FRENCH RIVER BASIN
CHARLTON, MASSACHUSETTS

LITTLE NUGGET LAKE DAM
MA 00103

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

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

Little Nugget Lake Dam is a dry-stone masonry and earth dam with a broad crested weir spillway. The dam has a maximum height of 13 feet and is approximately 170 feet long including spillway length. It has been classified as a "significant" hazard. The dam is considered to be in poor condition. An outflow test flood of 1,970 cfs (½ the PMF) will overtop the west dike by about 2.2 feet and the dam by 1.0 foot and the swale by 2.9 feet.

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CHARLTON, MASSACHUSETTS

PHASE I INSPECTION REPORT
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PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00103

Name of Dam: Little Nugget Lake

Town: Charlton

County and State: Worcester County, Massachusetts

Stream: Little River - A tributary of French River

Date of Inspection: August 31, 1978

Little Nugget Lake Dam is a dry-stone masonry and earth dam with a broad crested weir spillway. The existing dam was constructed prior to 1924 with major repairs performed in 1940 and 1967-1968. The dam has a maximum height of 13 feet and is approximately 170 feet long including spillway length. A 30-foot long swale located on the east end of the dam is about 2 feet lower than the remainder of the dam. Most of the downstream slope of the dam is a vertical dry-stone masonry wall. A 3-foot high dike is located several hundred feet west of the dam. The 20.5 foot long spillway is constructed of concrete with 2.5-foot high mortared stone masonry training walls.

Little Nugget Lake Dam was neither designed nor constructed according to current approved state-of-the-art procedures. Based upon the visual inspection at the site, the limited engineering data, and little evidence of operational or maintenance procedures, it was concluded that there are deficiencies that must be corrected to assure the continued performance of this dam. Generally, Little Nugget Lake Dam is considered to be in poor condition. Because of the potential danger to lives and property downstream Little Nugget Lake Dam has been classified as a "significant" hazard.

The following visible signs of distress indicate a potential hazard at the site: bulging of the stone wall on the downstream face of the dam, slight-to-moderate seepage at the downstream toe of the dam, accumulation of debris in the spillway channel; inoperable slide gate; spalling concrete on the spillway and missing concrete on the end of the spillway; lack of adequate riprap protection on the upstream face of the dam; and thick vegetation growing immediately downstream of the dam.

Hydraulic analyses indicate that the spillway (without flashboards) and emergency spillway can discharge a flow of 300 cubic feet per second (cfs) when the water surface is at elevation (El) 771.5, which is the average elevation of the crest on the dike west of the dam. An outflow test flood of 1,970 cfs (one-half the probable maximum flood) will overtop the west dike by about 2.2 feet and the main dam by 1.0 foot and the swale by 2.9 feet. The spillways may be inadequate since they can discharge only 15 percent of the test flood before the dam is overtopped. In the event of overtopping, complete failure of the dam and west dike could occur.

It is recommended that the Owner employ a qualified consultant to evaluate the stability of the dam, conduct a more detailed hydrologic and hydraulic investigation, and evaluate the seepage underneath the dam. It is also recommended that the Owner repair the concrete on the weir; repair the gate operating mechanism; add riprap to the upstream slope of the dam and dike; and remove all trees and brush from the upstream face and downstream of the toe of the dam. The Owner should also implement a systematic program of inspection and maintenance.

The above recommendations and remedial measures should be implemented by the Owner within a period of one year after receipt of this Phase I Inspection Report. An alternative to these recommendations would be draining the pond and breaching or removing the dam.

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

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

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

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

LITTLE NUGGET LAKE

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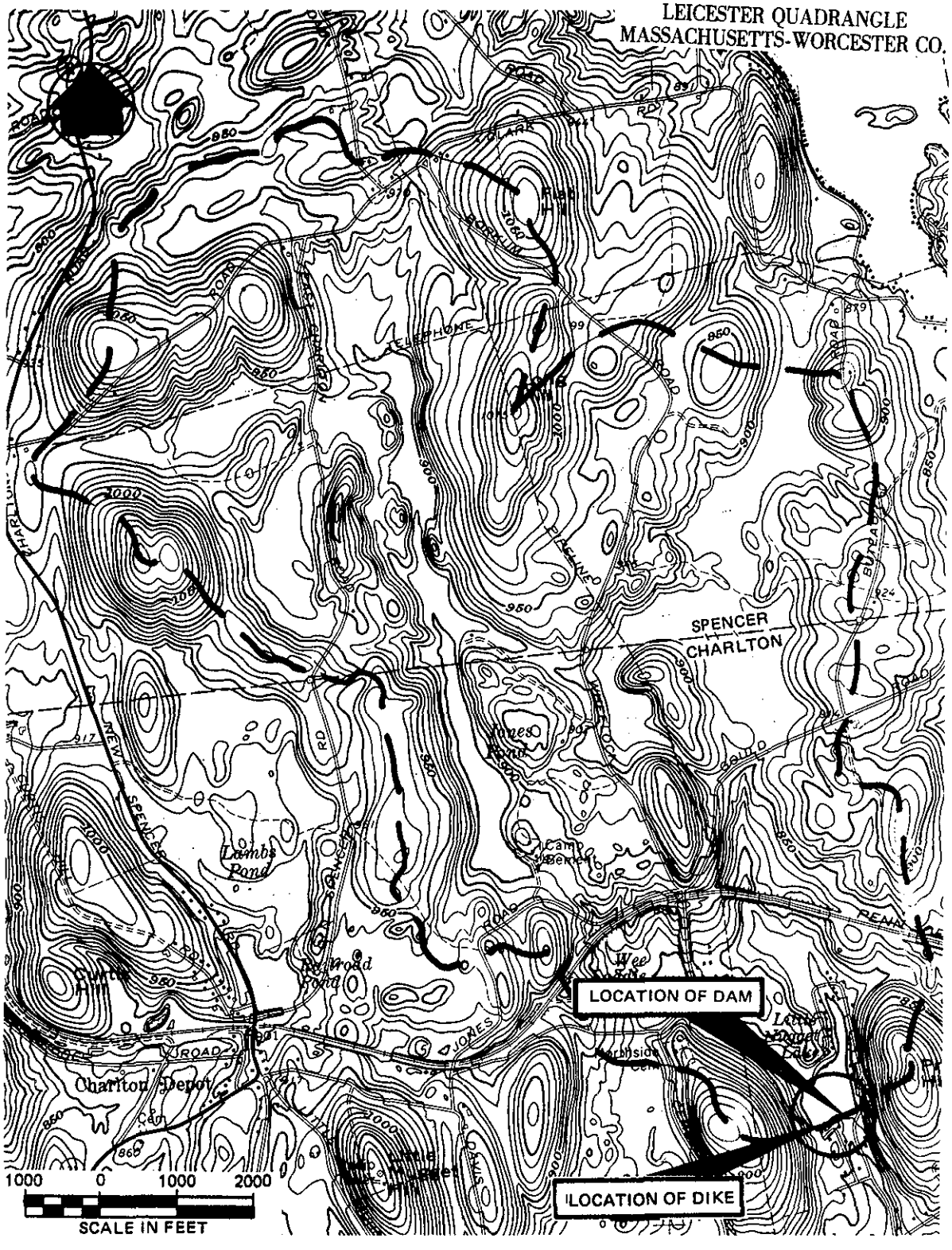
OVERVIEW
LITTLE NUGGETT LAKE
CHARLTON, MASSACHUSETTS

VIEW FROM UPSTREAM OF EAST ABUTMENT

Location and Direction of Photographs
Shown on Figure in Appendix B



LOCATION MAP - LITTLE NUGGET LAKE DAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

LITTLE NUGGET LAKE

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Metcalf & Eddy, Inc. under a letter of July 28, 1978, from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW 33-78-C-0306 has been assigned by the Corps of Engineers for this work.

b. Purpose:

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

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

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

1.2 Description of Project

a. Location. The dam is located on Little River, a tributary of the French River, Town of Charlton, Worcester County, Massachusetts (see Location Map and Figure B-1). A small dike is located west of the dam (see Location Map and Figure B-2).

b. Description of Dam and Appurtenances. Little Nugget Lake Dam is an earthfill dam with a downstream vertical stone face. There are no drawings available for this dam. A concrete spillway with mortared stone masonry training walls is located on the right abutment. The dam and spillway are about 170 feet long and the dam has a maximum height of 13 feet. The spillway is 20.5 feet wide and the downstream end of the concrete apron is partially missing. Flashboards 1.15 feet high are mounted on the crest. Sidewalls of the spillway are constructed of mortared stone and are 2.6 feet (west side) to 2.5 feet (east side) above the crest. The spillway discharges into a channel which connects with a separate smaller channel formed by water seepage apparently from underneath the dam.

The crest of the earthfill embankment is relatively flat for most of its length, at about elevation (El) 772.5. A swale is located for a length of about 30 feet on the east crest of the dam. The low point of the swale is at El 770.8. The swale serves as an emergency spillway. The axis of the dam is slightly concave upstream. The upstream face of the dam contains large riprap stones which may have been a vertical face at one time. The downstream vertical face is a dry masonry stone wall which bulges in the downstream direction. Voids as deep as 2 feet into the embankment were commonly observed in the joints. From the spillway to a point 15 feet east of the spillway there is a partly eroded knoll and no vertical stone face. There is a large pool of relatively clear water at the toe of the dam.

The one known outlet structure for the dam is located near the center (see Figure B-1). The intake consists of a dry stone sluiceway surrounded by riprap. A threaded valve stem extends through a metal plate resting on top of the sluiceway. There is no mechanism at the site for opening the gate. The invert of this outlet is at El 760.1. The vertical stone wall face at the outlet end is mortared for a width of 5 feet and a height of 5.3 feet. A leak of approximately 1 to 2 gpm of clear water was discharging from the outlet pipe. There are sections of an old deteriorated pipe downstream of the dam and outlet pipe.

