CONNECTICUT RIVER BASIN
SUNAPEE, NEW HAMPSHIRE

SUNAPEE LAKE TOWN DAM
NH 00108
NHWRB 229.05

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

MAY 1979

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**Abstract**

The dam is a stone masonry dam capped with a concrete slab over the upstream face. The dam is considered to be in good condition. It is intermediate in size with a high hazard potential classification. The extent of damage that might occur at the dam and in downstream areas in the event of overtopping should be assessed. There are various operating and maintenance measures which should be implemented by the owner.
Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire  03301

Dear Governor Gallen:

I am forwarding to you a copy of the Sunapee Lake Town Dam 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, Town of Sunapee, Sunapee, 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 yours,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer
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SUNAPEE, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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National Dam Inspection Program
Phase I Inspection Report

Identification No.: NH00108
Name of Dam: Sunapee Lake Town Dam
Town: Sunapee
County and State: Sullivan, New Hampshire
Stream: Sugar River
Date of Inspection: June 6, 1978

Brief Assessment

Sunapee Lake Town Dam is a stone masonry dam capped with a concrete slab over the upstream face. The dam has a maximum height of 15 feet and is approximately 71 feet long. In the middle of the dam there is a 30 foot long spillway. Over the spillway there is a footbridge spanning between two concrete abutments. The spillway is 11 feet wide and approximately 4.5 feet below the crest of the dam.

Based on visual inspection, available records and past operational performance, the dam is considered to be in good condition. A settlement area was noted adjacent to the north abutment. Erosion of the concrete was also noted. One vertical member of the footbridge railing located at the northern end of the dam was observed to be missing. Continuance of this classification depends on proper operations and maintenance of the dam.

This dam falls under the category of high hazard potential, and it is intermediate in size. Flood runoff from the Sunapee Lake watershed goes more into surcharge storage then into spillway discharge. With a full probable maximum test flood (PMF) runoff of 19 inches with an estimated peak inflow of 65,000 cfs, the outflow would be reduced to about 9,000 cfs, with about 16 inches of runoff going into surcharge storage. Such flood would overtop the dam by about 4.2 feet. A flood one-half the PMF, with 9.5 inches of runoff and a peak inflow of 32,000 cfs would result in a spillway outflow of 1,700 cfs with about 9 inches of the flood runoff going into surcharge storage. This flood would result in only about 0.3 foot overtopping of the dam.

Because of the large surcharge storage feature of this project, it is recommended that within two years after receipt of this Phase I report by the owner, more detailed hydrologic studies be performed to determine the ability of this project, through storage and spillway capacity, to withstand major flood runoff. The extent of damage that might occur at the dam and in downstream areas in the event of overtopping should be assessed.
The owner should also implement the following operating and maintenance measures:

1. The settled area adjacent to the north abutment should be reestablished and a missing rail post installed.

2. All eroded concrete surfaces should be repaired.

3. A program of regular maintenance should be established.

4. A program of technical biannual periodic inspection of the project features should be prepared and initiated.

5. A plan for surveillance and a formal warning system should be developed for periods of unusually heavy rains and runoff.

FAY, SPOFFORD & THORNDIKE, INC.
By:

Jurgis Gimbutas, P.E.
Project Engineer

Richard W. Albrecht, P.E.
Vice President
This Phase I Inspection Report on Sunapee Lake Town 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. Tiernan
CHARELS G. TIERNSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

Fred J. Raves, Jr.
FRED J. RAVES, JR., Member
Chief, Design Branch
Engineering Division

Saul Cooper
SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar
JOE B. FRYAR
Chief, Engineering Division
PREFACE

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

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

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

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.
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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. Fay, Spofford & Thorndike, Inc., Engineers, have 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 was issued to Fay, Spofford & Thorndike, Inc., under a letter of May 3, 1978, from Mr. Ralph T. Garver, Colonel, Corps of Engineers. Contract no. DACW 33-78-C-0308 has been assigned by the Corps of Engineers for this work.

b. Purpose

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

(2) Encourage and 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

Sunapee Lake Town Dam is located in the central western part of New Hampshire in the town of Sunapee, near the old town hall. The dam is built on the headwaters of Sugar River, approximately 750 feet to the west of Sunapee Harbor. Sunapee Harbor is a small bay of Sunapee Lake located between Garnett Hill and Keyser Hill on the east shore of the lake. Sugar River flows into the Connecticut River in the city of Claremont which is about 17 miles west of Sunapee.
b. Description of Dam

The town dam consists of stone masonry, capped with concrete, and a concrete slab over the upstream face. This dam is 71 feet long with a 15-foot long north wingwall and a 53-foot long concrete south wingwall. The overall length is 139 feet. In the middle of the dam, there is a 30-foot long spillway with steel pins to support the flashboards (Photographs No. 1, 2, and 3, Appendix C).

Over the spillway, there is a footbridge spanning between two concrete abutments. The spillway is 11 feet wide and approximately 4.5 feet below the crest of the dam. The north end of the dam contains a 5-foot by 5-foot waste gate with a manually operable gate hoist. At the south abutment near the left bank, there is a 5-foot diameter, 30-foot long penstock with a manually operable gate valve, and a trash rack on the upstream side (Photographs Nos. 6, 7, and 9, Appendix C). This penstock feeds water to the turbine in the waterworks pumping station which is located 18 feet downstream from the dam.

It is evident from the records that this dam is founded on both hardpan and ledge, and numerous boulders were observed in the downstream channel.

Near the northwest corner of the pumping station, about 50 feet downstream from the face of the dam, there is a low 3-foot wide stone masonry sill across the pool. It creates a 4- to 5-foot waterfall and an attractive reflection pool near the roadway bridge (Photograph Nos. 10, 11, and 12, Appendix C).

Upstream from the town dam there is a regulator dam, which was built at the outlet of Sunapee Lake (Sunapee Harbor) and is called "Upper Lake Dam." This regulator dam has three gates and a telemark gage reading system connected to the New Hampshire Water Resources Board office in Concord. A fishscreen was observed on the upstream side of the regulator dam (Photograph Nos. 13, 14, and 15, Appendix C).

Between the town dam and the regulator dam is a forebay pond approximately 750 feet long with a stone masonry retaining wall at its bend (Photograph No. 16, Appendix C). The flow into this pond is controlled by the regulator dam.

c. Size Classification

The storage capacity at the spillway crest is 16,340 acre-feet, which falls in the range 1,000 and 50,000 acre-feet. Therefore, on the basis of Table 1, Size Classification, in the "Recommended Guidelines for Safety Inspection of Dams," furnished by the Corps of Engineers, the dam is classified as intermediate in size.
d. Hazard Classification

In the event of failure of this dam, residential buildings in the towns of Sunapee, Wendell, Guild, and Newport, which are downstream of the dam at distances of 1/2 mile, 2 miles, 3 miles, and 5 miles, respectively, will be in danger of being flooded. It is assumed that the height of the flood wave is two-thirds the height of the dam. On this basis, an approximate outline on U.S.G.S. Map for the damage impact area is included in Appendix D. It is estimated that in the event of failure of this dam loss of more than a few lives and excessive property damage could possibly occur. Therefore, on the basis of Table 2, Hazard Potential Classification, in the "Recommended Guidelines for Safety Inspection of Dams," furnished by the Corps of Engineers, this dam falls in the category of high hazard potential.

e. Ownership

Present owners are the town of Sunapee. In 1931, the ownership of the dam was shared between the Sunapee Dam Corporation, Brampton Woolen Co., and the town of Sunapee. The town of Sunapee and the Brampton Woolen Co. each owned 25 per cent of the dam.

Subsequently, the town of Sunapee has bought all rights to the dam in order to use the water for power for the town's waterworks pumping station.

f. Operator

Mr. Henry Cunningham, superintendent of the waterworks pumping station, Sunapee, New Hampshire, telephone (603)-763-2449.

g. Purpose of Dam

The original purpose of this dam was to store water for power to be used by the mills in the area. Since reconstruction in 1932, the dam has been used for power by the Sunapee Waterworks Pumping Station. This dam serves recreational and environmental purposes, as the lake and the upstream pond are surrounded by summer cottages and permanent houses. The downstream pool has been reconstructed to create a reflecting pool with a sill across the pool.

h. Design and Construction History

From limited available data, it appears that a dam existed in the town of Sunapee in 1856, presumably on the same site. It was referred to as the "Saw Mill Sight," or as the "Second Dam from Lake."
Due to the needs of the waterworks pumping station and because the old stone and timber dam was leaking badly, the town of Sunapee undertook a major repair in 1931. In October of that year, I. W. Jones & Co., Engineers, of Milton, New Hampshire, prepared plans and specifications for partial rebuilding and repair. The New Hampshire Public Service Commission gave its authorization to proceed with the work to the town of Sunapee's Special Water Committee on November 12, 1931.

The construction was done by Gamsby Brothers, a local contractor of Sunapee and finished in January of 1932. This contract included the following items: removal of the old wooden planking from the upstream face; replacing part of the old stone masonry; capping the upstream face and the spillway crest with concrete; installing new gates and a rack structure, and a sluice way with stop logs in the spillway; excavation of a trench; and construction of a cutoff wall along the upstream base of the stone masonry. Cofferdams were used for this construction.

