
= (0.4) (147 feet)
≈ 58.8 feet

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

Elev. top of dam = 656.6
Elev. channel bottom = 647.6
9.0

Y_o = 9.0 feet

$$Q_{P1} = (8/27)(58.8\text{ft})(32.2)^{1/2}(9.0\text{ft})^{3/2}$$

Q_{P1} = 2,670 cfs

The pre-failure discharge over the spillway is small compared to the dam failure discharge and therefore has not been included in the calculations.

D-14

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

a. Pertinent Data

(1) Since the pond in Reach 1 is protected by a road embankment at the outlet, discharge from the reach will be controlled by the culvert section in the road

b. See Figure 3 for stage-discharge curve

4. STEP 4: Estimate reach outflow

a. Determine stage for O_{P_1} = 2,670 cfs from Figure 3 and volume in reach

(1) Stage = 10.3 feet

(2) Volume in reach = (Stage) (Average surface area of pond)

$$\text{Volume} = V_1 = (10.3') \left(\frac{0.6 \text{ acres} + 5.0 \text{ acres}}{2} \right)$$

$$V_1 = 31.9 \text{ acre-feet}$$

$V_1 < \frac{S}{2}$ ∴ reach will

b. Determine $O_{P2(TRIAL)}$

$$O_{P2(TRIAL)} = O_{P_1} \left(1 - \frac{V_1}{S} \right)$$

$$O_{P2(TRIAL)} = (2{,}160 \text{ cfs}) \left(1 - \frac{31.9}{16} \right)$$

$$Q_{P2(TRIAL)} = 2,140 \text{ cfs}$$

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

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

$$\text{Stage} = 9.9 \text{ feet}$$

$$V_2 = (9.9 \text{ ft}) \left(\frac{0.6 \text{ acres} + 5.4 \text{ acres}}{2} \right)$$

$$V_2 = 29.7 \text{ acre-feet}$$

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

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

$$V_{avg} = \frac{31.9 \text{ acre-ft} + 29.7 \text{ acre-ft}}{2}$$

$$V_{avg} = 30.8 \text{ acre-feet}$$

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

$$Q_{P2} = (2,670 \text{ cfs}) \left(1 - \frac{\quad}{\quad} \right)$$

$$Q_{P2} = 2160 \text{ cfs}$$

B. Reach 2

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

a. Pertinent Data

(1) Reach length = 1,250 feet
(2) Channel slope = 0.036
(3) Manning n = 0.05
(4) Channel shape - trapezoidal
(5) Base width ≈ 10 feet

b. See Figure 3 for stage-discharge curve

2. STEP 4: Estimate Reach Outflow

a. Determine stage for Q_{P2} = 2,160 cfs from Figure 3 and find volume in reach

(1) Stage (depth of flow) = 5.0 feet

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

$$\text{X-area} = (0.5)(5.0\text{ ft})(10\text{ ft} + 65\text{ ft})$$
$$= 188\text{ ft}^2$$

$$\text{Volume} = V_1 = \frac{(188\text{ ft}^2)(1250\text{ ft})}{43{,}560\text{ ft}^2/\text{acre}}$$

$$= 5.4\text{ acre-feet}$$

$V_1 < \frac{S}{2}$ ∴ reach length OK

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

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

$$Q_{P3(TRIAL)} = (2{,}160\text{ cfs})\left(1 - \frac{5.4}{13.1}\right)$$

$Q_{P3(TRIAL)}$ = 1,270 cfs

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

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

Stage = 4.9 feet

X-area = (0.5)(4.9 ft)(10 ft + 64 ft)

