

AD-A156 493 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
LOVELL LAKE DAM (NH 0.) (U) CORPS OF ENGINEERS WALTHAM
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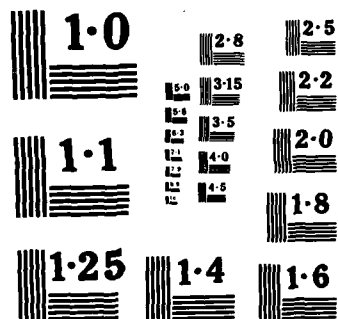
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AD-A156 493

PISCATAQUA RIVER BASIN
WAKEFIELD, NEW HAMPSHIRE

LOVELL LAKE DAM
NH 00223

STATE NO 241.06

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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

AUGUST 1978

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LOVELL LAKE DAM

NH 00223

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PISCATAQUA RIVER BASIN
WAKEFIELD, NEW HAMPSHIRE



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.: NH00223
Name of Dam: Lovell Lake Dam
Town: Wakefield
County and State: Carroll County, New Hampshire
Stream: Branch River
Date of Inspection: 19 June 1978

BRIEF ASSESSMENT

Lovell Lake Dam is 10 feet high, averages about 15 feet wide and is 240 feet long. It is an earthen embankment contained within a vertical dry stone masonry downstream wall and a concrete upstream wall (concave upstream). The dam spans the headwaters of the Branch River in east central New Hampshire. A 20'x36' three-sided box spillway has been built integrally with the concrete upstream wall. The 20' width contains an uncontrolled weir, the two 36' legs contain 7 bays of stoplogs, one of which has its sill at the elevation of the spillway apron. Water flows from the box into a 80' long conduit under State Route 109. Lovell Lake is now used for recreational purposes. The lake is 2.4 miles long and has a surface area of more than 500 acres. Maximum storage is 2,400 acre-feet.

The dam is in fair condition. Major concerns are: inadequate outlet discharge capacity, seepages at the downstream toe, and its small freeboard. Additional concerns include: erosion of the embankment on both sides of the spillway, a stump and several trees near the downstream wall, cracks in the upstream concrete wall, and large boulders thrown or pushed onto the spillway apron.

Based on size and hazard classifications in accordance with Corps guidelines, the test flood is the Probable Maximum Flood. With stoplogs in place a PMF outflow of 3050 cfs (622 csm) would overtop the dam by 1.6 feet; therefore the spillway is considered inadequate. With stoplogs, the spillway will pass 63 cfs, or 2 percent of the PMF. With stoplogs removed the spillway will pass 1329 cfs. A major breach at maximum pool would probably result in the loss of less than 10 lives and appreciable property damage.

The owner, New Hampshire Water Resources Board, should implement the results of the recommendations given in Section 7.2. within two years after receipt of this Phase I Report. The operating and maintenance measures recommended in Subsection 7.3.b. should be implemented within one year after receipt of this Phase I Report.

Warren A. Guinan

Warren A. Guinan
Project Manager
N.H. P.E. No. 2339

This Phase I Inspection Report on Lovell Lake 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.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL COOPER, Member
Chief, Water Control 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 (OCE), 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 test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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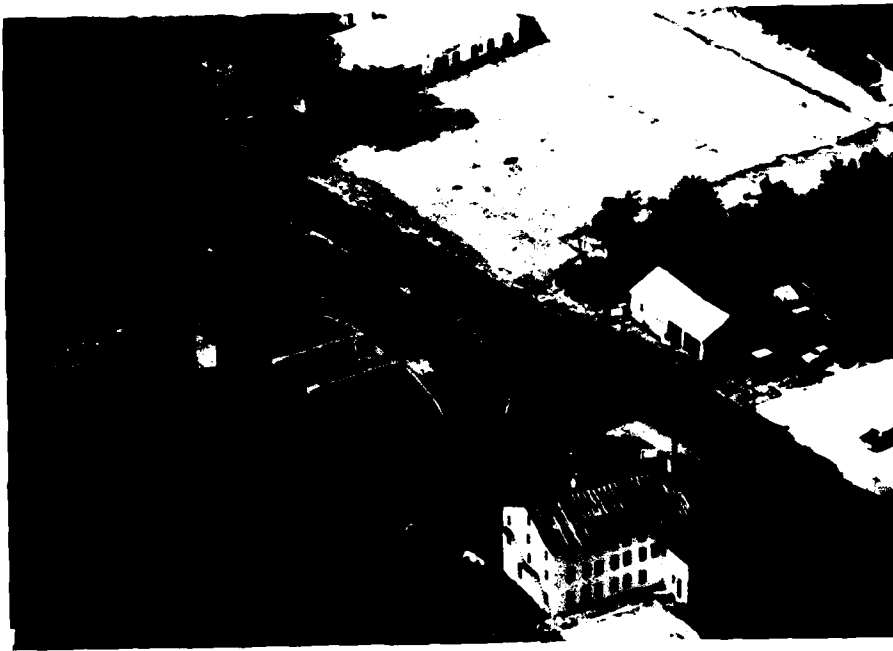
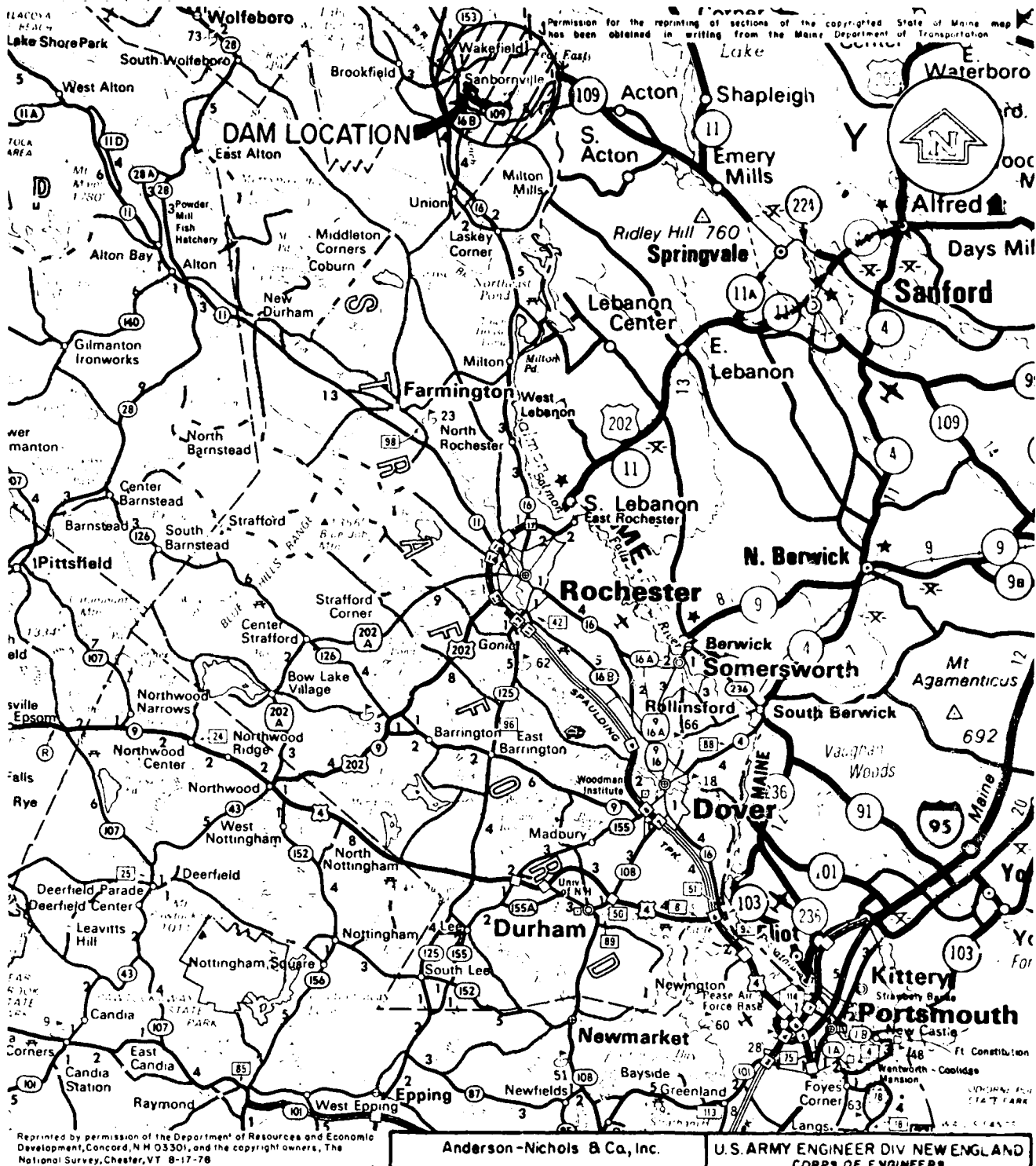


Figure 1 - Overview of Lovell Lake Dam.



NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
LOVELL LAKE DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1978, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols & Company, Inc. under a letter of May 3, 1978 from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0329 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. Lovell Lake is located in the Town of Wakefield, New Hampshire. The dam impounding the lake spans the headwaters of the Branch River. Below the dam the Branch River flows about 9 miles to its confluence with the Salmon Falls River in Milton Three Ponds about 3 miles above the Milton Three Ponds Dam. The Salmon Falls River in turn joins the Cocheco River 25 miles below the Milton Three Ponds Dam to form the Piscataqua River. Lovell Lake Dam is shown on the U.S.G.S. Quadrangle, Wolfeboro, New Hampshire, with coordinates approximately at N 43° 33' 11", W 71° 01' 32",

Carroll County, New Hampshire. (See Location Map page vii.)

b. Description of Dam and Appurtenances.

Lovell Lake Dam is an earthen embankment with a vertical upstream concrete wall and a vertical downstream dry masonry (stone) wall. The concrete wall is convex downstream. The dam is about 240 feet long and 10 feet high. The crest width ranges from 10 to 19 feet. A box stoplog and uncontrolled overflow spillway is located at the center of the upstream wall. The box is 36 feet long by 20 feet wide. Four bays each of stoplogs are located on either side at right angles to the uncontrolled overflow spillway. These stoplogs must be manually removed. The concrete sill of 7 bays of the stoplogs is 4 feet below and the sill of the eighth bay is 8.8 feet below the crest of the uncontrolled spillway. Discharge from the spillways flows across the apron through an old stoplog spillway and into a conduit about 80 feet long that passes under State Route 109 and discharges into an open channel west of the road. The inlet consists of a reinforced concrete box culvert 4.25'H x 8'W. About 25 feet from the upstream end the opening is restricted to 4'Hx4'W.

c. Size Classification. Intermediate (Hydraulic height-10 feet, Storage - 2,400 acre-feet) based on storage ($\geq 1,000$ to $< 50,000$ acre-feet) as given in the OCE Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant hazard. A breach would probably result in the loss of less than 10 lives and appreciable property damage.

e. Ownership. Lovell Lake Dam is reported to have been built sometime before 1820 by the Great Falls Manufacturing Company for use in their milling operations. Ownership passed on to the Public Service Company of New Hampshire sometime between 1925 and 1931. The New Hampshire Water Resources Board (NHWRB) acquired the dam and water rights in December of 1963.

f. Operator. Mr. Vernon K. Knowlton, Chief Engineer, New Hampshire Water Resources Board, 37 Pleasant Street, Concord, New Hampshire 03301, is responsible for the operation of Lovell Lake Dam. Phone (603) 271-3406.

g. Purpose of Dam. The original structure impounding Lovell Lake was constructed to provide greater industrial water storage for the Great Falls Manufacturing Company. Under the ownership of the Public Service Company of New Hampshire, Lovell Lake was utilized primarily as conservation

storage for the generation of hydroelectricity for the region, with some recreational usage. Lovell Lake is presently used for recreational purposes only.

h. Design and Construction History. Little information was disclosed concerning the original design and construction of the dam. It is reported that the first structure was basically a stone wall reinforced by an earthen embankment. The Great Falls Manufacturing Company rebuilt the dam in 1918. The upstream side was refaced with reinforced concrete, 15 inches thick. Work also included reconstruction of the sluiceway and gate.