The spillway crest is at Elevation 1090.5, with distance below the top of the dam of 4 feet at the north abutment and 4.5 feet at the south abutment. The height of the structure above the stream bed is about 15 feet.

In 1966, the town built a sill 50 feet downstream from the dam creating a reflective pool for recreational purposes.

In 1973, the Town Dam was improved again. The abutments were to be raised by adding 1 foot at the south end and 1.5 feet at the north end, making the distance between the top of the dam and the spillway crest to be 5.5 feet. It appears that this work was never done due to the fact that field measurements indicate that this distance varies from 4 feet 3 inches to 4 feet 7 inches. A footbridge consisting of two steel stringers, wooden planking, and a steel railing along the downstream side was built over the spillway. There are sketches and some computations, made by Mr. R. C. Chamberlin, Engineer, showing the proposed modifications of the dam; but there are no as-built drawings. The field observations indicate that the sluiceway in the spillway does not exist. The spillway crest is now uninterrupted along its full length at the same height. Both gates have manually operated hoists with wheels and cranks.
i. Normal Operational Procedure

The town's water supply is conveyed to the pumping station by a 12-inch diameter main pipe from the lake. Once a week an operator from the New Hampshire Water Resources Board checks and adjusts the water level at the regulator dam. The operator who works in the Sunapee Pumping Station checks the Town Dam daily, and when necessary he adjusts the gates.

During September of every year, the Water Resources Board closes the gates at the regulator dam. At this time, the operator at Sunapee Pumping Station dewater the forebay pond in order to perform yearly maintenance. It takes about two weeks to paint the turbine and to check the penstock and the town dam. During this time, the town's water supply is obtained from a one-million gallon storage tank which uses two pumps. For more detail, see Section 4.1.

1.3 Pertinent Data

a. Drainage Area

Although Sunapee Lake, as shown on the U.S.G.S. map, is a natural one, the water surface in the lake is controlled by the Sunapee Lake Regulator Dam, which is located about 750 feet upstream from the town dam and otherwise called the upper lake dam. It has a drainage area of 45 square miles. The watershed area is heavily wooded, undulated, and rolling.

b. Discharge at Town Dam Site

(1) Outlet works (conduits) - A 5-foot diameter penstock with an estimated invert elevation of 1083 is connected to a hydraulic turbine. The flow through the penstock drives a hydraulic turbine which, in turn, rotates a coupled centrifugal pump. There is a 5-foot by 5-foot waste sluice near the north abutment with an invert elevation of 1083. A 12-inch diameter suction pipe conveys water from Sunapee Lake to the the pumping station for Sunapee's water supply.

The estimated discharge capacities of the waste sluice are furnished below:

201 cfs when the reservoir is at Spillway Crest Elevation 1090.5.

333 cfs at maximum pool elevation 1099.2.
The estimated discharge capacities of the penstock are furnished below:

220 cfs at Elevation 1090.5, which corresponds to the spillway crest elevation.

363 cfs at Elevation 1099.2, which corresponds to the maximum pool elevation.

(2) Maximum known flood at dam site - flood of September 21-24, 1938, but the magnitude was not recorded.

(3) Ungated spillway capacity at maximum pool elevation - 9233 cfs at Elevation 1099.2.

(4) Total spillway capacity at maximum pool elevation - 9233 cfs at Elevation 1099.2.

c. Elevation (Feet above MSL)

(1) Top of dam - 1094.5 at the north abutment and 1095.0 at the south abutment.

(2) Maximum pool elevation - 1099.2.

(3) Full flood control pool - 1094.5. In the absence of pertinent data, it is assumed that the full flood control elevation coincides with the top of the dam.

(4) Recreation pool - 1090.5. It is assumed that the recreation pool elevation is the same as the spillway crest elevation.

(5) Spillway crest (ungated) - 1090.5.

(6) Stream bed at centerline of dam - 1075.5 (estimated).

(7) Maximum tail water - 1080 (estimated).

d. Reservoir

(1) Length of maximum pool - 32,000 feet (estimated).

(2) Length of recreation pool, downstream of dam, including reflection pool - 22,400 feet (estimated).

(3) Length of flood control pool - 26,000 feet (estimated).
e. Storage (Acre-Feet)
   (1) Recreation pool - 16,340 acre-feet (estimated).
   (2) Flood control pool - 16,160 acre-feet (estimated).
   (3) Design surcharge - 16,160 acre-feet (estimated).
   (4) Top of dam - 32,500 acre-feet (estimated).

f. Reservoir Surface (Acres)
   (1) Top of dam - 4500 acres (estimated).
   (2) Maximum pool - 4500 acres (estimated).
   (3) Flood control pool - 4500 acres (estimated).
   (4) Recreation pool - 4085 acres. It is assumed that the recreation pool elevation is the same as the spillway crest elevation.
   (5) Spillway crest - 4085 acres. This value is obtained from planimetering the lake area on the U.S.G.S Map.

g. Dam
   (1) Type
       Dry rubble masonry
   (2) Length
       Approximately 71 feet
   (3) Height
       15 feet
   (4) Top width
       Minimum 5.75 feet, maximum 14.5 feet
   (5) Side slopes
       (a) Upstream
           Approximately 1 vertical to 1 horizontal
       (b) Downstream
           Vertical
   (6) Zoning
       Not applicable
   (7) Impervious core
       Not applicable
(8) Cutoff
Upstream face of dam concrete masonry with the possibility of sheet piling

(9) Grout curtain
None

h. Spillway

(1) Type
Ungated concrete weir

(2) Length of weir
30 feet

(3) Crest elevation
1090.5 msl

(4) Gates
None

(5) U/S channel
Forebay pond (Sugar River)

i. Regulating Outlet

(1) Invert
1083 (estimated)

(2) Size
60-inch diameter

(3) Description
Steel penstock

(4) Control mechanism
One gate valve, manually operated

(5) Others

(a) Invert
1083 (estimated)

(b) Size
5 feet by 5 feet

(c) Description
Concrete waste gate opening

(d) Control mechanism
One gate, manually operated
SECTION 2 - ENGINEERING DATA

2.1 Design

a. General Project Data

As-built drawings indicating plans, elevations, and sections of the dam and appurtenant structures, including the details of the discharge facilities, such as outlet works, limit service, emergency spillways, flashboards, fuse plugs, and operation equipment, are not available from project records.

2.2 Construction

a. Concrete Properties

(1) In 1932, the materials were supplied by a local contractor, Gamsby Brothers, of Sunapee, New Hampshire.

(2) It is evident that in 1932, a specified concrete mix design was used, and tests were performed.

b. Construction History

(1) The diversion scheme, construction sequence, pertinent construction problems, and maintenance repair is not available from project records.

(2) This dam has been modified and altered since its original construction. Available project records indicate that major repairs to this dam were completed in 1932.

c. Testing

(1) Construction control test data are not available from project records.

2.3 Operation

No engineering operational data was disclosed. Normal operational procedures are described in Section 1.2.1.

The record of continuous water surface levels in Sunapee Lake, as telemetered by the gage at the outlet of the Sunapee Lake, is maintained by the Water Resources Board of the State of New Hampshire.
Information pertaining to the history of previous failures or deficiencies is presented in Section 1. In 1973, repairs to the dam were made. A footbridge with a handrail had been constructed over the dam and the sluice in the spillway dam was closed.

2.4 Evaluation

a. Availability

Except for the limited data previously mentioned, pertinent structural, geotechnical, hydrologic, and hydraulic data, which formed the basis of the design of the dam, are not available from the project records.

b. Adequacy

Sufficient engineering data are available for a Phase I inspection.

Profiles and cross sections of this dam were found in the project files. These were prepared for an inspection report and not for construction purposes.

c. Validity

The available engineering data is considered valid on the basis of the results of the visual inspection.
SECTION 3 - VISUAL INSPECTION

3.1 Findings

a. General

The Phase I inspection of Sunapee Lake Town Dam was performed on June 6, 1978. A copy of the inspection check list is included in Appendix A.

In general, the soil features are in good condition. The concrete was observed to be in good condition except for the north abutment and spillway, see subparagraph c.

b. Dam

No evidence of vertical or horizontal misalignment was observed. There is no indication of sloughing, bulging, or movement of the slopes, nor is there any evidence of seepage or piping.