A dike is located west of the dam. The dike is 81 feet long and has a maximum height of 3 feet. The dike is an earthfill embankment with a vertical downstream stone wall which has deteriorated.

c. Size Classification. Little Nugget Lake Dam is classified in the "small" category since it has a maximum height of 13 feet and a maximum storage capacity of 109 acre-feet.

d. Hazard Classification. Downstream of the dam are two homes, three culverts for a local road, and bridges for the Northside Turnpike and the Massachusetts Turnpike. In the event of overtopping and complete failure of the dam, a few lives could be lost and appreciable property damage could occur. Accordingly the dam has been classified in the "significant" hazard category.

e. Ownership. The dam and dike are located on property owned by the Town of Charlton, Massachusetts, Board of Selectmen, Town Hall, Main Street, Charlton, Massachusetts 01507. Mr. Leonard Haebler, Chairman, Board of Selectmen (617-248-5668) granted permission to enter the property and inspect the dam and dike. Prior to 1957 the dam was owned by Little Nugget Lake, Inc.

f. Operators. The only known operator of this dam is the Town Highway Superintendent. There are no fences around the outlet structure.

g. Purpose of Dam. The earliest records in 1924 indicate the dam provided storage water for unknown purposes. The lake and dam now serve for recreation and flood control.

h. Design and Construction History. There are no drawings available that show the construction of the dam prior to 1924. At that time the dam was owned by Mr. George M. Wright. Ownership was transferred to Mr. Edwin H. Perry in 1930, then to the Federal Land Bank in 1939, and to Isiah and Annette Newman in 1945. From 1948 to 1957 the dam was the property of Little Nugget Lake, Inc.

Previous inspection reports indicate no leakage in 1924. Seepage was then observed in 1930, 1938, and from 1964, until repairs were made in 1967. Holes and depressions were observed on the embankment crest in 1924, 1930, 1938, 1940, 1954, 1955, 1956, 1964, 1966, until 1967 repairs. One sinkhole in 1938 was 15 by 3 feet in plan dimensions and 1 foot deep. Sinkholes were again observed in 1973, one at the gate and one at the spillway. Evidence of piping was also noted in 1973.

Evidence of overtopping the dam was noted in 1930, and again in 1933 when sand bags and boards were readied as water came within 6 inches of the top. In 1938 a 6-foot wide by 2-1/2-foot deep break in the east end of the dam was observed. In 1955 the embankment was overtopped for the full length, causing face stones and soil to wash out on the downstream face. The overtopping washed out a road downstream of the dam, reported as the Stafford Turnpike. Flashboards were in place and the gate was inoperable. The water level was observed at the top of the embankment in two low places in 1967 prior to repairs.

In 1940, it is reported that the spillway crest was lowered 2 feet and a core wall placed in the embankment. In 1967 and 1968 the dam was apparently repaired and a new concrete cutoff wall 10 feet long was extended underneath the

existing cutoff wall. The crest was raised to the same elevation as the top of stone abutment walls at spillway. The missing east abutment wall on the spillway was also reported reconstructed and a new gate was placed in the outlet pipe.

i. Normal Operating Procedure. There are no operating procedures at the dam. There is one known outlet structure controlled by a slide gate located near the center of the dam. The outlet is reported to be operable, but has not been opened in four years. At that time vandals threw rocks into the inlet, so it was necessary to clean out the stones to close the gate. There is no handwheel on the valve stem. The stem appears to have a removable protective cap.

The spillway for Little Nugget Lake Dam is ungated. Flashboards extend across the full width of the spillway. Flashboards are removed from the spillway to regulate the water level. The operator prefers not to lower the lake water level significantly since this dries up local wells around the lake that are used for water supply.

1.3 Pertinent Data

a. Drainage Area. The drainage area for Little Nugget Lake is estimated to be 1,952 acres (3.05 square miles). Little River flows from the north through rural, sparsely developed woodland and swamp. Residential development is limited to the few homes located north and east of the lake.

b. Discharge at the Dam Site. Uncontrolled discharge at the dam site flows over the 20.5-foot long concrete-faced broad-crested weir at the west end of the dam and into the stream channel. The channel is approximately 22 feet wide 50 feet downstream of the edge of the spillway. The spillway surface is concrete lined and covered mostly with asphalt. The downstream slope is spalled, and the end of

the concrete apron is missing. The channel is bounded by trees, and contains many stones and debris. A pool of water at the toe of the slope in the center of the main dam discharges into a separate channel which joins with the main channel approximately 200 feet downstream of the dam. Water discharging through the 18-inch diameter outlet in the downstream face of the dam contributes to the pool of standing water. The channel flows through three culverts under a road and then further downstream under the Northside Turnpike and the Massachusetts Turnpike before it discharges into Pikes Pond. Below Pikes Pond Little River flows through sparsely developed woodland. The next major population center is the Town of Webster, almost 5 miles downstream of Pikes Pond.

Hydraulic analyses indicate that the spillway (without flashboards) and emergency spillway can discharge an estimated 300 cfs when the water surface is at El 771.5, which is the average elevation of the crest of the dike, and 150 cfs when the water surface is at El 770.8, which is the lowest point in the east swale on the main dam. This swale serves as an emergency spillway.

An inflow test flood of 2,060 cfs (one-half the probable maximum flood) adjusted for surcharge storage results in a maximum discharge of 1,970 cfs. This outflow will overtop the main dam by 1.0 foot, the swale by 2.9 feet and the dike by 2.2 feet. In 1930 and 1933 there was evidence of overtopping. Records revealed the dam was again overtopped in 1955.

c. Elevation (feet above MSL (Mean Sea Level)). A benchmark was established at El 769.0 on the crest of the spillway. This elevation was estimated from a United States Geological Survey (USGS) topographic map.

(1) Top dam - Main dam: 770.8 to 772.9
- Dike section: 771.0 to 772.2

(2) Test flood pool: 773.7

(3) Design surcharge (original design): Unknown

(4) Full flood control pool: N/A

(5) Recreation pool: 769.0

(6) Spillway crest (ungated): 768.9 to 769.0

(7) Upstream portal invert diversion tunnel: N/A

(8) Stream bed at centerline of dam: 761.0

(9) Tailwater: N/A (water in downstream channel)
Tailwater: 759.4 (water in pool downstream of main dam)

d. Reservoir

(1) Length of maximum pool: 1,500 feet

(2) Length of recreation pool: 1,500 feet

(3) Length of flood control pool: N/A

e. Storage (acre-feet)

(1) Test flood surcharge: 60 at El 773.7

(2) Top of dam: 109

(3) Flood control pool: N/A

(4) Recreation pool: 61 (Approximate)

(5) Spillway crest: 61

f. Reservoir Surface (acres)

*(1) Top dam: 12.8

*(2) Test flood pool: 12.8

*Based on the assumption that the surface area will not significantly increase with changes in pond elevation from 769.0 to 773.7.

(3) Flood-control pool: N/A

(4) Recreation pool: 12.8

(5) Spillway crest: 12.8

g. Dam

(1) Type - Main dam: dry-stone masonry earthfill
- Dike section: dry-stone masonry earthfill

(2) Length - Main dam: 170 feet
- Dike section: 81 feet

(3) Height - Main dam: (maximum) 13 feet
Dike section: (maximum) 3 feet

(4) Top width - Main dam: 22 feet
Dike section: 7 feet

(5) Side slopes - Main dam: downstream vertical to 0.25:1; upstream not visible
Dike section: upstream 4:1; downstream vertical

(6) Zoning: Unknown

(7) Impervious core: Unknown

(8) Cutoff: Poured in two sections - 24 feet long at top and 10 feet long at bottom - stepped reinforced concrete wall; short section of sheeting in 1938

(9) Grout curtain: Unknown.

i. Spillway

(1) Type: Broad crest

(2) Crest length: 20.5 feet

(3) Crest elevation: East - 769.0 (assumed benchmark)
West - 768.9

(4) Gates: None, flashboards 1.15 feet high

(5) Upstream channel: Mortared masonry sidewalls at spillway, concrete slab covered with asphalt

(6) Downstream channel: Downstream face of weir is spalled and bottom is missing. Below missing bottom is natural channel bounded by rocks. This channel converges with the channel created by seepage about 200 feet downstream of dam.

j. Regulating Outlets. The only regulating outlet at this dam is the one 3- by 3-foot sluice gate located near the center of the dam. The outlet has a capacity of 32 cfs (10.5 cfs per square mile). The gate has not been operated in about 4 years, and parts of the opening mechanism are missing.

SECTION 2

ENGINEERING DATA

2.1 General. There are no drawings available of Little Nugget Lake Dam. Visual observations during inspection, review of previous inspection reports, and conversations with the Owner and with personnel from Town, State and County agencies provided the remainder of the data for this evaluation.

We acknowledge the assistance and cooperation of personnel of the Massachusetts Department of Public Works, Messrs. Willis Regan and Raymond Rochford, and personnel of the Massachusetts Department of Environmental Quality Engineering, Division of Waterways, Messrs. John J. Hannon and Joseph Iagallo.

Also, we acknowledge the cooperation and assistance of personnel from the Worcester County Engineer's Office, Messrs. John O'Toole, Joseph Brazauskas, and Mr. Wallace Lindquist - recently retired from county service.

Mr. Leonard Haebler, Chairman, Board of Selectmen for the Town of Charlton, granted permission to enter the property and inspect the dam.

2.2 Construction Records. There are no as-built drawings for the dam. Information on the cutoff wall was obtained from an early County inspection report.

2.3 Operating Records. No operating records are available for the dam and no daily record is kept of the elevation of the pool or rainfall at the dam site.