Lovell Lake Dam was rehabilitated by the NHWRB in 1965. The outlet facilities were replaced with the present rectangular box stoplog spillway.

i. Normal Operational Procedures. No formal operational procedures were disclosed. Normal pool elevation during the summer months is about 570' MSL. This level is maintained by setting the stoplogs approximately 3 inches below the ungated overflow spillway crest. After the recreational season the lake is drawn down approximately 3 feet by removing stoplogs. The dam is visited on a weekly basis by the NHWRB.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 4.9 square miles (3,136 acres) of gently to steeply-sloping wooded terrain. The normal recreation level has a surface area of 538 acres, which is equivalent to 17 percent of the watershed.

b. Discharge at Damsite

(1) Outlet works (conduit under State Route 109) - total capacity - 116 cfs

(2) Maximum known discharge at damsite - unknown. No information regarding past overtopping was disclosed.

(3) Ungated overflow spillway capacity at maximum pool elevation - 9 cfs @ 570.6' MSL

(4) Gated (stoplog) spillway capacity at recreational pool elevation (stoplogs removed) - 1,100 cfs @ 570.0' MSL

(5) Stoplog spillway capacity at maximum pool elevation - 1,320 cfs @ 570.6' MSL

(6) Total spillway capacity at maximum pool elevation - 1,329 cfs @ 570.6' MSL

c. Elevation (ft. above MSL)

- (1) Top of dam - the crest varies from 570.6 to 572.3
- (2) Test Flood pool - 572.9
- (3) Full flood control pool - not applicable
- (4) Recreation pool - 570
- (5) Spillway crest - 561.5 (assuming stoplogs removed)
- (6) Upstream portal invert low level conduit - none
- (7) Streambed at centerline of dam - 560.7
(downstream invert of stilling basin measured 8/2/78)
- (8) Maximum tailwater - unknown
- (9) Design surcharge (original design) - unknown

d. Reservoir (miles)

- (1) Length of maximum pool - 2.4
- (2) Length of recreational pool - 2.4
- (3) Length of flood-control pool - not applicable

e. Storage (acre-feet)

- (1) Recreational pool - 2,000
- (2) Flood control pool - not applicable
- (3) Test Flood pool - 3,790
- (4) Top of dam - 2,400

f. Reservoir Surface (acres)

- (1) Top of dam (embankment) - 550
- (2) Test Flood pool - 630
- (3) Flood-control pool - not applicable
- (4) Recreation pool - 538
- (5) Spillway crest - 453

g. Dam

(1) Type - earthen embankment with a vertical concrete wall on the upstream side and a vertical dry masonry wall on the downstream side.

(2) Length - 240' (measured), 260' (from past inspection reports)

(3) Height - 12' (structural height)

(4) Top Width - ranges from 10'-19' (earth crest)

(5) Side Slopes - vertical

(6) Zoning - unknown

(7) Impervious Core - unknown

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - not applicable

i. Spillway

(1) Type - ungated concrete overflow weir and stoplog box

(2) Length of weir - 20' (ungated); 40' (stoplog)

(3) Crest elevation - 570.3' MSL (ungated); 561.5' (all stoplogs removed) (See (7) below.)

(4) Gates - not applicable

(5) U/S Channel - Lovell Lake

(6) D/S Channel - Discharge flows into a culvert that passes under State Route 109 for a distance of approximately 80 feet. Downstream of the culvert the channel is about 20 feet wide, consists of a gravel bottom, and has trees and brush growing on the banks.

(7) General - The stoplog spillway is comprised of eight bays separated by 2' wide concrete piers. Seven bays are at invert elevation 566.3' MSL; the eighth bay is at invert elevation 561.5' MSL. There is a 4' wide reinforced concrete service bridge over the stoplog spillway. This access bridge is 0.5 foot thick. The top of the service bridge is at elevation 572.3' MSL.

SECTION 2 ENGINEERING DATA

2.1 Design

A search of the files of the New Hampshire Resources Board disclosed a limited amount of recorded information concerning only the design of the present outlet structures at Lovell Lake. Plans of the spillway reconstruction in 1964 were found and used in the hydraulic computations.

2.2 Construction

No pertinent information regarding the actual construction of the present outlet facilities at Lovell Lake was disclosed.

2.3 Operation

No formal operational procedures were disclosed. However, correspondence reflecting past operational practice were discovered and validated.

2.4 Evaluation

a. Availability. Only a limited amount of data on the actual design and construction of the spillway at Lovell Lake Dam was disclosed.

b. Adequacy. The information obtained from extensive data collection efforts was not adequate to determine the hydraulic characteristics of Lovell Lake Dam. Supplemental data established by field investigation was needed to complete the engineering analysis. Because of the limited amount of detailed data available, the final assessments and recommendations of this investigation are based on the visual inspection and the hydrologic and hydraulic analysis.

c. Validity. The visual inspection is generally consistent with the 1964 spillway reconstruction plans.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Lovell Lake Dam is a small dam which impounds an intermediate-size reservoir. The watershed above the reservoir is gently to steeply sloping and heavily wooded. Cottages and homes have been built around the perimeter of the reservoir.

b. Dam. Lovell Lake Dam is an earthen embankment with a vertical upstream concrete wall and a vertical downstream dry masonry wall. The dam is convex downstream. (See Appendix C - Figures 2, 3, and 4.) The dam is about 240 feet long and 10 feet high. The crest width ranges from 10 to 19 feet. Fill has been placed against the reservoir side of the upstream concrete wall and the water depth at the upstream concrete wall varies from 0 to 4 feet. The minimum freeboard at the time of the inspection was 1.1 feet. The crest of the dam is covered with grass. Grass cover along the south embankment is thin, with some bare patches of ground. Erosion along the south embankment, probably due to wave action, was noted. (See Appendix C - Figure 5.)

The Town of Wakefield has a public bathing beach on the south abutment of the dam. (See Appendix C - Figure 6.)

There are two seepages downstream of the dam. One of the seepages discharges at the east edge of the pavement on State Route 109 downstream from the downstream dry masonry wall. (See Appendix C - Figure 7.) The pavement is broken and the shoulder is soft at the location of this seepage. The water being discharged was clear at the time of the inspection. The second seepage is taking place about 13 feet from the downstream toe near the bathing beach at the south abutment. (See Appendix C - Figure 8.) The elevation at which the seepage was discharging was only 1.4 feet below lake level at the time of the inspection. The water being discharged was clear.

There is one stump at the top of the downstream dry masonry wall, and several trees are growing at the base of the downstream dry masonry wall.

At the time of the inspection, the freeboard in the vicinity of the south abutment was only 1.2 feet.

There are several cracks in the upstream concrete wall (see Appendix C - Figure 9); no leakage was observed at the downstream side of the dam in the vicinity of these cracks.

c. Appurtenant Structures. A three-sided overflow spillway is located near the center of the dam. The box spillway structure is approximately 36 feet long by 28 feet wide (outside dimension.) Each 36-foot long side contains four stoplog sections. (See Appendix C - Figure 10.) The end of the box spillway section has a 20 foot wide concrete overflow weir. (See Appendix C - Figure 11.) The lake level is primarily maintained by the stoplogs. There is no low-level outlet gate on the dam. One stoplog section extends to the bottom of the spillway discharge channel and can be used to drain the lake if all stoplogs were removed.

The box spillway is constructed upstream of the original dam and abuts the old stoplog spillway section and outlet channel. Design drawings indicate the box spillway was constructed subsequent to 1964.

The concrete walls and floor of the spillway are in good condition with only loss of surface laitance eroded away due to contact with discharge water. Numerous rocks and boulders (3-15"size) have been thrown into the discharge channel by vandals.

The concrete service bridge and railings are in good condition. The steel angle stoplog supports are showing only minor evidence of corrosion. The wood stoplogs are in good condition with some leakage noted between the stoplogs and around their ends.

The original concrete stoplog spillway section is still in place, immediately downstream of the newer concrete box spillway. (See Appendix C - Figure 12.) It was constructed integrally with the dam embankment, and has considerable surface erosion. The concrete surface has eroded exposing the coarse aggregate to a maximum depth of 1 inch.

The wooden shed that has been constructed over the discharge conduit is showing signs of deterioration. The inside of the shed could not be inspected to determine the function of the building in relation to the operation of the dam. Serious erosion, probably due to trespassing, is occurring on the downstream side of the embankment on both sides of the shed. (See Appendix C - Figure 13.)

d. Reservoir Area. The reservoir slopes are gentle to steep and are covered with trees and brush. (See Appendix C - Figure 6.) Numerous cottages and homes have been built

along the southeast portion of the perimeter of the reservoir. Little sedimentation was observed in the reservoir.

e. Downstream Channel. The downstream channel for approximately 80 feet below the dam is enclosed in a conduit, of varying cross sections, under State Route 109. The entrance to the conduit is concrete lined; below the exiting end the channel consists of sand, stones, and boulders. Brush and trees overhang the channel. (See Appendix C - Figure 14.)

3.2 Evaluation

Based on the visual inspection, the condition of Lovell Lake Dam is considered to be fair.

The principal conditions which are of concern with respect to the long-term stability of the dam are:

- (1) Small freeboard between summer pool level and top of dam;
- (2) Use of the sandy south abutment as a bathing beach with the attendant problems of trespassing on the south embankment and potential for serious erosion;
- (3) Erosion of the embankment at the shed;
- (4) Seepage at two locations downstream of the south embankment;
- (5) Presence of at least one stump and several trees near the downstream dry masonry wall and the possibility that piping could start when the tree roots rot;
- (6) Cracks in the upstream concrete wall through which leakage could occur, which could cause piping through the embankment; and
- (7) The rocks that have been dumped into the spillway structure could be carried into the discharge conduit and could partially plug the conduit.

SECTION 4 OPERATIONAL PROCEDURES

4.1 Procedures

No formal operational procedures were found. The dam has been owned and operated by the NHWRB since December of 1963. During the summer months the lake level is maintained by setting the stoplogs 10 inches below the ungated spillway crest. After the recreational season the lake is drawn down approximately 4 feet by removing stoplogs.

4.2 Maintenance of Dam

The NHWRB is responsible for maintaining the dam at Lovell Lake. No formal maintenance procedures were disclosed. The dam is visited on a weekly basis by the NHWRB.

4.3 Maintenance of Operating Facilities

There are no gates or operating mechanisms at Lovell Lake Dam.

4.4 Description of Any Warning System in Effect

No description of any warning system was disclosed.

4.5 Evaluation

The report of the inspection procedures for Lovell Lake dam states that no major problem of inspection. This could ensure that any problem encountered can be remedied before it becomes a major problem. The NHWRB should also establish a maintenance and warning system to follow in the future.

SECTION 5
HYDROLOGY AND HYDRAULIC ANALYSIS

5.1 Evaluation of Features

a. Design Data. No original hydrologic and hydraulic design data (circa 1820) were found for Lovell Lake Dam. However, hydrologic and hydraulic information, dating from the ownership of the structure by the Public Service Company of New Hampshire to the present ownership by the New Hampshire Water Resources Board, were found and assessed to determine their acceptability in evaluating the overtopping potential of Lovell Lake Dam.

b. Experience Data. No information regarding past overtopping of Lovell Lake Dam was found.

c. Visual Observations. No visual evidence was found of damage to the structure caused by overtopping at the time of the inspection. However, erosion of the upstream face, apparently caused by wave action, was noted.

d. Overtopping Potential. Lovell Lake Dam is classified as being intermediate in size having a maximum storage of 2,400 acre-feet. The normal recreation level has a surface area of 538 acres, which is equivalent to 17 percent of the watershed.