A 1-foot section of the soil adjacent to the north abutment has dropped a maximum of 12 inches. This area is approximately 4 feet from the downstream edge of the dam. Observations indicated that this was probably caused by erosion (Photograph No. 8, Appendix C).

c. Appurtenant Structures

The wooden footbridge over the spillway and the concrete wingwall at the southern end of the dam is in good condition. The railing for the footbridge is generally in good condition. One vertical member located at the northern end of the dam was observed to be missing (Photograph No. 8, Appendix C). The spillway capped with concrete shows areas of erosion (Photograph No. 4, Appendix C). Concrete above the water level was observed to be in good condition except for the southern end of the north abutment where erosion was noticed. Both horizontal and vertical cracks were observed in the concrete cap of the north abutment (Photographs No. 5 and 9, Appendix C). The waste sluice gate and the penstock gate valve are both in working condition.

d. Reservoir Area

Sunapee Lake Town Dam is built on the headwaters of the Sugar River and is located in the town of Sunapee. The forebay behind the dam is small and its area is about 1/2 acre. The actual storage reservoir for Sunapee Lake Town Dam forebay is Sunapee Lake. The
storage area of Sunapee Lake is 4,085 acres. The shoreline is lined with a large number of trees. There are many cottages around the lake.

The discharge of Sunapee Lake flows through a regulator dam with a town road over it and into a forebay behind Sunapee Lake Town Dam. On both sides of the forebay, retaining walls were observed. The shoreline of the forebay is in good condition.

e. Downstream Channel

The downstream channel and side slopes are in good condition. Several large boulders were observed in the channel, and the slopes in some places are protected with dry rubble masonry. The downstream channel is deep and considerably wide only immediately downstream of the dam. At a distance of about 150 feet downstream of the dam, water flows under a roadway bridge and through a stone-lined channel. There is an abandoned dam approximately 475 feet downstream from the town dam.

Even though the channel immediately downstream of the dam has enough conveying capacity to handle flood flows within its banks, the downstream channel in the vicinity of the damage impact areas does not. This would result in flooding, and consequently damaging property and perhaps loss of life.

3.2 Evaluation

The observed condition of the dam is good. The potential problems observed during the visual inspection are listed as follows:

a. Concrete erosion.

b. Potential for overtopping.

c. Settlement of the area adjacent to the north abutment.
SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

The Town of Sunapee has operated Sunapee Lake Town Dam since about 1931. The water level of the forebay pond is maintained by a spillway located at the center of the dam. The flow is controlled by manually operated flashboards. Drawdown is accomplished by opening the waste sluice and the steel penstock. The waste sluice is controlled by a gate and the penstock by a gate valve, both manually operated.

4.2 Maintenance of Dam

The maintenance of Sunapee Lake Town Dam is the responsibility of the town of Sunapee.

4.3 Maintenance of Operating Facilities

The dam is inspected daily by the operator who works in the Sunapee Pumping Station. Maintenance of the operating facilities that regulate the intake gate valve, which controls the flow into the 5-foot diameter penstock, and the waste sluice gate opening is satisfactory.

4.4 Description of any Warning System in Effect

A flood warning system is in effect. There is a telemetered stream gage at the outlet of Sunapee Lake and it is maintained and monitored by the New Hampshire Water Resources Board. During floods, as soon as the water level in Sunapee Lake exceeds the permissible limit, the three gates of the regular outlet will be fully opened with instructions to the town of Sunapee to open the waste sluice gate in the body of the town dam.

4.5 Evaluation

The operation and maintenance procedures for Sunapee Lake Town Dam consisting of daily inspection, should ensure that all problems encountered can be remedied within a reasonable period of time.
5.1 Evaluation of Features

a. Design Data

(1) This dam fall under the category of high hazard potential and it is intermediate in size. Using the "Recommended Guidelines for Safety Inspection of Dams," the recommended spillway test flood peak inflow is equal to the probable maximum flood. The spillway test flood inflow hydrograph, estimated, is furnished in Appendix D. The spillway test flood peak inflow is 65,250 cfs.

(2) The estimated maximum peak outflow corresponding to the spillway test flood inflow is about 9,233 cfs. Refer to Appendix D for details.

(3) The lake storage capacity versus the elevation, an estimated capacity curve is included in Appendix D.

(4) The estimated composite discharge rating curve for the spillway and all discharge facilities is furnished in Appendix D.

(5) The hydrologic map of the watershed above the dam site, including reservoir area, water course, deviation contours, and principal stream flow is included in Appendix D.

b. Experience Data

Except for very limited information, details of past floods are not available for this dam. Rainfall records for the area are available for the years 1892 to 1941. It is noted that significant monthly rainfalls were recorded in September, 1938, and March, 1936. Rainfall recorded in the month of September, 1938, was 12.43 inches, which was more than 3.5 times the monthly average rainfall. The flood of September 21-24 is considered to be the maximum flood that has occurred. On the basis of regional frequency studies, the flood of 1938 corresponds to a 100-year flood. The maximum height of water over the permanent crest of the spillway was not measured.
c. Visual Observations

The crest of the non-overflow section of the south side of the dam is 4 feet above the crest of the spillway. The corresponding dimension of the north side is 4.5 feet. The hydraulic design of the spillway is poor, and there are no energy dissipation works below the spillway. Water is allowed to fall freely on the channel bed downstream of the spillway. The stream bed is lined with boulders.

d. Overtopping Potential

Sunapee Lake has a very large surface area (4,500± acres) and flood runoff from the watershed goes more into surcharge storage then into spillway discharge. With a full probable maximum test flood (PMF) runoff of 19 inches with an estimated peak inflow of 65,000 cfs, the outflow would be reduced to about 9,000 cfs, with about 16 inches of runoff going into surcharge storage. Such a flood would cause about an 8.7-foot rise in lake level, overtopping the dam by about 4.2 feet. A flood one-half the PMF, with 9.5 inches of runoff and a peak inflow of 32,000 cfs would result in a spillway outflow of about 1,700 cfs with about 9 inches of the flood runoff going into surcharge storage. This flood would cause a 4.8-foot rise in the lake level resulting in only about 0.3 foot overtopping of the dam. Spillway capacity with pool at top of dam is about 1,600 cfs.
SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The upstream slope could not be seen due to the fact that it was under water. The visual inspection revealed no evidence of stability problem except possibly for the settlement area adjacent to the north abutment.

Erosion of the spillway and the erosion and minor cracks at the north abutment does not pose an immediate stability problem but could lead to future problems if it is not repaired.

b. Design and Construction Data

There are no construction drawings or structural computations. There are a few free-hand sketches, dated 1937, which were prepared by the inspecting engineer, showing basic dimensions of the dam. Some computations and sketches made prior to the repairs in 1973, are available.

c. Operating Records

Except for memorandums and correspondence listed in Appendix B, other operating records were not available at the office of the New Hampshire Water Resources Board. There are additional records at the town of Sunapee pumping station.

d. Post-Construction Changes

The routine repairs that are recorded in the files were done in 1973. These repairs consisted of new concrete piers on the upstream side and repairing the gates in the dam. The structural stability was not affected by these repairs.

e. Seismic Stability

The dam is located in Seismic Zone 2 and in accordance with recommended Phase I guidelines does not warrant seismic analyses.
SECTION 7 - ASSESSMENT, RECOMMENDATIONS, & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

The visual inspection and operational history indicates that Sunapee Lake Town Dam is in good condition and functioning satisfactorily.

b. Adequacy of Information

An adequate assessment of the dam consistent with the scope of Phase I investigation has been made based upon the visual inspection and available information.

c. Urgency

The recommendations and remedial measures enumerated in Section 7.2 and 7.3 should be implemented within 2 years of receipt of this Phase I report by the owner.

d. Need for Additional Investigation

See Section 7.2.

7.2 Recommendations

Because of the large surcharge storage feature of this project, it is recommended that more detailed hydrologic studies be performed to determine the ability of this project, through storage and spillway capacity, to withstand major flood runoff. The extent of damage that might occur at the dam and in downstream areas in the event of overtopping should be assessed.

7.3 Remedial Measures

It is considered important that the following operating and maintenance procedures be attended to as early as practical:

a. Proper grade of the settled area adjacent to the north abutment should be reestablished and a missing rail post installed.

b. All damaged or eroded concrete surfaces should be repaired as continued deterioration could develop into a serious problem.
c. A program of regular maintenance should be established.
d. A program of technical biannual periodic inspection of the project features should be prepared and initiated.
e. Because the dam is located upstream of a populated area, round-the-clock surveillance should be provided during periods of high precipitation.
f. The owner should develop a formal warning system. An operational procedure to follow in event of an emergency should also be adopted.

7.4 Alternatives

None recommended.
APPENDIX A

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT: Sunapee Lake Town Dam
DATE: June 6, 1978
TIME: 1000-1530
WEATHER: Sunny
W.S. ELEV.: 1092.5 U.S. D.N.S.

