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NATIONAL DAM SAFETY PROGRAM. SWANNANOA LAKE DAM NUMBER 1 (NJ 00--ETC(U)
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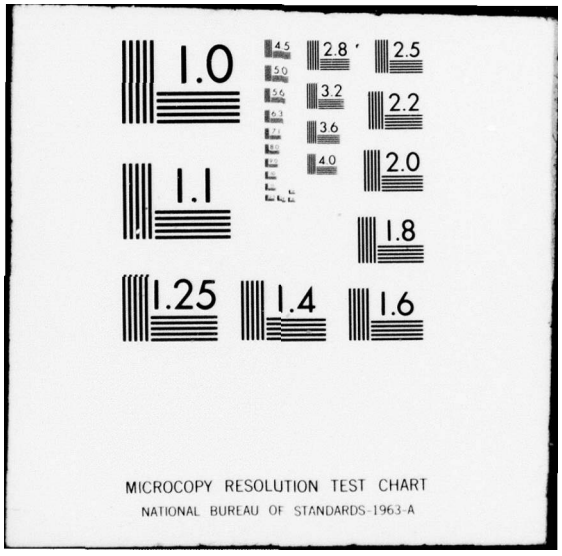
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PASSAIC RIVER BASIN
ROCKAWAY RIVER TRIB.
MORRIS COUNTY,
NEW JERSEY

SWANNANOA LAKE
DAM NO. 1
NJ 00311

LEVEL II

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

February, 1979

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

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Morris County, New Jersey

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Embankments
Structural Analysis
Safety
Visual Inspection
National Dam Safety Program
Swannonoa Lake Dam No 1

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

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

4 APR 1979

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Swannanoa Lake Dam No. 1 in Morris County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Swannanoa Lake Dam No. 1, a high hazard potential structure, is judged to be in poor overall condition. The spillway is considered inadequate since 4 percent of the Probable Maximum Flood would overtop the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant, engaged by the owner, using more sophisticated methods, procedures and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, detailed emergency operation and evacuation plans and a warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

b. Within six months from the date of approval of this report, the following engineering studies and analysis should be performed:

(1) Determine the foundation conditions of the dam and evaluate the need for and type of under seepage cutoff that may be required.

(2) Determine by means of core borings and tests the material characteristics of the dam and the engineering properties of the foundation materials, and evaluate the requirements for strengthening the dam.

(3) Evaluate the need for additional downstream support of the dam and measures for relieving hydrostatic pressure from within and below the dam.

(4) Determine whether or not a low level outlet exists below the spillway and, if so, make this outlet functional.

c. A more extensive topographic survey of the dam and vicinity should be made within six months from the date of approval of this report.

d. Within three months from the date of approval of this report, the following remedial actions should be performed:

(1) Remove the trash rack- flash board supports from the crest of the spillway to ensure blockage of the spillway crest does not occur.

(2) Repair the downstream sidewalls of the spillway and discharge channel.

(3) Repair spalled and cracked concrete areas on the crest of the dam.

(4) Repair the crack in the right spillway buttress.

(5) Repair open joints in the masonry on the upstream side of the dam.

(6) Eroded areas along the spillway side wall and embankment junction should be suitably filled.

(7) The small pipe drain at the left of the spillway should be made operational.

(8) Remove debris, trees and brush from along the toe of the dam and the discharge channel.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James A. Courter of the Thirteenth District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National

NAPEN-D
Honorable Brendan T. Byrne

Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely yours,

Joel Kobbe LTC

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Cy furn:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
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SWANNANOA LAKE DAM NO. 1 (NJ00311)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 30 November and 1, 11, 12 and 16 December 1978 by Langan Engineering Associates, Inc. under contract to the State of New Jersey. The state, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, P.L. 92-367.

Swannanoa Lake Dam No. 1, a high hazard potential structure, is judged to be in poor overall condition. The spillway is considered inadequate since 4 percent of the Probable Maximum Flood would overtop the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant, engaged by the owner, using more sophisticated methods, procedures and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, detailed emergency operation and evacuation plans and a warning system, should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

b. Within six months from the date of approval of this report, the following engineering studies and analysis should be performed:

(1) Determine the foundation conditions of the dam and evaluate the need for and type of under seepage cutoff that may be required.

(2) Determine by means of core borings and tests the material characteristics of the dam and the engineering properties of the foundation materials, and evaluate the requirements for strengthening the dam.

(3) Evaluate the need for additional downstream support of the dam and measures for relieving hydrostatic pressure from within and below the dam.

(4) Determine whether or not a low level outlet exists below the spillway and, if so, make this outlet functional.

c. A more extensive topographic survey of the dam and vicinity should be made within six months from the date of approval of this report.

d. Within three months from the date of approval of this report, the following remedial actions should be performed:

(1) Remove the trash rack- flash board supports from the crest of the spillway to ensure blockage of the spillway crest does not occur.

(2) Repair the downstream sidewalls of the spillway and discharge channel.

(3) Repair spalled and cracked concrete areas on the crest of the dam.

(4) Repair the crack in the right spillway buttress.

(5) Repair open joints in the masonry on the upstream side of the dam.

(6) Eroded areas along the spillway side wall and embankment junction should be suitably filled.

(7) The small pipe drain at the left of the spillway should be made operational.

(8) Remove debris, trees and brush from along the toe of the dam and the discharge channel.

APPROVED: Joel Robbins LTC
JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 4 Dec 1979

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	SWANNANOA LAKE DAM #1
ID NUMBER:	FED ID No. NJ00311
STATE LOCATED:	NEW JERSEY
COUNTY LOCATED:	MORRIS COUNTY
STREAM:	WEST BRANCH OF ROCKAWAY RIVER
RIVER BASIN:	PASSAIC
DATE OF INSPECTION:	30 November and 1,11,12 & 16 December 1978

ASSESSMENT OF GENERAL CONDITIONS

Lake Swannanoa Dam #1 is in poor overall condition. Available information is not sufficient to draw conclusions concerning the actual degree of stability of the dam. Based on our observations it is our opinion the dam is marginally stable. We are concerned about the bulging of the downstream face of the dam and seepage through and under the dam. These conditions can be expected to become worse if they remain uncorrected or an extreme flood occurs.

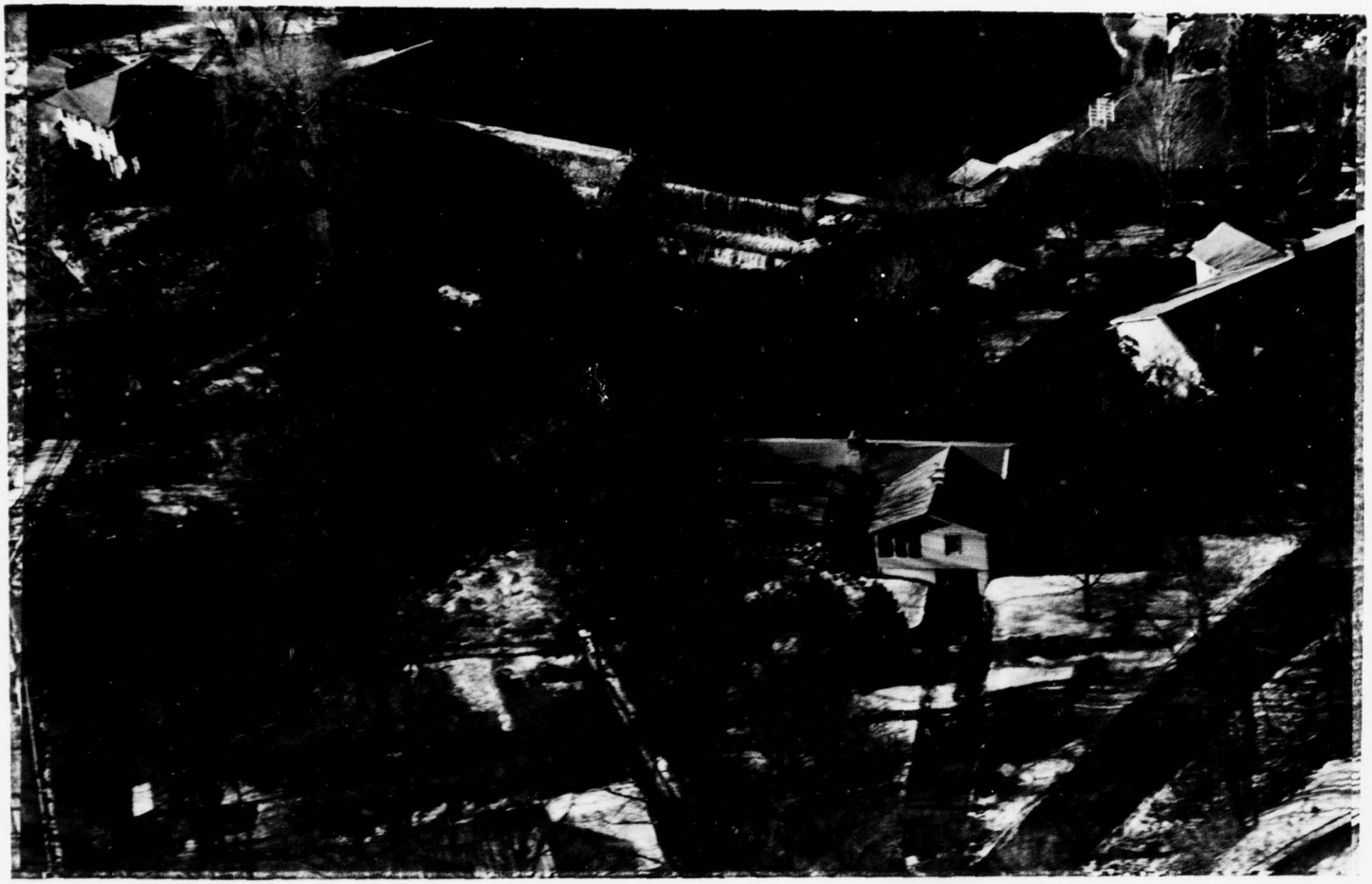
We recommend a determination be made as to the presence of a low level outlet below the spillway, and if necessary, measures be developed to make the outlet functional. In any case a low level outlet should be provided. The foundation conditions of the dam should be determined and an evaluation made of the need for and type of under seepage cutoff that may be required. The

condition of the concrete in the dam should be determined by means of core borings and tests and an evaluation made of the requirements for strengthening the dam. An evaluation should also be made of the need for additional downstream support of the dam and the measures necessary for relieving hydrostatic pressure from within and below the dam. The preceding recommendations should be done very soon. The trash rack-flashboard supports should be removed from the crest of the spillway to ensure blockage of spillway crest does not occur, and the downstream sidewalls of the spillway and discharge channel should be repaired. They should be done soon.

The spillway capacity as determined by CE Screening criteria is inadequate. We estimate the dam can adequately pass only 3.9% of the PMF. The capacity of the spillway and SDF should be determined using more precise and sophisticated methods and procedures. A more extensive topographic survey of the dam and vicinity should be made. The need for and type of mitigating measures should be determined. Around the clock surveillance during periods of unusually heavy precipitation should be provided, and a warning system established. This should be done very soon.

Dennis J. Leary

Dennis J. Leary, P.E.



OVERVIEW

SWANNANOA LAKE DAM #1

1 DECEMBER 1978

YELLOW

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	SWANNANOA LAKE DAM #1
ID NUMBER:	FED ID No. NJ00311
STATE LOCATED:	NEW JERSEY
COUNTY LOCATED:	MORRIS COUNTY
STREAM:	WEST BRANCH OF ROCKAWAY RIVER
RIVER BASIN:	PASSAIC
DATE OF INSPECTION:	30 November and 1,11,12 & 16 December 1978

LANGAN ENGINEERING ASSOCIATES, INC.

Consulting Civil Engineers
990 CLIFTON AVENUE
CLIFTON, NEW JERSEY
201-472-9366

CONTENTS

NATIONAL DAM SAFETY REPORT

SWANNANOA LAKE DAM #1 FED ID No. NJ00311

PREFACE

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

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. 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. 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.

SECTION 1 PROJECT INFORMATION

1.1 General

Authority to perform the Phase I Safety Inspection of Swannanoa Lake Dam #1 was received from the State of New Jersey, Department of Environmental Protection, Division of Water Resources by letter dated 20 November 1978. This Authority was given pursuant to the National Dam Inspection Act, Public Law 92-367 and by agreement between the State and US Army Engineers District, Philadelphia.

The purpose of the Phase I Investigation is to develop an assessment of the general conditions with respect to safety of Swannanoa Lake Dam #1 and appurtenances based upon available data and visual inspection, and, determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted. The assessment is made using screening criteria established in Recommended Guidelines for Safety Inspection of Dams prepared by the Department of Army, Office of the Chief of Engineers. It is not the purpose of the inspection to imply that a dam meeting or failing to meet the screening criteria, is per se, certainly adequate or inadequate.

1.2Project Description

Swannanoa Lake Dam #1 is located at the southeast end of Swannanoa Lake, south of Swannanoa Lake Dam #2, across a tributary of the Rockaway River. It is located immediately upstream from Berkshire Valley Road, about four miles north of Woodstock, in Jefferson Township, Morris County, New Jersey. A regional vicinity map is given in Fig 1.

The dam is a 228-ft-long, 15-ft-high masonry gravity dam with a free-fall spillway having a 50-ft-long crest. It is located at latitude 41° 0.5' north and longitude 74° 31.1' west. Pertinent features of the dam are given in Fig 2.

The area of the lake is approximately 51 acres. Lake Swannanoa Dam #1 is classified as being "small" on the basis of its reservoir storage volume of 539 Ac-ft which is less than 1,000-acre feet, but more than 50-acre feet. It is also classified as "small" on the basis of its total height of 15 ft, which is less than 40 feet. The dam is therefore, classified as "Small" in size.

In the National Inventory of Dams, Lake Swannanoa Dam #1 has been classified as having "High Hazard Potential" on the basis that failure of the dam would cause excessive property damage to residences downstream, and could potentially cause more than a few deaths. Visual inspection of the downstream area shows that breach of the dam would cause damage to a residence located immediately east of Berkshire Valley Road and could be hazardous to people utilizing the Road. Accordingly, it is proposed not to change the Hazard Classification Potential.

Swannanoa Lake Dam #1 is owned by Ringling Manor Inc., c/o Mrs. Gertrude Bohenna, 28 Manor Drive, Lake Swannanoa, Oak Ridge, New Jersey 07438.

The original purpose of the dam was recreation and power generation for lights. Its present purpose is recreation.

The dam was constructed in 1914 by E.R. Headley & Sons for Mr. A.T. Ringling.

Stone masons are engaged as necessary to replace cobbles in the stone facing as they fall out.

Operating procedures appear to be limited to the placement and removal of flash boards during the summer to increase the depth of the lake for swimming.

1.3 Pertinent Data

a. Drainage Area

At dam site, the drainage area is 13.9 sq mi

b. Discharge at Dam Site

Maximum known flood at dam site occurred 25 August 1955, magnitude not known.

