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NATIONAL DAM SAFETY PROGRAM. COLUMBIA DAM (NJ00124) DELAWARE RI--ETC(U)
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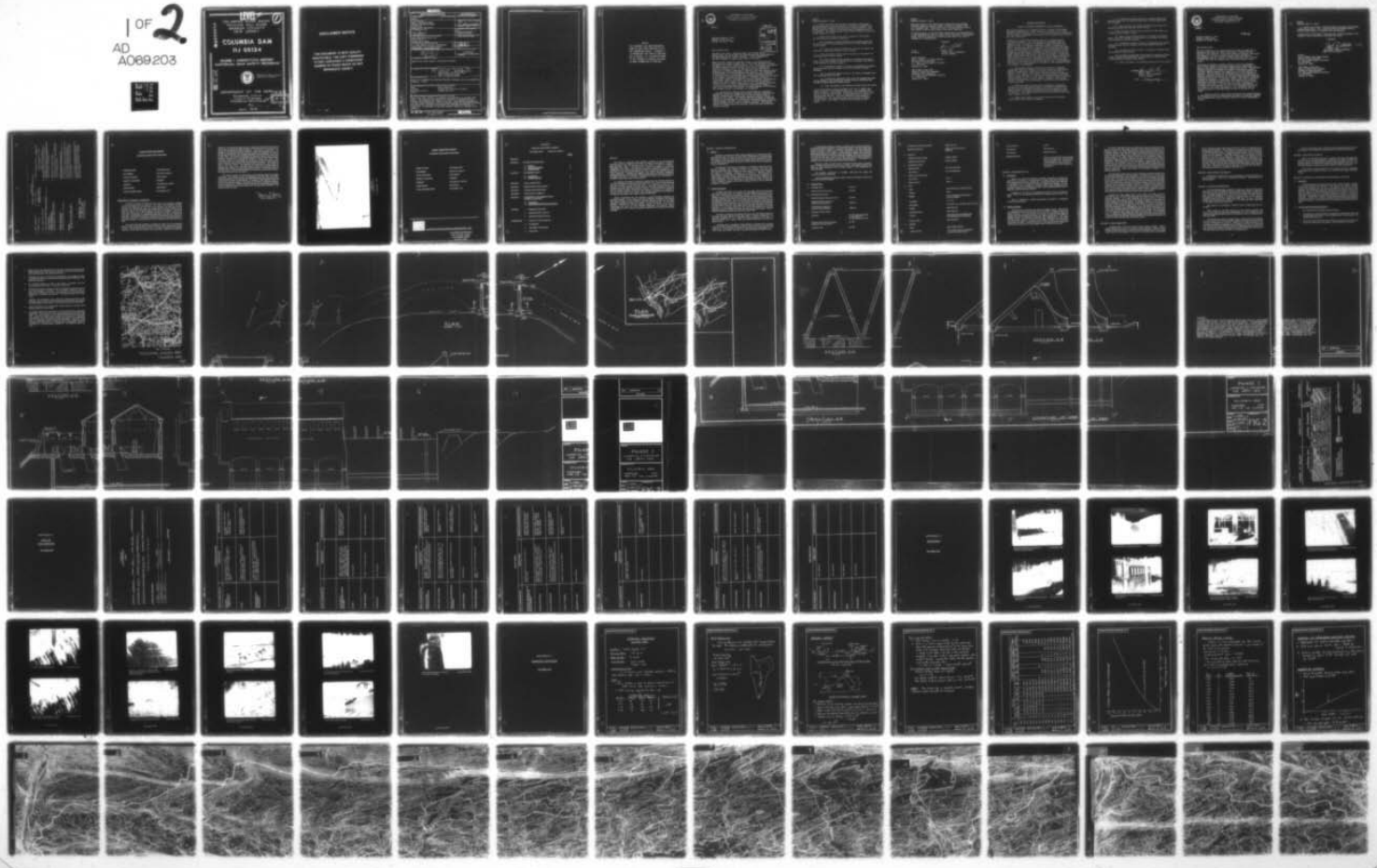