To determine the hazard classification for Lovell Lake Dam, the impact of failure of the dam at maximum pool was assessed using Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers. The analysis covered the reach extending from the dam to Route 109, immediately downstream of the dam. Failure of Lovell Lake Dam at maximum pool would probably result in an increase in stage of approximately 1 foot over Route 109. An increase in water depth of this magnitude would probably result in the loss of less than 10 lives and cause appreciable property damage.

As a result of the analysis described above, Lovell Lake Dam was classified - Significant Hazard. Using OCE Recommended Guidelines for Safety Inspection of Dams, the recommended test flood is the Probable Maximum Flood. The test flood inflow for Lovell Lake Dam, having a drainage area of 4.9 square miles, was determined to be 3920 cfs (800 csm). The test flood discharge after routing was determined to be 3050 cfs (622 csm).

The inadequacy of the outlet works makes overtopping potential great during periods of high runoff. Lovell Lake Dam is unable to pass the test flood without overtopping. The water depth over the dam embankment was calculated to be 1.6 feet. The spillway capacity, with all stoplogs removed, is less than 44 percent of the test flood. The capacity of the conduit downstream of the spillway is only 4 percent of the test flood.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The visual observation revealed the following conditions that may affect the long-term integrity of the dam:

(1) Seepages along the toe of the left embankment. The seepages occurring under the current low head indicate that areas within the embankment are permeable.

(2) Erosion of the embankment near the storage shed caused by trespassing, and general potential for erosion of the dam embankment initiated by uncontrolled trespassing on the dam.

(3) Low freeboard and inadequate outlet discharge capacity which may cause the dam to be overtopped and eroded during periods of high inflow or wave activity.

(4) Numerous cracks in the curved upstream wall. These cracks are sources of flow of water into the embankment which may eventually lead to piping and erosion.

(5) Trees growing from the downstream face. The tree roots could lead to piping when the roots decay.

(6) Lack of sufficient vegetation and erosion protection along the south embankment.

b. Design and Construction Data. No information was disclosed indicating the as-built conditions of the original dam, foundation material, or character of the earthfill. Design drawings dated November 9, 1964, by the NHWRB are available for the three sided concrete box spillway. Visual inspection indicated the physical conditions are similar to the information provided on the design drawings.

c. Operating Records. No records pertinent to the structural stability of the dam were disclosed.

d. Post-Construction Changes. In 1918, the upstream side was refaced with reinforced concrete, 15 inches thick, and the sluiceway and gate were reconstructed. The box spillway was added by the NHWRB in 1965.

e. Seismic Stability. This dam is in Seismic Zone 2, and hence does not have to be evaluated for seismic stability according to the OCE Recommended Guidelines.

SECTION 7
ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection indicates that the dam is in fair condition. The principle concerns with respect to the condition of the dam are:

(1) The spillway and the conduit that extends from the spillway to the west side of Route 109, downstream of the dam, are not adequate to carry the test flood;

(2) Small freeboard between summer pool level and top of dam;

(3) Seepage at two locations downstream of the south embankment;

(4) Use of the sandy south abutment, which has no vegetation, as a bathing beach, with the attendant problems of trespassing and erosion;

(5) Erosion of the embankment on both sides of the storage shed;

(6) Presence of at least one stump and several trees near the downstream dry masonry wall, and the possibility that piping could start along channels formed when the tree roots rot;

(7) Cracks in the upstream concrete wall through which leakage could occur and cause piping through the embankment; and

(8) Rocks that have been dumped into the spillway structure which could be carried into the discharge conduit and could partially plug the conduit.

b. Adequacy of Information. The information available is such that the assessment of the dam must be based primarily on the visual inspection.

c. Urgency. Recommendations in 7.2 below should be implemented by the owner within 2 years after receipt of this Phase I report. The operating and maintenance procedures in 7.3.b. below should be implemented by the owner within 1 year after receipt of this Phase I report.

d. Need for Additional Investigation. The information available from the visual inspection is adequate to identify

the potential problems which are: overtopping, seepage, and leakage into the control shaft of the gates. These problems require the attention of a competent engineer who will have to make additional engineering studies to design or specify remedial measures to rectify the problems. If left unattended, the problems could lead to instability of the structure.

7.2 Recommendations. It is recommended that the NHWRB should accomplish the remedial measures resulting from the following:

- a. Evaluate further the hydrology and hydraulics of the reservoir, dam, spillway, and discharge conduit, and design such changes as are necessary.
- b. Remedy the seepage conditions at the two locations downstream of the south half of the dam.
- c. Modify the beach area near the south abutment in such a way as to permit the use of the beach and at the same time ensure against trespassing and erosion.

7.3 Remedial Measures

a. Alternatives. The NHWRB should, as a practical alternative pending implementation of the above recommendations, operate the summer lake level at least six inches lower so as to provide more storage and freeboard, thereby minimizing the potential for overtopping during any major flood event.

b. Operating and Maintenance Procedures.

- (1) Repair the erosion next to the storage shed.
- (2) Monitor the seepage downstream of the dam on a weekly basis.
- (3) Control trespassing on the dam which could lead to erosion and further vandalism.
- (4) Remove the rocks that have been dumped in the spillway structure by vandals and control trespassing.
- (5) Remove trees, stumps, and roots from the dam, and backfill the root excavations with a suitable soil under the direction of a competent engineer.
- (6) Repair the cracks in the concrete upstream side of the dam.

(7) Establish a round the clock surveillance during periods of unusually heavy rainfalls, and develop a formal warning system for alerting residents in case of emergency. The warning system should be included also in the written procedures of "Project Linkup", a disaster plan involving Civil Defense (as coordinator), state agencies, and town officials. "Project Linkup", at this time, is in draft form awaiting the Governor's approval.

(8) Continue periodic inspection systems on a bi-annual frequency.

APPENDIX A
CHECK LIST - VISUAL INSPECTION

VISUAL INSPECTION CHECK LIST

PARTY ORGANIZATION

PROJECT Lovell Lake Dam, N.H.

DATE June 19, 1978

TIME 10:00 A.M.

WEATHER Sunny, warm

W.S. ELEV. 570.1 U.S. 560.7 D.N.S.

PARTY:

- | | |
|-----------------------------|-----------|
| 1. <u>Warren Guinan</u> | 6. _____ |
| 2. <u>Stephen Gilman</u> | 7. _____ |
| 3. <u>Robert Langen</u> | 8. _____ |
| 4. <u>Robert Hirschfeld</u> | 9. _____ |
| 5. <u>John Falcione</u> | 10. _____ |

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>Hydrology/Hydraulics</u>	<u>R. Langen</u>	
2. <u>Structural Stability</u>	<u>S. Gilman</u>	
3. <u>Soils and Geology</u>	<u>R. Hirschfeld</u>	
4. <u>Mechanical</u>	<u>J. Falcione</u>	
5. _____	_____	
6. _____	_____	
7. _____	_____	
8. _____	_____	
9. _____	_____	
10. _____	_____	

PERIODIC INSPECTION CHECK LIST

PROJECT Lovell Lake Dam, NH DATE June 19, 1978

PROJECT FEATURE Dam Embankment NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	568.9
Current Pool Elevation	570.1
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	Not paved
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Erosion of embankment next to gatehouse
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	Town beach is partly on south end of dam
Sloughing or Erosion of Slopes or Abutments	See "Condition at Abutment and at Concrete Structures"
Rock Slope Protection - Riprap Failures	None
Unusual Movement or Cracking at or near Toes	None observed
Unusual Embankment or Downstream Seepage	Seepage at two locations downstream of dam
Piping or Boils	None observed
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	None observed

PERIODIC INSPECTION CHECK LIST

PROJECT Lovell Lake Dam, NH

DATE June 19, 1978

PROJECT FEATURE Spillway outlet and conduit

NAME _____

DISCIPLINE _____

NAME _____

AREA EVALUATED

CONDITION

OUTLET WORKS - OUTAKE CHANNEL AND INTAKE STRUCTURE

a. Approach Channel

Slope Conditions

Lovell Lake forms the approach

Bottom Conditions

Vertical slopes

Rock Slides or Falls

Not visible

Log Boom

None

Debris

None

Condition of Concrete Lining

None

Drains or Weep Holes

Not applicable

None visible

b. Intake Structure

Condition of Concrete

Good

Stop Logs and Slots

Good condition. Considerable leakage through stoplog joints

PERIODIC INSPECTION CHECK LIST

PROJECT Lovell Lake Dam, NH

DATE June 19, 1978

PROJECT FEATURE Spillway Weir

NAME _____

DISCIPLINE _____

NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel	See previous page
General Condition	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Approach Channel	
b. Weir and Training Walls	
General Condition of Concrete	Good
Rust or Staining	Only at embedded angles at stop logs
Spalling	None
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None
Drain Holes	None
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Several trees overhang channel
Floor of Channel	Sand, gravel and boulders
Other Obstructions	None observed

PERIODIC INSPECTION CHECK LIST

PROJECT Lovell Lake Dam, NH

DATE June 19, 1978

PROJECT FEATURE Service Bridge

NAME _____

DISCIPLINE _____

NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SERVICE BRIDGE</u>	
a. Super Structure	To stoplogs and spillway
Bearings	Concrete to concrete
Anchor Bolts	None
Bridge Seat	None
Longitudinal Members	Good
Under Side of Deck	Good
Secondary Bracing	None
Deck	Good
Drainage System	None
Railings	Good Condition
Expansion Joints	None
Paint	Railings good
b. Abutment & Piers	
General Condition of Concrete	Good
Alignment of Abutment	No visible movement
Approach to Bridge	N/A
Condition of Seat & Backwall	Concrete - Good

PERIODIC INSPECTION CHECK LIST

PROJECT Lovell Lake Dam, NH

DATE June 19, 1978

PROJECT FEATURE Conduit Entrance

NAME _____

DISCIPLINE _____

NAME _____

AREA EVALUATED

CONDITION

OUTLET WORKS - TRANSITION AND CONDUIT

General Condition of Concrete

Rust or Staining on Concrete

Spalling

Erosion or Cavitation

Cracking

Alignment of Monoliths

Alignment of Joints

Numbering of Monoliths

Surface eroded due to years of submergence. Visual observation indicates that an average of $\frac{1}{2}$ inch has eroded away from surface with a maximum of 2 inches on right wing wall. No reinforcing was visible.

PROJECT Lovell Lake Dam, NH

DATE June 19, 1978

PROJECT FEATURE Reservoir

NAME R. Langen

AREA EVALUATED	REMARKS
Stability of Shoreline	Good
Sedimentation	No visible problems
Changes in Watershed Runoff Potential	Minor
Upstream Hazards	Several homes; lowest is about 6' above lake
Downstream Hazards	Road, culvert, garage
Alert Facilities	None observed
Hydrometeorological Gages	None
Operational & Maintenance Regulations	None observed

APPENDIX B
INSPECTION REPORTS/SKETCHES

August 12, 1975

Board of Selectmen
Wakefield
New Hampshire 03838

Gentlemen:

A recent inspection of the dam at the outlet of Lovell Lake indicates that this area, which is adjacent to the town's beach area, under lease from the Water Resources Board, is being abused.

At the time of the inspection parties using the bathing facilities were swimming in the area adjacent to the dam, which is in violation of the lease agreement; were pulling stone off the bottom of the pond and depositing them below the spillway; the stone retaining wall downstream of the dam is being torn apart; i.e., individual stones are being rolled into the area below the embankment; stones are being dropped into the culvert entrance below the gatehouse; and a fence on the dam has been dismantled, therefore opening up access to the dam from the beach area.