Spillway capacity at pool elevation equal to crest of dam:	560 cfs

c. Elevation (ft above MSL)

Top Dam:	773+
Normal pool:	770.4
Streambed at centerline of dam:	758 (estimated)
Maximum tailwater:	Approx. El. 760 at time of inspection

d. Reservoir

Length of Maximum pool:	3530 ft (estimated)
Length of normal pool:	3500 ft (estimated)

e. Storage (acre-feet)

Normal pool:	400 AF

	Top of dam:	539 AF
f.	Reservoir Surface (acres)	
	Top dam:	56 Acres
	Maximum pool:	56 Acres (Assumed to be at top of dam)
	Recreation pool:	51 Acres
	Spillway crest:	51 Acres
g.	Dam	
	Type:	Masonry Gravity Dam
	Length:	228 ft
	Height:	15 ft
	Top width:	4.8 ft
	Side slopes:	d/s 6 hor to 1 vert; u/s 1 hor to 12 vert
	Impervious core:	None Observed
	Cutoff:	None Observed
	Grout curtain:	None Observed

SECTION 2 ENGINEERING DATA

2.1 Introduction

No essential information has been made available concerning the design, construction and operation of the dam. Available information is inadequate. It is not possible to make an evaluation of the validity of the available information beyond the observed materials and geometry of the dam. Sketches indicate 5 ft to 10 ft below the base of the dam has been either backfilled with an unidentified material, or, a masonry key was constructed below the dam. Sketches also indicate there is a 4-ft-dia low level outlet below the spillway. The outlet was not observed and it is not known if construction was done according to the sketches. The sketches also indicate the subsoils beneath the dam vary laterally from right to left as hard pan, blue clay, and gravel.

2.1 Regional Geology

Swannanoa Lake Dam #1 is located in the New Jersey Highlands physiographic province. The New Jersey Highlands extend across the state in a northeast southwest direction from the border of New York to the Delaware River and includes the northwest portions of Hunterdon, Passaic, and Morris Counties and the southeastern parts of Warren and Sussex Counties. This province is part of the New England Physiographic Province and lies between the Appalachian Ridge and Valley Province to the northwest and the Piedmont Province to the southeast. See Fig 3.

The Highlands are characterized by rounded and flattopped northeast southwest ridges and mountains up to 1,400 ft high separated by narrow valleys. The orientation of the valleys are usually, but not always controlled by the underlying geologic structure.

The regional geologic structure reflects the very old age of bedrock. A number of regional faults cross the area in northeast southwest direction, including the Ramapo Fault; the more than 30 mile long fault scarp forms the eastern border of the province. Faults control many of the river valley orientations. The relatively uniform slope of the mountain elevations, from northwest to southeast, is a direct result of the faulting. The entire area is part of the now dissected Schooley Peneplain.

The Pleistocene Age Wisconsin glacier covered all of the dam site area.

The glacier stripped most of the existing overburden and weathered rock and uncovered the numerous hard bedrock knobs and ridges seen throughout the province. Most of the side-slopes in the area are covered with heavy boulder tills (ground moraine), whereas glacial outwash and recent alluvium cover the valleys.

SECTION 3 VISUAL INSPECTION

Swannanoa Lake Dam #1 was inspected on 14 May 1974 by the N.J.D.E.P. Division of Water Resources. This inspection concluded the general condition of the dam to be good, however, there are a few places where slight bulges of about 3 to 5 inches beyond the plane of the downstream face of the dam were observed. Some of these areas also showed seepage. The total amount of seepage was difficult to determine but was estimated at about 1 second foot. At the time of the inspection there had been a rainfall the previous day of approximately 2.5 inches. The inspection report recommended that a complete inspection be made by a qualified engineer. This was followed by an inspection on 20 September 1974 by William S. Kowalski P.E. A copy of both inspection reports is given in Appendix 1.

The results of our inspection indicate Swannanoa Lake Dam is in poor overall condition. The lower part of the right downstream face of the dam is bulging over a significant portion of its length. The bulge varies from about 1 inch to 3 inches. Leakage is occurring through the face of the dam and along the toe. The immediate downstream area is wet and spongy.

The spillway right downstream channel side wall has collapsed and the left sidewall is deteriorating. There are trees and bushes in the downstream channel and erosion has occurred along the sidewalls. There is cracking and spalling of the masonry concrete and cobble stones have fallen from the side walls of the downsream channel.

No low level outlet was observed.

The check list giving the results of our visual inspection is given in Appendix 2 and photographs are given in Appendix 3.

SECTION 4 OPERATIONAL PROCEDURES

No essential information is available concerning operational procedures for the dam. Operation of the dam consisted of replacement and removal of flash boards. No warning system is in effect.

SECTION 5 HYDRAULIC/HYDROLOGIC

Information regarding flood waters overtopping the dam was obtained from Mrs. Bohenna, President of Ringling Manor, Inc. To the best of her knowledge the dam was overtopped on 3 occasions:

1. During a hurricane in 1940,

2. 25 August 1955 during hurricane Doria, and

3. June 1972 during hurricane Agnes.

On these occasions the dam is reported to have been overtopped with 1 to 2 inches, causing no erosion on the downstream side or below the dam, nor inflicting damage to the spillway. It is reported the August 1955 overtopping was increased as a result of failure of two earth dams located upstream of the lake.

The hydraulic/hydrologic evaluation is based on a Spillway Design Flood (SDF) equal to the full Probable Maximum Flood (PMF) in accordance with the evaluation guidelines for dams classified as high hazard and small in size. Hydrologic design data for this dam is not available. The PMF has been determined by developing a synthetic hydrograph based on the maximum probable precipitation of 22.2 inches (200 square mile - 24 hour). Hydrologic computations are presented in Appendix 4. The PMF determined for the subject watershed is 17,177 cfs.

The capacity of the spillway is 560 cfs which is significantly less than SDF.

Flood routing for both the PMF and 1/2 PMF indicates the dam will overtop by 4.5 ft and 2.9 ft respectively. We estimate the dam can adequately pass only 3.9% of the PMF.

The downstream potential damage center (a reasonably well traveled road and nearby residential building), is located a few hundred feet from the dam. Based on our visual inspection of the immediately downstream topography and knowledge of the degree of overtopping potential it is our opinion that dam failure resulting from overtopping would increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

Drawdown of the lake below spillway crest has been evaluated considering the drop-box spillway structure located at Swannanoa Dam #2 is altered and the 42-in-dia pipe serves a low level outlet. Our calculations indicate that the lake level could be lowered 6 ft in approximately 5 days.

SECTION 6 STRUCTURAL STABILITY

The stability of Swannanoa Lake Dam #1 is marginal. The structures are nearly 65 years old and essentially no information is available concerning the foundation or material characteristics of the dam. Consequently, analytical methods cannot be used to reasonably evaluate factors of safety with respect to present day requirements. On the other hand our inspection observations indicate the dam is in poor condition. It is our opinion the dam requires immediate remedial work to ensure stability of the dam.

Swannanoa Lake Dam #1 is located in Seismic Zone 1 of the Seismic Zone Map of Contiguous States. The static stability of the dam is marginal and not within conventional safety margins. Therefore, the dam is considered unstable under earthquake loading.

SECTION 7 ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Assessment

The available engineering and construction information on Swannanoa Lake Dam #1 is not sufficient to draw a conclusion concerning the actual degree of stability of the dam. Based on our observations it is our opinion the dam is in poor condition and marginally stable. We are concerned about the bulging of the downstream face of the dam and seepage throughout the dam. Conditions can be expected to become worse if they remain uncorrected or an extreme flood occurs.

7.2 Recommendations/Remedial Measures

We recommend the following remedial measures:

1. Determine whether or not a low level outlet is present below the spillway and develop measures to make the outlet functional. This should be done very soon.

2. Determine the foundation conditions of the dam and evaluate the need for and type of under seepage cutoff that may be required. This should be done very soon.

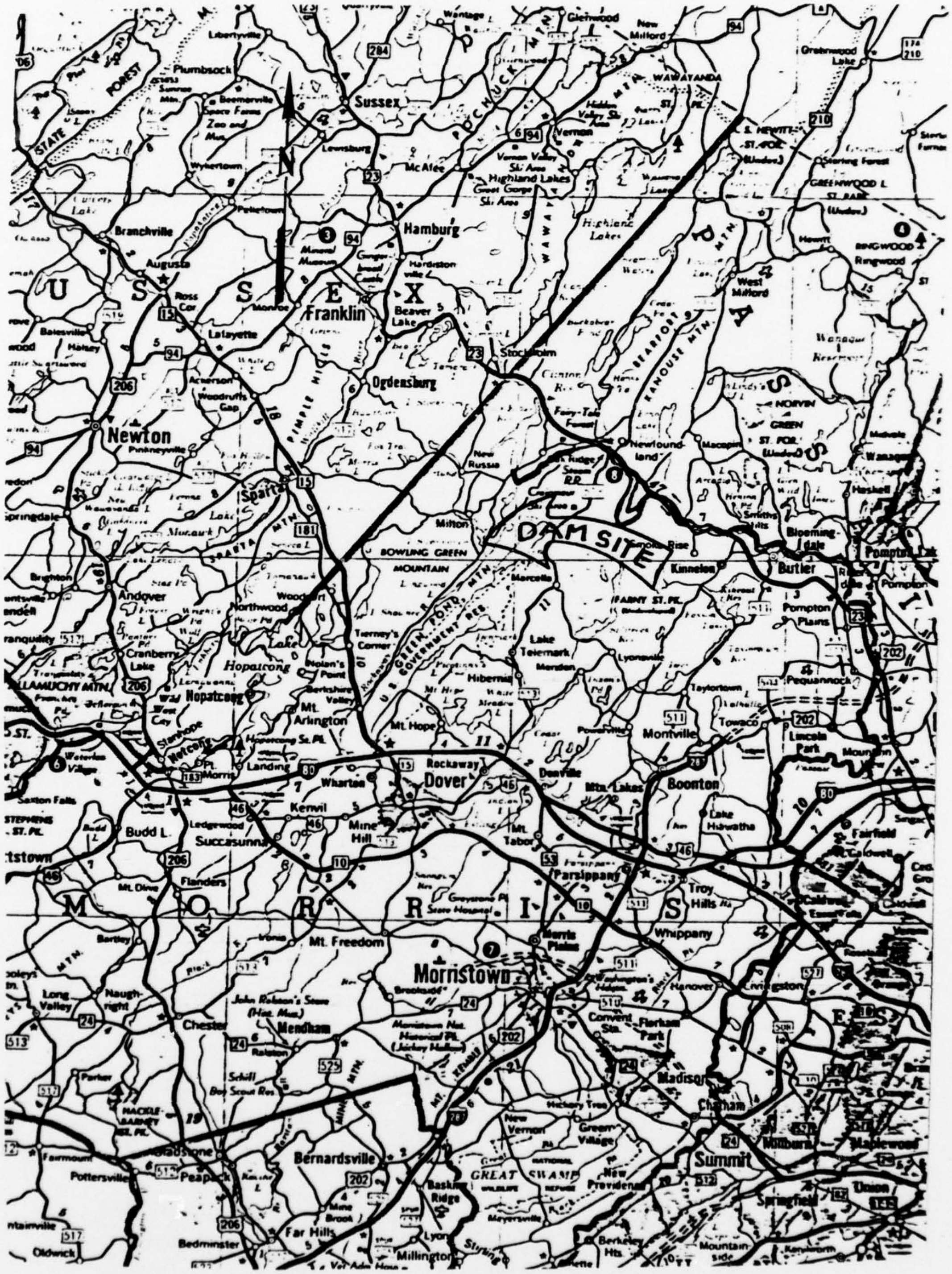
3. Determine by means of core borings and tests the condition of the concrete in the dam and the engineering properties of the foundation materials, and, evaluate the requirements for strengthening the dam. This should be done very soon.

4. Evaluate the need for additional downstream support of the dam and measures for relieving hydrostatic pressure from within and below the dam. This should be done very soon.

5. Remove the trash rack- flash board supports from the crest of the spillway to ensure blockage of spillway crest does not occur. This should be done soon.

6. Repair the downstream sidewalls of the spillway and discharge channel. This should be done soon.

7. The spillway capacity as determined by CE Screening criteria is inadequate. We estimate the dam can adequately pass only 3.9% of the PMF. The capacity of the spillway and SDF should be determined using more precise and sophisticated methods and procedures. A more extensive topographic survey of the dam and vicinity should be made. The need for and type of mitigating measures should be determined. Around the clock surveillance during periods of unusually heavy precipitation should be provided, and a warning system established. This should be done very soon.



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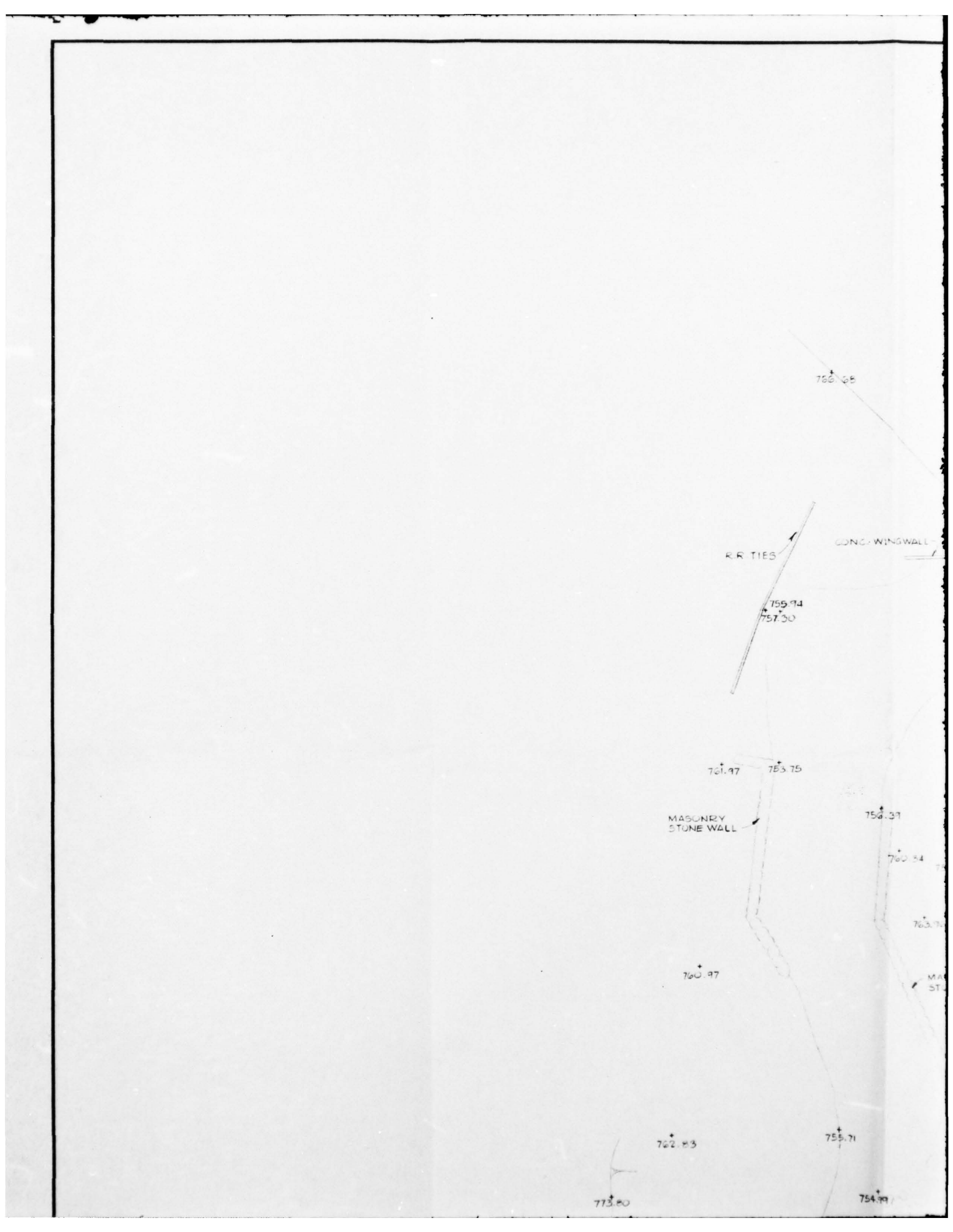
REGIONAL VICINITY MAP
SWANNANOA LAKE DAM #1