2.4 Evaluation

a. Availability. Due to the age of this dam, there is no engineering data available.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore the adequacy of this dam could not

be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and engineering judgment.

c. Validity. The limited engineering data available is valid for this assessment.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The Phase I Inspection of the dam and dike at Little Nugget Lake was performed on August 31, 1978. A copy of the inspection check list is in Appendix A. Periodic inspections of this dam have been made by others since 1924. A partial listing of these inspections is in Appendix B. An inspection by the Massachusetts Department of Public Works was made in 1972 and 1973, and a copy of that report is also included in Appendix B. In addition, earlier inspection reports were reviewed at the Worcester County Engineer's office.

b. Dam. In general the dam is in poor condition. The downstream vertical stone face has bulged outward between the knoll and the outlet pipe; and the unmortared joints between many of the stones indicate voids back into the earthen embankment. A large pool of relatively clear water immediately downstream of the dam indicates considerable seepage through or underneath the dam. There is a surface depression near the outlet structure west of the swale. A flat filled area is exposed on the northwest corner of the dam next to the spillway.

The area at the downstream toe is completely covered with brush and trees. There is slight to moderate riprap protection of the upstream slope.

c. Appurtenant Structures. The concrete and stonework of the spillway are in poor to fair condition. Pieces of the downstream end of the mortared stone masonry east training wall are dislodged. Some of the mortar of the spillway sidewalls is missing or has cracked. At the time of the inspection, water was flowing over

the flashboards. The concrete facing of the spillway is eroded away, and there are local areas of spalled concrete. Evidence of slight to moderate seepage was observed at the downstream edge of the apron where surface concrete has been completely eroded, exposing underlying stones. The subsided ground surface adjacent to the west spillway sidewall has been filled in with leaves. The downstream channel is relatively clear except for a few overhanging trees and small tree trunks and logs in the bottom of the channel.

The outlet structure is in fair condition. The inlet is not visible. The inlet to the gate structure is a dry stone masonry wall. A gate stem extends through a metal welded platform mounted on top of the masonry walls. The wheel is missing and the gate is reportedly 3 feet by 3 feet. The gate stem is reportedly operable. The gate was last opened four years ago. The Owner indicated that vandals threw rocks into the inlet and it was necessary to clean out the rocks to close the gate. For that reason the reservoir surface is now regulated by removing flashboards from the spillway.

The outlet structure is in good condition. The outlet from the gate structure is an 18-inch diameter corrugated metal pipe recessed into a mortared vertical stone wall which blends into the unmortared downstream stone wall. There is leakage from the outlet pipe estimated at 1 gpm. A small deflector stonewall extends 4.5 feet downstream of the outlet pipe.

d. Reservoir Area. Moderately populated areas of residential development are located on the east, north and south sides of the lake.

e. Downstream Channel. The discharge from the spillway flows down Little River before it flows into Pikes Pond. About 1,000 feet downstream of the dam, the Little River crosses under a road through three culverts with diameters of 3 feet, 3 feet and 2.5 feet.

3.2 Evaluation. The above findings indicate that the dam has several areas of distress that require attention. It is evident that the dam is not adequately maintained and that deterioration will continue unless action is taken. Recommended measures to improve these conditions are included in Section 7.

SECTION 4

OPERATING PROCEDURES

4.1 Procedures. There are no operating procedures at Little Nugget Lake Dam.

4.2 Maintenance of Dam. There is no systematic maintenance program at the dam.

4.3 Maintenance of Operating Facilities. The outlet gate is closed and cannot be opened with the existing available mechanism. Flow over the spillway is controlled only to the extent that flashboards are removed.

4.4 Description of Any Warning System in Effect. There is no warning system in effect at the dam.

4.5 Evaluation. Little Nugget Lake Dam is in poor condition and has been placed in the "significant" hazard category because of the possible danger to life and property downstream. For this reason, it is important that procedures for operation, maintenance, and emergencies be implemented as recommended in Section 7.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data. The Probable Maximum Flood (PMF) rate was determined to be 1,350 cfs per square mile. This calculation is based on the average drainage area slope of 2.5 percent, the pond-plus-swamp area to drainage area ratio of 13 percent, and the U. S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). Applying one-half the PMF to the 3.05 square miles of drainage area results in a calculated peak flood of 2,060 cfs as the inflow test flood. By adjusting the inflow test flood for surcharge storage, the maximum discharge rate was established as 1,970 cfs, with a water surface at El 773.7.

Flow over the crest of the dam and the dike is predicted to be 1,060 cfs, and flow through the spillway (without flashboards) and emergency spillway (swale area on main dam) would be 910 cfs. The maximum head on the dam would be 1.0 feet, and 2.9 feet in the swale area with a discharge of 382 cfs per foot of width. Depth at critical flow would be at 0.60 feet with a velocity of 4.35 feet per second.

Flow over the crest of the dike is predicted to be 666 cfs. The maximum head on the dike is 2.2 feet with a discharge of 8.32 cfs per foot of width. Depth at critical flow would be at 1.29 feet with a velocity of 6.45 feet per second.

Hydraulic analyses indicate that the spillway (without flashboards) and emergency spillway (the swale) can discharge an estimated 300 cfs when the water surface is at El 771.5, which is the average elevation of the crest of the dike. The spillways can discharge only 15 percent of the test outflow before the dam is overtopped.

b. Experience Data. Hydraulic records are not available for this dam, however, information supplied by the County indicated there was evidence of overtopping the dam in 1930 and 1933. In 1955 the embankment was overtopped for the full length.

c. Visual Observations. Discharge from Little Nugget Lake is over the spillway located on the west end of the main dam. The spillway is a 20.5-foot long broad crested weir.

The concrete spillway is in poor to fair condition; it is severely pitted and the downstream edge is missing. The west end of the weir is 0.1 foot lower than the east end.

d. Overtopping Potential. Overtopping of the dam by about 1.0 foot, overtopping of the swale by about 2.9 feet, and overtopping of the dike by about 2.2 feet is expected under the outflow test flood of 1,970 cfs. In the event of overtopping, complete failure of the dam and dike could occur.

Failure of the dam would produce a peak discharge of 3,400 cfs and a flood wave 6.5 feet high, at a point 700 feet downstream of the dam, as estimated using the Corps of Engineers criteria.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The evaluation of the structural stability of the dam is based on the visual inspection conducted on August 31, 1978.

Based on the observations as discussed in Section 3, Visual Inspection, it is recommended that a more detailed investigation be initiated to evaluate the stability of the dam and the seepage at the downstream toe.

b. Design and Construction Data. Discussions with the Owner and County and State personnel indicate there are no available plans, specifications, or computations on the design, construction, or repair of the dam. Information on the type, shear strength and permeability of the soil and/or rock materials is nonexistent.

c. Operating Records. There is no evidence that any type of instrumentation has ever existed at Little Nugget Lake Dam. The performance of the spillway and dam under prior loading can only be inferred from physical evidence at the site.

d. Post-construction Changes. The only recorded changes after 1924 were repairs undertaken by the Owner in 1940 and 1967-1968. In 1940 the spillway crest was lowered 2 feet, the apron partly paved with concrete; and a core wall was placed. In 1967 changes included placing concrete on the spillway crest and filling a large hole on the downstream end of the crest; removing the center spillway pier, and placing a 10-foot long concrete cutoff wall. In 1968 changes included replacing the missing downstream end of the east spillway abutment wall, raising the main dam to the same elevation as the top of the stone abutment

walls at the spillway, replacing missing stones on the upstream and the downstream dam face; and replacing the gate in the outlet structure.

e. Seismic Stability. The dam is located in Seismic Zone No. 2 and in accordance with Phase I "Recommended Guidelines" does not warrant seismic analyses.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Built prior to 1924, Little Nugget Lake Dam was neither designed nor constructed according to current approved state-of-the-art procedures. Based upon the visual inspection, the limited engineering data, and no evidence of operation or maintenance procedures, it is determined that various deficiencies must be corrected to assure the continued performance of this dam. Generally, the dam is considered to be in poor condition. The principal areas of concern are: seepage at the toe of the dam; outward bulging of the vertical downstream stone wall; deep voids extending into dam through open joints between downstream wall stones; an inoperable slide gate; spalling and missing concrete on the weir; lack of adequate riprap protection on the upstream face of the dam and the dike; erosion caused by surface runoff at the knoll left of the spillway on the downstream slope; vegetation on the upstream slopes of the dam and thick vegetation immediately downstream of the dam; and lack of competent fill behind the west training wall of the spillway.

Hydraulic analyses indicate that the existing spillway (without flashboards) and emergency spillway can discharge a flow of 300 cfs when the water level in the lake is at El 771.5, which is the average elevation of the dike. The spillway may be inadequate since it can discharge only 15 percent of the test flood before the dam is overtopped. An outflow test flood of 1,970 cfs will overtop the dike by 2.2 feet, the main dam by 1.0 foot, and 2.9 feet at the swale.

The limited information available indicates that in 1930, 1933 and 1955 water overtopped the dam.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore the adequacy of this dam and west dike could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and engineering judgment.

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

d. Need for Additional Investigation. Additional investigations to further assess the adequacy of the dam and spillway are outlined below in Section 7.2, Recommendations.

7.2 Recommendations. In view of the concerns over the continued performance of the dam, dike and spillway, it is recommended that the Owner employ a qualified consultant to:

a. evaluate the stability of the dam

b. conduct a more detailed hydrologic and hydraulic investigation of the site to design an adequate spillway

c. evaluate the seepage at the downstream toe of the dam.