This office requests that the town of Wakefield more properly supervise this area and maintain it from damage. Dam operators from the Water Resources Board's office have been told that no one is allowed on the dam; however, it appears that the other conditions existing above are not being supervised.

Could we suggest that the energy used to place the stones within the spillway be again used to remove them from this area so that during times of high flow they do not impede the flow under the highway and become deposited downstream. During the fall while our construction crew is in the immediate area we hope to make other changes to the structure which will help eliminate some of this problem.

Our staff is always available to assist you in accomplishing the above.

Respectfully yours,

George M. McGee, Sr.
Chairman

GMS/VAK/pd

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION

STATE NO. 241.06 ✓
Town Wakefield : County Carroll
Stream Lovells Lake
Basin-Primary Piscataqua R. : Secondary Salmon Falls R.
Local Name
Coordinates—Lat. : Long.

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 4.58 ✓ Sq. Mi.
Overall length of dam 260 ft.: Date of Construction
Height: Stream bed to highest elev. 11.167 ft.: Max. Structure ft.
Cost—Dam : Reservoir

DESCRIPTION

Boulders & Gravel

Waste Gates

Type
Number 1 : Size 5 ft. high x 5.417 ft. wide
Elevation Invert 11.5 : 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 NONE ✓
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 cfs.: cfs/sq. mi.

Abutments

Materials:
Freeboard: Max. ft.: Min. ft.

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

OWNER Public Service Co. of NH, Manchester, NH. ✓

REMARKS Menace—(Lovell's Lake is limited to a 3ft. drawdown by Sept 15,
by an informal agreement P.S.Co.
Use—Conservation, Public Utility.

Tabulation By RLT Date 9/20/59

**NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON RESERVOIRS & PONDS IN NEW HAMPSHIRE**

LOCATION

AT DAM NO. 241.06

Town Wakefield : County Carroll

Stream Lovells Lake

Basin—Primary Piscataqua R. : Secondary Salmon Falls

Local Name

DRAINAGE AREA

Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 4.58 Sq. Mi.

ELEVATION vs. WATER SURFACE AREA vs. VOLUME

Point	Head Feet	Surface Area Acres	Volume Acre Ft.
(1) Max. Flood Height	.....	.....	.....
(2) Top of Flashboards	.....	.....	.....
(3) Permanent Crest	<u>5PSC,</u>	.....	<u>2160-PSC,</u>
(4) Normal Drawdown	<u>3.5WRB</u>	<u>536</u>	<u>1380WRB</u>
(5) Max. Drawdown	.....	.....	.....
(6) Original Pond	.....	.....	.....

Base Used: Coef. to change to U.S.G.S. Base

RESERVOIR CAPACITY

	Total Volume	Useable Volume
Drawdown	.....ft.	.....ft.
Volume	.....ac. ft.	.....ac. ft.
Acre ft. per sq. mi.	.....	.....
Inches per sq. mi.	.....	.....

USE OF WATER Conservation-Public Utility

OWNER Public Service Co., of NH Manchester, NH

REMARKS

Tabulation By BLT Date 9/10/32

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASED Ocean NO. 6 - 534 - I - 4804 (4.7PSCo)
 PLANT Lorell's Lake MILES FROM MOUTH D.A.S.Q.NE. 4.58
 DRAIN Wakefield OWNER Public Service Co. of N.H., Manchester
 TYPE Gravity Boulders Earth
 FOUND Concrete on Earth

PERMIT NO. 538 DRAINAGE FT. 3.5 FLOOD CAPACITY - ACRE FT. 2180 PSCo
 HEIGHT - TOP TO BED OF STREAM - FT. 11.167 MAX. MIN. 1880 W.B.
 OVERALL LENGTH OF DAM - FT. 260± MAX. FLOOD HEIGHT ABOVE CREST - FT. 11.5
 ELEV. OF CREST ELEV. U.S.G.S. None LOCAL ALIGNMENT
 TAILWATER ELEV. U.S.G.S. None LOCAL GAGE
 SPILLWAY LENGTHS - FT. None FREEBOARD - FT. 11.5
 FLASHING TYPE, HEIGHT ABOVE CREST
 WEIR TYPE - U.S. WEIR MAX. OPENING 1 5.417 5 11.5
 SILL BELOW CREST

REMARKS Condition Good Depth sill gate below crest from inspection

7.5 into Branch R. Salmon Falls Piscataqua
P.S.C. says 157 cfs weeks at 5' useful draft

POWER DEVELOPMENT

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

Conservation, Public Utility
Conservation, Public Utility

Mendee * here Lorell's Lake is limited to 3 ft draft
by Sept 15th by an informal agreement. PSCo

10/1/35

TOWN	WAKEFIELD	TOWN NO.	6	STATE NO.	52-241
RIVER STREAM DRAINAGE AREA	Novellis Pond L. A. R. A.		POND AREA		
DAM TYPE	Gravity		FOUNDATION NATURE OF Earth		
MATERIAL OF CONSTRUCTION Boulders, Earth, Concrete					
PURPOSE OF DAM POWER- <u>CONSERVATION</u> -DOMESTIC-RECREATION-TRANSPORTATION-PUBLIC UTILITY					
HEIGHTS TOP OF DAM TO BED OF STREAM		11'-2"		TOP OF DAM TO SPILLWAY CRESTS	
SPILLWAYS LENGTHS		None		LENGTH OF DAM	
DEPTHS BELOW TOP OF DAM		Gate opening 5' high 5'-5" wide		Approx. 260'	
FLASHBOARDS TYPE, HEIGHT ABOVE CREST					
OPERATING HEAD		TOP OF FLASHBOARDS TO N. T. W.			
CREST TO N. T. W.		TO N. T. W.			
WHEELS NUMBER					
KINDS & H. P.					
GENERATORS NUMBER					
KINDS & K. W.					
H. P. 90 P. C. TIME		H. P. 75 P. C. TIME			
100 P. C. EFF.		100 P. C. EFF.			
REFERENCES, CASES					
PLANS, INSPECTIONS					
REMARKS Condition fair					

211

OWNER Pull Service Co. of N. H.
Manchester, N. H.

CONTRACTOR

NO.

APPLICATION

RECEIVED

INVESTIGATED BY

DATE

IF DAM IMPROPERLY CONSTRUCTED IT Would

BE A MENACE TO THE PUBLIC SAFETY

IS DAM SUBJECT TO PROVISIONS OF P. L. CHAP. 218, SECTS 15-26?

Yes

RECEIVED

CHECKED BY

DATE

PLANS &
SPECIFICATIONS

APPROVED BY COMMISSION

COMMISSION CONSTRUCTION INSPECTOR

FINAL COMPLETION APPROVAL

CHARGES

PAID

IS DAM SUBJECT TO PERIODIC INSPECTION?

Yes

DAM INSPECTION RECORD

DATE	REPORT	CHARGES	PAID	DATE	INSPECTOR	REPORT	CHARGES	PAID
10/1/51	Condition fair							

Town No. 0 Town Wakefield No.
 Data by U.S.G.S. File
 Owner Great Falls Manufacturing Company
 River or Stream Lovells Pond Outlet
 Public Utility In Part Drainage area sq. mi.
 Wheel Capacity H. P. { Primary H. P. }
 { 90% time }
 Type of Construction Stone and Concrete
 Height 10 ft. Operating Head 6 ft. Storage ft.
 Length 120 ft. Spillway Length (No. 1) ft. (No. 2) ft.
 Would Failure of Dam do Harm? Yes
 Present Condition Good Date 1922
 LWB Good 1925

SURVEYS.
PLANS AND
ESTIMATES
MADE FOR
DAMS,
PULP AND
PAPER
MILLS.
ELECTRIC
POWER
PLANTS.
ETC.

I. W. JONES & CO.



ENGINEERS AND DESIGNERS
OF WATER POWER PLANTS

TELEPHONE CONNECTION

MILTON, NEW HAMPSHIRE

December 16, 1920.

REFERENCE

Public Service Commission,

Atten. John F. Storrs, C.E.

Concord, N.H.

Gentlemen:-

Yesterday I visited the outlet of Lovell Lake in
Sambornville, which was the first opportunity I have had since
writing you on December 9th., and made a careful examination of
the conditions existing there.

I found that there is no spillway in connection with
the dam and the only means of drawing off the water is through
a waste gate opening 5'0" X 5'0". The distance from the bottom
of the discharge flume to the top of the concrete work is approx-
imately 11'0", therefore, the center of the gate opening is 8'6"
below the top of the concrete wall. The iron pins cast into
the sides of the intake walls, presumably limiting the legal
height to which the water may be carried, is approximately 16"
from the top of the concrete walls, resulting in a depth from
the iron pins to center of gate opening of approximately 7'2".
I found the water surface today to be 2" above the iron pins,
and the gate was then raised about one ft. which appeared to be
taking care of the present flow, which must be far above the

I am enclosing a blue print of sketch which I have prepared, which fairly shows the conditions at the outlet, on a scale of 3/32 inch. to a foot. This sketch does not hold true to scale in all respects as the width of pond was simply estimated. On this print at the point marked "low", I found the surface of the water to be within 8" of the top of the embankment. This condition, however, extends only for a short distance, possibly 20', beyond which the banks are fully as high as the surface of the concrete walls shown. I find by computing the drainage area tributary to Lovell Lake, from the best map which I possess, to be 5.6 sq. miles, and have computed the discharge of the wastegate, assuming the surface of the lake to be 4" below the top of the concrete walls, to be approximately 65 cubic feet per second. The control of this gate is in charge of Mr. James Young, who is employed by the Great Falls Manufacturing Company. Mr. Young has a garage located adjacent to the dam, and it is presumed that he has a telephone connection with his company, and acts upon their orders. I have no doubt that in case of Mr. Young's disability the Great Falls Manufacturing Company would arrange for a substitute. A similar condition exists here at the main dam in Milton, ^{where ponds} where flashboards are maintained to the extreme legal height to which the water may rise and the control of the flashboards is dependent upon the care of the operator.

In the case of Lovell Lake, my judgment is that if the pond should over-flow by neglect of the operator that no great damage would be done, although there might be some inconvenience to the