Fig. 1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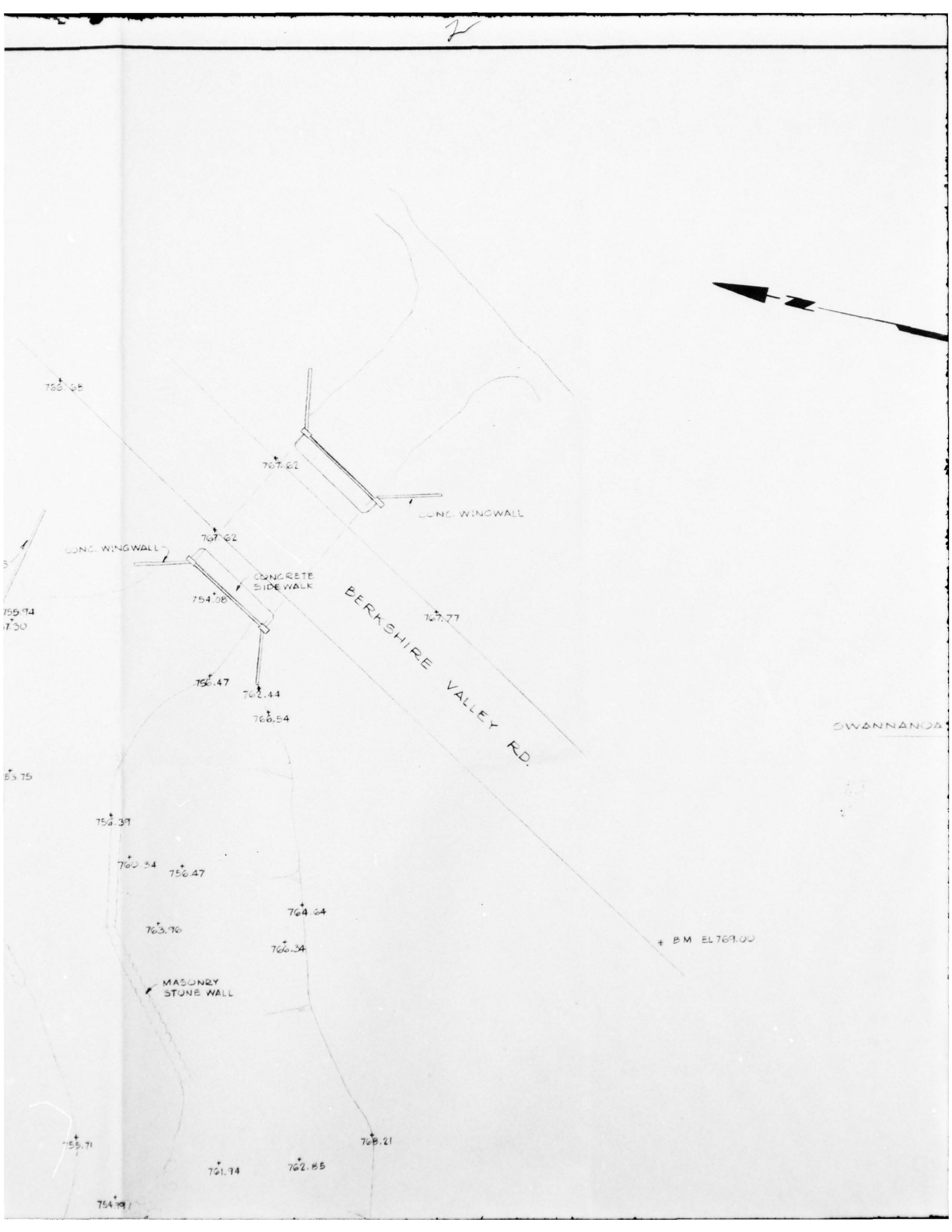
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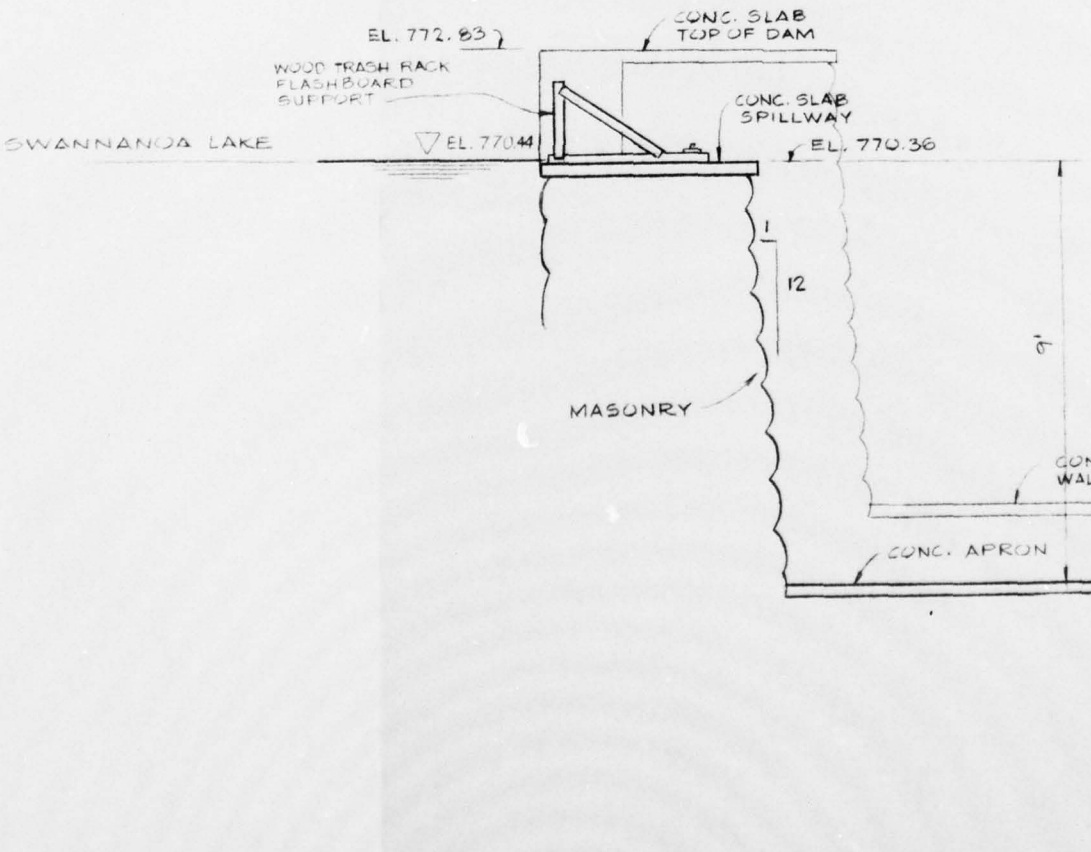
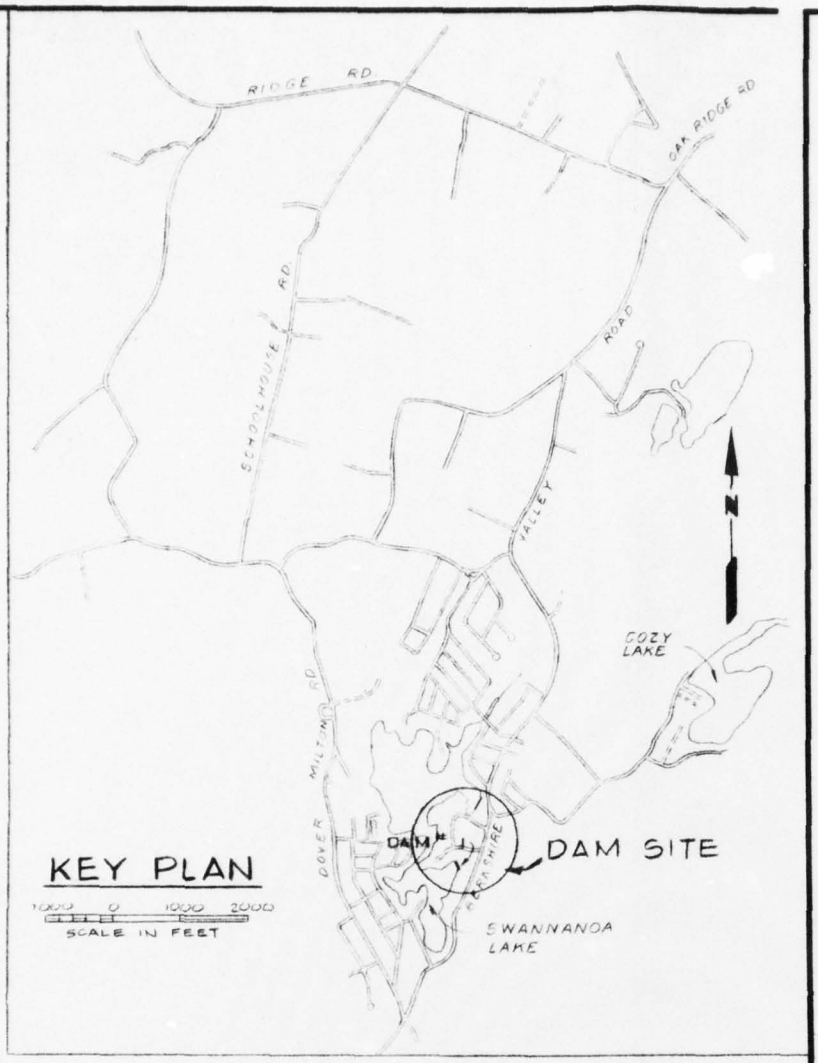
766.34
+ B.M. EL 769.00
MASONRY STONE WALL
755.71
768.21
761.94
762.85
754.99