PARTY:

1. Jurgis Gimbutas, P.E. - Team Captain - Structural and Concrete
2. Harvey H. Stoller, P.E. - Soils, Geology and Foundation
3. V. Rao Maddineni, P.E. - Hydraulics and Hydrology

PROJECT FEATURE

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>INSPECTED BY</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam Embankment</td>
<td>H. H. Stoller</td>
<td>Good</td>
</tr>
<tr>
<td>Outlet Works</td>
<td>J. Gimbutas</td>
<td>Fair</td>
</tr>
<tr>
<td>Waste Gate Outlet</td>
<td>J. Gimbutas</td>
<td>Good</td>
</tr>
<tr>
<td>Outlet Works - Penstock</td>
<td>J. Gimbutas</td>
<td>Good</td>
</tr>
<tr>
<td>Spillway Weir</td>
<td>J. Gimbutas</td>
<td>Fair</td>
</tr>
<tr>
<td>Approach and Discharge Channels</td>
<td>V. R. Maddineni</td>
<td>Good</td>
</tr>
<tr>
<td>Pond and Downstream Channel</td>
<td>V. R. Maddineni</td>
<td>Good</td>
</tr>
</tbody>
</table>

A-1
PERIODIC INSPECTION CHECK LIST

PROJECT Sunapee Lake Town Dam          DATE June 6, 1978

PROJECT FEATURE Dam Embankment

DISCIPLINE Soils & Foundations

NAME

PROJECT FEATURE

DISCIPLINE

NAME

DISCIPLINE

NAME

AREA EVALUATED

CONDITION

DAM EMBANKMENT

Crest Elevation

1094.8 msl (North Abutment)

1095.1 msl (South Abutment)

Current Pool Elevation

1092.5 msl

Maximum Impoundment to Date

1094.5 msl

Surface Cracks

Minor crack in concrete cap of North Abutment

Pavement Condition

None

Movement or Settlement of Crest

None observed

Lateral Movement

None observed

Vertical Alignment

No visual vertical misalignment observed

Horizontal Alignment

No visual horizontal misalignment observed

A-2
PERIODIC INSPECTION CHECK LIST

**PROJECT** Sunapee Lake Town Dam  
**DATE** June 6, 1978

**PROJECT FEATURE** Dam Embankment

**DISCIPLINE** Soils & Foundations  
**NAME**

**PROJECT FEATURE**

**DISCIPLINE**  
**NAME**

**DISCIPLINE**

**NAME**

<table>
<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition at Abutment and at Concrete Structures</td>
<td>Erosion observed at southern end of North Abutment</td>
</tr>
<tr>
<td>Indications of Movement of Structural Items on Slopes</td>
<td>None observed</td>
</tr>
<tr>
<td>Trespassing on Slopes</td>
<td>None observed</td>
</tr>
<tr>
<td>Sloughing or Erosion of Slopes or Abutments</td>
<td>None observed</td>
</tr>
<tr>
<td>Rock Slope Protection - Riprap Failures</td>
<td>None</td>
</tr>
<tr>
<td>Unusual Movement or Cracking at or Near Toes</td>
<td>None observed</td>
</tr>
<tr>
<td>Unusual Embankment or Downstream Seepage</td>
<td>None observed</td>
</tr>
<tr>
<td>Piping or Boils</td>
<td>None observed</td>
</tr>
<tr>
<td>Foundation Drainage Features</td>
<td>None</td>
</tr>
</tbody>
</table>

A-3
PERIODIC INSPECTION CHECK LIST

PROJECT Sunapee Lake Town Dam
DATE June 6, 1978

PROJECT FEATURE Dam Embankment
DISCIPLINE Soils and Foundations
NAME

PROJECT FEATURE
DISCIPLINE
NAME
DISCIPLINE
NAME

AREA EVALUATED
CONDITION

Toe Drains
None

Instrumentation System
None
PERIODIC INSPECTION CHECK LIST

PROJECT Sunapee Lake Town Dam
DATE June 6, 1978

PROJECT FEATURE Outlet Works
DISCIPLINE Structural & Concrete
NAME

AREAS EVALUATED

OUTLET WORKS - WASTE GATE

<table>
<thead>
<tr>
<th>OUTLET</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Condition of Concrete</td>
</tr>
<tr>
<td>Erosion or Cavitation</td>
</tr>
<tr>
<td>Condition at Joints</td>
</tr>
<tr>
<td>Gates</td>
</tr>
</tbody>
</table>

OUTLET WORKS - PENSTOCK

<table>
<thead>
<tr>
<th>Size</th>
<th>60-inch diameter steel pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Condition</td>
<td>Could not be observed</td>
</tr>
<tr>
<td>Gate Valve</td>
<td>One, manually operated</td>
</tr>
</tbody>
</table>

A-5
PERIODIC INSPECTION CHECK LIST

PROJECT Sunapee Lake Town Dam

DATE June 6, 1978

PROJECT FEATURE Spillway Weir

DISCIPLINE Structural & Concrete

NAME

PROJECT FEATURE Channels

DISCIPLINE Hydraulics & Hydrology

NAME

DISCIPLINE Soils & Foundations

NAME

<table>
<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</td>
<td></td>
</tr>
<tr>
<td>a. Approach Channel</td>
<td></td>
</tr>
<tr>
<td>General Condition</td>
<td>Good condition</td>
</tr>
<tr>
<td>Loose Rock</td>
<td></td>
</tr>
<tr>
<td>Overhanging Channel</td>
<td>None observed</td>
</tr>
<tr>
<td>Trees Overhanging Channel</td>
<td>None observed</td>
</tr>
<tr>
<td>Floor of Approach Channel</td>
<td>Could not be observed</td>
</tr>
<tr>
<td>b. Weir and Retaining Walls</td>
<td></td>
</tr>
<tr>
<td>General Condition of Concrete</td>
<td>Fair</td>
</tr>
<tr>
<td>Rust or Staining</td>
<td>None observed</td>
</tr>
<tr>
<td>Spalling and Cracking of Concrete</td>
<td>Little at North Abutment</td>
</tr>
</tbody>
</table>
PERIODIC INSPECTION CHECK LIST

PROJECT  Sunapee Lake Town Dam  DATE  June 6, 1978
PROJECT FEATURE  Spillway Weir
DISCIPLINE  Structural & Concrete  NAME

PROJECT FEATURE  Channels
DISCIPLINE  Hydraulics & Hydrology  NAME  [Signature]
DISCIPLINE  Soils & Foundations  NAME  [Signature]

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<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Visible Reinforcing</td>
<td>None observed</td>
</tr>
<tr>
<td>Any Seepage or Efflorescence</td>
<td>None observed</td>
</tr>
<tr>
<td>Drain Holes</td>
<td>None</td>
</tr>
<tr>
<td>c. Discharge Channel</td>
<td></td>
</tr>
<tr>
<td>General Condition</td>
<td>Good condition</td>
</tr>
<tr>
<td>Loose Rock</td>
<td></td>
</tr>
<tr>
<td>Overhanging Channel</td>
<td>None observed</td>
</tr>
<tr>
<td>Trees Overhanging</td>
<td></td>
</tr>
<tr>
<td>Channel</td>
<td>None observed</td>
</tr>
<tr>
<td>Floor of Channel</td>
<td>Good condition</td>
</tr>
<tr>
<td>Other Obstructions</td>
<td>None observed</td>
</tr>
</tbody>
</table>
APPENDIX B

EXISTING AVAILABLE INFORMATION
APPENDIX B

1. Listing of Design, Construction and Maintenance Records

Filed at New Hampshire Water Resources Board in Concord, New Hampshire under Town/Dam No. 229.05:

(1) Photograph dated October 7, 1931, showing the dam prior to the 1932 reconstruction. The old wooden saw mill was still on the north bank of the river, and the present town hall in the background.

(2) October 5, 1931. Gamsby Brothers' (contractors) letter proposing to do the rebuilding of the dam. There are handwritten notes of years 1856, 1857, 1860 and later, indicating that this dam is at least that old.

(3) October 8, 1931. Questionnaire - dam information, written by the chairman, Special Water Committee, town of Sunapee, received by New Hampshire Public Service Commission. This document describes the intended rebuilding to be done.

(4) October 27, 1931. Specifications for Rebuilding Dam for Village of Sunapee, New Hampshire, by I. W. Jones & Co., Engineers, Milton, New Hampshire. This 14-page typewritten document includes 2 pages of the contract proposed, not signed. With these specifications, plans were furnished as follows: Sheet A - Survey of Existing Conditions; Sheet B - Plan, Elevation and Sections, showing the proposed reconstruction of the dam and gates; Sheet C - Details of Miscellaneous Ironwork.

Note: None of these plans could be located in the files of the New Hampshire Water Resources Board nor at the town hall in Sunapee.

(5) November 12, 1931. Authorization from the New Hampshire Public Service Commission to proceed with the reconstruction of the dam.

(6) December 5, 1931. Letter from I. W. Jones & Co., Engineers, to the Public Service Commission in Concord, New Hampshire, explaining a change of Design Sheet B showing a sluiceway 5 feet 0 inch wide in the location of the former opening which they had planned to close. Enclosed were two curve sheets, copies of which are available. One shows the
discharge capacity of the dam at various stages of the water level. The second curve sheet shows effect on Sunapee Lake of a very severe storm.

(7) January 1932. Sketch showing location of top of ledge rock under north end of dam. By Mr. E. L. Grimes, Sunapee, New Hampshire. Apparently he was the contractor's representative.


(9) July 10, 1942. A questionnaire from the New Hampshire Water Resources Board, filled out by Mr. M. G. Chase, Selectman of the town of Sunapee, stating the good condition of the dam and the power plant (water supply pump) in operation.

(10) April 16, 1965. Discharge measurement notes on Sunapee River (Sugar River) 500+ feet below the upper dam.