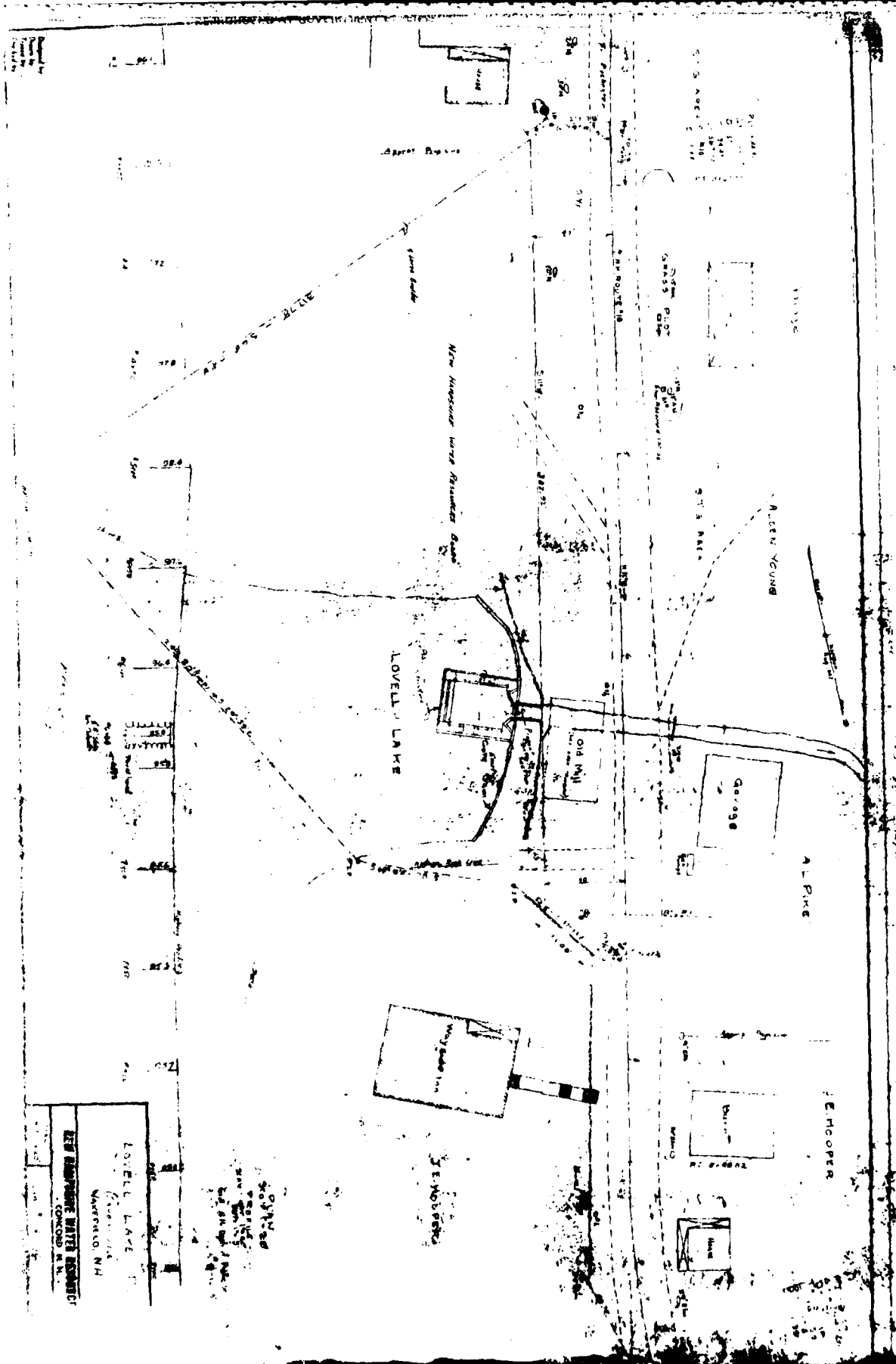
#3

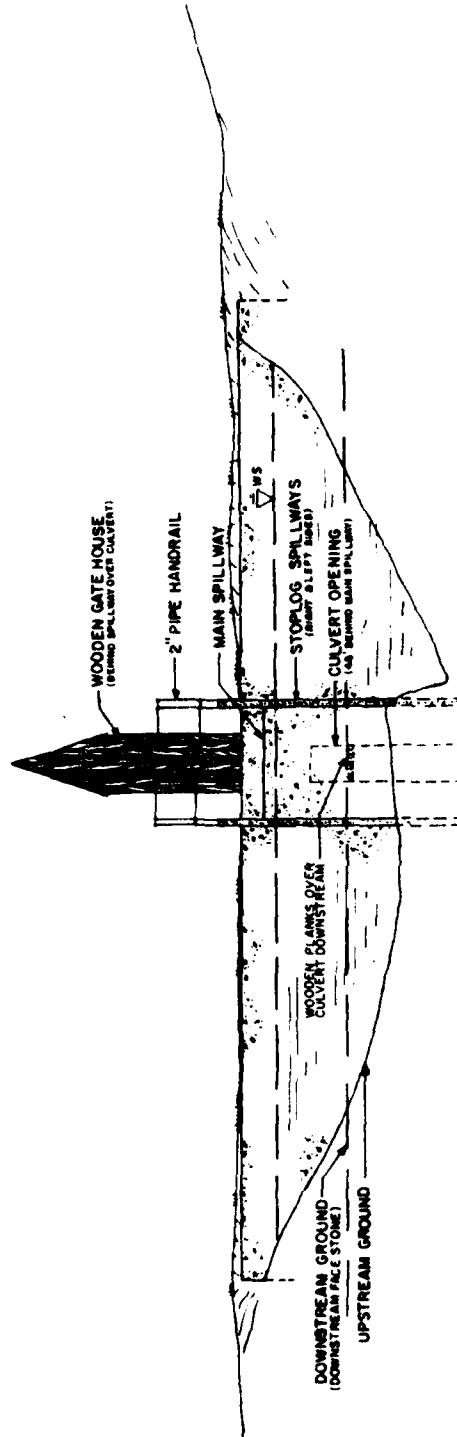
public by reason of over-flowing the road.

I trust that the sketch submitted, and the above description will give you the information which you desire. If this is not so, and you desire further information, I shall be glad to serve you upon request.

Very truly yours,

Copy:
Office.





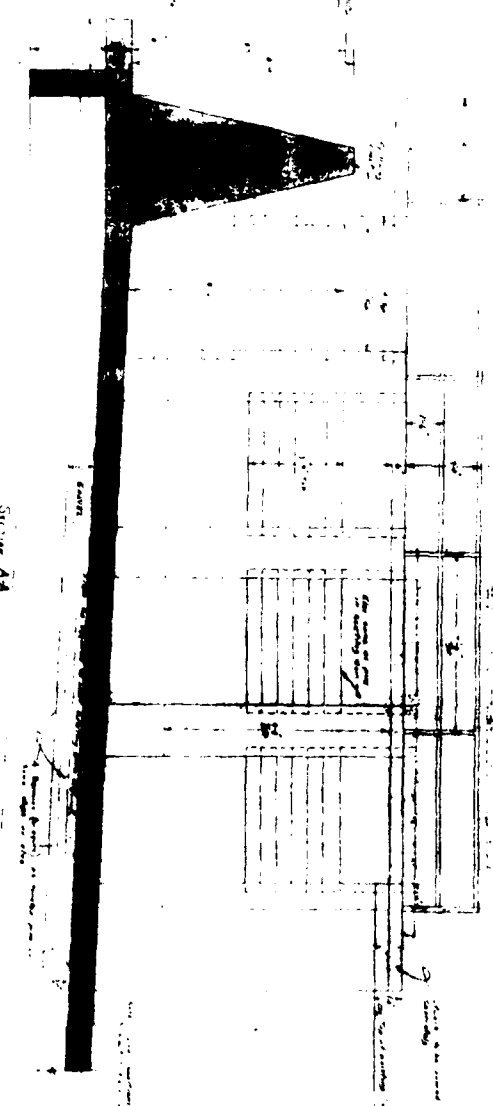
ELEVATION

Auderman-McGowan & Co., Inc. NEW HAMPSHIRE CONTRACTORS	U.S. ARMY ENGINEER DIV. NEW ENGLAND COMP. OF 7 BATTALIONS BUILT 1945, 1946
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
LOVELL LAKE DAM	
LOVELL LAKE	NEW HAMPSHIRE
SCALE NOT TO SCALE	
DATE AUGUST 1972	

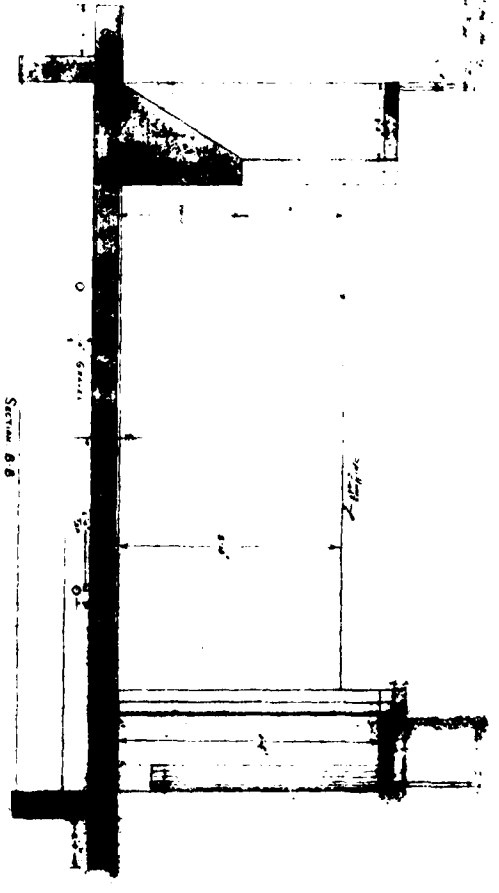
DATE

REVISIONS

Drawn by: [illegible]
 Checked by: [illegible]
 Date: [illegible]



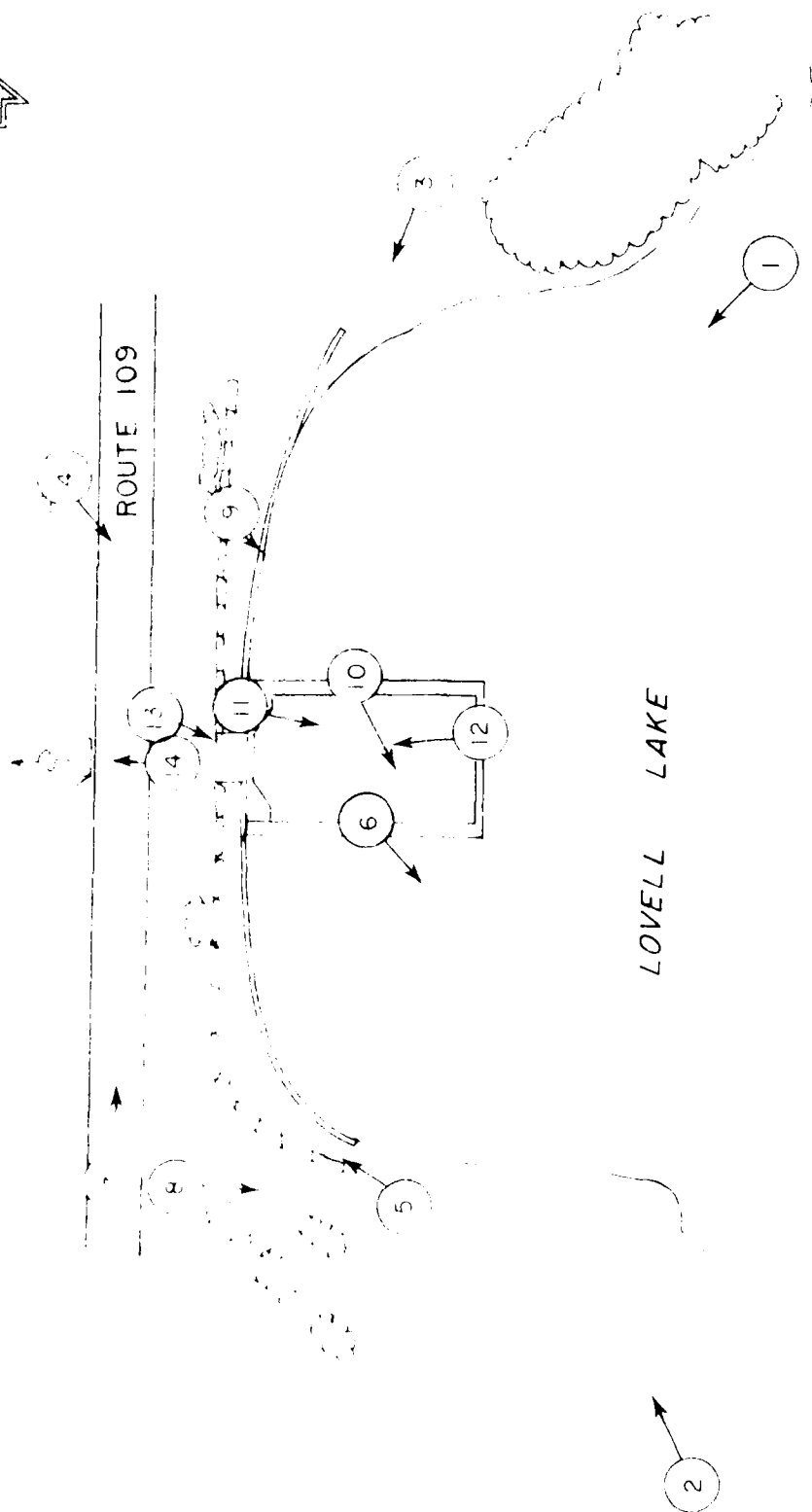
Section A-A	
Structural (material)	
BY [illegible] DATE [illegible]	
CONC'D N.Y.	
Scale	1" = 1'-0"



Section B-B

Notes:
 1. [illegible]
 2. [illegible]
 3. [illegible]

APPENDIX C
PHOTOGRAPHS



Anderson-Nichols & Co., Inc.		U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	
CONCORD		NEW HAMPSHIRE	
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS			
LOVELL LAKE		NEW HAMPSHIRE	
		SCALE NOT TO SCALE	
		DATE AUGUST 1978	



Figure 4 - Looking at the downstream face of the dam.