KEY PLA

1000 0 1000

SCALE IN FEET

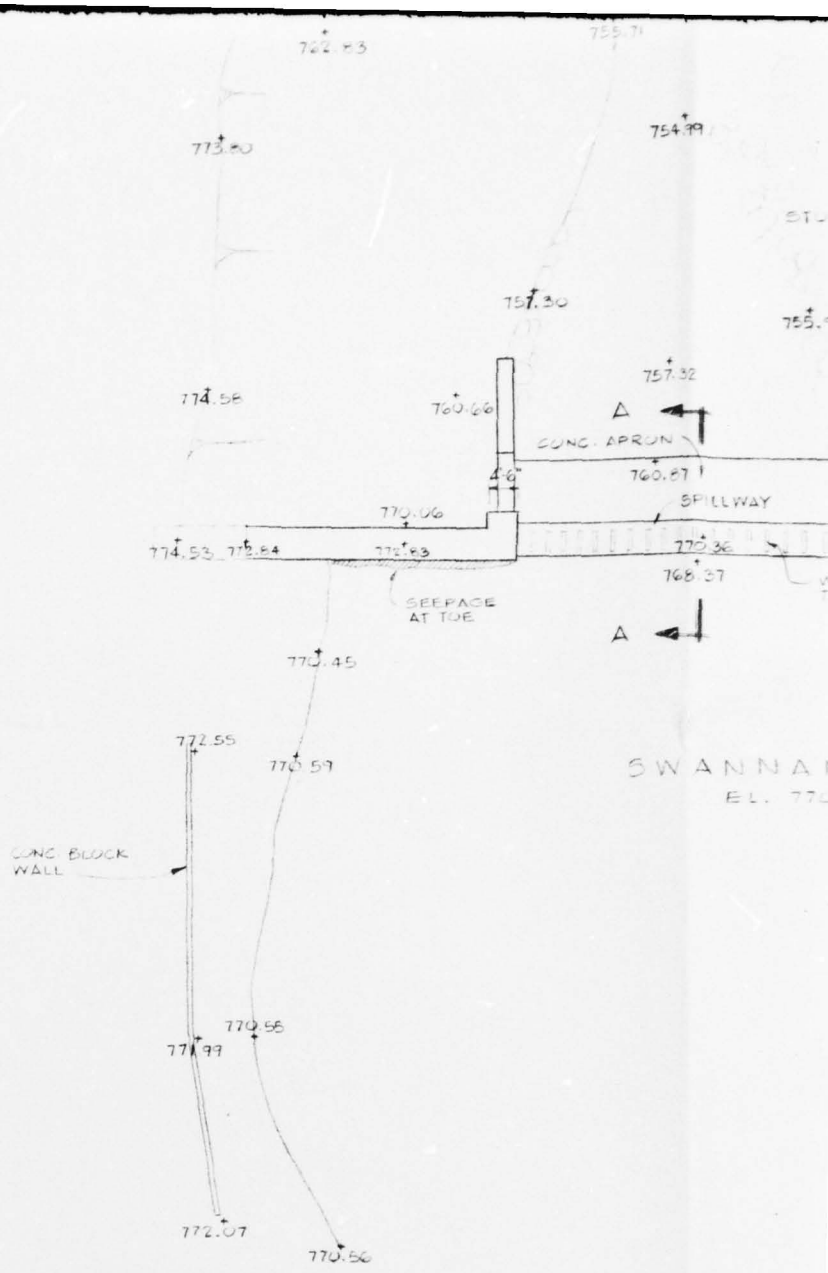




AB ON MASONRY
762.87

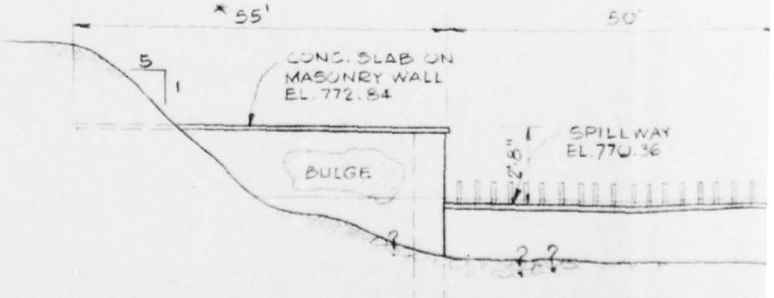
EL. 760.87

CONC SLAB ON MASONRY
WALL EL. 761.60

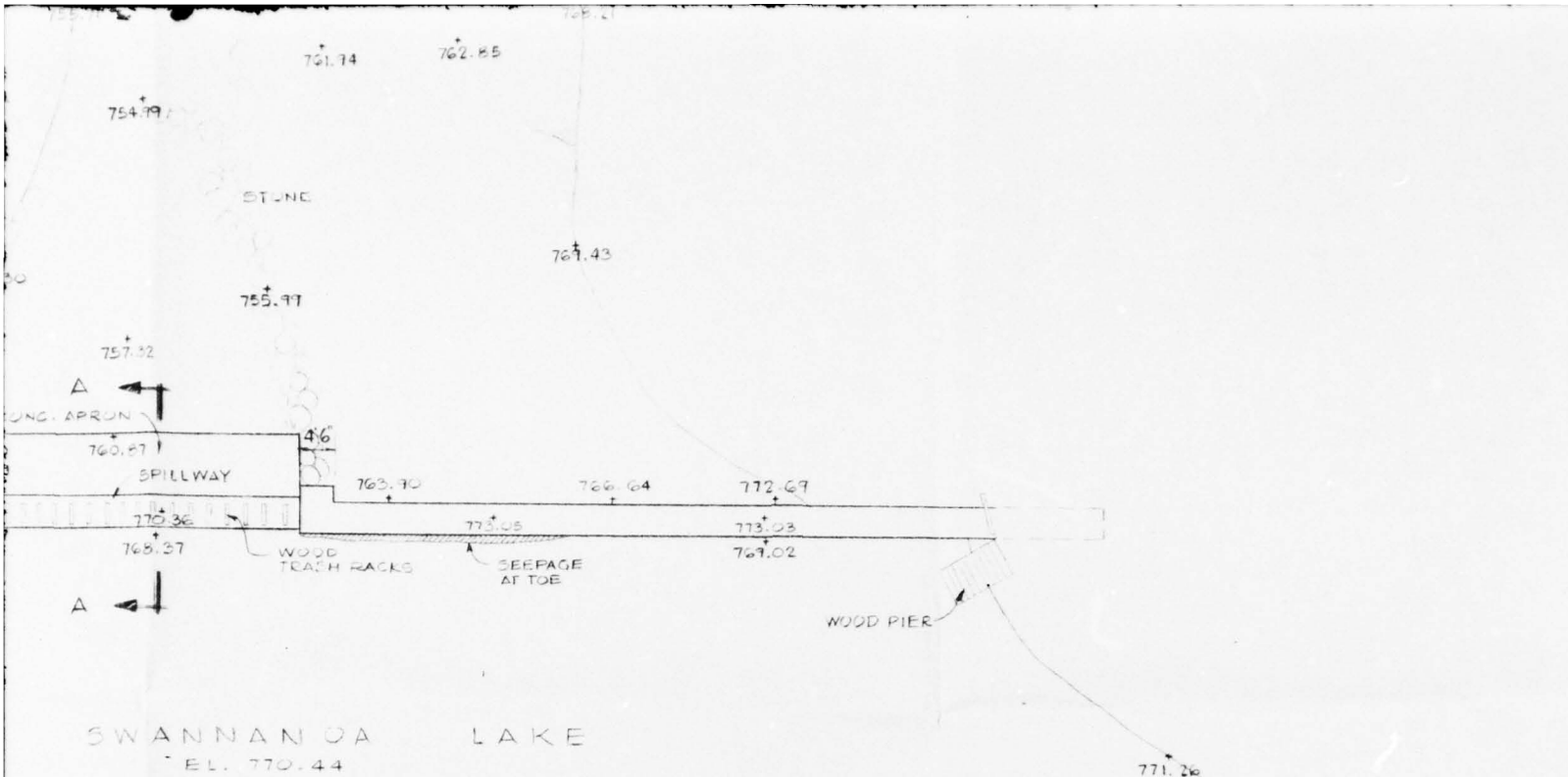


SWANNA

EL. 77

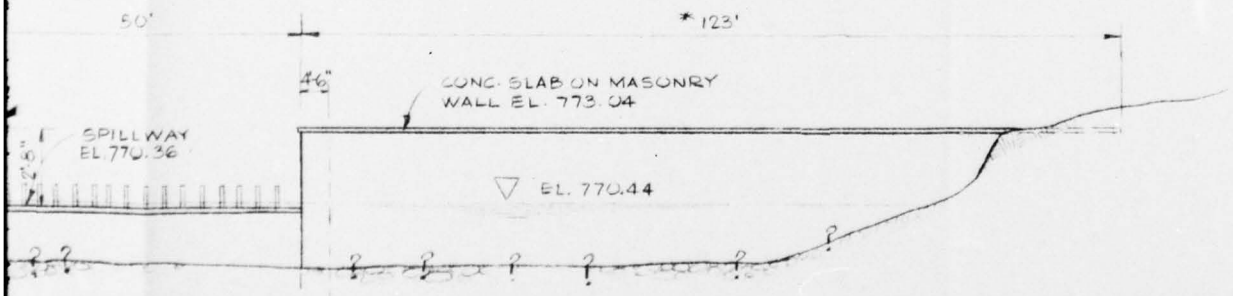


* DIMENSIONS NOT OBSE



PLAN

SCALE 1" = 20'



DIMENSIONS NOT OBSERVED

PROFILE

SCALE: HORIZ. 1" = 20'
VERT. 1" = 4'

SE

SCA

771.26

NOTE:

THE ELEVATIONS
TRANSIT AND LEV
QUADRANGLE. A
PAVEMENT OF BE
INDICATED ON

SECTION A-A

SCALE: 1" = 3'

NOTE:

THE ELEVATIONS SHOWN WERE OBTAINED USING A SURVEYOR'S TRANSIT AND LEVEL AND THE U.S.G.S. MAP FOR FRANKLIN N.J. QUADRANGLE. A SELECTED BENCH MARK ELEVATION OF 767.00 AS THE PAVEMENT OF BERKSHIRE VALLEY ROAD WAS USED. THIS IS INDICATED ON SAID U.S.G.S. MAP. THESE ELEVATIONS ARE APPROXIMATE.

DATE	DESCRIPTION	NO.
REVISIONS		

LANGAN ENGINEERING ASSOCIATES, P.C.

970 Clifton Avenue, Clifton, New Jersey 07013
(201) 472-9366

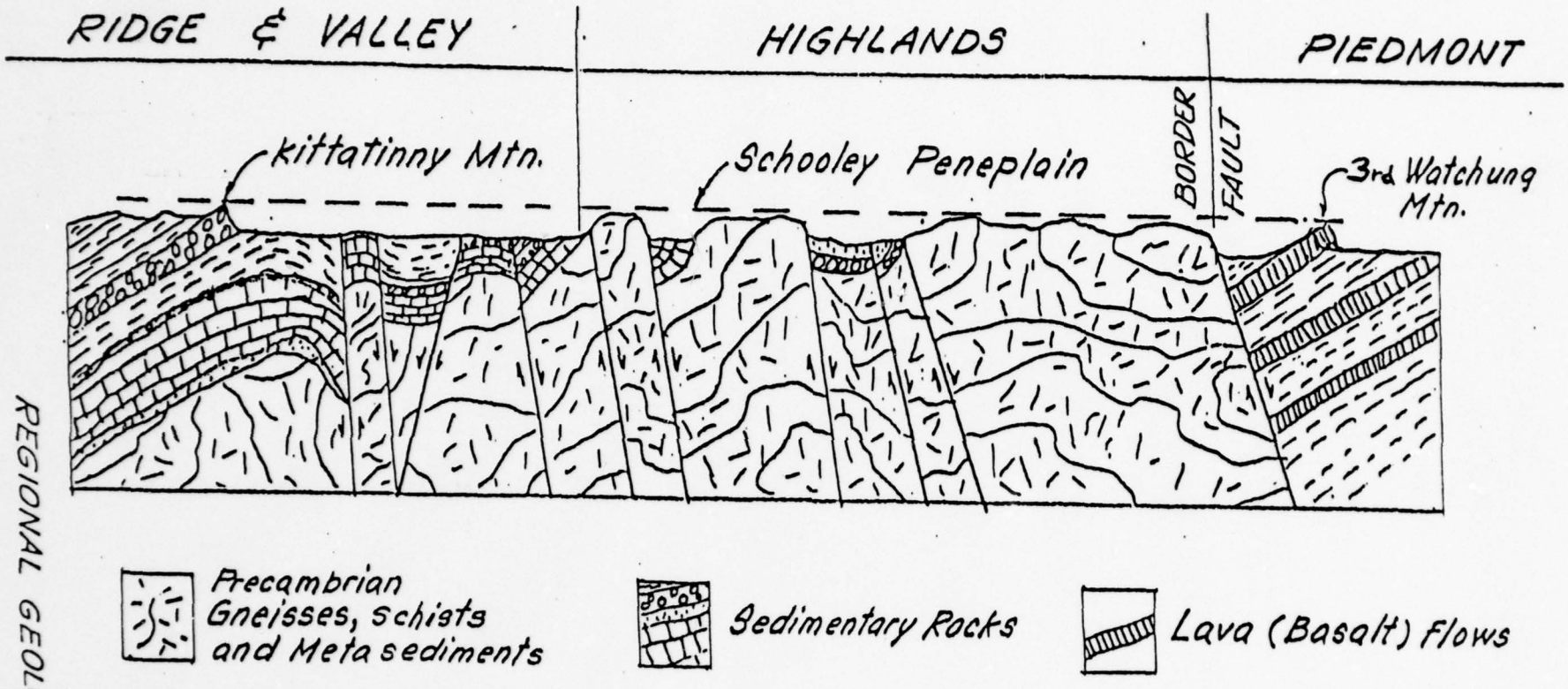
PROJECT

PHASE I
INSPECTION & EVALUATION
OF
NEW JERSEY DAMS

DRAWING TITLE

SWANNANOA LAKE
DAM # 1
NOVEMBER 1978
FED. I.D. NO. NJ00311

JOB NO.	DRAWING NO.
J-811	FIG. 2
DATE: 21 NOV 1978	
SCALE: AS NOTED	
DRN. BY: J R	
CHKD. BY: D J L	



Schematic Cross-section of New Jersey Highlands Physiographic Province (After Wolfe, 1977)

REGIONAL GEOLOGIC FEATURES

Fig. 3

APPENDIX I

INSPECTION REPORTS

SWANNANOA LAKE DAM # 1

Swannanoa Lake
Dam No. 8
Morris County
Inspection Report

On May 14, 1974, at about 1300 hours, an inspection was made in company with Mr. Robert Fonte of the north and south dams of Swannanoa Lake across tributaries of the Rockaway River and located immediately upstream from Berkshire Valley Road in Jefferson Township, Morris County.

The inspection was made at the request of Mr. Fonte, Director of the D.P.W. of Jefferson Township who stated that the dam appeared in need of repair.

The structures were built about 1914 by E.R. Headley and Sons as contractors for Ringling Brothers. A recent phone call to the office of the Tax Assessor revealed that the entire lake to a point 10 feet beyond the waterline is still the property of Ringling Manor, Inc.

The general condition of both the north and south dams is good, however, there are a few places where slight bulges of about 3 to 5 inches beyond the plane of the downstream faces of the dams have appeared. Some of these areas also show seepage. The total amount of seepage was difficult to determine but is estimated at about 1 second foot at each dam. At the time of the inspection there was at least a 6 inch head on the 50 foot south spillway due to a rainfall the previous day of approximately 2.5 inches. The northerly spillway has an 8 foot drop inlet and leads into a 4 foot diameter clam type lift gate that enters a flume leading to a 4 foot R.C.P. under Berkshire Valley Road. The capacity of the south spillway assuming a 2 foot head available would be 438 second feet.

It is recommended that a letter be sent to the owner requesting a complete inspection of the structure by a qualified engineer, with such inspection submitted to this office along with recommendations for repairs.

William F. Rogers
Dam Analysis Section

WFR:M:A18
cc: Dirk C. Hofman

Received
Oct. 21 1975

DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
BUREAU OF WATER CONTROL
P.O. BOX 2809
TRENTON, NEW JERSEY 08625

CONDITION REPORT - DAMS

Dam Application No. _____ Date of Inspection 9/20/74

Name of Dam Lake Swannanoa (South)

Owner's Name Ringling Manor, Inc.

Address Lake Swannanoa, Oak Ridge, Morris County, New Jersey

Comment on the following items in accordance with the instructions enclosed:

A. Earthfill and/or Timber Dams — NOT APPLICABLE

1. Maintenance

2. Condition

3. Other

B. Masonry and Concrete Dams

1. No abnormal settlement, heaving, tilting or lateral movement of the structure was observed.

2. There is some minor spalling of the stone facing and of the top walkway and coping.

3. Erosion and cavitation along the structure was not observed.

4. Only minor seepage near the base of the dam was observed through the masonry.

5. There is no evidence of undermining of the structure.

6. About 50% of the flight board supports are rotted and deteriorated.

C. Channels, Stilling Basins and Surrounding Areas

1. The effluent channel, banks and surrounding area are generally in good condition, but in need of some minor debris cleaning and brush removal.

2.

3.

4.

5.

6.

D. Mechanical Equipment

1. There is no mechanical equipment at the south dam other than the flight boards on the spillway.

2.

E. Miscellaneous

1. See Supplemental Sheet

2.

5

CONCLUSION

A. I certify that the above dam was personally inspected by me and was found to be in (good, fair, poor) condition. (Circle one

B. I recommend that the following repairs be made immediately.

1. The wood flight board supports should be replaced and repaired as required.

2. The masonry top walkway and coping should be repaired as required, also the spalling on the face of the dam.

3. Where seepage is occurring through the masonry structure, this leakage should be sealed.

C. The following improvements should also be undertaken.

1. The effluent channel and banks should be cleared of debris.

2.

3.

Inspected by: William S. Kowalski, P.E.

Consulting Engineer: _____

Address: 27 Cedar Grove Parkway

Cedar Grove

New Jersey 07009

Telephone: 201-239-0528

N.J.P.E. License No. 12070

Date: March 17, 1975

SEAL

LAKE SWANNANOA (SOUTH)

E. Miscellaneous

1. The only information which I was able to obtain regarding flood waters overtopping the dam was from Mrs. Bohenna, President of Ringling Manor, Inc., who informed me that to the best of her knowledge the dam was overtopped on two occasions only:

    a) During a hurricane in 1940.

    b) During Hurricane Doria in the early 1970's.

    On both occasions the dam was overtopped with 1 to 2 inches, causing no erosion on the side or below the dam, nor inflicting any damage to the spillway.

APPENDIX 2

CHECK LIST

VISUAL INSPECTION

SWANNANOA LAKE DAM I

CHECK LIST
VISUAL INSPECTION

Phase I

NAME DAM Swannanoa Lake Dam #1 COUNTY Morris County STATE New Jersey COORDINATORS N.J. DEP

DATE(s) INSPECTION See Below WEATHER Partly cloudy TEMPERATURE 36° F

POOL ELEVATION AT TIME OF INSPECTION 770.5* M.S.L. TAILWATER AT TIME OF INSPECTION 755* M.S.L.