The recommendations on repairs and maintenance procedures are outlined below under Section 7.3, Remedial Measures.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The dam and spillway are not adequately maintained. It is recommended that the Owner accomplish the following:

(1) repair the gate mechanism to make the slide gate operable,

(2) repair and replace where missing, the concrete on the weir and replace the missing end of the east training wall

(3) add riprap on the upstream face of the dam and west dike,

(4) remove all trees and brush from the upstream face and crest of the dam and the dike,

(5) remove all trees and brush downstream of the dam,

(6) institute a definite plan for surveillance and a warning system during periods of unusually heavy rains and/or runoff. The warning system should be coordinated with one at the upstream reservoirs in the watershed, because flooding or failure of the upper dams will have a severe effect on Little Nugget Lake,

(7) implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances and be supplemented by additional inspections during and after severe storms. All repairs and maintenance should be undertaken in compliance with all applicable State regulations.

(8) technical inspection of this dam should be continued on an annual frequency,

(9) remove miscellaneous fill of leaves, etc. outside the west training wall of the spillway and replace with compacted soil, covered by loam, and then seeded.

(10) clear all debris from the spillway and downstream channel.

7.4 Alternatives. An alternative to implementing the recommendations and remedial measures listed above would be to drain the pond and breach or remove the dam. This could be an undesireable alternative, causing the lowering of the groundwater around the lake resulting in a deleterious effect on the local water wells.

APPENDIX A

PERIODIC INSPECTION CHECKLIST

LITTLE NUGGET LAKE

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT Little Nugget Lake

DATE August 31, 1978

TIME 2:00 p.m.

WEATHER rain

W.S. ELEV. 769.9 U.S. 759.4 DN.S.

PARTY:

1. Michael Larson
2. Lyle Branagan
3. Susan Pierce
4. David Cole
5. Frank Sviokla
6. Henry Lord
7.
8.
9.
10.

PROJECT FEATURE	INSPECTED BY	REMARKS
1. Dam	M. Larson	
2. Spillway	L. Branagan	
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

PERIODIC INSPECTION CHECK LIST

PROJECT Little Nugget Lake DATE 8-31-78

PROJECT FEATURE Dam NAME M. Larson

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	varies 770.8 to 772.9
Current Pool Elevation	769.9
Maximum Impoundment to Date	unknown
Surface Cracks	none
Pavement Condition	no pavement - miscellaneous fill on right crest, grass on left crest. Local erosion to right of swale, behind intake plate
Movement or Settlement of Crest	crest fairly flat west of swale
Lateral Movement	2 main areas: d/s face - left of spillway u/s face - rock shifted either side of intake
Vertical Alignment	bulging in downstream wall, about mid-height
Horizontal Alignment	concave upstream
Condition at Abutment and at Concrete Structures	earth and rock at left abutment; miscellaneous fill in spillway grass-covered right abutment
Indications of Movement of Structural Items on Slopes	no structural items
Trespassing on Slopes	at spillway: footpath on right above training wall, on left below d/s wall
Sloughing or Erosion of Slopes or Abutments	Downstream face: left of spillway, evidence of erosion or collapse of wall
Rock Slope Protection - Riprap Failures	Either side of intake: placed riprap, some pieces missing. Rocks bulging outward near top. Riprap slope 15' either side of intake
Unusual Movement or Cracking at or near Toes	Few riprap blocks scattered on length of u/s face none visible
Unusual Embankment or Downstream Seepage	wet areas d/s of toe; seepage pool to right of outlet. Combined seepage flows downstream at 20 to 30 gpm. Outlet leaking 1 to 2 gpm
Piping or Boils	none visible; unconfirmed report of boiling at crest, to left of spillway.
Foundation Drainage Features	none visible
Toe Drains	none visible
Instrumentation System	none

PERIODIC INSPECTION CHECK LIST

PROJECT Little Nugget DATE 8-31-78

PROJECT FEATURE dike NAME M. Larson

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITIONS
DIKE EMBANKMENT	
Crest Elevation	varies 771.0 to 777.5
Current Pool Elevation	769.9
Maximum Impoundment to Date	unknown
Surface Cracks	none
Pavement Condition	n/a - crest is earth
Movement or Settlement of Crest	irregular surface
Lateral Movement	irregular
Vertical Alignment	n/a
Horizontal Alignment	n/a
Condition at Abutment and at Concrete Structures	no concrete: earth abutments tie into natural ground, overgrown with small trees, brush, weeds. House adjacent to left abutment
Indications of Movement of Structural Items on Slopes	n/a
Trespassing on Slopes	small footpath; many tree roots, brush. brush pile on downstream face
Sloughing or Erosion of Slopes or Abutments	none
Rock Slope Protection - Riprap Failures	no riprap; stone fill on downstream slope
Unusual Movement or Cracking at or near Toes	n/a
Unusual Embankment or Downstream Seepage	seepage below stone on toe of downstream slope, small amount of standing water at toe
Piping or Boils	slight piping below rock fill
Foundation Drainage Features	none
Toe Drains	none
Instrumentation System	none

PERIODIC INSPECTION CHECK LIST

PROJECT Little Nugget Lake DATE 8-31-78

PROJECT FEATURE Outlet works NAME M. Larson

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	not visible
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	see notes below
Condition of Concrete	no concrete
Stop Logs and Slots	none visible

Intake structure built of dry stone masonry. Metal plate sitting on rocks, not bolted down. Valve stem extends from upstream of plate down to gate. No gate mechanism on plate. Plate may be removable for adding hand wheel.

Transition not visible.

PERIODIC INSPECTION CHECK LIST

PROJECT Little Nugget Lake DATE 8-31-78

PROJECT FEATURE Outlet Works NAME M. Larson

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL General Condition of ~~Concrete~~ stonework	stone wall mortared only in vicinity of outlet pipe. Pipe 18-inch dia. corrugated metal
Rust or Staining	slight rusting noted at bottom of pipe,
Spalling	none
Erosion or Cavitation	n/a
Visible Reinforcing	none
Any Seepage or Efflorescence	outlet leaking clear water, 1-2 gpm slight rust noted through water in pipe
Condition at Joints	n/a
Drain Holes	n/a
Channel	disconnected corroded pipe conducts some of the flow to seepage pool. *
Loose Rock or Trees Overhanging Channel	channel overgrown with shrubs
Condition of Discharge Channel	fair - cluttered with vegetation

* Pipe lies in eroded channel. Channel continues downstream past old mill house (small, collapsed building)

PERIODIC INSPECTION CHECK LIST

PROJECT Little Nugget Lake DATE 8-31-78

PROJECT FEATURE Spillway NAME M. Larson

DISCIPLINE Hydraulic NAME L. Branagan

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	mortared stone walls, some mortar missing, some cracks
General Condition	fair to good
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	one large tree, bushes, on right wall
Floor of Approach Channel	submerged; apparently concrete
b. Weir and Training Walls	Flashboard (wooden) 1.15' high; 3.5" wide
General Condition of Concrete *	concrete weir with asphalt cap, crest - fair cond. d/s slope spalled, cap partially missing end of concrete apron missing - poor cond.
Rust or Staining	none
Spalling	Considerable amount on d/s slope of weir
Any Visible Reinforcing	none; rock missing from left training wall, d/s end
Any Seepage or Efflorescence	possible under asphalt, but covered by litter and rock debris
Drain Holes	none visible
c. Discharge Channel	converges with seepage channel about 200' downstream. **
General Condition	fair
Loose Rock Overhanging Channel	very little; possible collapse on right bank
Trees Overhanging Channel	many small trees
Floor of Channel	natural rock pavement
Other Obstructions	minor shrubs and debris

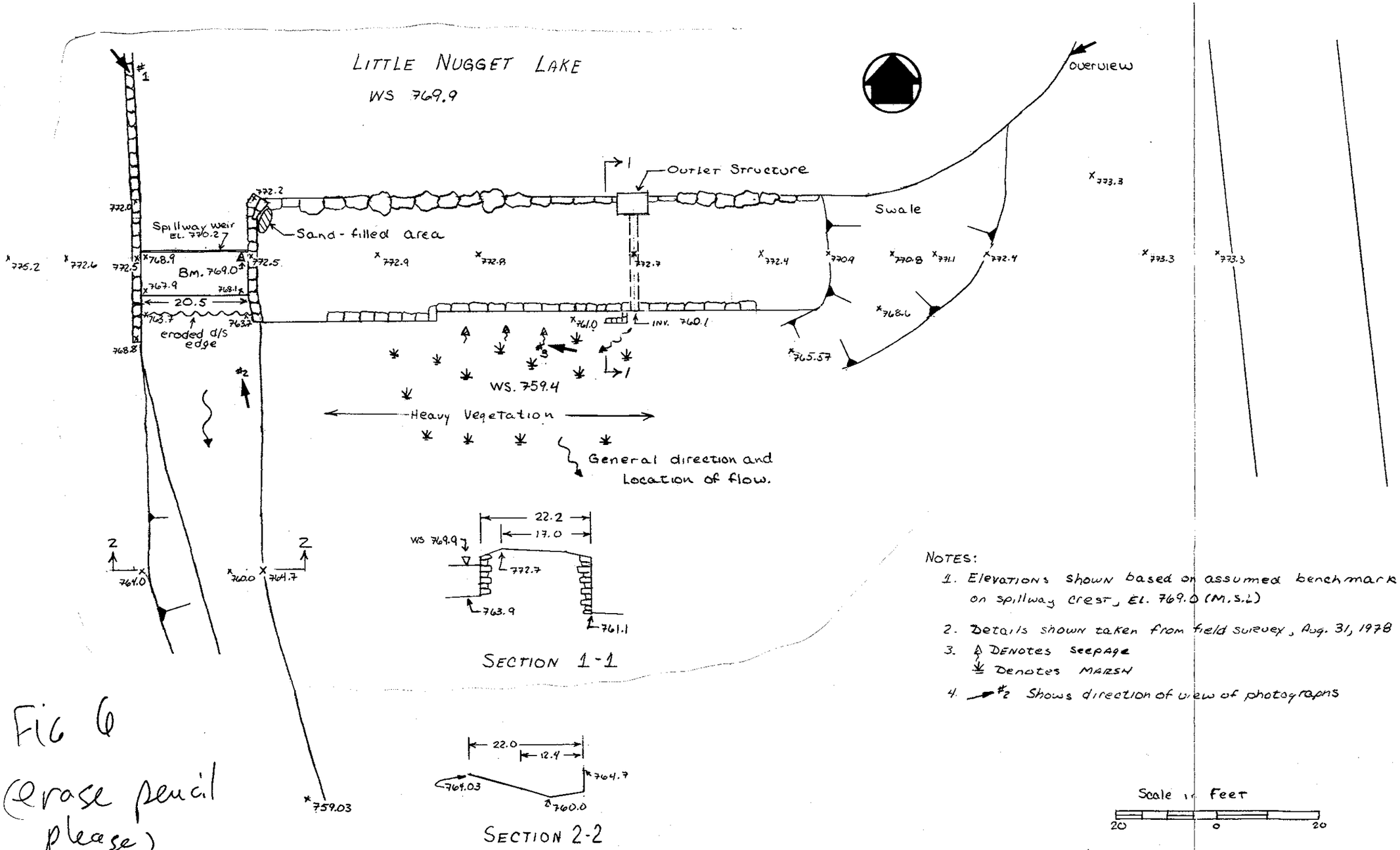
* slight to moderate amount of mortar missing or dislodged from training walls.