≈ 181 ft^2

$$V_2 = \frac{(181\ ft^2)(1{,}250\ ft)}{43{,}560\ ft^2/acre}$$

V_2 = 5.2 acre-feet

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

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

$$V_{avg} = \frac{5.4\ ac\text{-}ft + 5.2\ ac\text{-}ft}{2}$$

Vavg = 5.3 acre-feet

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

$$Q_{P3} = (2{,}160\ cfs)\left(1 - \frac{5.3}{161}\right)$$

Q_{P3} = 2,090 cfs

C. Reach 3

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

   a. Pertinent Data

      (1) Reach length = 1,050 feet
      (2) Channel slope = 0.036
      (3) Manning n = 0.05
      (4) Channel shape - trapezoidal
      (5) Base width ≈ 10 feet

   b. See Figure 3 for stage-discharge curve

2. STEP 4: Estimate Reach Outflow

   a. Determine stage for Q_{p3} = 2,090 cfs from Figure 3 and find volume in reach

      (1) Stage (depth of flow) = 4.3 feet

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

      X-area = (0.5)(4.3 ft)(10 ft + 92 ft)
      ≈ 219 ft²

      Volume = V_1 = [illegible]

      = 5.3 acre-feet

      $V_1 < \frac{S}{2}$ ∴ reach length OK

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

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

      $Q_{P4(TRIAL)}$ = [illegible]

      $Q_{P4(TRIAL)}$ = [illegible]

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

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

Stage = 4.2 feet

X-area = (0.5) (4.2 ft) (10 ft + 90 ft)

≈ 210 ft²

$$V_2 = \frac{(210\ ft^2)(1{,}050\ ft)}{43{,}560\ ft^2/acre}$$

V_2 = 5.1 acre-feet

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

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

$$V_{avg} = \frac{5.3\ ac\text{-}ft + 5.1\ ac\text{-}ft}{2}$$

V_{avg} = 5.2 acre-feet

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

$$Q_{P4} = (2{,}090\ cfs)\left(1 - \frac{5.2}{161}\right)$$

Q_{P4} = 2,020 cfs

D. Reach 4

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

   a. Pertinent Data

      (1) Reach length = 1,000 feet
      (2) Channel slope = 0.06
      (3) Manning n = 0.05
      (4) Channel shape - ~~trapezoidal~~
      (5) Base width ≈ 10 feet

   b. See Figure 3 for stage-discharge curve

2. STEP 4: Estimate Reach Outflow

   a. Determine stage for Q_{P4} = 2,020 cfs from Figure 3 and find volume in reach

      (1) Stage (depth of flow) = 4.4 feet

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

      X-area = (0.5)(4.4 ft)(10 ft + 58 ft)
      = 150 ft²

      Volume = V_1 = $\frac{(150 \text{ ft}^2)(1{,}000 \text{ ft})}{43{,}560 \text{ ft}^2/\text{ac}}$

      = 3.4 acre-feet

      $V_1 < \frac{S}{2}$ ∴ reach length OK

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

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

      $Q_{P5(TRIAL)}$ = (2020 cfs)(1 − [illegible])

      $Q_{P5(TRIAL)}$ = 1,9[illegible] cfs

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

From Figure 3 determine stage for $Q_{P5(TRIAL)}$

Stage = 4.3 feet

X-area = (0.5)(4.3 ft)(10 ft + 57 ft)