(12) February - May 1973. Several letters and sketches by Mr. Robert B. Chamberlin discussing proposed remodeling of the dam. This would have included raising the abutments, date controls and side walls, construction of a footbridge, and installation of electric gate operators with motors at both stems.

2. Copies of Past Inspection Reports

(1) September 17, 1937. Inventory of dams, by New Hampshire Water Resources Board. Includes freehand sketches with dimensions.

(2) September 12, 1939. Data on dams, by New Hampshire Water Resources Board. Tabulated by RLT.
NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN
RIVER
TOWN
LOCAL NAME OF DAM
BUILT

DESCRIPTION

POND AREA-ACRES
DRAWDOWN FT.
POND CAPACITY-ACRE FT.
HEIGHT-TOP TO BED OF STREAM-FT.
OVERALL LENGTH OF DAM-FT.
PERMANENT CREST ELEV.U.S.G.S.
TAILWATER ELEV.U.S.G.S.
SPILLWAY LENGTHS-FT.
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST
WASTE GATES-NO. WIDTH MAX. OPENING DEPTH Still BELLOW CREST

REMARKS

POWER DEVELOPMENT

UNITS NO.
RATED
HEAD
C.F.S.

HP
FEET
FULL GATE

USE

REMARKS

DATE
**NEW HAMPSHIRE WATER CONTROL COMMISSION**
**DATA ON DAMS IN NEW HAMPSHIRE**

**LOCATION**
- **Town:** Sunapee  
- **County:** Sullivan  
- **Stream:** Sugar River  
- **Basin-Primary:**  
- **Basin-Secondary:** Sugar R.  
- **Local Name:**  
- **Coordinates—Lat.:**  
- **Coordinates—Long.:**

**GENERAL DATA**
- **Drainage area:** Controlled  
- **Waste Gates:**  
- **Abutments:**  
- **Spillway:**  
- **Waste Gates Conduit:**  
- **Embankment:**  
- **Materials:** Masonry, stone & concrete  
- **Reservoir:**

**DESCRIPTION**
- **Masonry wall—stone & concrete**

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<tr>
<th>Waste Gates</th>
<th>Type</th>
<th>Number</th>
<th>Size: 5 x 6 ft. high x 1-5, 1-3.5 ft. wide</th>
<th>Elevation Invert</th>
<th>7 ft. 6 in.</th>
<th>Total Area</th>
<th>sq. ft.</th>
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<table>
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<tr>
<th>Waste Gates Conduit</th>
<th>Number</th>
<th>Size</th>
<th>ft. Length</th>
<th>ft. Area</th>
<th>sq. ft.</th>
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<table>
<thead>
<tr>
<th>Embankment</th>
<th>Type</th>
<th>Height—Max.</th>
<th>ft. Min.</th>
<th>Top—Width</th>
<th>Elev.</th>
<th>ft.</th>
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<table>
<thead>
<tr>
<th>Slopes—Upstream</th>
<th>on.</th>
<th>Downstream</th>
<th>on.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Length—Right of Spillway</th>
<th>Left of Spillway</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Spillway</th>
<th>(sluice in center of spillway)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Materials of Construction</th>
<th>Masonry</th>
</tr>
</thead>
</table>

| Length—Total | 27.5 ft. | Net | ft. |

| Height of permanent section | Max. 10.5 ft. | Min. 1 ft. |

<table>
<thead>
<tr>
<th>Flashboards—Type</th>
<th>Removable stop planks in sluice gate</th>
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<table>
<thead>
<tr>
<th>Elevation—Permanent Crest</th>
<th>1090.3 ft.</th>
<th>Top of Flashboard</th>
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<table>
<thead>
<tr>
<th>Flood Capacity</th>
<th>cfs:</th>
<th></th>
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</table>

<table>
<thead>
<tr>
<th>Abutments</th>
<th>Materials:</th>
</tr>
</thead>
</table>

| Freeboard | Max. 4' 6" | ft. Min. | ft. |

**OWNER**
- **Town of Sunapee**

**REMARKS**
- **Use:** Public Utilities, Pumping station for town water supply.  
- **Condition:** Good

**Tabulation By**
- **PLT**  
- **Date:** 2/12/33
APPENDIX C

PHOTOGRAPHS
# APPENDIX C

## REPRESENTATIVE PHOTOGRAPHS OF PROJECT

### LOCATION PLAN

Plan 1 - Location of Photographs Taken on June 6, 1978

### PHOTOGRAPHS

<table>
<thead>
<tr>
<th>No.</th>
<th>Negative No.</th>
<th>Page</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>Town Dam and Water Pump House, looking south.</td>
<td>5-15</td>
</tr>
<tr>
<td>2.</td>
<td>Town Dam, looking north from the road by the upstream forebay pond.</td>
<td>5-2</td>
</tr>
<tr>
<td>3.</td>
<td>Spillway and footbridge, looking north.</td>
<td>5-6</td>
</tr>
<tr>
<td>4.</td>
<td>Center part of spillway, showing the flashboard along the coast.</td>
<td>5-4</td>
</tr>
<tr>
<td>5.</td>
<td>North abutment, showing concrete erosion.</td>
<td>5-5</td>
</tr>
<tr>
<td>6.</td>
<td>Trash rack at the pump house penstock near the south abutment.</td>
<td>5-3</td>
</tr>
<tr>
<td>7.</td>
<td>Waste gate outlet near the north wingwall.</td>
<td>5-19</td>
</tr>
<tr>
<td>8.</td>
<td>Disrupted railing and washed away backfill at the north wingwall.</td>
<td>5-18</td>
</tr>
<tr>
<td>9.</td>
<td>Town Dam, looking south, showing both gate hoists and some cracks in concrete.</td>
<td>5-8</td>
</tr>
<tr>
<td>10.</td>
<td>Reflecting pool and bridge across the downstream channel, looking south.</td>
<td>5-16</td>
</tr>
<tr>
<td>11.</td>
<td>Downstream channel and bridge looking from the Town Dam.</td>
<td>5-9</td>
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</table>

C-1
<table>
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<tr>
<th>No.</th>
<th>Negative No.</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.</td>
<td>Downstream channel looking west from the bridge.</td>
<td>5-12</td>
</tr>
<tr>
<td>13.</td>
<td>Gate operating stems at the &quot;Upper Lake Dam.&quot;</td>
<td>5-22</td>
</tr>
<tr>
<td>14.</td>
<td>&quot;Upper Lake Dam&quot; looking upstream.</td>
<td>5-21</td>
</tr>
<tr>
<td>15.</td>
<td>Fish screens at the &quot;Upper Lake Dam,&quot; looking downstream</td>
<td>8-30A</td>
</tr>
<tr>
<td>16.</td>
<td>Sugar River bank protection at the bend midway between the &quot;Upper Lake Dam&quot; and the Town Dam, looking south.</td>
<td>8-29A</td>
</tr>
</tbody>
</table>
PHOTOGRAPHS NO. 13, 14, AND 15 ARE TAKEN AT THE UPPER DAM ON THE SUNAPEE LAKE OUTLET INTO SUGAR RIVER

PHOTOGRAPH NO. 16 IS TAKEN MIDWAY BETWEEN THE UPPER AND THE TOWN DAMS ON SUGAR RIVER

SUNAPEE LAKE TOWN DAM
LOCATION OF PHOTOGRAPHS
11. Downstream Channel and Bridge Looking From the Town Dam.
16. Fish Screens at the "Upper Lake Dam," Looking Downstream.

16. Sugar River Bank Protection at the Bend Midway Between the Upper and the Town Dams, Looking South.
APPENDIX D

HYDROLOGIC & HYDRAULIC COMPUTATIONS
Total drainage area of Sunapee Lake = 450 sq mi

The drainage area of Sunapee Lake is characterized by mountainous topography.

From guide curves furnished by the Corps of Engineers, it is found that:

\[
\text{INFLOW} = Q_P, = 65,250.0 \text{ CFS}
\]

According to size classification, Sunapee Town Dam is intermediate.