** House situated on left bank of channel about 300 feet downstream of dam

APPENDIX B

PLAN OF DAM AND PREVIOUS INSPECTION REPORTS

	Page
Figure B-1, Plan of Dam, Spillway and Sections	B-1
Figure B-2, Plan of Dike and Section	B-2
Previous Inspections (Partial Listing)	B-3
Inspection Report by Massachusetts Department of Public Works, February 1972	B-5
Inspection Report by Massachusetts Department of Public Works, September 1973	B-7
Letter Report by Massachusetts Department of Public Works, September 1973	B-13

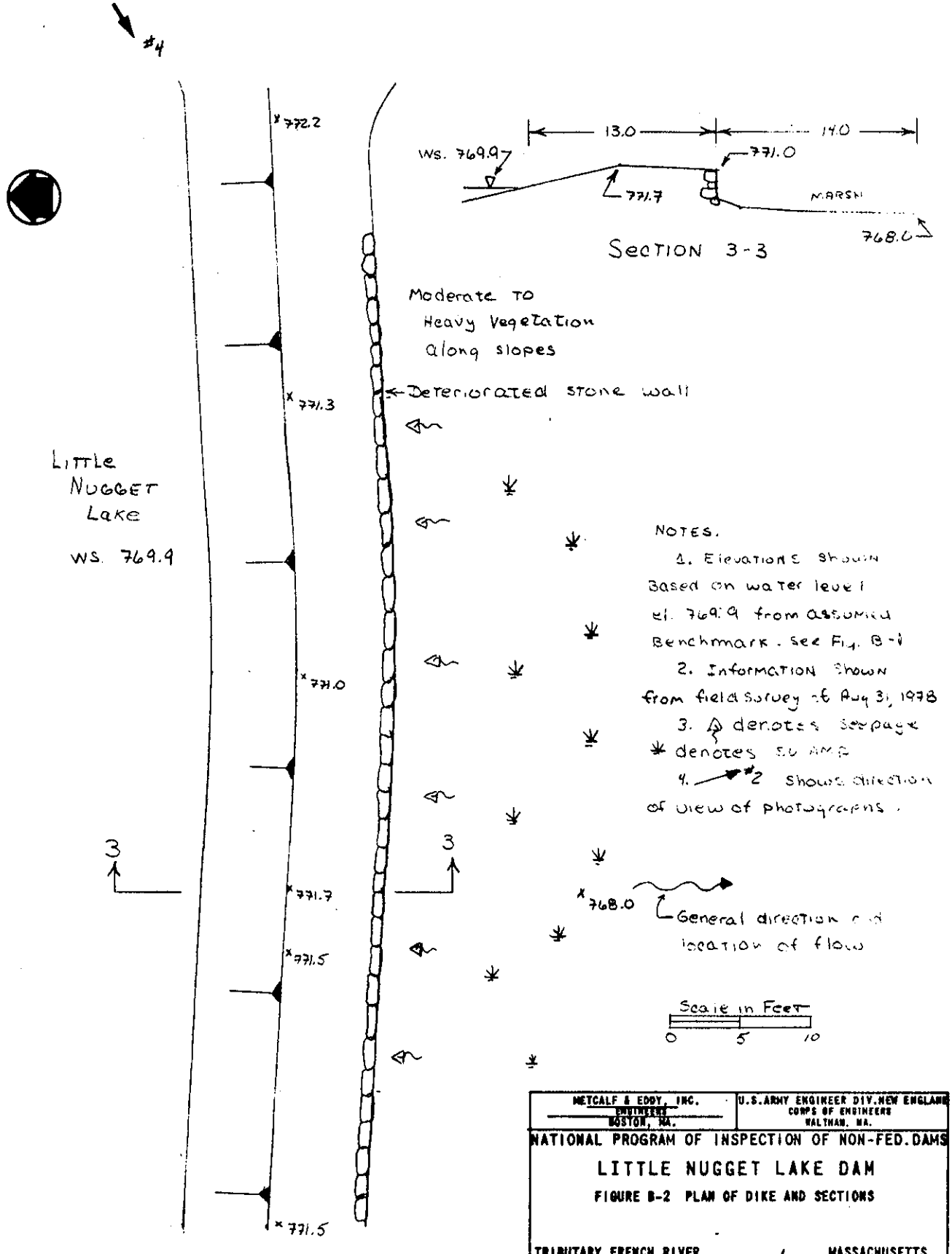


NOTES:

1. Elevations shown based on assumed benchmark on spillway crest, El. 769.0 (M.S.L)
2. Details shown taken from field survey, Aug. 31, 1978
3. Denotes seepage
   Denotes MARSH
4. #2 Shows direction of view of photographs

Fig 6
(erase pencil please)

METCALF & EDDY, INC. ENGINEERS BOSTON, MA.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
LITTLE NUGGET LAKE DAM	
FIGURE B-1 PLAN OF DAM AND SECTIONS	
TRIBUTARY FRENCH RIVER	MASSACHUSETTS
SCALE: 1" = 20'	DATE: OCTOBER, 1978



METCALF & EDDY, INC. ENGINEERS BOSTON, MA.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LITTLE NUGGET LAKE DAM

FIGURE B-2 PLAN OF DIKE AND SECTIONS

TRIBUTARY FRENCH RIVER / MASSACHUSETTS

SCALE: 1" = 10'	DATE: OCTOBER, 1978

TOWN OR CITY Charlton DECREE NO. Little Nugget Lake Recreation PLAN NO. DAM NO. 54-10-24

LOCATION North Charlton - Stafford St. C. C. DOCKET NO.

DESCRIPTION OF DAM

Type	Earth - Ver. Rubble Wall - El. 100'
Length	170'
Height	18.
Thickness top	16 - 20.
" bottom	24 - 30.
Downstream Slope	Vertical
Upstream "	"
Length of Spillway	El. crest = 97.0 24.
Size of Gates	El. 82.0 24" ϕ Iron Pipe.
Location of Gates	50' west end dam.
Flashboards used	None
Width Flashboards or Gates	—
Dam designed by	
" constructed by	
Year constructed	

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream	Little River - 10 Acre Pond
" " any other Streams	
Length of Watershed	
Width " "	
Is Watershed Cultivated	
Percent in Forests	
Steepness of Slope	
Kind of Soil	Rocky
No. of Acres in Watershed	3.06 S & M
" " " " Reservoir	
Length of Reservoir	
Width " "	
Max Flow Cu. Ft. per Sec.	Town of Charlton Tax Title
Head or Flashboards-Low Water	
" " " -High	" Corp dissolved May 17, 1957

GENERAL REMARKS

Owned by Edwin H. Perry - Charlton. -
Inspected Dec. 31, 1924. L. O. Marden.
" Feb. 12, 1928 " "
" Nov. 15, 1933 Aug 6. 1930 " "
" Sept. 3, 1934 " "
Measured: Oct. 5, 1938 B. P. St. John
Inspected: Nov. 15, 1933 - L. O. Marden.
Measured: 3-23-39 - E. C. Corcoran & Manty
Field BK 154 P. 44

GENERAL REMARKS

Now Federal Land Bank - Springfield.
1942 - Isaiah L. & Annette S. Newman - Worcester
Inspected: June 14. 1940 - L. O. M. & Lindquist
with Mr. Harris of the Fed. Land Bank discuss
repairs to dam.
Inspected: Aug. 6, 1940 - L O M - Harris & Bozzell
" " 9. " K. M. Finlayson
" Dec. 12, 1945 L. H. S.
owned by Little Nugget Lake Inc. Boston

2-Library Bureau 10-52760

B-3

PREVIOUS INSPECTIONS (PARTIAL LISTING)

COPY OF INSPECTION CARD ON FILE AT THE MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS, DISTRICT OFFICE, WORCESTER.

10-24

Inspected: Dec. 3, 1951 - L H S
" Mar 29, 1954 "

Feb. 18, 1960 - L.O.M.