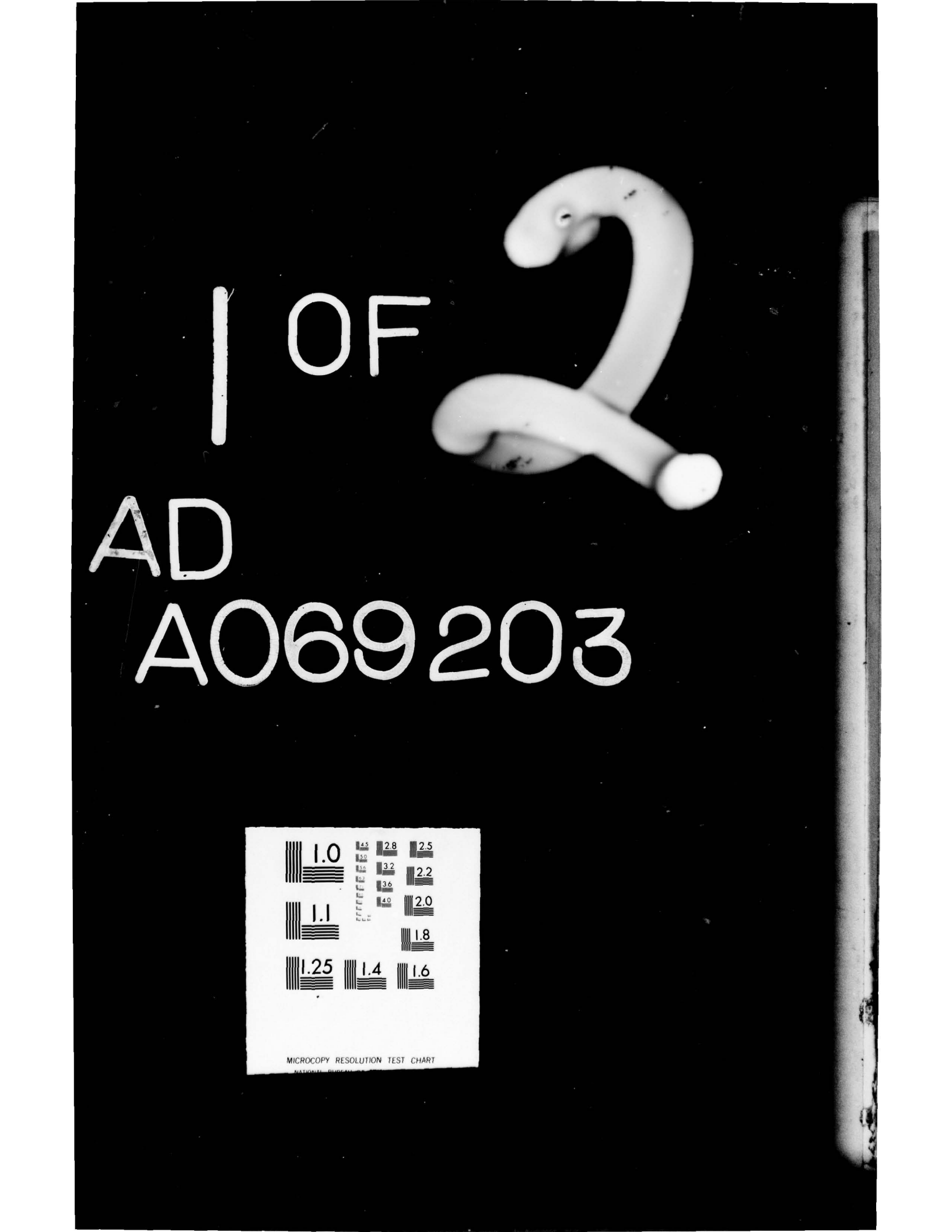
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DELAWARE RIVER BASIN
PAULINS KILL RIVER
WARREN COUNTY
NEW JERSEY

COLUMBIA DAM
NJ 00124

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: NJ00124	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): Phase I Inspection Report National Dam Safety Program Columbia Dam Warren County, New Jersey	5. TYPE OF REPORT & PERIOD COVERED: (9) FINAL rept.
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7. AUTHOR(s): (10) Dennis J. Leary	8. CONTRACT OR GRANT NUMBER(s): (15) DACW61-78-C-0124
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Langan Engineering Assoc. Inc. 970 Clifton Ave. Clifton, N.J. 07013	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Engineer District, Philadelphia Custom House, 2d & Chestnut Streets Philadelphia, Pennsylvania 19106	(11) 12. REPORT DATE: April 1979 13. NUMBER OF PAGES: 69
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): (12) 116p.	15. SECURITY CLASS. (of this report): Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

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

(6) National Dam Safety Program.
Columbia Dam (NJ 00124) Delaware River Basin, Paulins Kill River, Warren County, New Jersey.
Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

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

Dams
Spillway
Structural Analysis
Safety
Visual Inspection
National Dam Inspection Act Report
Columbia Dam, N.J.

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 - 2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

15 MAY 1979

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A

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

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Columbia Dam in Warren 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, Columbia Dam, a high hazard potential structure, is judged to be in poor overall condition. Also, the spillway is considered seriously inadequate since 19 percent of the Probable Maximum Flood (PMF) would overtop the dam. The seriously inadequate spillway is assessed as an UNSAFE, non-emergency condition, until more detailed studies prove otherwise or corrective measures are completed. The classification of UNSAFE applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with an UNSAFE classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard of loss of life downstream from 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, a detailed emergency operation plan and 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, engineering studies and analyses should be performed to determine the dam and spillway foundation condition and structural stability. This should include test borings to determine material properties relative to stability. Any remedial measures found necessary should be initiated within calendar year 1979.

c. Within three months of the date of approval of this report, the following actions should be completed.

(1) Investigate and make functional the openings controlling the water intake into the abandoned power house so that Columbia Lake can be lowered.

(2) Lower the water level behind the spillway and inspect the upstream and downstream condition of the spillway.

d. Within six months from the date of approval of this report the following actions should be taken:

(1) Repair cracks and deterioration of concrete of the power house at the right abutment of the dam and at the entrance and interior of the spillway at the left abutment.