≈ 144 ft²

$$V_2 = \frac{(144\ ft^2)(1{,}000\ ft)}{43{,}560\ ft^3/acre}$$

V_2 = 3.3 acre-feet

d. Average V_1 and V_2 and compute Q_{P5}

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

$$V_{avg} = \frac{3.4\ ac\text{-}ft + 3.3\ ac\text{-}ft}{2}$$

Vavg = 3.35 acre-feet

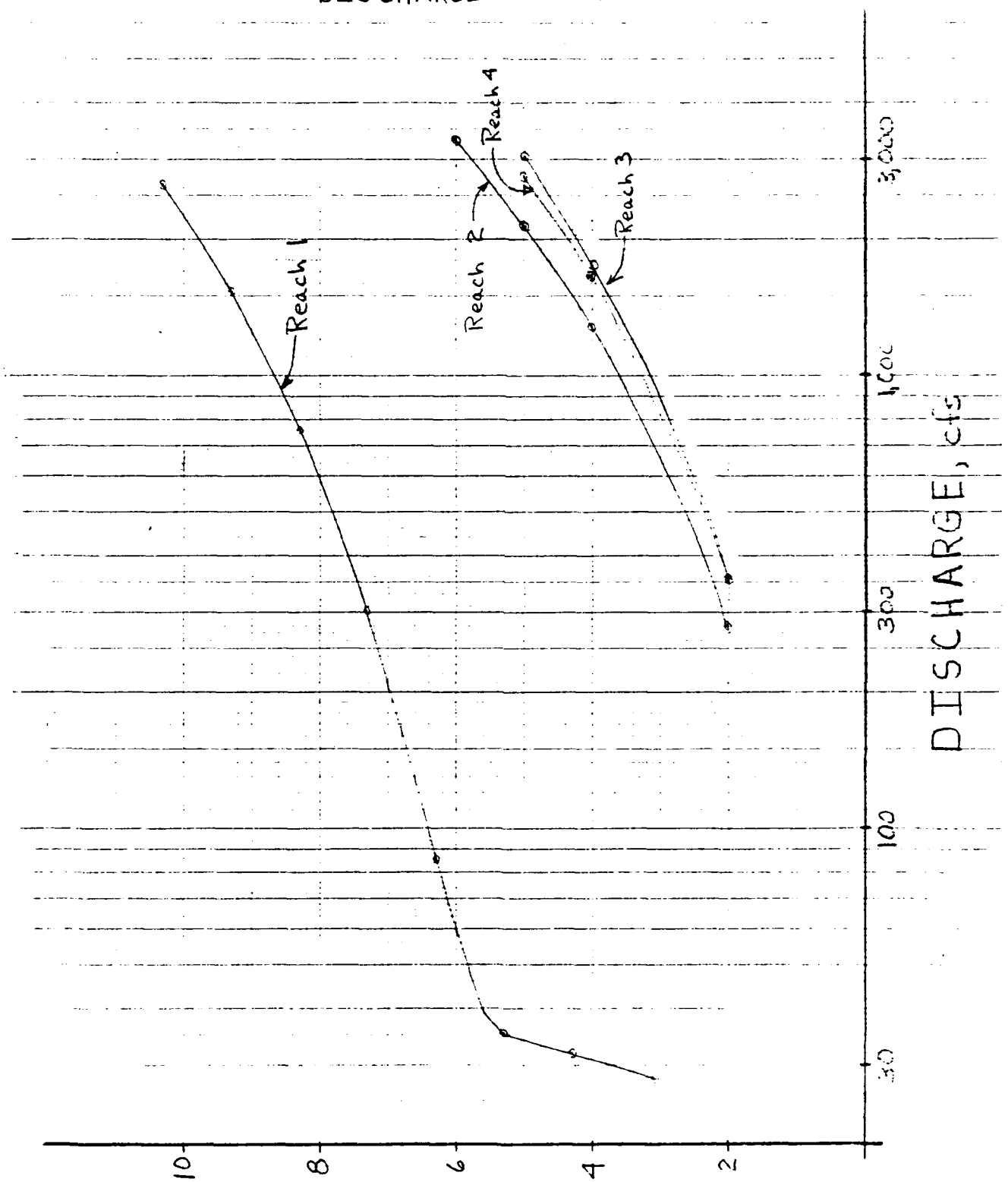
(2) $$Q_{P5} = Q_{P4}\left(1 - \frac{Vavg}{S}\right)$$

$$Q_{P5} = (2{,}020\ cfs)\left(1 - \frac{3.35}{13.}\right)$$

Q_{P5} = 1,980 cfs

FIGURE 3

DISCHARGE vs STAGE



NO. 341-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH
DIETZGEN CORPORATION
MADE IN U.S.A.