OWNER - TOWN OF CHARLTON

INSPECTED - 2/16/72 - NICHOLSON, MULCAHY

INSPECTION REPORT & DATA FOR DAMS

Dam No. 54-24
Town: Charlton
Stream: Little River
Pond: Little Nugget Lake
Date: 2/16/72
By: [illegible]

Owner: Town of Charlton
His Address: Board of Selectmen
Function of Dam: RECREATION

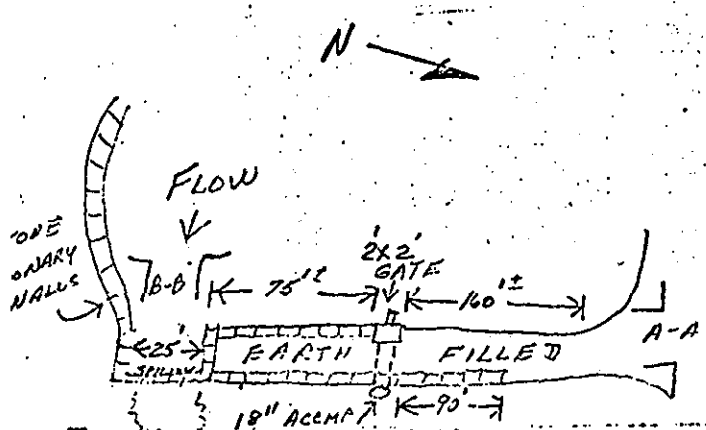
Location & Access: 0.35 Mile N.W. on Access Rd. off Northside Turnpike (off MILL WARD ST.)
USGS Quad. Leicester Lat. 42°10'12" Long. 71°57.02"
Drain.Ar.: 3.06 Sq.Mi.; Ponds: ___ ac.; Res. Dam: ___
Character of D.A.:

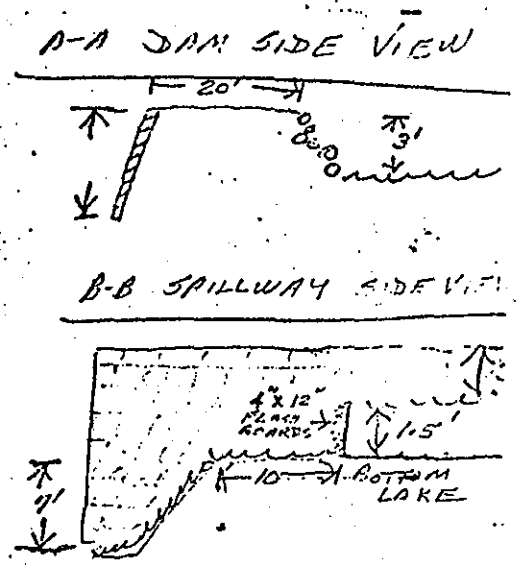
CONDITION RATING
Structural: GOOD
Hydraulic: [illegible]
General: GOOD
PRIORITY: NONE

Estimated
Discharge
Capacity:

General Description of Dam and Discharge Control:
STONE MASONRY WALLED DOWNSTREAM, NATIVE STONE RIP RAP UPSTREAM, EARTH FILL, GATE OPERATABLE 5 YEARS OLD. 2'X2' GATE FEEDS 18" ACCMP. 4"X12" FLASHBOARDS.

Sketch (Not to Scale):



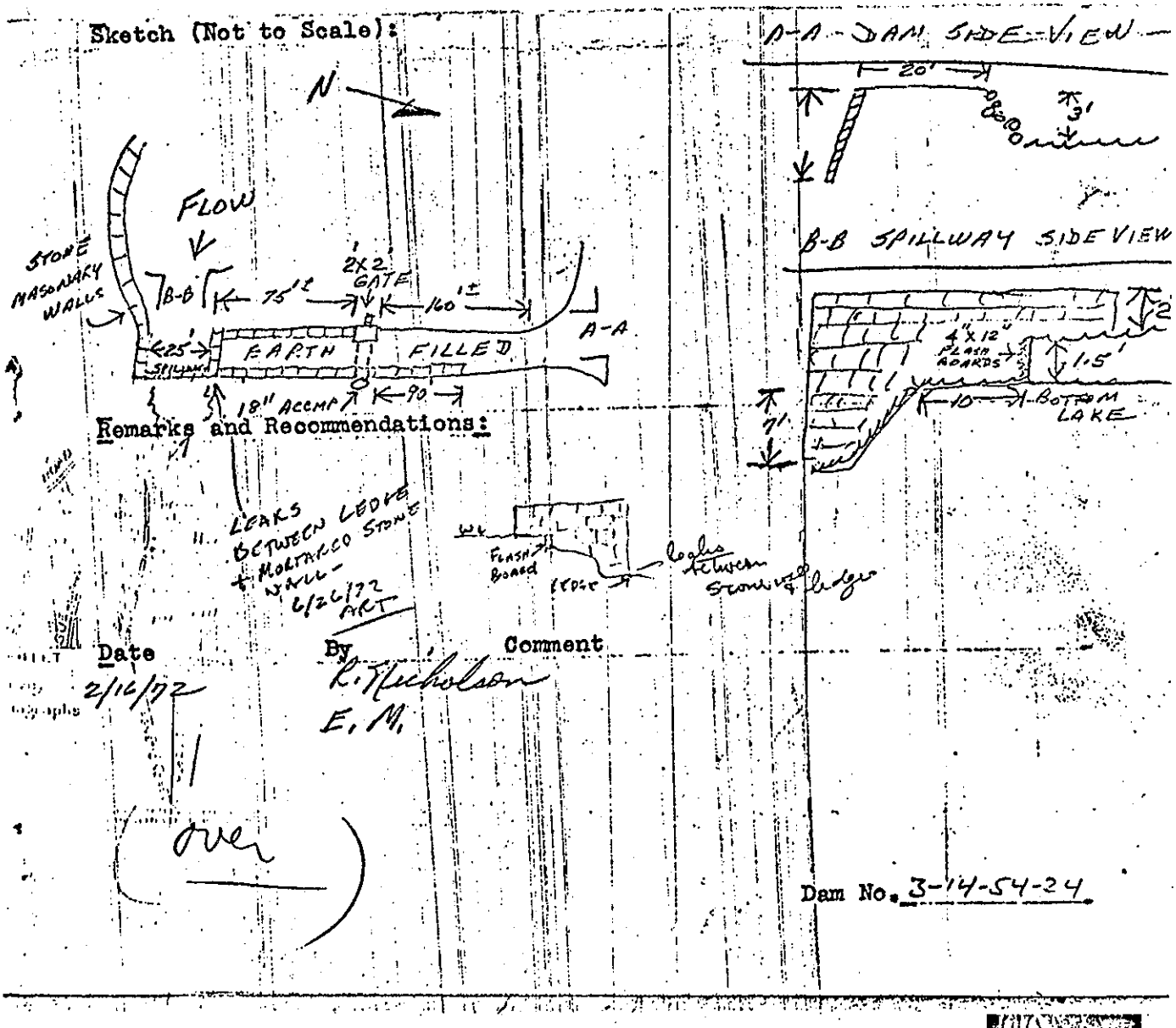


Remarks and Recommendations:

Date	By	Comment
2/16/72	R. Nicholson E.M.	

Dam No. 3-14-54-24

Sketch (Not to Scale):



Remarks and Recommendations:

Date	By	Comment
2/16/72	R. Nicholson E.M.	

over

Dam No. 3-14-54-24

INSPECTION REPORT - DAMS AND RESERVOIRS

1. Location: ~~City~~/Town Charlton Dam No. 3-14-54-24

Name of Dam Little Dugger Lake Inspected by G.F. Frodeur T. Powers

Date of Inspection 9-4-72

2. Owner/s: per: Assessors _____ Prev. Inspection 2-16-72

Reg. of Deeds _____ Pers. Contact _____

1. Town of Charlton Charlton Mass. 01507
Name St. & No. City/Town State Tel. No.

2. _____
Name St. & No. City/Town State Tel, No.

3. _____
Name St. & No. City/Town State Tel. No.

3. Caretaker (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

Name: Board of Selectmen St. & No.: Town Hall Charlton

~~City~~/Town: Charlton State: Mass. Tel.No.:

4. No. of Pictures taken none

5. Degree of Hazard: (if dam should fail completely)*

1. Minor X 2. Moderate _____

3. Severe _____ 4. Disastrous _____

* This rating may change as land use changes (future development)

6. Outlet Control: Automatic _____ Manual X

Operative _____ yes; _____ No.

Comments: Water level controlled by flashboards at spillway.

7. Upstream Face of Dam: Condition:

1. Good _____ 2. Minor Repairs X

3. Major Repairs ____ 4. Urgent Repairs ____

Comments: Dry stone face deteriorating, between the spillway and the gate

DAM NO: 3-14-54-24

8. Downstream Face of Dam:

Condition: 1. Good X 2. Minor Repairs ____

3. Major Repairs ____ 4. Urgent Repairs ____

Comments:

9. Emergency Spillway: None ?

Condition: 1. Good ____ 2. Minor Repairs ____

3. Major Repairs ____ 4. Urgent Repairs ____

Comments: 30" drawdown gate

10. Water Level at time of inspection: 6" at spillway above X below ____

top of dam ____ principal spillway X

other ____

11. Summary of Deficiencies Noted:

Growth (Trees and Brush) on Embankment none

~~Animal Burrows and Washouts~~ (2) 1 at gate 1 at spillway

Damage to slopes or top of dam Dry stone walls (upstream)

Cracked or Damaged Masonry Minor cracking at spillway

Evidence of Seepage none

Evidence of Piping yes * SEE NOTE PAGE 3

Erosion Minor erosion downstream face

Leaks none

Trash and/or debis impeding flow at spillway outlet

Clogged or blocked spillway none

Other Settlement (sinkholes)

12. Remarks & Recommendations: (Fully Explain)

Debris should be removed from spillway outlet.