* Elevations based on PK nail in Berkshire Valley Road assumed El 769.00

INSPECTION PERSONNEL:

D. Leary	11/30/78 12/12/78 1/12/78	C. Campbell	11/16/78	W. Zink	12/12/78 (Corps of Engineers)
J. Richards	11/30/78	P. Yu	11/16/78	H. Rubright	12/12/78 (Corps of Engineers)
J. Rizzo	11/16/78	B. Langan	11/12/78		

James Richards RECORDER

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Trees & brush in downstream channel	Downstream channel should be cleaned.
SLOPES	Appear satisfactory	
APPROXIMATE NO. OF HOMES AND POPULATION	1 home immediately downstream. Sand & gravel pit downstream. Over 100 homes 2 miles downstream. Town of Woodstock's population estimated more than 300.	Warning system should be installed.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE	Seepage occurring through face of dam and along toe. Total seepage approx. 10 gpm.	Considerable portions of the toe of the dam were covered with debris and brush and full extent of underseepage could not be visually estimated.
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Erosion along spillway side wall and embankment junction.	Eroded areas should be suitably filled.
DRAINS	Small pipe drains, through right wall working. Drain on the left of spillway was not operating.	
WATER PASSAGES	None observed	Low level outlet suspected but not confirmed.
FOUNDATION		

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Surface cracks on crest of dam. Spalling of concrete at crest.	Surface cracks should be repaired. Spalled concrete areas should be repaired.
STRUCTURAL CRACKING	Downstream face bulges 1"-3" out of the vertical plane of the wall. Crack on right buttress at spillway.	Crack on right spillway buttress should be repaired.
VERTICAL AND HORIZONTAL ALIGNMENT	Appears Satisfactory	
MONOLITH JOINTS	Several joints in upstream masonry open above water level.	Joints should be repaired.
CONSTRUCTION JOINTS		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARK OR RECOMMENDATIONS
SLOPES	Vertical Bulkheads at homes. Soil slopes are 4 Hor. to 1 Vert., some areas show minor erosion.	
SEDIMENTATION	Appears satisfactory	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Algae covers most of concrete. Trash-rack & flashboard support connected to spillway crest has nuts missing.	
APPROACH CHANNEL	Appears Satisfactory	
DISCHARGE CHANNEL	Debris, trees & brush in channel. Channel side walls have deteriorated. Cavities are present.	Remove debris, trees & brush. Repair sidewalls.
BRIDGE AND PIERS	Berkshire Valley Road Bridge across discharge channel.	
	Right spillway d/s sidewall deteriorated. Left spillway d/s sidewall has missing cobbles. Splash bench lip is broken.	Sidewalls should be repaired.

APPENDIX 3

PHOTOGRAPHS

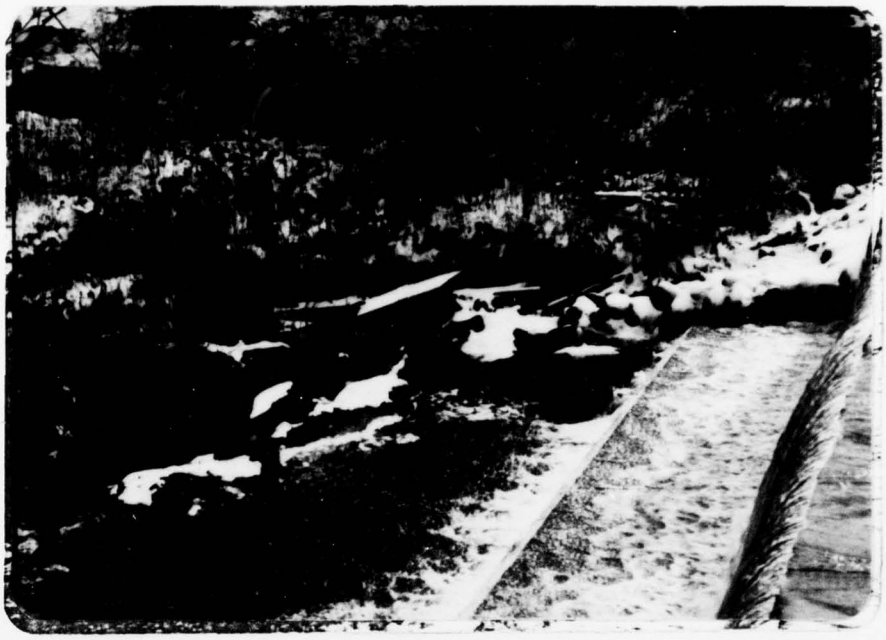
SWANNANOA LAKE DAM I

Left Abutment and left side of spillway. 30 November 1978

Spillway. Looking downstream. 30 November 1978

Spillway. 30 November 1978

Right side of dam. Looking downstream. 30 November 1978



Deteriorated downstream spillway right sidewall. 30 November 1978

Cobbles loosened and removed from left downstream spillway sidewall. 30 November 1978

Broken concrete lip of splash bench at toe of spillway. 30 November 1978

Discharge channel. Looking downstream. 30 November 1978

Berkshire Valley Road Bridge over discharge channel. 30 November 1978

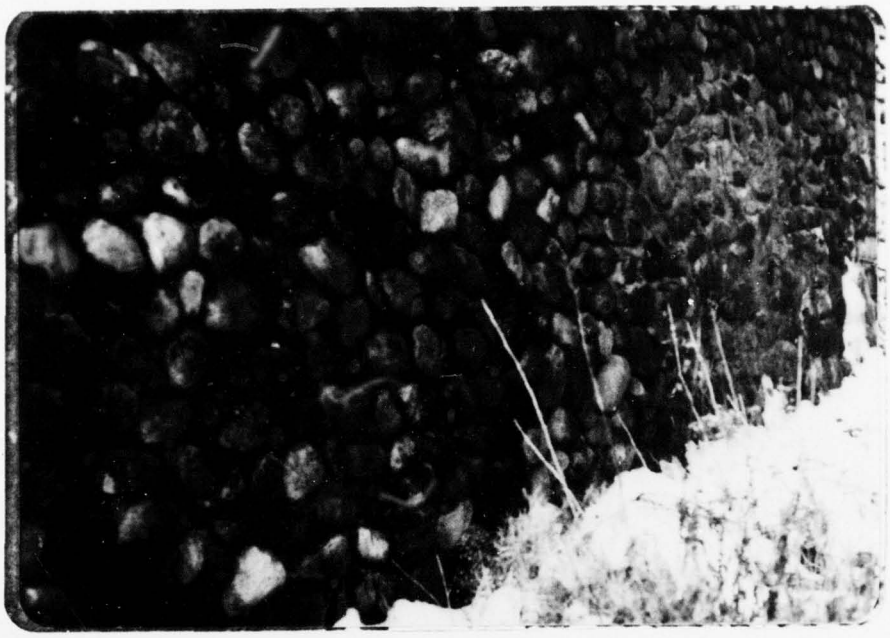
Debris in discharge channel. 30 November 1978

Downstream area beyond Berkshire Valley Road. 30 November 1978

Weep pipes in face of right side of dam. 30 November 1978

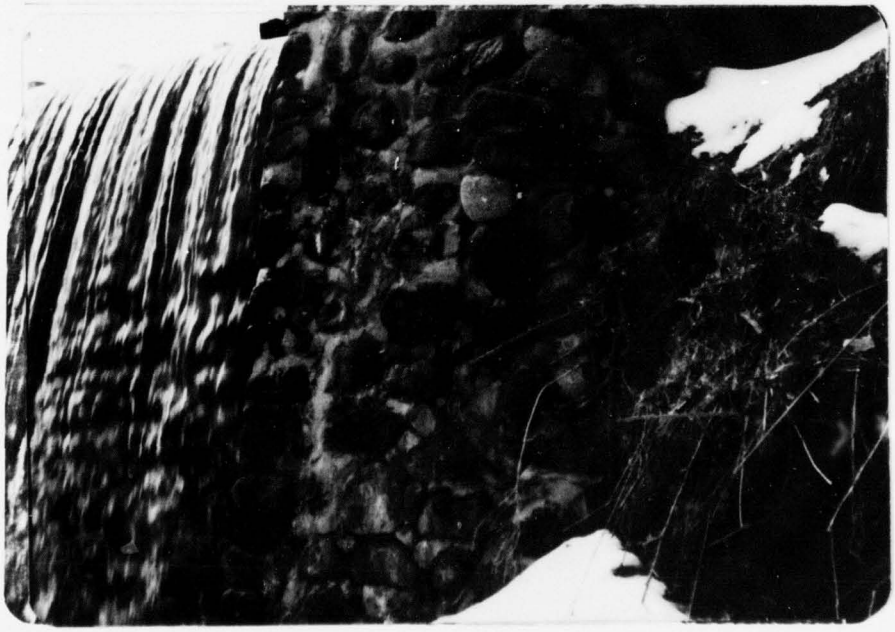
Repaired cobble facing at right side of dam. 30 November 1978

Weep pipe at right spillway retaining wall. 30 November 1978



Repaired right downstream face of dam. Note slight bulging of face.

30 November 1978



Left retaining wall of spillway. Note replaced cobbles and weep pipe.

30 November 1978

APPENDIX 4

HYDROLOGIC COMPUTATIONS

SWANNANOA LAKE DAM I

LANGAN ENGINEERING ASSOCIATES, INC.

HYDROLOGICAL COMPUTATIONS
SWANNANOA LAKE DAMS

A. Location Morris County

B. Drainage Basin 13.9 sq mi
Area of Lake 51 acres

C. Classification
Size - Small
Hazard — High

D. Spillway Design Flood (SDF)
In accordance with evaluate guideline, use PMF

E. PMP -

1. Dam Located in Zone 1
PMP = 22.2 inches

2. PMF must be adjusted for basin size

Duration - hr	% 24 hr (for 14 sq mile)	Reduction Factor *
0-6	108	
0-12	120	.805
0-24	130	
0-48	139	

* p. 48 D.S.D.

BY CED DATE 1.4.79 Swannanoa Lake JOB NO. T-7838

CKD JH CED DATE 1.5.79 2.13.79 SHEET NO. 1 OF 12

LANGAN ENGINEERING ASSOCIATES, INC.

F. UNIT HYDROGRAPH

Corp of Engineers has indicated that Snyder Method be used. The follow coefficients are recommended:

$C_t = 2.0$, $C_p = 0.55$

Snyder Lag time:

$t_p = C_t (L \cdot L_{ca})^{0.3}$

from drainage area

$L \doteq 32000 ft \doteq 6 mi$

$L_{ca} \doteq 16000 ft \doteq 3 mi$

$\therefore t_p = 2.0 (6 \times 3)^{0.3}$

$= 4.76$

$C_p = 0.55$

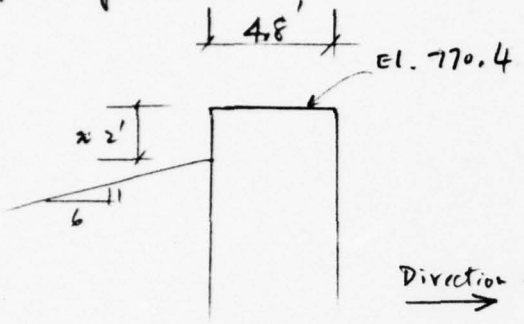
BY Tng DATE 2-6-79 Susquehanna Lake Dam JOB NO. J-783 B

CKD [illegible] DATE 2-13-79 SHEET NO. 2 OF 12

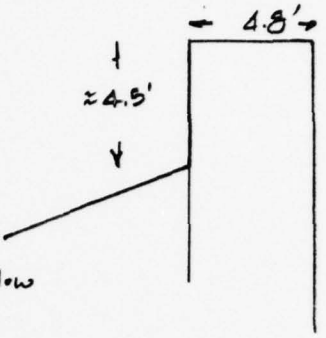
LANGAN ENGINEERING ASSOCIATES, INC.

SPILLWAY CAPACITY

Spillway section



Dam Section (Typ)



Shape of weir is similar to broad-crested weir

$Q = CLH^{3/2}$

L = length (varies)
H = head, ft above crest

Take C from Table 5-3 on page. 5-46 of 'Handbook of Hydraulics' by King & Brater

There are two dams in this lake — north dam and south dam, the spillway is located at the south dam. The top of both dams are at about El. 773.0 therefore if the dam ever overtopped, the outflow will consist of those from both dams.

Both dams have a similian section as the spillway.
∴ use correspond value of C from the same table

The gate for the sluiceway in the north dam is not operating. Therefore, for the purpose of analysis, no outlet is assumed for the north dam.

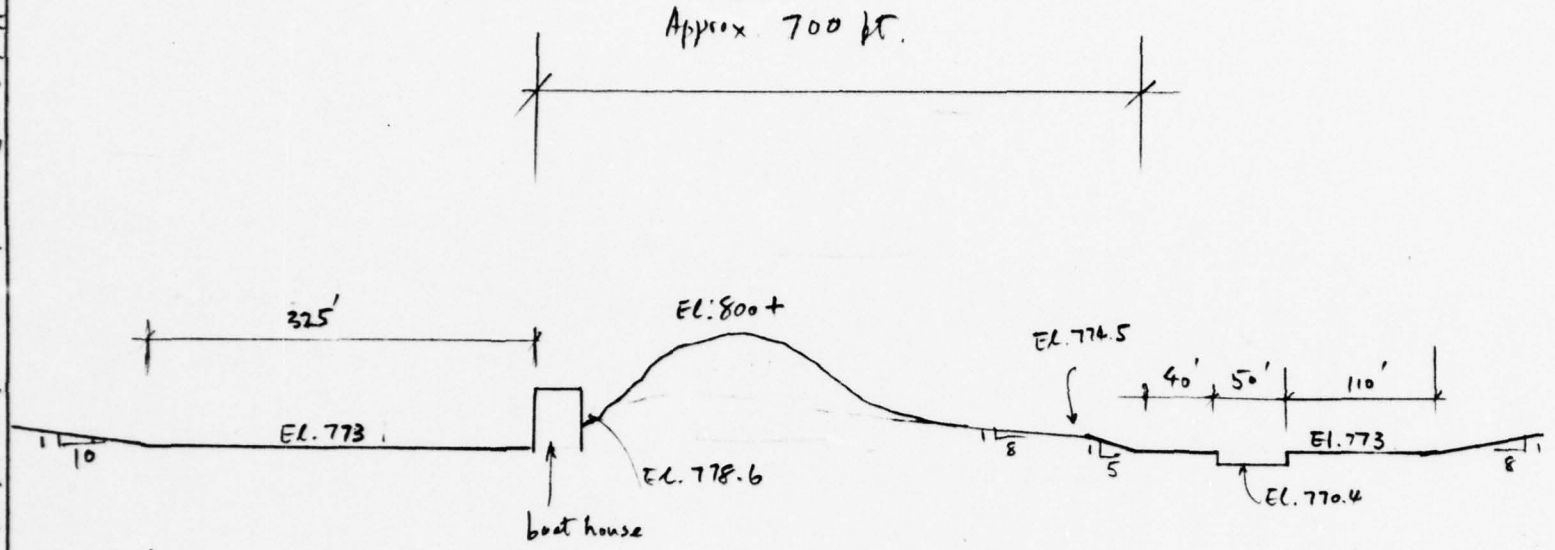
See Sheet No 3 for schematic profile of the two dams

BY Dry DATE 12/19/78 Outflow capacity evaluation JOB NO. J-783B
CKD GEB DATE 1-4-79 Swannanoa SHEET NO. 5 OF 12

LANGAN ENGINEERING ASSOCIATES, INC.