Figure 5 - Looking at the low point in the south embankment. Note the erosion near the water's edge and the bare patches of ground along the crest.



Figure 2 - Looking northwest at the upstream face of the dam.



Figure 3 - Looking southwest at the upstream face of the dam.



Figure 6 - Looking upstream at the reservoir and the beach near the south abutment.



Figure 7 - Looking north along Route 100. The downstream face of the dam is visible at the extreme right edge of the photo. Note the deep gap in the vegetation at the nearest telephone pole.



Figure 8 - Seepage just downstream of the south
embankment.



Figure 9 - Crack in the upstream concrete facing.
There are similar cracks every 4 to 6
feet.



Figure 10 - North end of south stoplog spillway.
Note the rocks at the base of the
spillway.



Figure 11 - Looking upstream at the concrete over-
flow spillway.

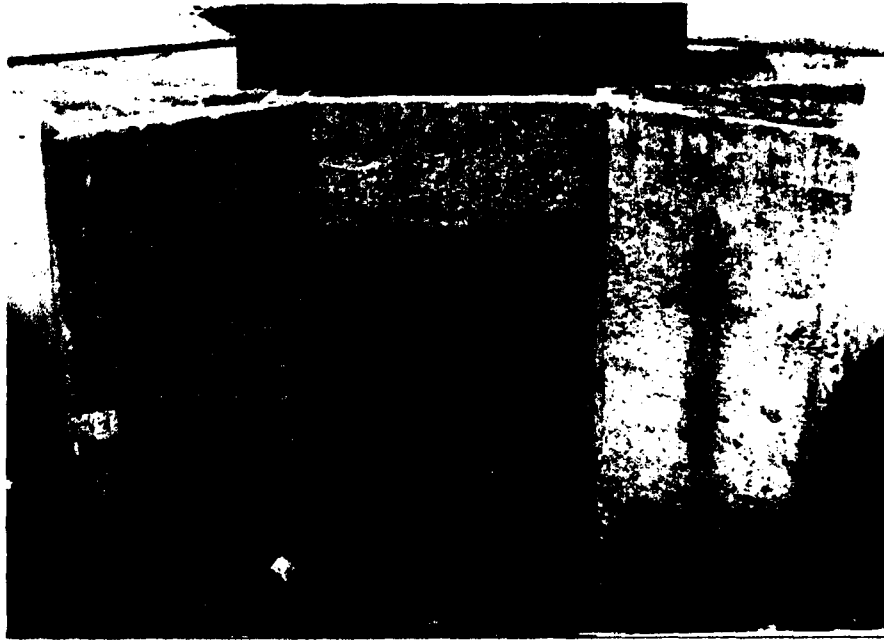


Figure 12 - Looking downstream at the entrance to the outlet channel.

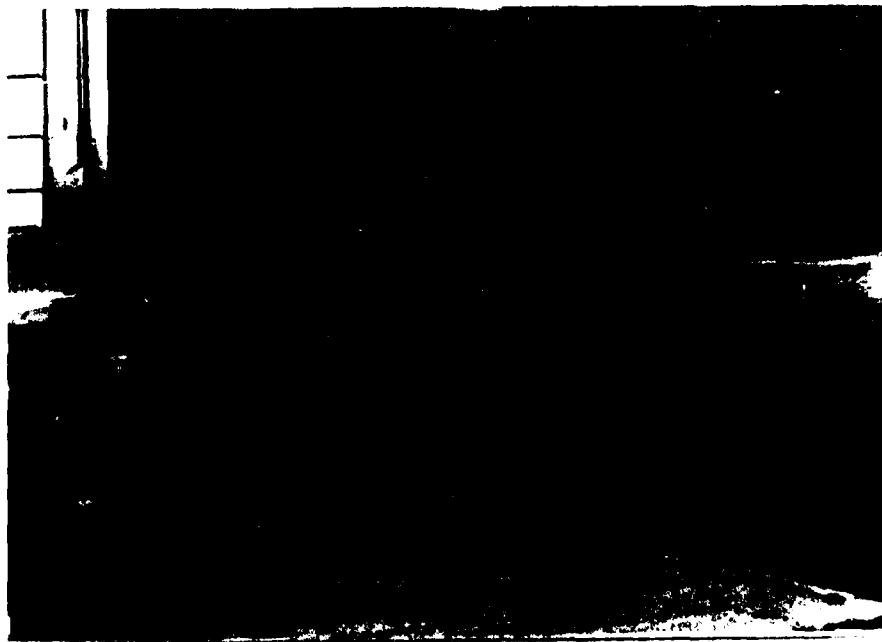
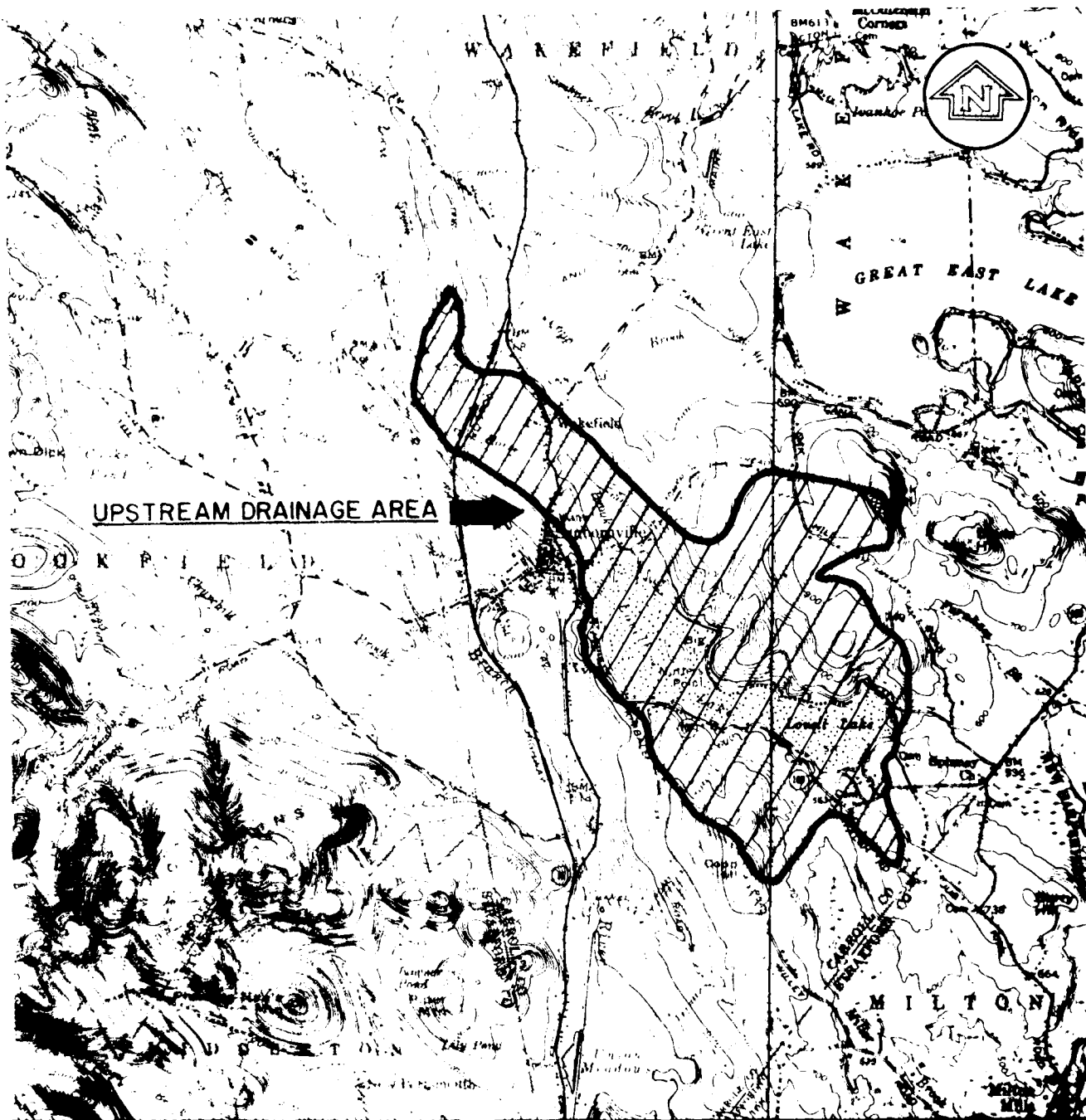


Figure 13 - Looking upstream at the base of the storage shed. Note the erosion along both sides of the shed.



Figure 14 - Looking from the storage shed at the channel downstream of Route 109.

APPENDIX D
HYDROLOGY/HYDRAULICS



**NATIONAL PROGRAM OF INSPECTION OF
NON-FED DAMS**

LOVELL LAKE DAM

WAKEFIELD, NEW HAMPSHIRE

REGIONAL VICINITY MAP

AUGUST 1978

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

ANDERSON, NICHOLAS B. JR.

NEWTON, NH

SCALE IN MILES



MAP BASED ON U.S.G.S 15 MINUTE QUADRANGLE
SHEETS WOLFEBORO, N.H., 1958, NEWFIELD, ME.-
NH, 1958

H/H
LOVELL LAKE

1/14

HYDROLOGY

6/29/78
(30)

LOVELL LAKE

STEP

1: PROBABLE MAXIMUM FLOOD DETERMINATION (PMF)

RE: PRELIMINARY GUIDANCE FOR ESTIMATING
MAXIMUM PROBABLE DISCHARGES IN PHASE I
DAM SAFETY INVESTIGATIONS, NED-COE,
MARCH 1978

USING FLAT & COASTAL CURVE TO DETERMINE
PMF PEAK INFLOW

DA = 5.6 sq miles	(IWJCo	20)
DA = 4.7 sq miles	(WRB	64)
DA = 4.7 sq miles	(PSCo	32)
DA = 4.4 sq miles	(WRB	68)
DA = 4.58 sq miles	(WRB	39)
DA = 4.58 sq miles	(PSCo	35)
DA = 5 sq miles	(COE	74)
DA = 4.88 sq miles	(ANCo	78)

USING DA = 4.9 sq miles

PMF = 800 cfs / sq mile

PMF = 800 cfs / sq mile x 4.9 sq miles

PMF = 3920 cfs

LOVELL LAKE HYDROLOGY & HYDRAULICS

① $PMF = 3920 \text{ cfs} = Q_{P_1}$
 STAGE = 573.3 MSL (SEE RATING CURVE)

② $\begin{matrix} @ 573.3 & \text{STOR} & = & 4050 \text{ AF} \\ @ 570.0 & \text{STOR} & = & 2000 \text{ AF} \end{matrix} \left\{ \text{SEE STORAGE CURVE} \right\}$