~~Presently the dam requires minor repairs to~~ the (two ~~washouts~~ sinkholes and) to the vertical face of the upstream dry wall. Minor Repairs

Note * There is some evidence of piping and a later inspection will be made.

13. Overall Condition:

1. Safe X
2. Minor repairs needed upstream face & washouts
3. Conditionally safe - major repairs needed no
4. Unsafe no
5. Reservoir impoundment no longer exists (explain)

Recommend removal from inspection list _____

LITTLE NUGGET LAKE

DESCRIPTION OF DAM

DISTRICT III

Submitted by George D. Brodeur Dam No. 3-14-54-24

Date Sept. 4, 1973 ~~City~~/Town Charlton

Name of Dam Little Nugget Lake

1. Location: Topo Sheet No. 21 A

Provide 8½" x 11" in clear copy of topo map with location of Dam clearly indicated.

2. Year built: _____ Year/s of subsequent repairs _____

3. Purpose of Dam: Water Supply _____ Recreational X

Irrigation _____ Other _____

4. Drainage Area: 3.06 sq. mi. _____ acres

5. Normal Ponding Area: 12 ± acres; Ave. depth _____

Impoundment: _____ gals.; _____ acre ft.

6. No. and type of dwellings located adjacent to pond or reservoir

20 i.e. summer homes, etc. _____

7. Dimensions of Dam: Length _____ Max. Height _____

Slopes: Upstream Face Vertical

Downstream Face Vertical

Width across top 20'

8. Classification of Dam by Material:

Earth X Conc. Masonry Spillway Stone Masonry X

Timber _____ Rockfill _____ Other _____

9. A. Description of present land usage downstream of dam:

80% % rural; 20% % urban.

B. Is there a storage area or flood plain downstream of dam which could accomodate the impoundment in the event of a complete dam failure? yes X no _____.

DAM NO. 3-14-54-24

10. Risk to life and property in event of complete failure.

No. of people 15.

No. of homes 4.

No. of Businesses none.

No. of industries none. Type _____

No. of utilities none. Type _____

Railroads none.

Other dams 3-14-54-24 & 3-14-54-24.

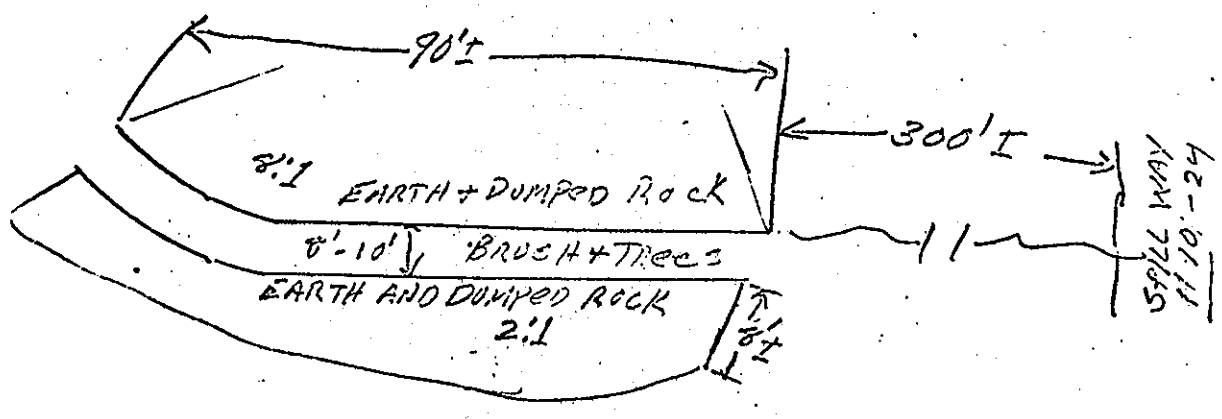
Other Northside Turnpike & Massachusetts Turnpike

11. Attach Sketch of dam to this form showing section and plan on 8½" x 11" sheet.

12. How to Locate:

0.35 miles Northwesterly on access road off Northside Turnpike (opposite Millward Road)

Dam # 3-14-54-24



COMMENTS:

This area cannot be used as an emergency spillway, as no means to control flow of water.

September 12, 1973

Board of Selectmen
Town Hall
Charlton, Massachusetts

RE: Inspection-Dam#3-14-54-24
Charlton
Little Nugget Lake Dam

Gentlemen:

An engineer from the Massachusetts Department of Public Works has inspected the above dam, owned by the Town of Charlton.

The inspection was made in accordance with Chapter 253 of the Massachusetts General Laws, as amended by Chapter 595 of the Acts of 1970.

The results of the inspection indicate that this dam is safe; however, the following conditions were noted that require attention.

1. Two settlement or sinkholes, located at the gate and at the spillway, should be investigated and corrected and repaired as needed.

2. The upstream face of the dry stone wall between the spillway and the gate is deteriorated and needs rebuilding.

3. Remove the accumulation of debris from the spillway.

We call these conditions to your attention now, before they become serious or more expensive to correct.

Very truly yours,

William E. Donahue
WILLIAM E. DONAHUE, P.E.
Acting Deputy Chief Engineer

LRA
LRA/afscc
cc: S. C. Waruzila Acting DHE#3
Dams and Reservoir Engr. Dist#3

APPENDIX C

PHOTOGRAPHS

LITTLE NUGGET LAKE

NO. 1 UPSTREAM VIEW OF SPILLWAY

NO. 2 VIEW OF SPILLWAY FROM DOWNSTREAM TOE

NO. 3 VIEW OF DOWNSTREAM WALL OF DAM

NO. 4 VIEW OF DIKE

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

LITTLE NUGGET LAKE

(I) Test Flood, 100 year Storm & Storage Functions

1 – Total Drainage Area – 3.05 mi^2

2 – Pond(s) Area: 0.02 + 0.01 + 0.05 = 0.08 mi^2
Swamp(s) Area: 0.16 + 0.15 = 0.31 "
Total Area Pond(s) & Swamp(s): 0.39 "

$$\% \text{ Ponds \& Swamps} = \frac{0.39}{3.05} = 13\%$$

3 – $\frac{El.\ 1075 - 769}{10400\ ft} = 3.0\%$
$\frac{El.\ 1075 - 769}{15200\ ft} = 2.0\%$ } Say Ave Slope = 2.5%

4 – Using C. of E. Curves for Peak Flow Rates & above guide values the Peak Flow Rate was estimated to be between "Rolling" and "Flat and Coastal", and taken at 1350 c.f.s./mi^2

Due to low dam height use ½ MPF

5 – $\boxed{\text{Test Flood Inflow} = \tfrac{1}{2}(1350)\,3.05 = 2060 \text{ c.f.s.}}$

6 – Pond Storage
The pond area is 0.02 sq. mi. at elev. . Based on a const. area, storage increases at 12.8 ac. feet per foot of depth increase. Although "storage/foot" will increase with depth, the variation is not significant for this study.

7 – Storage Functions are based on $Q_{out} = Q_{in}\left[1 - \frac{S_{out}}{R}\right]$

S_{out} = Storage Vol. in Reservoir related to final Q_{out} in terms of inches of rain over the drainage area.

S(in Inches) $= 12\,D\left(\frac{0.02}{3.05}\right) = 0.08\,D$; R = 6hr rain of storm

D = Storage Depth (above spillway) on reservoir, in feet

8 – Storage Functions: (F_{TF}) $D = 0'$ @ Pond El. 769

$$\boxed{F_{TF} = 2060 - 217\,S = 2060 - 17.4\,D}$$

(II) Dam Discharge Ratings

A - Broad Crested Spillway - $Q_s = CLH^{1.5}$ [Ref. pp. 360-362] (see below)

$C = 3.27 + 0.4\frac{H}{h}$; $L = L' - 0.1NH$

H = Physical Water Head on CREST (h_v not included)

h = Weir Height, L' = Measured Crest Length

Assumptions

For Floods or Peak Flows, $\frac{H}{h} \simeq 0.5$ ∴ C = 3.47

L = 90% L'

$$\therefore \quad Q_s = 3.12\, L' H^{3/2}$$

B - Flow over Crest of Dam - $q_c = 3.475\left[\frac{y}{y+h'}\right]^{1/2}(H')^{3/2}$ [Ref. pp. 52-3] see below

q_c = Disch./ft. of width

H' & h' as defined above; $y = h' + H'$

Assumptions

For Floods (flow over dam crest)

$H' = \frac{1}{6}h'$ [note $h' \simeq h + H$ in Item (I) above]

$\therefore\ y = \frac{7}{6}h'$ & $\left[\frac{y}{y+h'}\right]^{1/2} = \left[\frac{7/6\, h'}{13/6\, h'}\right]^{1/2} = 0.734$

$$\therefore \quad q_c = 2.55(H')^{3/2}$$

Apply to Crest in steps where levels are roughly const.

[Ref.: "Open Channel Hydraulics" - V.T. Chow]

(II) Dam Discharge Rating – Cont.

C - Four areas of discharge

1- Spillway: $Q_S = 3.12(20.5')\,H^{1.5}$; Crest @El. 769.0*

2- Emergency Spillway (Swale): $Q_{ES} = 2.55(20')\,H^{1.5}$
Crest @ El. 770.8 ±

3- West Dike Crest: $Q_{WD} = 2.55(80')\,H^{1.5}$; Crest @El. 771.5 ±

4- Main Dam Crest: $Q_{MD} = 2.55(150')\,H^{1.5}$; Crest @El. 772.7 ±

D - Discharge vs Pond Elev.