BY Py DATE 12/79 Relative location of North & South Dams, Swannanoa Lake JOB NO. T-7838

CKD [illegible] DATE 1.4.79 2.13.79 SHEET NO. 4 OF 12



NORTH DAM (#2)

SOUTH DAM (#1)

SWANNANOA LAKE DAMS

(Direction: Looking downstream)

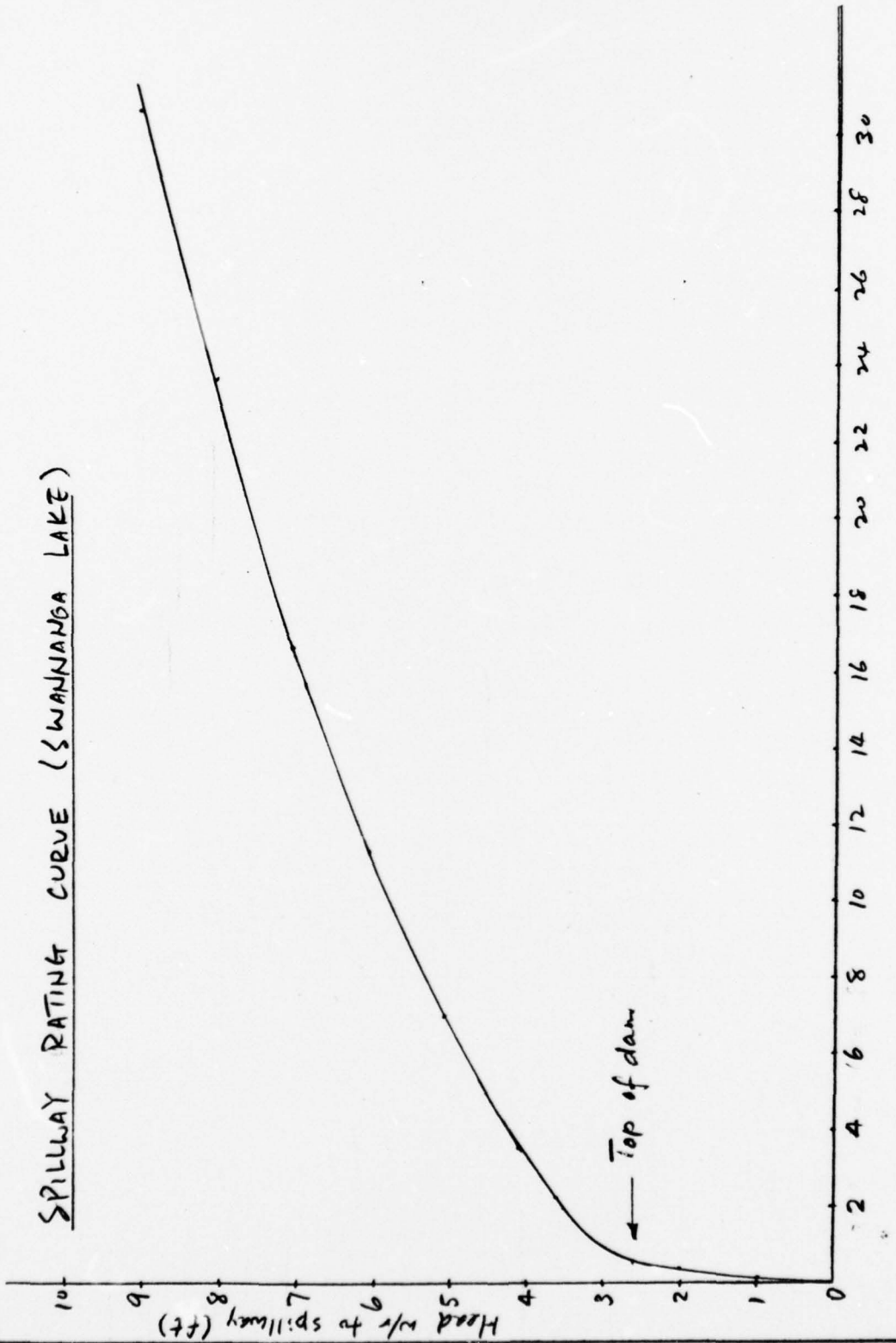
LANGAN ENGINEERING ASSOCIATES, INC.

BY Dy DATE 1/2/79 Swansonville Lake Dam JOB NO. T-7838

CKD RED DATE 1/2/79 2.13.79 SHEET NO. 5 OF 12

Elev. (ft)	South Spillway				South Dam				North Dam				Total (cfs)	
	H(ft)	C	L(ft)	Q_S(cfs)	H(ft)	C	L(ft)	Q_{SD}(cfs)	H(ft)	C	L(ft)	Q_{ND}(cfs)	$Q_T = Q_S + Q_{SD} + Q_{ND}$	
770.4	0												0	
771.4	1	2.68	50	134									134	
772.4	2	2.65	50	375									375	
773.0	2.6	2.67	50	560	0				0				560	← Top of dam
774.0	3.6	2.68	50	915	1	2.68	157	421	1	2.68	330	884	2220	
774.5	4.1	2.70	50	1121	1.5	2.65	160	779	1.5	2.65	332	1616	3516	
775.5	5.1	2.79	50	1607	2.5	2.67	169	1784	2.5	2.67	337	3557	6948	
776.5	6.1	2.88	50	2169	3.5	2.68	176	3089	3.5	2.68	342	6002	11260	
777.5	7.1	2.88	50	2724	4.5	2.74	185	4839	4.5	2.74	347	9076	16639	
778.5	8.1	2.88	50	3320	5.5	2.88	194	7207	5.5	2.88	352	13076	23603	
779.5	9.1	2.88	50	3953	6.5	2.88	203	9689	6.5	2.88	357	17038	30680	

LANGAN ENGINEERING ASSOCIATES, INC.



BY Dy DATE 1-5-79 Spillway Rating Curve JOB NO. J-783B

CKD TED DATE 1·5·79 / 2·13·79 Swannanoa Lake SHEET NO. 6 OF 12

LANGAN ENGINEERING ASSOCIATES, INC.

Reservoir Storage Capacity

Assume a linear distribution for the increase of the area with elevation. Start at a zero storage at the crest of the spillway.

Area of Lake ≃ 51 acres

Perimeter of Lake ≃ 14,500 ft. (measured from USGS Topo maps)

Ave. side slope of Lake (from site inspection) ≃ 1V:6H

∴ for every foot of water above the crest of spillway, the area of the lake increases by

$$\frac{6(14500)}{43560} \cong 2 \text{ acres}^*$$

Elev. (ft)	H (ft)	Increase in Lake area (Acs)	Area of the lake (Acres)	Average Area (Acres)	Increase in storage (acre-ft)
770.4	0		51	51	
771.4	1	2	53	52	52
772.4	2	4	55	54	106
773.0	2.6	5.2	56.2	55.6	139
774.0	3.6	7.2	58.2	57.2	196
774.5	4.1	8.2	59.2	58.7	226
775.5	5.1	10.2	61.2	60.2	286
776.5	6.1	12.2	63.2	62.2	348
777.5	7.1	14.2	65.2	64.2	412
778.5	8.1	16.2	67.2	66.2	479
779.5	9.1	18.2	69.2	68.2	547

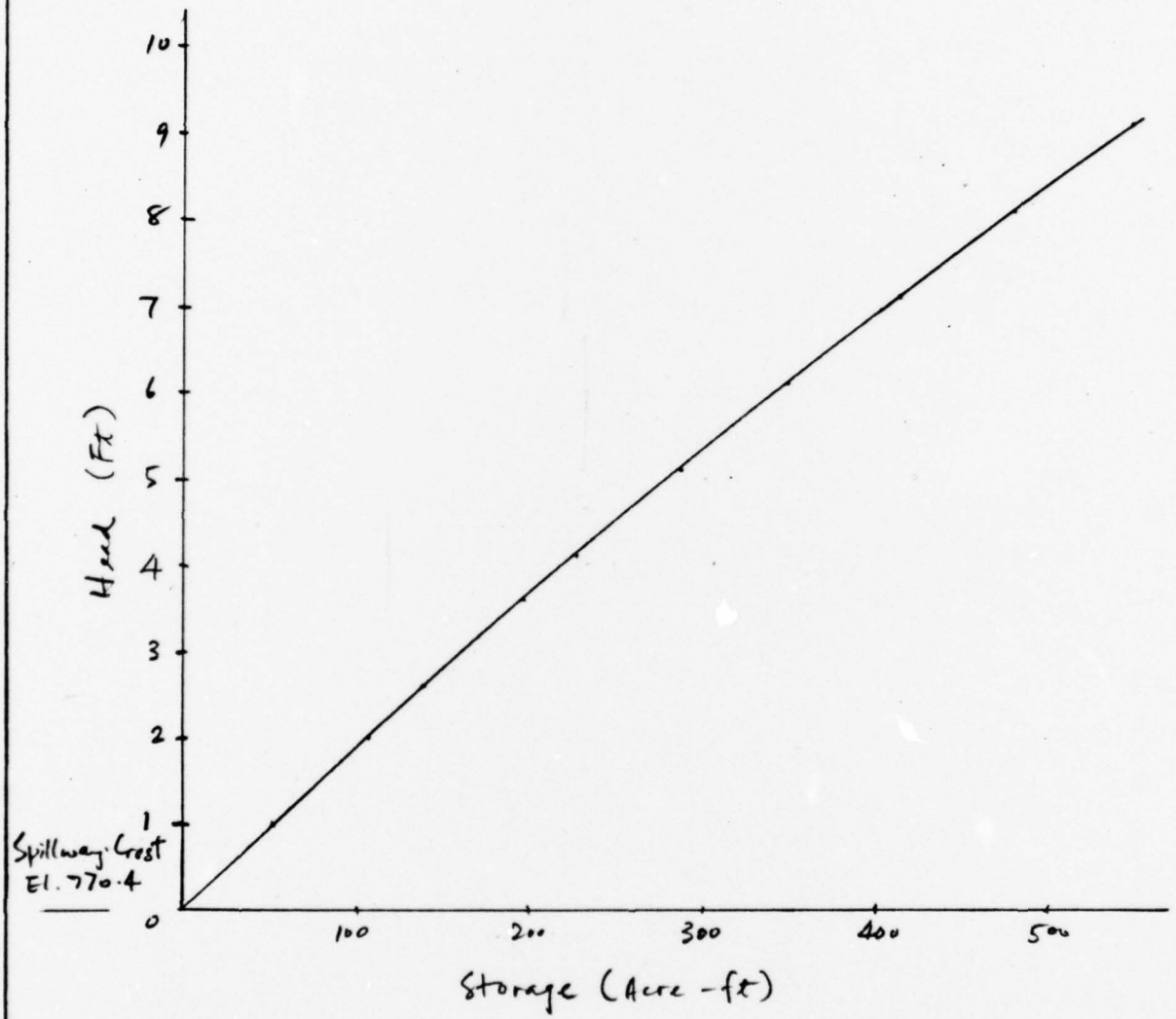
* since perimeter of lake at spillway crest is approximate (measured from USGS map to the nearest hundred-foot), ∴ assume perimeter constant with head.

BY DRJ DATE 12/19/78 Reservoir Storage Capacity JOB NO. J-783B

CKD GED DATE 1.4.79 2.13.79 SHEET NO. 7 OF 12

LANGAN ENGINEERING ASSOCIATES, INC.

Storage - Capacity Curve



BY RJ DATE 1-5-79 Storage capacity curve JOB NO. J-7838

CKD GED DATE 1-5-79 / 2-13-79 SHEET NO. 8 OF 12

LANGAN ENGINEERING ASSOCIATES, INC.

STORAGE - OUTFLOW SUMMARY

	Elev	Storage ac ft	Outflow cfs
spillway crest →	770.4	0	0
	771.4	52	134
	772.4	106	375
top of dam	773.0	139	560
	774.0	196	2220
	774.5	226	3516
	775.5	286	6948
	776.5	348	11260
	777.5	412	16639
	778.5	479	23603
	779.5	547	30680

SUMMARY OF HYDROGRAPH AND FLOOD ROUTING

1. Hydrograph and routing calculated using HEC-1
2. PMF for Swannanoa Lake is 17,177 cfs (routed to 17,064 cfs)
3. Routing indicates dam will overtop by approximately 4.5 ft for PMF

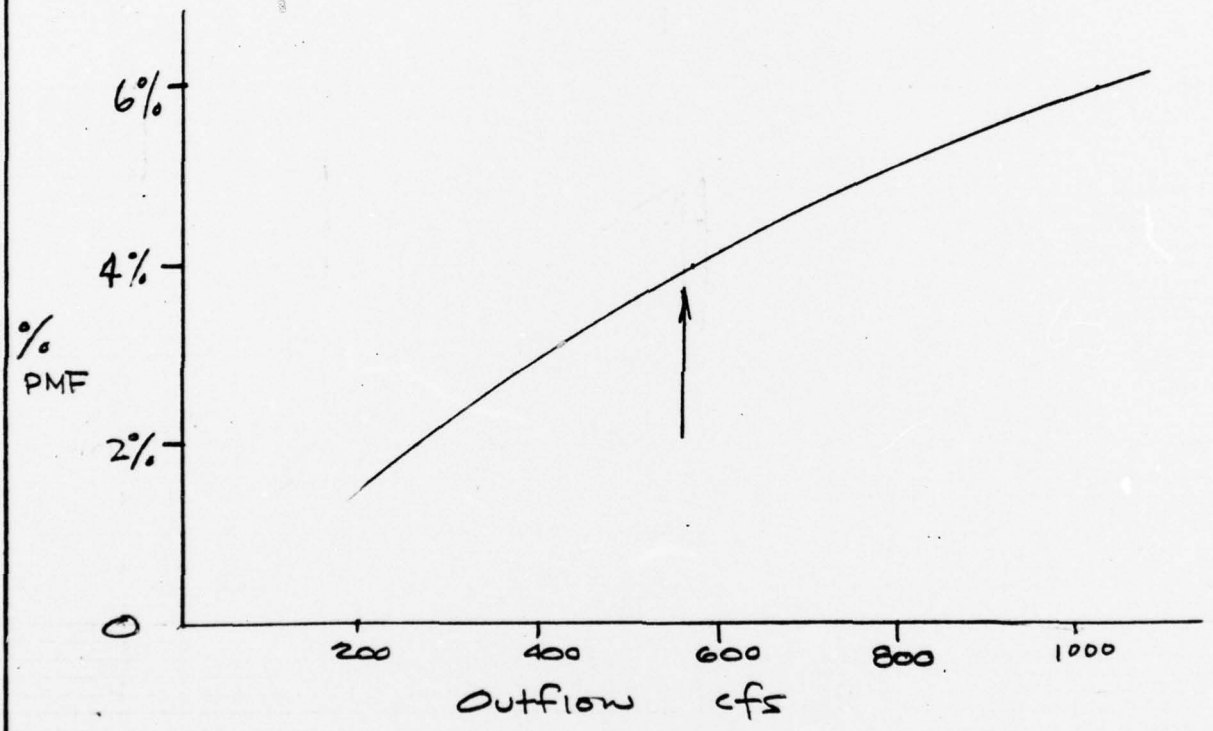
BY GED DATE 1.4.79 Swannanoa Lake JOB NO. J-783B

CKD. Py DATE 1-5-79 2.13.79 SHEET NO. 9 OF 12

LANGAN ENGINEERING ASSOCIATES, INC.

OVERTOPPING POTENTIAL

1. Various % of PMF have been routed using HEC 1
2. Plot peak outflow vs % PMF



3. Dam overtops at approx el 773 with Q = 560 cfs
   ∴ dam can pass approx 3.9% the PMF

BY GED DATE 1.4.79 Swannanoa Lake JOB NO. J-783B
CKD. PMJ DATE 1.5.79 / 2.13.79 SHEET NO. 10 OF 12

LANGAN ENGINEERING ASSOCIATES, INC.