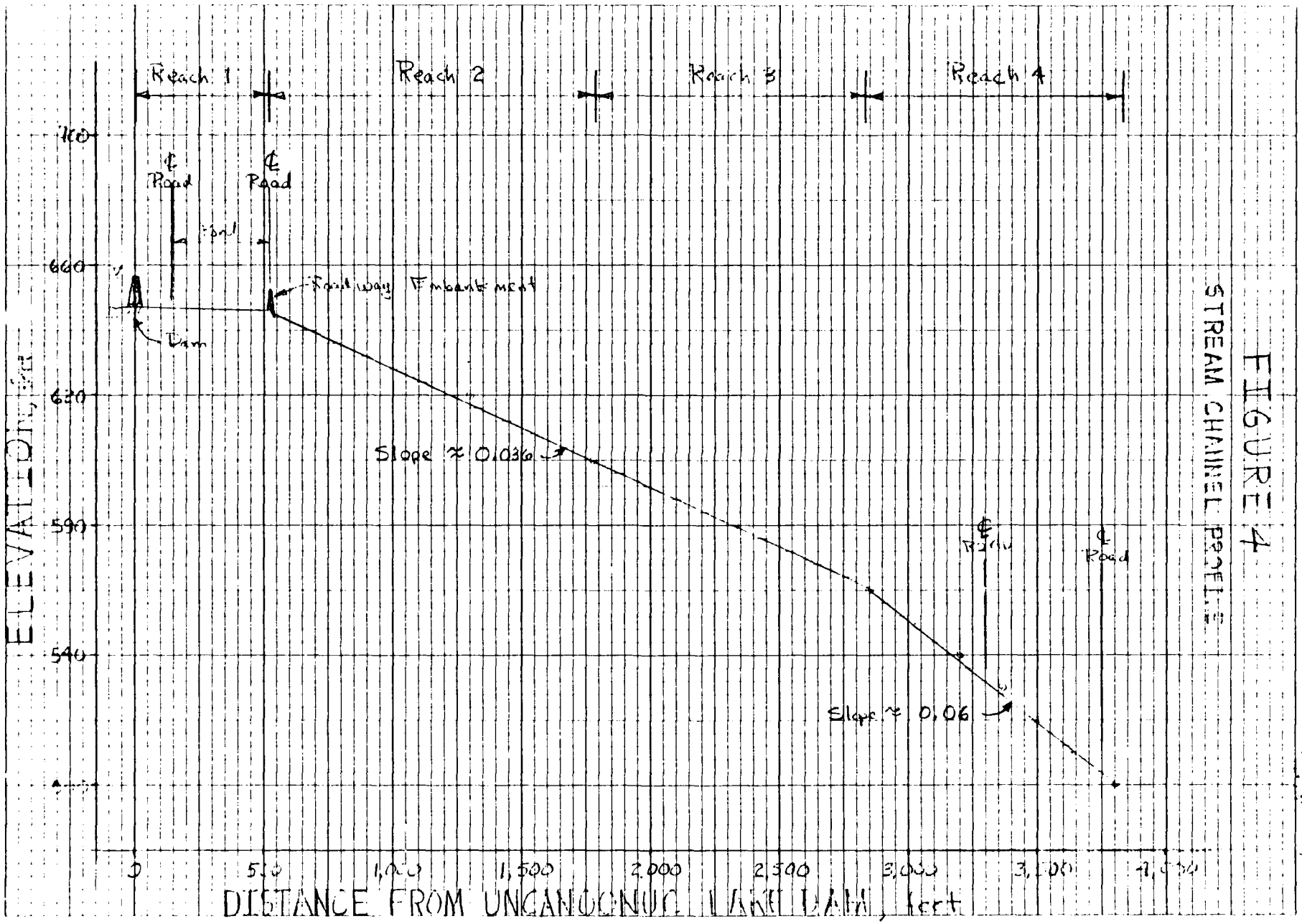


FIGURE 4

STREAM CHANNEL PROFILE

NOT AVAILABLE AT THIS TIME

END

FILMED

8-85

DTIC