According to hazard classification, it falls under the category of high hazard dam.

\[
\text{SPILLWAY TEST FLOOD PEAK INFLOW} = 65,250.0 \text{ CFS.}
\]
1. Length of travel from farthest point to Sunapee Lake = 37,800'  
Length of travel through lake to outlet = 22,400'  
Total travel from farthest point to outlet = 60,200'

2. Elevation of farthest point = 1900  
Elevation of outlet = 1100  
Difference = 800'
Max. length of tongue = 60,200 ft.
Difference in elevation = 800 ft.

\[ t_c = \frac{(60,200)^{1.15}}{7700 \times (800)^{0.38}} \text{ hrs.} \]

\[ = \frac{313715.49}{7700 \times 12.68} \text{ hrs.} \]

\[ = 3.213 \text{ hrs.} \]

Spillway test inflow flood peak = 65,250 cfs.
**Spillway Test Inflow Flood Hydrograph**

Basis on Secs Dimensionless Unit Hydrograph

\[
T_c = 3.25 \text{ hrs}
\]

\[
Q_{DF} = 65,250 \text{ cfs}
\]

<table>
<thead>
<tr>
<th>(T/%)</th>
<th>(T/T_c)</th>
<th>(Q/Q_p)</th>
<th>(Q) (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.81</td>
<td>0.25</td>
<td>0.05</td>
<td>32,621.5</td>
</tr>
<tr>
<td>1.625</td>
<td>0.50</td>
<td>0.18</td>
<td>11,765.0</td>
</tr>
<tr>
<td>2.44</td>
<td>0.75</td>
<td>0.73</td>
<td>47,632.5</td>
</tr>
<tr>
<td>3.25</td>
<td>1.00</td>
<td>1.00</td>
<td>65,250.0</td>
</tr>
<tr>
<td>4.06</td>
<td>1.25</td>
<td>0.80</td>
<td>52,260.0</td>
</tr>
<tr>
<td>4.875</td>
<td>1.50</td>
<td>0.40</td>
<td>26,160.0</td>
</tr>
<tr>
<td>5.69</td>
<td>1.75</td>
<td>0.25</td>
<td>16,312.5</td>
</tr>
<tr>
<td>6.50</td>
<td>2.00</td>
<td>0.17</td>
<td>11,042.5</td>
</tr>
<tr>
<td>8.94</td>
<td>2.75</td>
<td>0.06</td>
<td>3,915.0</td>
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<tr>
<td>11.375</td>
<td>3.50</td>
<td>0.02</td>
<td>13,455.0</td>
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<tr>
<td>13.175</td>
<td>4.00</td>
<td>0.01</td>
<td>6,821.5</td>
</tr>
</tbody>
</table>
**Subject:** SUNFEE TOWN DAM  
**Discharge Rating Table for Waste Sluice**

Waste Sluice = 5' x 5'.  
\[ A = 25 \text{ ft}^2 \]

Invert Elevation = 1083.0  

\[ Q = C_1 \cdot A \cdot \sqrt{y} \]  
\[ C_1 = 0.45 \]

\[ y = \text{Elevation} \]

<table>
<thead>
<tr>
<th>ELE</th>
<th>y</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>1070.5</td>
<td>5.0</td>
<td>201.0</td>
</tr>
<tr>
<td>1091.5</td>
<td>6.0</td>
<td>220.0</td>
</tr>
<tr>
<td>1093.5</td>
<td>7.0</td>
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<td>255.0</td>
</tr>
<tr>
<td>1094.5</td>
<td>9.0</td>
<td>270.0</td>
</tr>
<tr>
<td>1095.5</td>
<td>10.0</td>
<td>285.0</td>
</tr>
<tr>
<td>1096.5</td>
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<tr>
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<td>12.0</td>
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<td>325.0</td>
</tr>
<tr>
<td>1099.5</td>
<td>14.0</td>
<td>337.0</td>
</tr>
<tr>
<td>1101.5</td>
<td>15.0</td>
<td>349.0</td>
</tr>
<tr>
<td>1102.5</td>
<td>16.0</td>
<td>361.0</td>
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<td>1103.5</td>
<td>17.0</td>
<td>373.0</td>
</tr>
<tr>
<td>1104.5</td>
<td>18.0</td>
<td>385.0</td>
</tr>
<tr>
<td>1105.5</td>
<td>19.0</td>
<td>397.0</td>
</tr>
<tr>
<td>1106.5</td>
<td>20.0</td>
<td>409.0</td>
</tr>
<tr>
<td>1110.5</td>
<td>25.0</td>
<td>450.0</td>
</tr>
<tr>
<td>1115.5</td>
<td>30.0</td>
<td>492.0</td>
</tr>
<tr>
<td>1120.5</td>
<td>35.0</td>
<td>532.0</td>
</tr>
<tr>
<td>1125.5</td>
<td>40.0</td>
<td>574.0</td>
</tr>
</tbody>
</table>
Elevation of the center of pinballc = 10.83 ft.

\[ Q = 6.25 \times \frac{h}{4} \times 1.25 \times 8 \times \sqrt{h} \]
\[ = 98.175 \times \sqrt{h} \]

<table>
<thead>
<tr>
<th>ELE</th>
<th>h</th>
<th>( Q_p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1090.5</td>
<td>5</td>
<td>219.526 = 220.0</td>
</tr>
<tr>
<td>1091.5</td>
<td>6</td>
<td>240.478 = 241.0</td>
</tr>
<tr>
<td>1092.5</td>
<td>7</td>
<td>259.746 = 260.0</td>
</tr>
<tr>
<td>1093.5</td>
<td>8</td>
<td>277.680 = 278.0</td>
</tr>
<tr>
<td>1094.5</td>
<td>9</td>
<td>294.525 = 295.0</td>
</tr>
<tr>
<td>1095.5</td>
<td>10</td>
<td>310.456 = 310.0</td>
</tr>
<tr>
<td>1096.5</td>
<td>11</td>
<td>325.609 = 326.0</td>
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<tr>
<td>1097.5</td>
<td>12</td>
<td>340.068 = 340.0</td>
</tr>
<tr>
<td>1098.5</td>
<td>13</td>
<td>353.775 = 354.0</td>
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<tr>
<td>1099.5</td>
<td>14</td>
<td>367.737 = 367.0</td>
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<td>1100.5</td>
<td>15</td>
<td>381.908 = 382.0</td>
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<tr>
<td>1101.5</td>
<td>16</td>
<td>396.315 = 396.0</td>
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<tr>
<td>1102.5</td>
<td>17</td>
<td>410.975 = 411.0</td>
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<tr>
<td>1103.5</td>
<td>18</td>
<td>425.906 = 426.0</td>
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<td>19</td>
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</tr>
<tr>
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<td>20</td>
<td>456.051 = 456.0</td>
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<td>1106.5</td>
<td>21</td>
<td>471.275 = 471.0</td>
</tr>
<tr>
<td>1107.5</td>
<td>22</td>
<td>486.606 = 487.0</td>
</tr>
<tr>
<td>1108.5</td>
<td>23</td>
<td>502.047 = 502.0</td>
</tr>
<tr>
<td>1109.5</td>
<td>24</td>
<td>517.609 = 518.0</td>
</tr>
<tr>
<td>1110.5</td>
<td>25</td>
<td>533.291 = 533.0</td>
</tr>
<tr>
<td>1111.5</td>
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<td>549.106 = 549.0</td>
</tr>
<tr>
<td>1112.5</td>
<td>27</td>
<td>565.047 = 565.0</td>
</tr>
<tr>
<td>1113.5</td>
<td>28</td>
<td>581.109 = 581.0</td>
</tr>
<tr>
<td>1114.5</td>
<td>29</td>
<td>597.291 = 597.0</td>
</tr>
<tr>
<td>1115.5</td>
<td>30</td>
<td>613.606 = 614.0</td>
</tr>
<tr>
<td>1116.5</td>
<td>31</td>
<td>630.109 = 630.0</td>
</tr>
<tr>
<td>1117.5</td>
<td>32</td>
<td>646.806 = 647.0</td>
</tr>
<tr>
<td>1118.5</td>
<td>33</td>
<td>663.609 = 664.0</td>
</tr>
<tr>
<td>1119.5</td>
<td>34</td>
<td>680.806 = 681.0</td>
</tr>
<tr>
<td>1120.5</td>
<td>35</td>
<td>698.291 = 698.0</td>
</tr>
<tr>
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<td>36</td>
<td>715.609 = 716.0</td>
</tr>
<tr>
<td>1122.5</td>
<td>37</td>
<td>733.109 = 733.0</td>
</tr>
<tr>
<td>1123.5</td>
<td>38</td>
<td>750.806 = 751.0</td>
</tr>
<tr>
<td>1124.5</td>
<td>39</td>
<td>768.809 = 769.0</td>
</tr>
<tr>
<td>1125.5</td>
<td>40</td>
<td>788.109 = 788.0</td>
</tr>
<tr>
<td>1126.5</td>
<td>41</td>
<td>808.806 = 809.0</td>
</tr>
</tbody>
</table>

D-6
Length of spillway = 30 feet

Length of dam = 41 feet

Length of embankment = 270 - 71 = 199 feet.