DRAWDOWN ANALYSIS

1. Outlet Structure

Dam #1 (South) – no outlets work found

Dam #2 (North) – 42" ϕ Steel Pipe with gate (non-operating)

[Note: For this analysis assume gate is repaired]

2. Outlet Capacity

a. Invert of pipe = el 762

b. el of lake = 770.4

c. Pipe capacity based on culvert flow (short culvert)
Use BPR Hydraulic Circular #10

Elev	Head	Q cfs
770.4	8.4	120
770.0	8.0	115
768.0	6.0	92
766.0	4.0	62
764.0	2.0	25
762.0	0	

3. Storage Capacity

a. Estimated storage below spillway is 400 ac ft

b. Assume area varies linearly with height and area @ 8.4 ft is 51 ac

c.

Elevation	Acres	Δ Storage	Total Storage
770.4	51		400 ac ft
		20.32	
770	50.6		
		99.6	
768	49.0		
		96.4	
766	47.4		
		93.2	
764	45.8		
		90.0	
762	44.2		0

BY CED DATE 1.4.79 Swannanoa Lake JOB NO. J783B

CKD. PJ DATE 1.5.79 2.13.79 SHEET NO. 11 OF 12

LANGAN ENGINEERING ASSOCIATES, INC.

4. Assume inflow to be 2 cfs/sq mi

$13.9 \times 2 = 27.8$

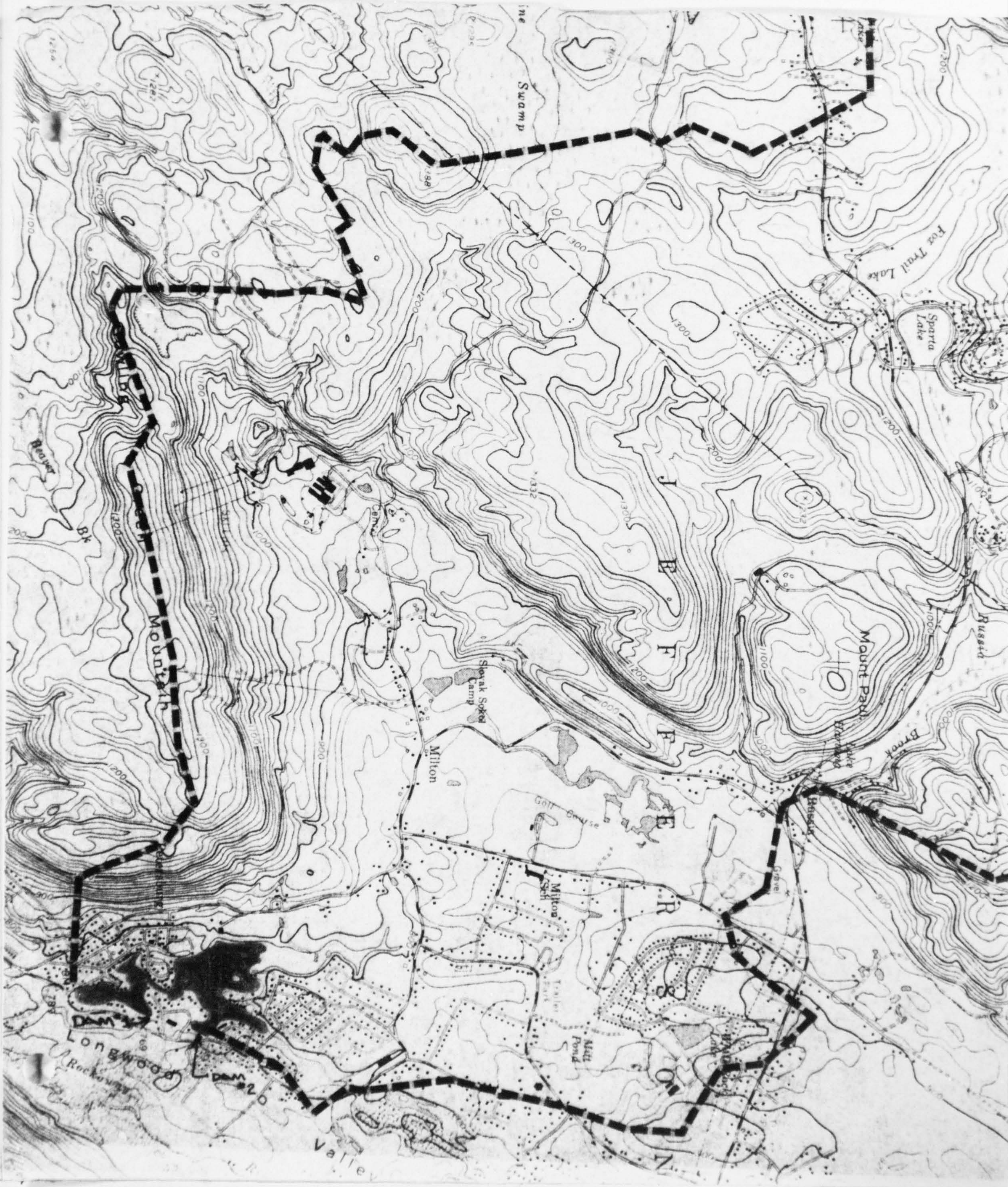
Elev	Qout	Qavg	Qnet	storage	Δt hr	$\Sigma \Delta t$ hr	days
770.4	120	117.5	90	20.32	2.7		
770.0	115	103.5	76	99.6	15.9	19	
768.0	92	77	49	96.4	23.8	42	
766.0	62	43.5	16	93.2	70.5	113	4.70
764.0	25		**	90.0			
762.0	0						

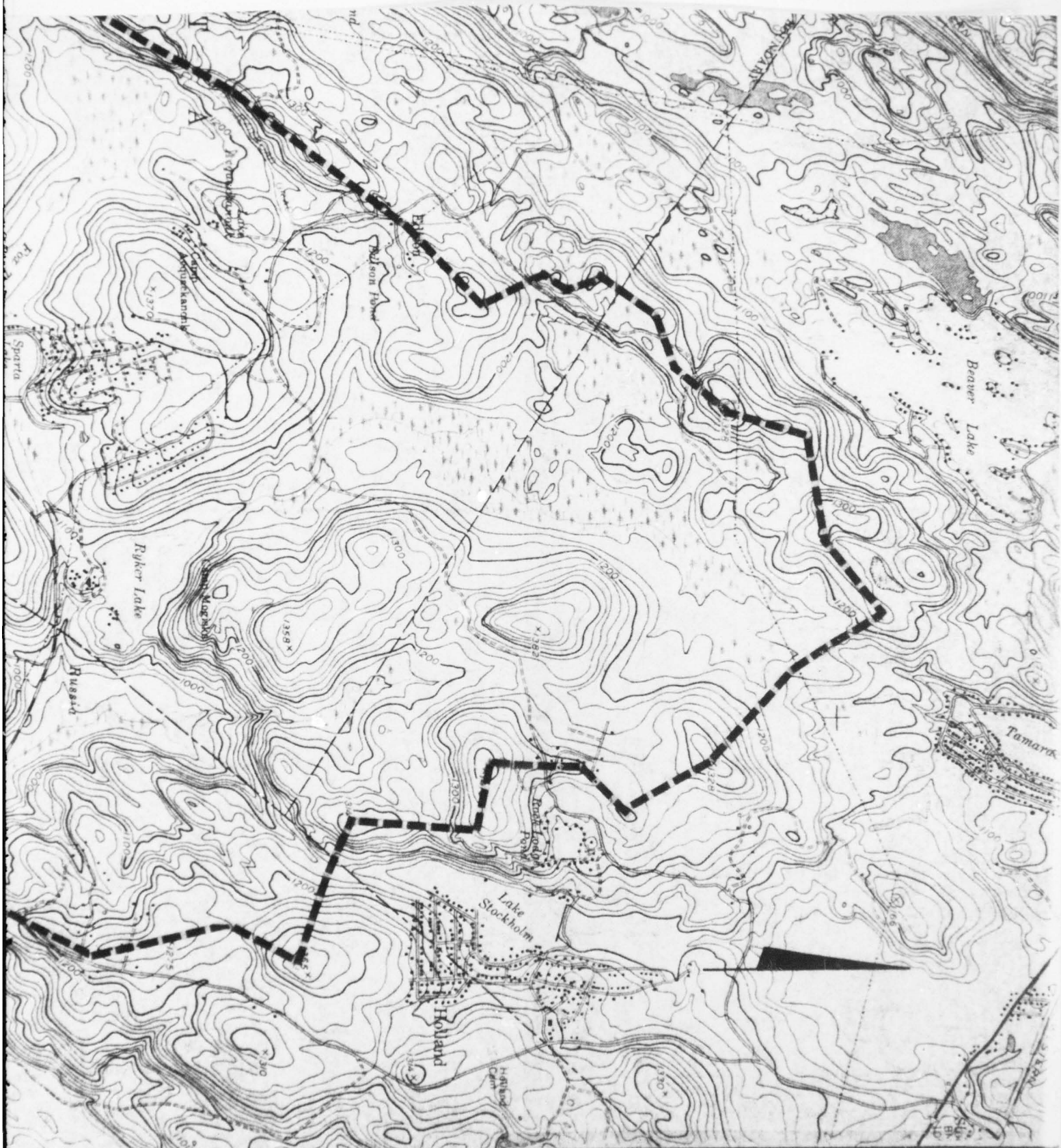
* $Q_{net} = Q_{out\,avg} - 28$

** below elev 764 inflow exceeds outflow

BY GED DATE 1.4.79 Swannanoa Lake JOB NO. J783B

CKD. DY DATE 1.5.79 / 2.13.79 SHEET NO. 12 OF 12


Swamp
Fox Trail Lake
Sparta Lake
Mount Paden
Milton
Golf Course
Slovak School Camp
Mountain
Beaver
Bk
Brook
Milton Pond
DAM #1
DAM #2
Longwood
Valley
1300
1200
1100
1000
900



MAP SOURCE: U.S.G.S.
FRANKLIN
SCALE 1" = 2000'

DRAINAGE BASIN
SWANNANOA LAKE DAM # 1

LANGAN ENGINEERING ASSOCIATES, INC.
CONSULTING ENGINEERS
990 CLIFTON AVE CLIFTON, N.J. 07012 201 472-9366

HEC-1 OUTPUT

SWANNANOA LAKE DAM 1

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  25 SEP 78
**********
    1                 A    SWANNANOA LAKE DAMS
    2                 A    DETERMINE INFLOW HYDROGRAPH AND ROUT
    3                 A    N.J. DAM INSPECTION
    4                 B     100         1         0         0         0         0         0         0         0         0
    5                 B1      3
    6                 K                 1                                                 1
    7                 K1   COMPUTE HYDROGRAPH
    8                 M       1         1      13.9                      .805
    9                 P                       22.2       108       120       130       139
   10                 T                                                                 1      .15
   11                 W    4.76      0.55
   12                 X      -2                 1
   13                 K       1                 2                                       1
   14                 K1   ROUTING COMPUTATIONS
   15                 Y                                             1
   16                 Y1      1
   17                 Y2      0        52       106       139       196       226       286       348       412       479
   18                 Y2    547
   19                 Y3      0       134       375       560      2220      3516      6948     11260     16639     23603
   20                 Y3  30680
   21                 K      99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS.

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
END OF NETWORK	

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  25 SEP 78
**********************************

RUN  DATE= 79/02/06.
     TIME= 17.28.25.


                    SWANNANOA LAKE DAMS
                    DETERMINE INFLOW HYDROGRAPH AND ROUT
                    N.J. DAM INSPECTION

                                JOB SPECIFICATION
          NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
         100        1        0        0        0        0        0        0        0        0
                                   JOPER      NWT    LROPT    TRACE
                                       3        0        0        0

     **********          **********          **********          **********          **********

                              SUB-AREA RUNOFF COMPUTATION

          COMPUTE HYDROGRAPH

                          ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME  ISTAGE    IAUTO
                              1        0        0        0        0        0       10        0        0

                                    HYDROGRAPH DATA
          IHYDG     IUHG    TAREA     SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
              1        1    13.90     0.00    13.90      .81    0.000        0        0        0

                                    PRECIP DATA
                SPFE      PMS       R6      R12      R24      R48      R72      R96
                0.00    22.20   108.00   120.00   130.00   139.00     0.00     0.00

                                    LOSS DATA
          LROPT    STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
              0     0.00     0.00     1.00     0.00     0.00     1.00     1.00      .15     0.00     0.00

                                UNIT HYDROGRAPH DATA
                          TP=  4.76     CP= .55     NTA=  0

                                  RECESSION DATA
                          STRTQ=    -2.00     QRCSN=     0.00     RTIOR= 1.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 5.25 AND R= 5.55 INTERVALS