$\therefore \text{STORAGE OF SURCHARGE} = \text{STOR}_1 = 2050 \text{ AF}$

③ $2050 \text{ AF} \times 1/4.9 \text{ sq miles} \times 1/640 = 0.654'$

$0.654' = 7.8'' \text{ OF RUNOFF OVER BASIN}$

④ $Q_{P_2} = Q_{P_1} \times \left(1 - \frac{\text{STOR}_1}{19} \right) = 3920 \times \left(1 - \frac{7.8}{19} \right)$

$Q_{P_2} = 2310 \text{ cfs}$

⑤ FROM RATING CURVE: STAGE @ 2310 cfs = 572.5 MSL

⑥ $\begin{matrix} @ 572.5 & \text{STOR} & = & 3550 \text{ AF} \\ @ 570.0 & \text{STOR} & = & 2000 \text{ AF} \end{matrix} \left\{ \text{FROM STORAGE CURVE} \right\}$

$\therefore \text{STORAGE OF SURCHARGE} = \text{STOR}_2 = 1550 \text{ AF}$

⑦ $1550 \text{ AF} \times 1/4.9 \text{ sq miles} \times \frac{1}{640} = 0.494$

$0.494' = 5.9'' \text{ OF RUNOFF OVER BASIN}$

⑧ $\begin{matrix} \text{STOR}_1 = 7.8'' \\ \text{STOR}_2 = 5.9'' \end{matrix} \left\{ \text{AVE STOR} = 6.85'' \right\}$

$6.85'' \times 4.9 \text{ sq miles} \times 1/12 \times 640 = 1790 \text{ AF}$

$\text{STORAGE} = 1790 + \overset{D-3}{2000} = 3790 \text{ AF}$

3/10

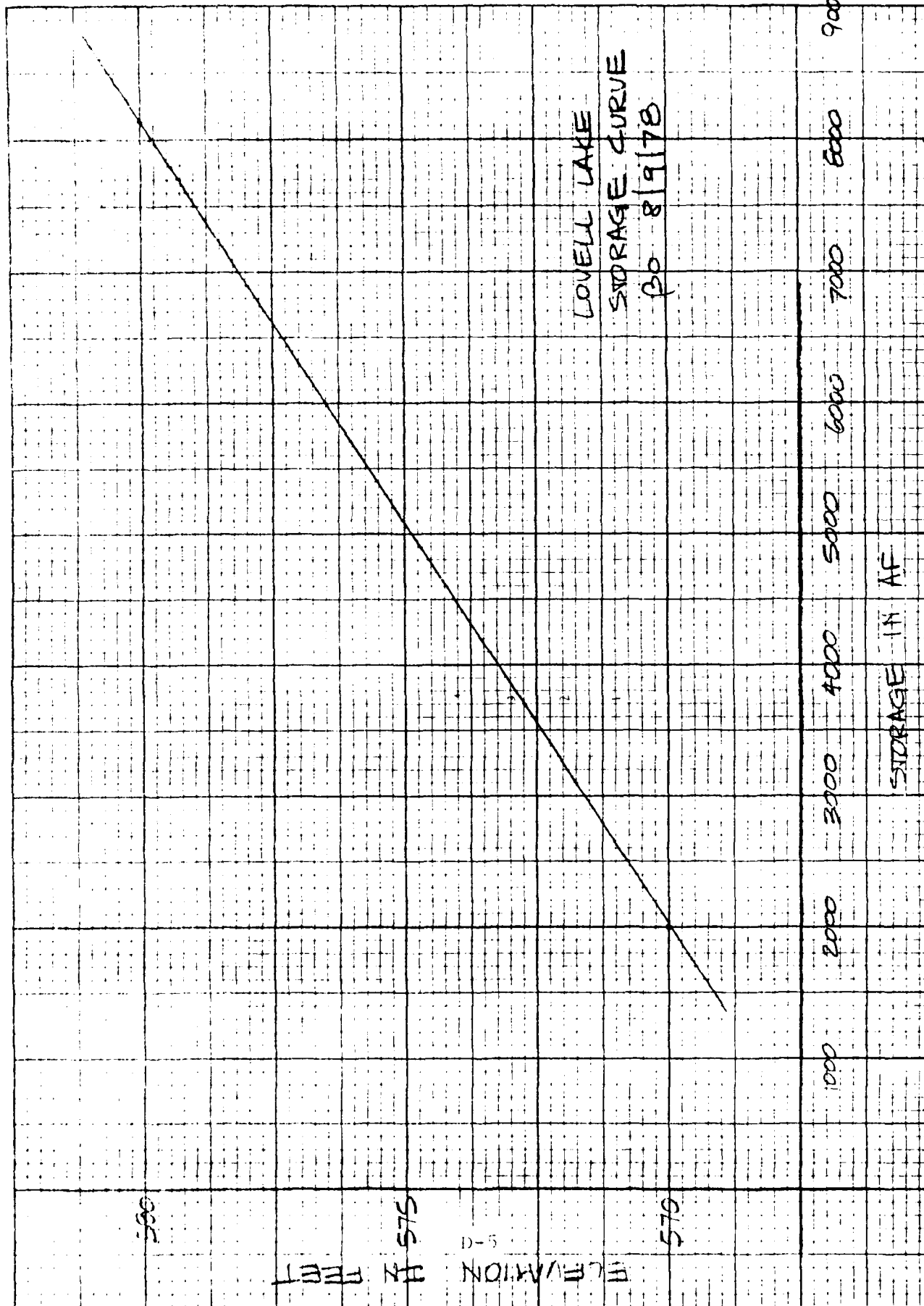
FROM STORAGE CURVE: STAGE @ 3790 AF = 572.9

FROM RATING CURVE: Q @ 572.9 = 3050 cfs

$$Q_{PF3} = PMF = 3050 \text{ cfs @ } 572.9$$

CHECK AGAINST $\frac{1}{2} PMF = 1525 \text{ cfs}$

STAGE @ 1525 cfs = 572.16 \approx 572.2



5/14

LOUIE LAKE

HYDRAULIC COMPUTATIONS

(30 8/8/78

3141-01

RATING CURVE DATA

PIF = 3920 cfs

ASSUMPTIONS: STOPLOGS @ ELEV 570.0 MSL = FULL POND

RATING CURVE DATA

570.3 = CONCRETE SPILLWAY

$$Q_{\text{ALL STOPLOGS}} = CLH^{3/2}$$

C = 2.9 FOR STOPLOGS

L = 8 x 5 = 40'

H = 0.3

$$Q = (2.9)(40)(0.3)^{3/2} = \boxed{19 \text{ cfs}}$$

570.6 = LOW POINT ALONG BEACH TO LEFT OF STRUCTURE

$$Q_{\text{TOP}} = (2.9)(40)(0.6)^{3/2} = 54 \text{ cfs}$$

$$Q_{\text{SPILLWAY}} = CLH^{3/2}$$

C = 2.8 FOR SPILLWAY

L = 20

H = 0.3

$$Q_{\text{SPILL}} = (2.8)(20)(0.3)^{3/2} = 9 \text{ cfs}$$

$$\text{TOTAL} = 54 + 9 = \boxed{63 \text{ cfs}}$$

D-6

@ 570.8 = LOW POINT TO RIGHT OF STRUCTURE

$$Q_{\text{STOP}} = (2.9)(40)(0.8)^{3/2} = 83$$

$$Q_{\text{SPILL}} = (2.8)(20)(0.5)^{3/2} = 20$$

$$Q_{\text{LEFT}} = CLH^{3/2}$$

$C = 2.7$ FOR OVERLAND FLOW

$$L = \frac{1}{2} \times 20 = 10'$$

$$H = 0.2$$

$$Q_{\text{LEFT}} = (2.7)(10)(0.2)^{3/2} = 2$$

$$\text{TOTAL} = 83 + 20 + 2 = \boxed{105 \text{ cfs}}$$

@ 571.1

$$Q_{\text{STOP}} = (2.9)(40)(1.1)^{3/2} = 134$$

$$Q_{\text{SPILL}} = (2.8)(20)(0.8)^{3/2} = 40$$

$$Q_{\text{LEFT}} = (2.7)(20)(0.5)^{3/2} = 19$$

$$Q_{\text{RIGHT}} = (2.7)(10)(0.3)^{3/2} = \frac{4}{197}$$

$$\boxed{197 \text{ cfs}}$$

@ 571.8 = LOW CHORD OF CONCRETE WALKWAY

$$Q_{\text{STOP}} = (2.9)(40)(1.8)^{3/2} = 280$$

$$Q_{\text{SPILL}} = (2.8)(20)(1.5)^{3/2} = 103$$

$$Q_{\text{RIGHT}} = (2.7)(43)(1.0)^{3/2} + (2.7)(35)(0.7)^{3/2} = 171$$

D-7

$$\begin{array}{rcl}
 (2.7)(36)(0.1)^{1/2} & = & 83 \\
 (2.7)(27)(0.3)^{3/2} & = & 12 \\
 (2.7)(25)(0.1)^{3/2} & = & 2 \\
 (2.7)(14)(0.2)^{3/2} & = & 3 \\
 (2.7)(15)(0.4)^{3/2} & = & 10 \\
 (2.7)(23)(0.3)^{3/2} & = & 10 \\
 (2.7)(79)(0.1)^{3/2} & = & 7 \\
 \text{113} \Rightarrow (2.7)(212)(0.3)^{3/2} & = & 94
 \end{array}
 \left. \begin{array}{l} \\ \\ \\ \\ \\ \\ \end{array} \right\} \begin{array}{l} 100 \\ 27 \end{array}$$

$$280 + 103 + 171 + 100 + 27 + 94 = \boxed{775 \text{ cfs}}$$

TOP OF CONCRETE WALKWAY

AT THIS ELEVATION, STOPLOG BAY BEHAVING LIKE
ORIFICE UNDER PRESSURE FLOW

$$Q_{\text{orifice}} = CA\sqrt{2gh} \quad K = \frac{1}{C^2} \quad K_f = \frac{(29.1)(n^2)(L)}{R^{4/3}}$$