\[ (H_5)_1 = 1.0 \quad (Q_5)_1 = 90.0 \text{ cfs} \]

\[ (H_5)_2 = 2.0 \quad (Q_5)_2 = 255.0 \text{ cfs} \]

\[ (H_5)_3 = 3.0 \quad (Q_5)_3 = 468.0 \text{ cfs} \]

\[ (H_5)_4 = 4.0 \quad (Q_5)_4 = 720.0 \text{ cfs} \]

\[ (H_5)_5 = 5.0 \quad (H_D) = 0.5 \]

\[ Q = 3 \times 30 \times (5)^{3/2} + 2.6 \times 41 \times (0.5)^{3/2} \]

\[ = 1086.23 + 37.68 \quad = 1123.91 \text{ cfs} \]

\[ (H_5)_6 = 6.0 \]

\[ Q = 3 \times 30 \times (6)^{3/2} + 2.6 \times 41 \times (1.5)^{3/2} \]

\[ = 1322.72 + 1351.83 \quad = 2674.55 \text{ cfs} \]

\[ (H_5)_7 = 7.0 \]

\[ Q = 3 \times 30 \times (7)^{3/2} + 2.6 \times 41 \times (2.5)^{3/2} + 2.6 \times 19 \times (1)^{3/2} \]

\[ = 1667 + 421 + 517 \quad = 2605.0 \text{ cfs} \]

\[ (H_5)_8 = 8.0 \]

\[ Q = 3 \times 30 \times (8)^{3/2} + 2.6 \times 41 \times (3.5)^{3/2} + 2.6 \times 19 \times (2)^{3/2} \]

\[ = 2036 + 678 + 14 \quad = 2720 \text{ cfs} \]

\[ (H_5)_9 = 9.0 \]

\[ Q = 3 \times 30 \times (9)^{3/2} + 2.6 \times 41 \times (4.5)^{3/2} + 2.6 \times 19 \times (3)^{3/2} \]

\[ = 2430 + 1018 + 2688 \quad = 6156 \text{ cfs} \]

\[ (H_5)_10 = 10.0 \]

\[ Q = 3 \times 30 \times (10)^{3/2} + 2.6 \times 41 \times (5.5)^{3/2} + 2.6 \times 19 \times (4)^{3/2} \]

\[ = 2846 + 1373 + 4152 \quad = 8371 \text{ cfs} \]
\[
(H_5) = 12.0 \quad Q = 3 \times 30 \times (12)^{3/2} + 2.6 \times 41 \times (7.5)^{3/2} + 2.6 \times 199 \times (6)^{3/2} \\
= 3,741 + 21.3 + 714.4 \\
= 12,535 \text{ cfs}
\]

\[
(H_5) = 15.0 \quad Q = 3 \times 30 \times (15)^{3/2} + 2.6 \times 41 \times (12.5)^{3/2} + 2.6 \times 199 \times (9)^{3/2} \\
= 5,229 + 362.7 + 13,970 \\
= 22,826 \text{ cfs}
\]

\[
(H_5) = 20.0 \quad Q = 3 \times 30 \times (20)^{3/2} + 2.6 \times 41 \times (15.5)^{3/2} + 2.6 \times 199 \times (14)^{3/2} \\
= 8050 + 6505 + 27163.0 \\
= 41658.
\]

\[
Q_5 = 3 \times 30 \times (2.7)^{3/2} = 230.95 \\
= 231 \text{ cfs}
\]

D-8
<table>
<thead>
<tr>
<th>HEAD CIRCE SPILLWAY</th>
<th>ELE.</th>
<th>FLOW IN WHITE ELUICE</th>
<th>FLOW IN SPILLWAY</th>
<th>FLOW OVER SPILLWAY</th>
<th>TOTAL ( Q )</th>
<th>( Q )</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1549.5</td>
<td>201</td>
<td>220</td>
<td>0</td>
<td>421</td>
<td></td>
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<tr>
<td>1</td>
<td>1091.5</td>
<td>220</td>
<td>241</td>
<td>96.0</td>
<td>551</td>
<td></td>
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<tr>
<td>2</td>
<td>1092.5</td>
<td>238</td>
<td>260</td>
<td>255.0</td>
<td>752</td>
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<tr>
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<td>278</td>
<td>468.0</td>
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<tr>
<td>4</td>
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<td>270</td>
<td>295</td>
<td>720.0</td>
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<td>295</td>
<td>310</td>
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<tr>
<td>6</td>
<td>1096.5</td>
<td>299</td>
<td>326</td>
<td>1519.0</td>
<td>5144</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1097.5</td>
<td>312</td>
<td>340</td>
<td>2088.0</td>
<td>2740</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1098.5</td>
<td>325</td>
<td>354</td>
<td>4197.0</td>
<td>4876</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1100.5</td>
<td>349</td>
<td>380</td>
<td>8360.0</td>
<td>9687</td>
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</tr>
<tr>
<td>15</td>
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<td>439</td>
<td>22826.0</td>
<td>23618</td>
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</tr>
<tr>
<td>20</td>
<td>1110.5</td>
<td>450</td>
<td>491</td>
<td>21658.0</td>
<td>42591</td>
<td></td>
</tr>
</tbody>
</table>

D-9
Spillway crest elevation = 1090.5

Surface area of lake at elevation 1010.5 = 4685 acres

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>STORAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.25.0</td>
<td>16,340</td>
</tr>
<tr>
<td>10.91.0</td>
<td>18,382.5</td>
</tr>
<tr>
<td>10.12.0</td>
<td>22,467.5</td>
</tr>
<tr>
<td>10.14.0</td>
<td>30,637.5</td>
</tr>
<tr>
<td>10.15.0</td>
<td>34,722.5</td>
</tr>
<tr>
<td>10.16.0</td>
<td>38,807.5</td>
</tr>
<tr>
<td>10.00.0</td>
<td>55,147.5</td>
</tr>
<tr>
<td>10.55.0</td>
<td>75,572.5</td>
</tr>
<tr>
<td>11.10.0</td>
<td>95,997.0</td>
</tr>
<tr>
<td>11.20.0</td>
<td>1,368,475.5</td>
</tr>
<tr>
<td>11.25.0</td>
<td>1,572,722.5</td>
</tr>
<tr>
<td>11.30.0</td>
<td>1,776,777.5</td>
</tr>
</tbody>
</table>
PEAK INFLOW \((Q_p) = 65,250 \text{ cfs}\).

**TRIAL #1:**

Assume inflow volume = 19" of runoff.

Available storage above the top of dam:

\[
\begin{align*}
\text{Available storage} &= 45 \times 4.5 \\
&= 202.5 \text{ ft}^3
\end{align*}
\]

\[
\begin{align*}
\text{Available storage} &= 6.44 \text{ inches}
\end{align*}
\]

\[
\begin{align*}
\text{Inflow volume} &= 8.44 \\
\text{Inflow runoff} &= 19
\end{align*}
\]

\[
\begin{align*}
\text{Available storage} &= 8.44 \\
\text{Inflow runoff} &= 19
\end{align*}
\]

\[
\begin{align*}
\text{Volume} &= 0.45
\end{align*}
\]

Referring to Figure 17-11 in Sec. NEH, Section 4

\[
\begin{align*}
\frac{\text{Outflow peak rate}}{\text{Inflow peak rate}} &= 0.70
\end{align*}
\]

\[
\begin{align*}
\text{Outflow peak rate} &= 0.7 \times 2,250 \\
&= 1,575 \text{ cfs -- too high above value}
\end{align*}
\]

**TRIAL #2:**

Consider available storage up to 5 feet above top of dam.

D-11
Available storage = upper 5 feet above top of dam at 9.5 feet above spillway crest

\[
\frac{4550 \times 9.5}{45 \times 640} = 1.464 \text{ ft}
\]

\[
= 17.81 \text{ uncheked}
\]

\[
\frac{17.81}{19.0} = 0.94
\]

\[
\text{Cutflow Peak Rate} = 0.08
\]

\[
\text{Inflow Peak Rate}
\]

\[
\text{Cutflow Peak Rate} = 0.08 \times 65,250 \text{ cfs}
\]

\[
= 5,220 \text{ cfs}
\]

From the composite rating curve, the above cutflow peak rate corresponds to ELE. 1698.9

d.e. Surchage height above spillway crest

\[
= 8.4 \text{ feet}
\]
TRIAL # 2:

Volume of cutback (cum) = \( \frac{4500 \times 3.4}{45 \times 130} \)

= 15.75"

\[ Q_p = Q_{p_1} \left( 1 - \frac{5.25}{19} \right) \]  

\[ = 65.25 \times \left( 1 - \frac{5.25}{19} \right) \]

\[ = 65.25 \times \left( 1 - 0.28 \right) \]

\[ = 11,158 \text{ cfs} \]  

TRIAL #4:

From the composite rating curve, the above cutback peak rate corresponds to ELE 1101.3

i.e. surcharge height above spillway crest =

\[ = 10.8 \text{ ft} \]

Vol. of surcharge (stor) = \( \frac{4500 \times 15.8}{45 \times 130} \)

\[ = 20.25'' \text{ of runoff > 19''} \]

The above formula (A) does not work.

\[ \text{Cutback Peak Rate} = \frac{11,158}{65.250} = 0.171 \]
To determine peak outflow.