          UNIT HYDROGRAPH 33 END-OF-PERIOD ORDINATES, LAG=   4.79 HOURS, CP=  .55  VOL= 1.00
            87.      319.      626.      896.     1031.      982.      830.      693.      579.      483.
           403.      337.      281.      234.      196.      163.      136.      114.       95.       79.
            66.       55.       46.       39.       32.       27.       22.       19.       16.       13.
            11.        9.        8.
     0
   MO.DA   HR.MN  PERIOD    RAIN    EXCS    LOSS     COMP Q      MO.DA   HR.MN  PERIOD    RAIN    EXCS    LOSS     COMP Q
    1.01    1.00       1     .01    0.00     .01        28.      1.01    3.00      51    0.00    0.00    0.00      6334.
    1.01    2.00       2     .01    0.00     .01        28.      1.01    4.00      52    0.00    0.00    0.00      5304.
    1.01    3.00       3     .01    0.00     .01        28.      1.01    5.00      53    0.00    0.00    0.00      4436.
```

1.01	4.00	4	.01	0.00	.01	28.	1.03	6.00	54	0.00	0.00	0.00	3768.
1.01	5.00	5	.01	0.00	.01	28.	1.03	7.00	55	0.00	0.00	0.00	3099.
1.01	6.00	6	.01	0.00	.01	28.	1.03	8.00	56	0.00	0.00	0.00	2592.
1.01	7.00	7	.02	0.00	.02	28.	1.03	9.00	57	0.00	0.00	0.00	2168.
1.01	8.00	8	.02	0.00	.02	28.	1.03	10.00	58	0.00	0.00	0.00	1814.
1.01	9.00	9	.02	0.00	.02	28.	1.03	11.00	59	0.00	0.00	0.00	1519.
1.01	10.00	10	.02	0.00	.02	28.	1.03	12.00	60	0.00	0.00	0.00	1273.
1.01	11.00	11	.02	0.00	.02	28.	1.03	13.00	61	0.00	0.00	0.00	1067.
1.01	12.00	12	.02	0.00	.02	28.	1.03	14.00	62	0.00	0.00	0.00	895.
1.01	13.00	13	.13	0.00	.13	28.	1.03	15.00	63	0.00	0.00	0.00	752.
1.01	14.00	14	.16	0.00	.16	28.	1.03	16.00	64	0.00	0.00	0.00	631.
1.01	15.00	15	.20	0.00	.20	28.	1.03	17.00	65	0.00	0.00	0.00	530.
1.01	16.00	16	.51	.14	.37	40.	1.03	18.00	66	0.00	0.00	0.00	446.
1.01	17.00	17	.19	.04	.15	76.	1.03	19.00	67	0.00	0.00	0.00	375.
1.01	18.00	18	.15	0.00	.15	128.	1.03	20.00	68	0.00	0.00	0.00	316.
1.01	19.00	19	.01	0.00	.01	177.	1.03	21.00	69	0.00	0.00	0.00	267.
1.01	20.00	20	.01	0.00	.01	206.	1.03	22.00	70	0.00	0.00	0.00	217.
1.01	21.00	21	.01	0.00	.01	204.	1.03	23.00	71	0.00	0.00	0.00	172.
1.01	22.00	22	.01	0.00	.01	181.	1.04	0.00	72	0.00	0.00	0.00	131.
1.01	23.00	23	.01	0.00	.01	156.	1.04	1.00	73	0.00	0.00	0.00	68.
1.02	0.00	24	.01	0.00	.01	135.	1.04	2.00	74	0.00	0.00	0.00	45.
1.02	1.00	25	.12	0.00	.12	117.	1.04	3.00	75	0.00	0.00	0.00	30.
1.02	2.00	26	.12	0.00	.12	103.	1.04	4.00	76	0.00	0.00	0.00	29.
1.02	3.00	27	.12	0.00	.12	90.	1.04	5.00	77	0.00	0.00	0.00	29.
1.02	4.00	28	.12	0.00	.12	80.	1.04	6.00	78	0.00	0.00	0.00	29.
1.02	5.00	29	.12	0.00	.12	71.	1.04	7.00	79	0.00	0.00	0.00	28.
1.02	6.00	30	.12	0.00	.12	64.	1.04	8.00	80	0.00	0.00	0.00	28.
1.02	7.00	31	.36	.21	.15	76.	1.04	9.00	81	0.00	0.00	0.00	28.
1.02	8.00	32	.36	.21	.15	137.	1.04	10.00	82	0.00	0.00	0.00	28.
1.02	9.00	33	.36	.21	.15	263.	1.04	11.00	83	0.00	0.00	0.00	28.
1.02	10.00	34	.36	.21	.15	445.	1.04	12.00	84	0.00	0.00	0.00	28.
1.02	11.00	35	.36	.21	.15	656.	1.04	13.00	85	0.00	0.00	0.00	28.
1.02	12.00	36	.36	.21	.15	857.	1.04	14.00	86	0.00	0.00	0.00	28.
1.02	13.00	37	1.93	1.78	.15	1165.	1.04	15.00	87	0.00	0.00	0.00	28.
1.02	14.00	38	2.32	2.17	.15	1842.	1.04	16.00	88	0.00	0.00	0.00	28.
1.02	15.00	39	2.90	2.75	.15	3120.	1.04	17.00	89	0.00	0.00	0.00	28.
1.02	16.00	40	7.33	7.18	.15	5441.	1.04	18.00	90	0.00	0.00	0.00	28.
1.02	17.00	41	2.70	2.55	.15	8866.	1.04	19.00	91	0.00	0.00	0.00	28.
1.02	18.00	42	2.12	1.97	.15	12647.	1.04	20.00	92	0.00	0.00	0.00	28.
1.02	19.00	43	.18	.03	.15	15707.	1.04	21.00	93	0.00	0.00	0.00	28.
1.02	20.00	44	.18	.03	.15	17177.	1.04	22.00	94	0.00	0.00	0.00	28.
1.02	21.00	45	.18	.03	.15	16724.	1.04	23.00	95	0.00	0.00	0.00	28.
1.02	22.00	46	.18	.03	.15	14942.	1.05	0.00	96	0.00	0.00	0.00	28.
1.02	23.00	47	.18	.03	.15	12783.	1.05	1.00	97	0.00	0.00	0.00	28.
1.03	0.00	48	.18	.03	.15	10738.	1.05	2.00	98	0.00	0.00	0.00	28.
1.03	1.00	49	0.00	0.00	0.00	9007.	1.05	3.00	99	0.00	0.00	0.00	28.
1.03	2.00	50	0.00	0.00	0.00	7556.	1.05	4.00	100	0.00	0.00	0.00	28.
									SUM	24.84	20.00	4.85	181289.
										(631.)	(508.)	(123.)	(5133.53)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	17177.	14838.	7080.	2507.	181257.
CMS	486.	420.	200.	71.	5133.
INCHES		9.93	18.95	20.13	20.22
MM		252.22	481.38	511.39	513.52
AC-FT		7357.	14042.	14918.	14980.
THOUS CU M		9075.	17321.	18401.	18477.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING COMPUTATIONS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

STORAGE	0.00 547.00	52.00	106.00	139.00	196.00	226.00	286.00	348.00	412.00	479.00
OUTFLOW	0.00 30680.00	134.00	375.00	560.00	2220.00	3516.00	6948.00	11260.00	16639.00	23603.00

0 MO.DA	HR.MN	PERIOD	EOP STOR	AVG IN	EOP OUT	STAGE	AVG PUMP
1.01	1.00	1	2.	28.	5.	0.0	0.
1.01	2.00	2	4.	28.	10.	0.0	0.
1.01	3.00	3	5.	28.	13.	0.0	0.
1.01	4.00	4	6.	28.	16.	0.0	0.
1.01	5.00	5	7.	28.	18.	0.0	0.
1.01	6.00	6	8.	28.	20.	0.0	0.
1.01	7.00	7	8.	28.	22.	0.0	0.
1.01	8.00	8	9.	28.	23.	0.0	0.
1.01	9.00	9	9.	28.	24.	0.0	0.
1.01	10.00	10	10.	28.	25.	0.0	0.
1.01	11.00	11	10.	28.	25.	0.0	0.
1.01	12.00	12	10.	28.	26.	0.0	0.
1.01	13.00	13	10.	28.	26.	0.0	0.
1.01	14.00	14	10.	28.	26.	0.0	0.
1.01	15.00	15	10.	28.	27.	0.0	0.
1.01	16.00	16	11.	34.	28.	0.0	0.
1.01	17.00	17	13.	56.	34.	0.0	0.
1.01	18.00	18	18.	102.	47.	0.0	0.
1.01	19.00	19	26.	153.	67.	0.0	0.
1.01	20.00	20	35.	192.	91.	0.0	0.
1.01	21.00	21	44.	205.	113.	0.0	0.
1.01	22.00	22	50.	193.	129.	0.0	0.
1.01	23.00	23	53.	169.	138.	0.0	0.
1.02	0.00	24	53.	146.	140.	0.0	0.
1.02	1.00	25	52.	126.	136.	0.0	0.
1.02	2.00	26	51.	110.	130.	0.0	0.
1.02	3.00	27	48.	96.	124.	0.0	0.
1.02	4.00	28	45.	85.	116.	0.0	0.
1.02	5.00	29	42.	76.	108.	0.0	0.
1.02	6.00	30	39.	68.	101.	0.0	0.
1.02	7.00	31	37.	70.	95.	0.0	0.
1.02	8.00	32	38.	107.	97.	0.0	0.
1.02	9.00	33	45.	200.	117.	0.0	0.
1.02	10.00	34	62.	354.	180.	0.0	0.
1.02	11.00	35	88.	551.	296.	0.0	0.
1.02	12.00	36	120.	757.	453.	0.0	0.
1.02	13.00	37	149.	1011.	858.	0.0	0.
1.02	14.00	38	173.	1504.	1563.	0.0	0.
1.02	15.00	39	205.	2481.	2626.	0.0	0.
1.02	16.00	40	250.	4280.	4865.	0.0	0.
1.02	17.00	41	303.	7153.	8144.	0.0	0.
1.02	18.00	42	357.	10756.	12055.	0.0	0.
1.02	19.00	43	397.	14177.	15350.	0.0	0.
1.02	20.00	44	416.	16442.	17064.	0.0	0.
1.02	21.00	45	414.	16951.	16880.	0.0	0.
1.02	22.00	46	395.	15833.	15244.	0.0	0.
1.02	23.00	47	370.	13862.	13099.	0.0	0.
1.03	0.00	48	345.	11761.	11032.	0.0	0.
[illegible]	[illegible]	49	[illegible]	[illegible]	9312.	0.0	0.

1.03	2.00	50	298.	8282.	7783.	0.0	0.
1.03	3.00	51	279.	6945.	6561.	0.0	0.
1.03	4.00	52	261.	5819.	5518.	0.0	0.
1.03	5.00	53	245.	4870.	4607.	0.0	0.
1.03	6.00	54	232.	4072.	3855.	0.0	0.
1.03	7.00	55	220.	3403.	3247.	0.0	0.
1.03	8.00	56	208.	2846.	2733.	0.0	0.
1.03	9.00	57	197.	2380.	2280.	0.0	0.
1.03	10.00	58	187.	1991.	1955.	0.0	0.
1.03	11.00	59	176.	1667.	1640.	0.0	0.
1.03	12.00	60	167.	1396.	1373.	0.0	0.
1.03	13.00	61	159.	1170.	1151.	0.0	0.
1.03	14.00	62	153.	981.	965.	0.0	0.
1.03	15.00	63	148.	823.	810.	0.0	0.
1.03	16.00	64	143.	691.	680.	0.0	0.
1.03	17.00	65	139.	580.	571.	0.0	0.
1.03	18.00	66	134.	488.	532.	0.0	0.
1.03	19.00	67	126.	410.	487.	0.0	0.
1.03	20.00	68	116.	346.	434.	0.0	0.
1.03	21.00	69	107.	292.	380.	0.0	0.
1.03	22.00	70	97.	242.	336.	0.0	0.
1.03	23.00	71	87.	194.	292.	0.0	0.
1.04	0.00	72	78.	151.	248.	0.0	0.
1.04	1.00	73	67.	99.	202.	0.0	0.
1.04	2.00	74	57.	57.	157.	0.0	0.
1.04	3.00	75	49.	38.	125.	0.0	0.
1.04	4.00	76	41.	30.	107.	0.0	0.
1.04	5.00	77	36.	29.	92.	0.0	0.
1.04	6.00	78	31.	29.	80.	0.0	0.
1.04	7.00	79	27.	28.	70.	0.0	0.
1.04	8.00	80	24.	28.	62.	0.0	0.
1.04	9.00	81	21.	28.	55.	0.0	0.
1.04	10.00	82	19.	28.	50.	0.0	0.
1.04	11.00	83	18.	28.	46.	0.0	0.
1.04	12.00	84	16.	28.	42.	0.0	0.
1.04	13.00	85	15.	28.	39.	0.0	0.
1.04	14.00	86	14.	28.	37.	0.0	0.
1.04	15.00	87	14.	28.	35.	0.0	0.
1.04	16.00	88	13.	28.	34.	0.0	0.
1.04	17.00	89	13.	28.	33.	0.0	0.
1.04	18.00	90	12.	28.	32.	0.0	0.
1.04	19.00	91	12.	28.	31.	0.0	0.
1.04	20.00	92	12.	28.	30.	0.0	0.
1.04	21.00	93	12.	28.	30.	0.0	0.
1.04	22.00	94	11.	28.	30.	0.0	0.
1.04	23.00	95	11.	28.	29.	0.0	0.
1.05	0.00	96	11.	28.	29.	0.0	0.
1.05	1.00	97	11.	28.	29.	0.0	0.
1.05	2.00	98	11.	28.	29.	0.0	0.
1.05	3.00	99	11.	28.	28.	0.0	0.
1.05	4.00	100	11.	28.	28.	0.0	0.
				SUM	181166.		
				(	5130.05)		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	17064.	14863.	7075.	2507.	181149.
CMS	483.	421.	200.	71.	5130.
INCHES		9.95	18.94	20.13	20.21
MM		252.65	481.03	511.30	513.21
AC-FT		7370.	14032.	14915.	14971.
THOUS CU M		9091.	17309.	18398.	18466.

5

RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	17177.	14838.	7080.	2507.	13.90
		(486.41)(	420.15)(	200.47)(	70.99)(	36.00)
ROUTED TO	2	17064.	14863.	7075.	2507.	13.90
		(483.20)(	420.88)(	200.33)(	70.98)(	36.00)

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  25 SEP 78
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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  25 SEP 78
**********************************
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PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
END OF NETWORK	

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  25 SEP 78
**********

RUN  DATE# 79/02/06.
     TIME# 18.16.50.


                SWANNANOA LAKE DAMS
                % PMF
                N.J. DAM INSPECTION

                                JOB SPECIFICATION
          NQ      NHR     NMIN     IDAY     IHR     IMIN    METRC     IPLT     IPRT    NSTAN
         100        1        0        0       0        0        0        0        4        0
                                   JOPER      NWT    LROPT    TRACE
                                       5        0        0        0

                             MULTI-PLAN ANALYSES TO BE PERFORMED
                                  NPLAN= 1 NRTIO= 6 LRTIO= 1
                RTIOS=    1.00     .50     .10     .06     .04     .02

**********          **********          **********          **********          **********

                                SUB-AREA RUNOFF COMPUTATION

          COMPUTE HYDROGRAPH

                              ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                  1       0       0       0       0       0      10       0       0

                                        HYDROGRAPH DATA
               IHYDG     IUHG    TAREA     SNAP   TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
                   1        1    13.90     0.00    13.90      .81    0.000        0        0        0

                                        PRECIP DATA
                        SPFE      PMS       R6      R12      R24      R48      R72      R96
                        0.00    22.20   108.00   120.00   130.00   139.00     0.00     0.00

                                        LOSS DATA
          LROPT    STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
              0     0.00     0.00     1.00     0.00     0.00     1.00     1.00      .15     0.00     0.00

                                   UNIT HYDROGRAPH DATA
                                TP=  4.76   CP= .55    NTA=  0

                                   RECESSION DATA
                              STRTQ=    -2.00    QRCSN=     0.00    RTIOR= 1.00

          UNIT HYDROGRAPH 33 END-OF-PERIOD ORDINATES, LAG=   4.79 HOURS, CP=   .55  VOL= 1.00
            87.      319.      626.      896.     1031.      982.      830.      693.      579.      483.
           403.      337.      281.      234.      196.      163.      136.      114.       95.       79.
            66.       55.       46.       39.       32.       27.       22.       19.       16.       13.
            11.        9.        8.

                                   END-OF-PERIOD FLOW
          0
     MO.DA   HR.MN  PERIOD   RAIN    EXCS    LOSS     COMP Q       MO.DA  HR.MN  PERIOD   RAIN    EXCS    LOSS     COMP Q
```

SUM 24.84 20.00 4.85 181289.
(631.)(508.)(123.)(5133.53)

9

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING COMPUTATIONS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

STORAGE	0.00 547.00	52.00	106.00	139.00	196.00	226.00	286.00	348.00	412.00	479.00
OUTFLOW	0.00 30680.00	134.00	375.00	560.00	2220.00	3516.00	6948.00	11260.00	16639.00	23603.00

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .50	RATIO 3 .10	RATIO 4 .06	RATIO 5 .04	RATIO 6 .02
HYDROGRAPH AT	1	13.90	1	17177.	8589.	1718.	1031.	687.	344.
		(36.00)		(486.41)(	243.20)(	48.64)(	29.18)(	19.46)(	9.73)(
ROUTED TO	2	13.90	1	17064.	8527.	1698.	1024.	570.	263.
		(36.00)		(483.20)(	241.46)(	48.09)(	29.00)(	16.13)(	7.46)(

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 25 SEP 78
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APPENDIX 5

REFERENCES

SWANNANOA LAKE DAM I

APPENDIX 5

REFERENCES

SWANNANOA LAKE DAM #1

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