$$Q = (0.95)(72)(64.4 \cdot 1.7)^{1/2}$$

$$R = \frac{A}{P} \quad A = 1.8 \times 40 = 72$$

$$Q = 716 \text{ cfs}$$

$$WP = 3.10 + 8.1 = 11.2$$

$$Q = (2.8)(20)(2.0)^{3/2}$$

$$R = \frac{72}{83.6} = 0.861$$

$$= 158 \text{ cfs}$$

$$K_f = \frac{(29.1)(0.015)^2(0.33)}{(0.861)^{4/3}}$$

$$K_f = 0.003$$

$$\text{entrance} + \text{exit} = 1.1$$

$$\text{TOTAL } K = 1.1 \pm$$

$$K = \frac{1}{C^2} = 1.1$$

D-8

$$C = 0.95$$

$$Q_{\text{RIGHT}} = (2.7)(61)(1.5)^{3/2} + (2.7)(55)(1.2)^{3/2} = 498$$

$$Q_{\text{LEFT}_1} = 100$$

$$Q_{\text{LEFT}_2} = (81)(2.7)(0.2)^{3/2} + 20 = 40$$

$$Q_{\text{LEFT}_3} = (2.7)(215)(0.5)^{3/2} + (2.7)(224)(0.3)^{3/2} = 305$$

$$Q_{\text{LEFT}_4} = (2.7)(109)(0.4)^{3/2} = 74$$

$$\text{TOTAL } Q_{572.3} = 716 + 158 + 498 + 100 + 40 + 305 + 74$$

$$= \boxed{1891 \text{ cfs}}$$

@
elevation = 572.6

$$Q_{\text{STOP}} = (0.95)(72)(64.4 \cdot 2.0)^{1/2} = 776$$

$$Q_{\text{SPILL}} = 158$$

$$Q_{\text{LEFT}} = 100 + 40 + 305 + 74 = 519$$

$$Q_{\text{CUTS}} = (2.7)(449)(0.3)^{3/2} = 199$$

$$Q_{\text{RIGHT}} = (2.7)(70)(1.8)^{3/2} + (2.7)(66)(1.5)^{3/2} = 784$$

$$Q_{\text{TOT}} = 776 + 158 + 519 + 199 + 784 = \boxed{2436 \text{ cfs}}$$

@
573.5

$$Q_{\text{STOP}} = (0.95)(72)(64.4 \cdot 2.9)^{1/2} = 935$$

$$Q_{\text{SPILL}} = 519 + 158 =$$

$$Q_{\text{CUTS}} = (2.7)(458)(1.2)^{3/2} =$$

$$Q_{\text{RIGHT}} = 784 + (2.7)(71)(0.9)^{3/2} = 1478$$

611

1626

1478

4116

D-9

$$(0.95)(72)(64.4 \cdot 2.5)^{1/2} = 868$$

+ LEFT =

677

$$(2.7)(453)(0.8)^{3/2} =$$

875

$$= 784 + (2.7)(287)(0.5)^{3/2} = 1058$$

3478

$$(0.95)(72)(64.4 \cdot 2.7)^{1/2} = 902$$

677

$$(2.7)(451)(1.0)^{3/2} =$$

1218

$$(2.7)(294)(0.7)^{3/2} + 784 =$$

1249

4046

DISCHARGE IN CFS

LOVELL LAKE

RATING CURVE

8/19/78

SPILLWAY = 570.3

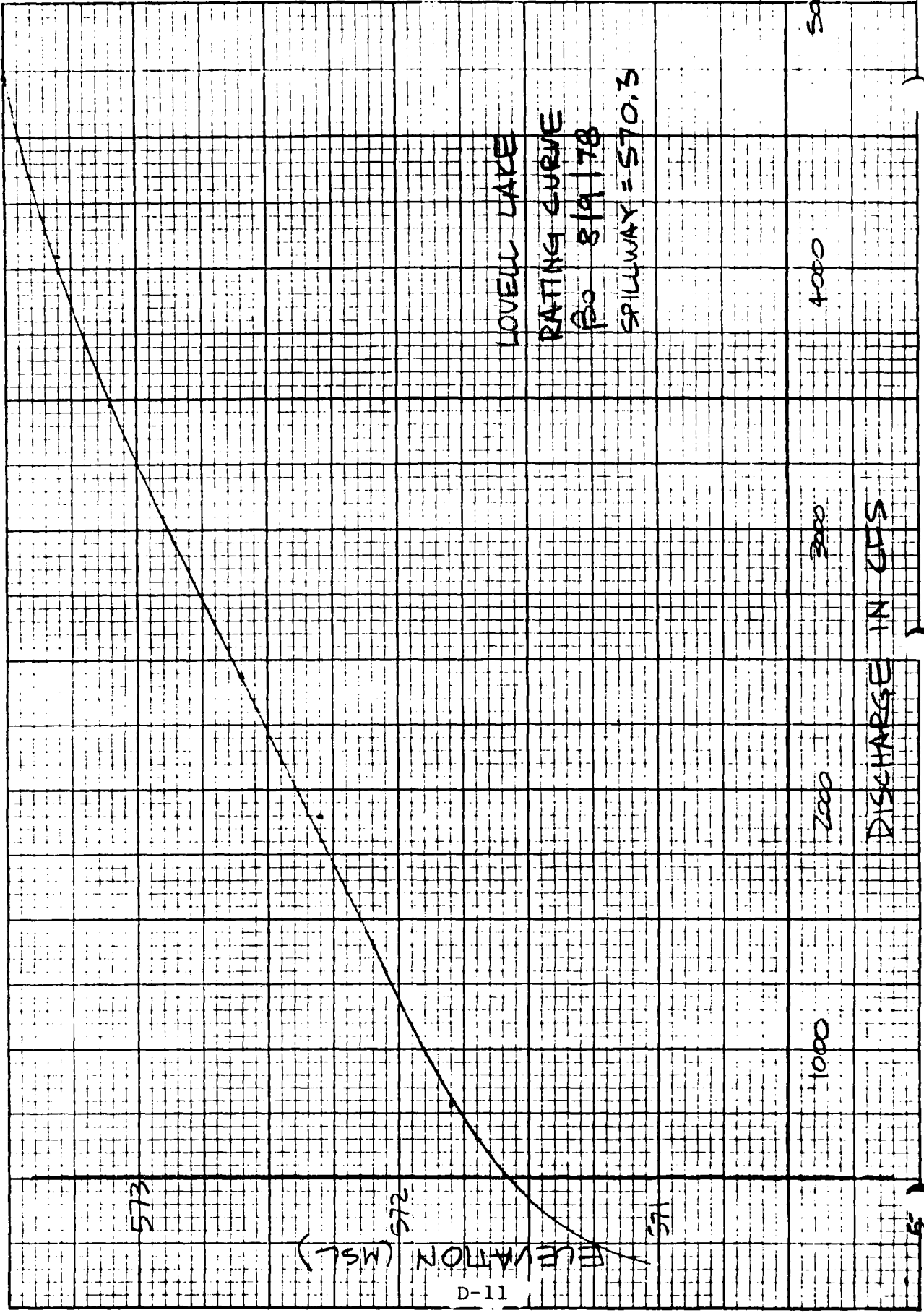
573

572

571

ELEVATION (MSL)

D-11



11/14

WELL LAKE
 SW LOG CAPACITIES
 (30) 8/9/78

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

① @ RECREATIONAL POOL = 570.0 ±

7 BAYS INVERT = 566.25

1 BAY INVERT = 561.50

$$Q = (2.9)(35)(3.75)^{3/2} + (2.9)(5)(8.5)^{3/2}$$

$$Q = 1096 \text{ cfs} \Rightarrow \text{SAY } 1100 \text{ cfs}$$

② MAXIMUM POOL = 570.6

$$Q = (2.9)(35)(4.35)^{3/2} + (2.9)(5)(9.1)^{3/2}$$

$$Q = 1319 \text{ cfs} \Rightarrow \text{SAY } 1320 \text{ cfs}$$

JOB NO. 3141-01 Lovell LAKE DAMRES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
I. SCALE

1 D/S Hazard ANALYSIS - using maximum pool elevation of
2 570.6 to determine breach discharge.
3 Storage @ time of failure - 2400 AC-FT
4

5 Step 2: $Q_{p1} = \frac{8}{27} W_b \sqrt{g} y_o^{3/2}$
6 W_b = breach width
7 $g = 32.2 \text{ ft/sec}^2$
8 y_o = pool elev. \rightarrow river bed
9

10 @ Lovell Lake Dam:

11 $W_b = 130'$

12 $y_o = 570.6 - 569 = 1.6'$

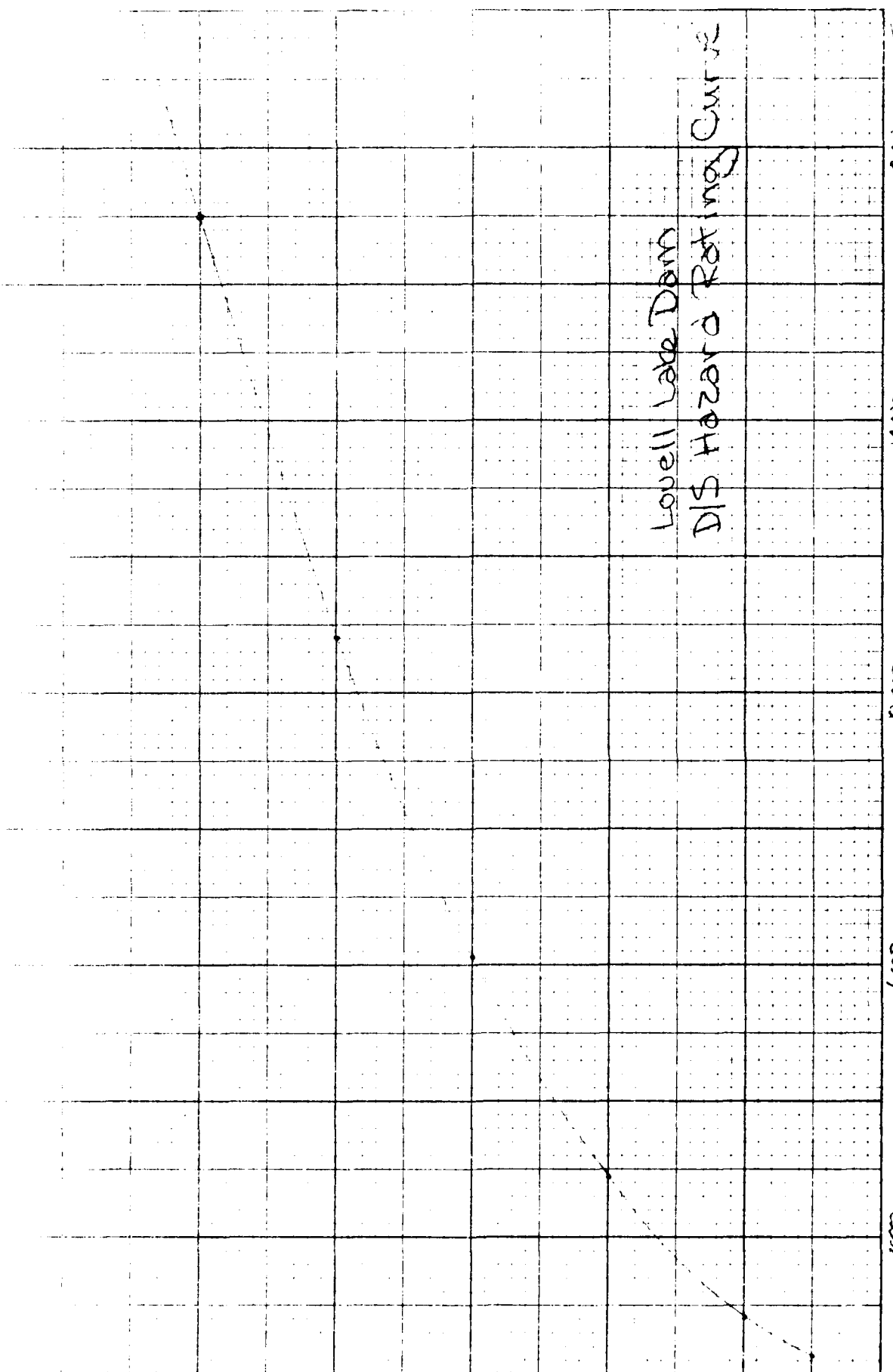
13 From above equation: $Q = 410 \text{ cfs}$

14 Establish rating curve of typical downstream
15 section using road as weir.

16 $Q - 410 \text{ cfs} - \text{Stage } 0.6'$
17

18 Hazard Classification based on the above analysis
19 is Significant Hazard.
20

21 Breach was used along left embankment.
22
23
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38



Lovell Lake Dam
 DIS Hazard Rating Curve

3/4

Lovell Lake - D/S Road Culvert Capacity

Culvert Data: Reinforced concrete box

L = 65' under road + 15' under gatehouse

∴ Total length = 80'

At inlet: 4.25'H x 8'W

however - $\frac{1}{3}$ through is a restricted opening estimated to be 4' x 4'

Hw = Top Rd. - low chord = 1.5'

Using Hydraulic Charts for the Selection of Highway Culverts, Hydraulic Engineering Circular No. 5, page 5-21.

Use 0° wingwalls - assumed due to gradual transition.

$$Hw = 4 + 1.5 = 5.5$$

$$D = 4'$$

$$\frac{Hw}{D} = 1.375$$

$$Q/B = 29 \text{ cfs}$$

$$Q \therefore = 29 \text{ cfs} \times 4 = \underline{\underline{116 \text{ cfs}}}$$

END

FILMED

8-85

DTIC