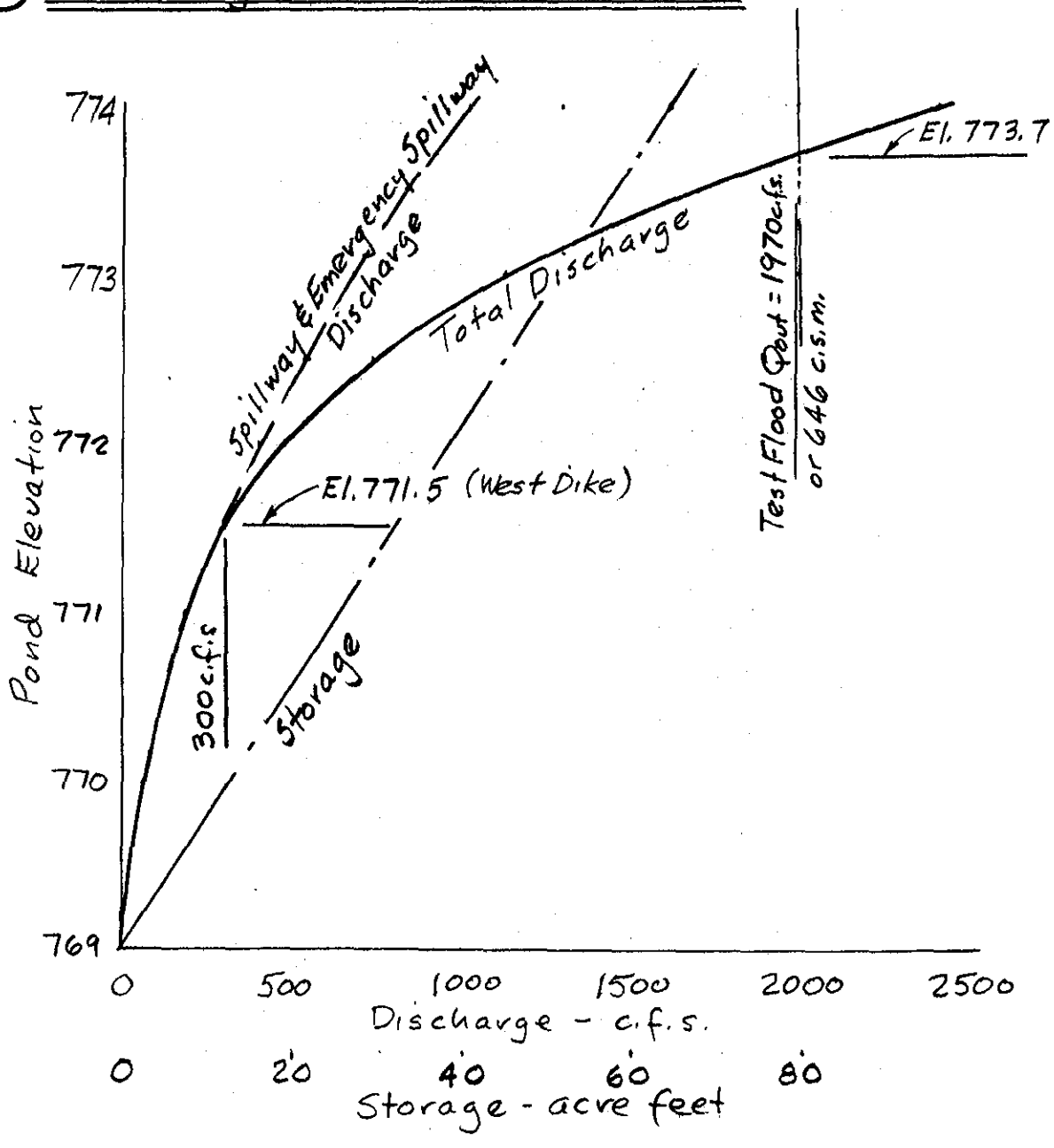
Pond Elev.	Q_S*	Q_{ES}	Q_{WD}	Q_{MD}	Total Disch (c.f.s.)
770	64	—	—	—	64
771	181	4	—	—	185
772	332	67	72	—	471
772.5	419	113	204	—	736
773	512	166	375	63	1116
773.5	611	226	577	274	1688
774	715	292	806	567	2380

* Assume 15" ± flashboard has failed

E - Outlet Pipe Discharge

Pond El. 770 ±, ℄ outlet 760.5 ±, Net Head = 9.5'
Ignore pipe friction; Head Loss = 1.0 h_v @ exit + 0.5 h_v @ ent.
∴ $1.5\,V^2/2g = 9.5$; V = 20 fps – Use 18.0 fps to allow for frict.
Pipe Size: 18" c.m.p., Area = 1.767 ft², ∴ Q_{out} = 32 cfs.
Time to Drain 1': $\frac{0.02(640)43560}{32(3600)} = 4.8$ hr.
32 cfs from drainage area = 10.5 c.s.m.

III Disch., Storage & Stor. Function vs Pond Elev.



Under Peak Test Flood Discharge:

Flow Over West Dike = $2.55(80)(2.2)^{1.5}$ = 666 cfs or 8.32 cfs/ft

Flow Over Main Dam = $2.55(150)(1.0)^{1.5}$ = 382 cfs. or 2.55 cfs/ft

Critical Flow:

	West Dike	Main Dam
y_c:	1.29'	0.60'
V_c:	6.45 fps	4.35 fps

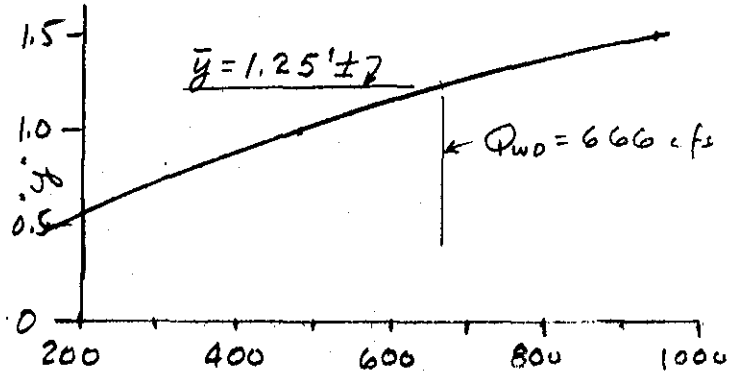
$\left\{ y_c = \left[\frac{q^2}{g} \right]^{1/3} \right\}$

(IV) West Dike Discharge Channel

Flow over the West Dike would flow thru a swampy, broad channel. From USGS this channel slope is 9' in 350' or .0257
For Vel. use: $V = \frac{1.49}{.04} R^{2/3} (.0257)^{1/2} \cong 6.0 R^{2/3}$

Say Channel 80' wide & flat ; $R \simeq y$ = Depth Flow.

y	Area	$R^{2/3}$	Vel	Q
0.5	40	0.630	3.78	151
1.0	80	1.0	6.0	480
1.5	120	1.31	7.86	943



Ave Flow Vel = 7.0 fps ±

(V) Failure of Dam

Peak Failure Flow:

Pond Elevation - 772±
Toe Elevation — 761±
Y_o = 11'

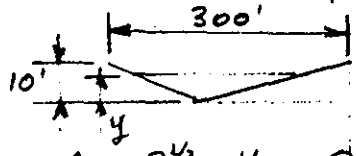
Dam Length Subject to Breaching = 140'
$W_o = 40\%(140) = 56'$

$$Q_{P_1} = 1.68\, W_o (Y_o)^{1.5} = 1.68(56)(11)^{1.5} = \underline{3400 \text{ cfs.}}$$

Storage Volume Released:

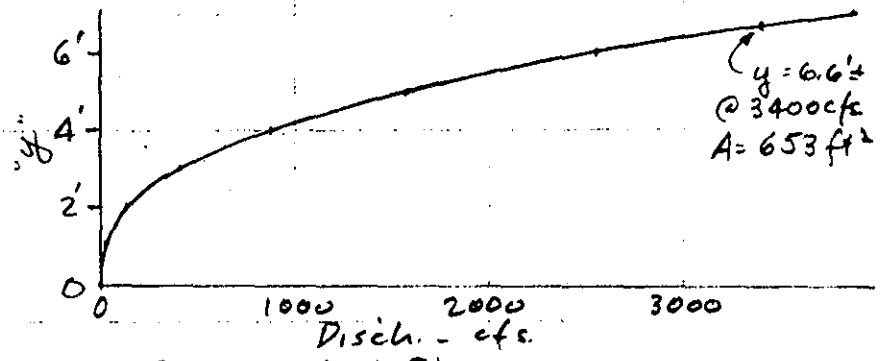
Storage Above Spillway: 3(0.02)640 = 38.4 acre ft
Storage Below Spillway: ⅓(8)(0.02)640 = 34.1 " "
S = Total Storage = 72.5 " "

Channel Hydraulics:



$S = \frac{20}{850} = .0235$, $S^{1/2} = 0.153$, $n \simeq 0.10$
$A = 15y^2$, $P = 30y$, $R = y/2$, $Vel = 2.285\, R^{1/2}$

y	A	$R^{1/3}$	V	Q
1	15	.630	1.44	22
2	60	1	2.28	137
3	135	1.31	3.00	404
4	240	1.59	3.63	870
5	375	1.84	4.20	1578
6	540	2.08	4.75	2566
7	735	231	5.27	3871



$V_1 = 653 \times 700' = 10.5$ ac. ft. ; $Q_{P_2} = 3400(1 - \frac{10.5}{72.5}) = 2900$ cfs ; $y_2 = 6.3$ ft
$A_2 = 595 ft^2$; Ave $A = \frac{1}{2}(653 + 595) = 624 ft^2$; $\bar{y} = 6.45'$, $\bar{Q}_P = 3100$ cfs.
Note: 700' is distance to "critical" house below dam

Time to Drain:

$$\frac{43560\ (72.5)}{3600(\frac{1}{2})(3400)} = 0.52 \text{ Hours.} = 31 \text{ minutes.}$$

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

LITTLE NUGGET LAKE