Refer to Figure 17-11 in SCS NEH, Section 14.5

\[
\text{get} \quad \frac{\text{surcharge volume}}{\text{infiltration volume}} = 0.88
\]

1. surcharge volume = 0.88 \times 19 = 16.72\text{ ft}^3

Now, apply the above eqn (4)

\[
\text{peak outflow} \quad Q_p = 65,250 \left( 1 - \frac{16.72}{19} \right)
\]

\[
= 65,250 \left( 1 - 0.88 \right)
\]

\[
= 65,250 \times 0.12
\]

\[
= 7,830 \text{ cfs} \quad (3)
\]

**TRIAL #5:**

From the composite rating curve, the ultimate outflow peak rate equals 1200 ft \(^3\)/min. That is surcharge height above spillway crest = 9.4 ft

1. vol. of surcharge (cubic ft) = \[
\frac{4500 \times 9.4}{45 \times 640}
\]

\[
= 17.625 \text{ in.}
\]

Now, apply the above eqn (4)

\[
\text{peak outflow} \quad Q_p = 65,250 \left( 1 - \frac{17.625}{19} \right)
\]

\[
= 65,250 \left( 1 - 0.9276 \right)
\]

\[
= 65,250 \times 0.0724
\]

\[
= 4,735 \text{ cfs}
\]

D-14
PEAK OUTFLOW \( Q_p = 65,250 \times 0.8754 \)
\( = 47,242 \text{ cfs} \)  \( (4) \)

**TRIAL #6:**

From the composite rating curve, the above outflow peak rate corresponds to ELE: 1048.6

\( \text{S. Change} = 0.1 \)

\( \text{Vol. of S. Change (STOR)} = \frac{45,000 \times 0.1}{45 \times 640} \)
\( = 15.1875'' \text{ of Runoff} \)

Now, apply the above to \( (4) \)

PEAK OUTFLOW \( Q_p = 65,250 \left( 1 - \frac{15.1875}{19} \right) \)
\( = 65,250 \left( 1 - 0.799 \right) \)
\( = 65,250 \times 0.201 \)
\( = 13,115 \text{ cfs} \)  \( (5) \)

**TRIAL #7:**

From the composite rating curve, the above outflow peak rate corresponds to ELE: 1102.1

\( \text{S. Change} = 11.6 \text{ ft} \)

D-15
To determine peak cutflow:

\[ V_r = \frac{4500 \times 11.6}{45 \times 6.4} = 21.75'' \text{ of runoff} \]

The above formula (A) does not work.

\[ \frac{V_r}{V_{r_0}} = \frac{12.15}{250} = 0.048 \]

Referring to Figure 17-11 in EPM NEH, Section 4, we get:

\[ \frac{V_r}{V_{r_0}} = 0.85 \]

\[ V_r = 0.85 \times 19.15'' \text{ of runoff}. \]

Now, apply the above eqn (A):

\[ \text{Peak Cutflow } Q_{P_2} = 65.250 \left(1 - \frac{16.15}{19.15}\right) = 65.250 \times 0.21 = 9787.0 \text{ cfs.} \]

D-16
From the computed rating curve, the alone outflow peak rate corresponds to $E_{25} = 1150.8$

\[
\text{Sediment Volume} = 10.3 \text{ ft}^3.
\]

\[
\text{Vol. of Sediment} = \frac{1150.8 \times 10.3}{48 \times 640} = 19.31 \text{ inch of water}
\]

The above formula (A) did not work.

\[
\text{Cutflow Peak Rate} = \frac{9737}{65,250} = 0.15 \text{ ft/s}.
\]

Referring to Figure 17-11 in SES NEH, SECTION 4

One gets \( \frac{\text{Sediment Volume}}{\text{Inflow Volume}} = 0.89 \)

\[
\text{Sediment Volume} = 0.89 \times 19 = 16.91 \text{" of water.}
\]

Now, apply the above eqn. (A).

\[
\text{Peak Cutflow} Q_p = 65.250 \left(1 - \frac{16.91}{19}\right) = 65.250 \left(1 - 0.89\right) = 7178.475. \quad (7)
\]
TRIAL # 9:

From the Composite Action Curve, the above peak rate corresponds to ELE. 1099.7

\[ M_{S} = 7.2 \text{ ft} \]

\[ V_{L} = \frac{4800 \times 7.2 \times 12}{45 \times 640} = 17.25 \text{ in. cub.} \]

Now, apply the above equation (A)

**Peak Outflow**

\[ Q_{p} = 65,250 \left( 1 - \frac{17.25}{19} \right) \]

\[ = 65,250 \left( 1 - 0.090789 \right) \]

\[ = 60,10 \text{ cfs} \quad (8) \]

TRIAL # 10:

From the Composite Action Curve, the above peak outflow rate corresponds to ELE. 1099.2

\[ M_{S} = 8.7 \text{ ft} \]

\[ V_{L} = \frac{4800 \times 8.7 \times 12}{45 \times 640} = 16.3125 \text{ inches of water.} \]

Now, apply the above eqn. (A)
TO DETERMINE PEAK OUTFLOW:

$$Q_p = 65,250 \left(1 - \frac{16.25}{17} \right)$$

$$= 65,250 \left(1 - 0.9535 \right)$$

$$= 65,250 \times 0.0465$$

$$= 3,023.0 \text{ cfs}.$$ \hspace{1cm} (9)

**TRIAL #1:

AVERAGE PEAK OUTFLOW = \( \frac{60.10 + 92.32}{2} \)

$$= 76.22 \text{ cfs}.$$ \hspace{1cm} (10)

From the composite rating curve, the above PEAK OUTFLOW RATE CORRESPONDS TO ELE. 1099.9

\[ \text{S. Change} = 9.4 \text{ ft.} \]

\[ \text{Vol. of S. Change: (Storage)} = \frac{450 \times 9.4 \times 12}{45 \times 640} \]

$$= 17.625'' \text{ of runoff}.$$ 

Now, apply the above Eqn. (A)

$$Q_p = 65,250 \left(1 - \frac{12.625}{17} \right)$$

$$= 65,250 \left(1 - 0.7376 \right)$$

$$= 65,250 \times 0.2624$$

$$= 44,724 \text{ cfs}.$$ \hspace{1cm} (11)
TO DETERMINE PEAK OUTFLOW.

TRIAL #12:

From the complete rating curve, the above PEAK OUTFLOW RATE corresponds to ELE. 1038.7

\[ \text{s. Surchage} = 8.7 \text{ feet} \]

\[ \text{Vol. of Surchage} = \frac{4500 \times 8.7 \times 12}{4.5 \times 640} \]

\[ = 16.3125 \text{ inches of snow} \]

Now, apply the above eqn. (A).

\[ \text{PEAK OUTFLOW} Q^2 = 65,250 \left( 1 - \frac{16.3125}{19} \right) \]

\[ = 9233.0 \text{ cfs} \]

\[ \therefore \text{PEAK OUTFLOW} = 9233.0 \text{ cfs} \]

\[ \text{Surchage} = 8.7 \text{ feet} \]

\[ \text{(active spillway crest)} \]

\[ \text{Amount of overtopping of dam} = 4.2 \text{ feet} \]
Try 4.7' Surchage

\[
\text{STOR} = \frac{4.7(4500)}{45(53)} = 8.8''
\]

\[
Q_{P2} = 32,500 \left(1 - \frac{8.8}{9.5}\right) = 2405 \text{ cfs (little high)}
\]

Try 4.8' Surchage

\[
\text{STOR} = \frac{4.8(4550)}{45(53)} = 9.0''
\]

\[
Q_{P2} = 32,500 \left(1 - \frac{9.0}{9.5}\right) = 1720 \text{ cfs (OK)}
\]

\[
\text{POOL HL} = 1090.3 + 4.8 = 1095.3 \text{ ft m.s.l.}
\]
APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS
### INVENTORY OF DAMS IN THE UNITED STATES

<table>
<thead>
<tr>
<th>NAME</th>
<th>POPULAR NAME</th>
<th>STATE</th>
<th>COUNTY</th>
<th>COUNTY DIST</th>
<th>NAME OF COMPANY</th>
<th>NEAREST CITY-TOWN-VILLAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUNAPEL LAKE, JOHN</td>
<td></td>
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<table>
<thead>
<tr>
<th>TYPE OF DAM</th>
<th>YEAR COMPLETE</th>
<th>PURPOSES</th>
<th>MAXIMUM HEIGHT</th>
<th>INFLOWING CAPACITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUGAR HILL</td>
<td>1932</td>
<td>RS</td>
<td>15</td>
<td>52,000</td>
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</table>

<table>
<thead>
<tr>
<th>SPILLWAY</th>
<th>MAX. VOLUME OF DAM</th>
<th>POWER CAPACITY</th>
<th>NAVIGATION LOCKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>30</td>
<td>720</td>
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<tr>
<th>OWNER</th>
<th>ENGINEERING BY</th>
<th>CONSTRUCTION BY</th>
<th>LANDS, ETC. OF</th>
<th>REGULATORY AGENCY</th>
<th>CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>JONES &amp; CO.</td>
<td></td>
<td>SUNAPEL</td>
<td></td>
<td></td>
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<tr>
<th>WATER M.S. CO.</th>
<th>M.M. WATER M.S. BO.</th>
<th>M.M. WATER M.S. CO.</th>
<th>M.M. WATER M.S. CO.</th>
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<th>INSPECTION BY</th>
<th>INSPECTION DATE</th>
<th>AUTHORITY FOR INSPECTION</th>
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<tr>
<th>PAY SPUGFORD &amp; SPROLE, INC.</th>
<th>UNJUNTA</th>
<th>PL92-557</th>
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</table>

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<tr>
<th>REMARKS</th>
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