(2) Investigate by means of borings and piezometers the leakage occurring around the left abutment and provide remedial grouting if necessary.

(3) An evaluation should be made of the amount of sediment that has accumulated behind the dam.

(4) Upstream and downstream riprap should be repaired and areas of the abutments where erosion has occurred should be backfilled and suitably protected against further erosion.

(5) Trees and bushes in the downstream channel should be removed.

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.

NAPEN-D
Honorable Brendan T. Byrne

Additional copies of this report may be obtained from the National 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,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
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
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

COLUMBIA DAM (NJ00124)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 14 December 1978 and 9 January 1979 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, Public Law 92-367.

Columbia Dam, a high hazard potential structure, is judged to be in poor overall condition. Also, the spillway is considered seriously inadequate since 19 percent of the Probable Maximum Flood (PMF) would overtop the dam. The seriously inadequate spillway is assessed as an UNSAFE, non-emergency condition, until more detailed studies prove otherwise or corrective measures are completed. The classification of UNSAFE applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with an UNSAFE classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard of loss of life downstream from 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, a detailed emergency operation plan and 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, engineering studies and analyses should be performed to determine the dam and spillway foundation condition and structural stability. This should include test borings to determine material properties relative to stability. Any remedial measures found necessary should be initiated within calendar year 1979.

c. Within three months of the date of approval of this report, the following actions should be completed.

(1) Investigate and make functional the openings controlling the water intake into the abandoned power house so that Columbia Lake can be lowered.

(2) Lower the water level behind the spillway and inspect the upstream and downstream condition of the spillway.

d. Within six months from the date of approval of this report the following actions should be taken:

(1) Repair cracks and deterioration of concrete of the power house at the right abutment of the dam and at the entrance and interior of the spillway at the left abutment.

(2) Investigate by means of borings and piezometers the leakage occurring around the left abutment and provide remedial grouting if necessary.

(3) An evaluation should be made of the amount of sediment that has accumulated behind the dam.

(4) Upstream and downstream riprap should be repaired and areas of the abutments where erosion has occurred should be backfilled and suitably protected against further erosion.

(5) Trees and bushes in the downstream channel should be removed.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 9 May 1979

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

IN REPLY REFER TO
NAPEN-D

30 MAR 1979

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

Dear Governor Byrne:

This is in reference to our ongoing National Program for Inspection of Non-Federal Dams within the State of New Jersey. Columbia Lake Dam (Federal I.D. No. NJ00124), a high hazard potential structure, has recently been inspected. The dam is owned by the New Jersey Department of Environmental Protection, Division of Parks and Forestry, and is located on Paulins Kill near the Delaware River in Knowlton Township, Warren County.

Using Corps of Engineers screening criteria, it has been determined that the dam's spillway is seriously inadequate since approximately 19 percent of the Probable Maximum Flood would overtop the dam. The seriously inadequate spillway is assessed as an UNSAFE, non-emergency condition, until more detailed studies prove otherwise, or corrective measures are completed. The classification of UNSAFE applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with an UNSAFE classification applied for a structural deficiency. It does mean, however, that based on an initial screening and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam could take place, significantly increasing the hazard potential to loss of life downstream from the dam. As a result of this UNSAFE determination, it is recommended that the following measures be undertaken within 30 days of the date of this letter:

a. Initiate a study to more accurately determine the spillway adequacy by using more detailed and sophisticated hydrologic and hydraulic analyses, and to recommend any remedial measures required to prevent overtopping of the dam.

NAPEN-D
Honorable Brendan T. Byrne

b. Develop and initiate a detailed emergency operation plan and downstream warning system. Also, around-the-clock surveillance should be provided during periods of unusually heavy precipitation.

A final report on this Phase I Inspection with a detailed analysis of the situation, will be forwarded to you within two months.

Sincerely,

Joel Kallaban LTC

JAMES G. TON
Colonel, Corps of Engineers
for District Engineer

Cy Furn:
Dirk C. Hofman, Actg. Deputy Director
Division of Water Resources
N.J. Dept of Environmental Protection
P.O. Box CN029
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John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N.J. Dept of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

UNSAFE DAM
NATIONAL PROGRAM OF INSPECTION OF DAMS

a. NAME: COLUMBIA LAKE

b. ID NO.: NJ00124

c. LOCATION State: New Jersey County: Warren
River or Stream: Paulins Kill
Nearest D/D City or Town:

d. HEIGHT: 18 feet

e. MAXIMUM IMPOUNDMENT CAPACITY: 900 ac. ft.

f. TYPE: Amersen Type, Concrete

g. OWNER: New Jersey Department of Environmental Protection, Division of Parks and Forestry.

h. DATE GOVERNOR NOTIFIED OF UNSAFE CONDITIONS: 30 Mar 79

i. CONDITION OF DAM RESULTING IN UNSAFE ASSESSMENT:
Preliminary report calculations indicate 19% of PMF would overtop the dam.

l. URGENCY CATEGORY:
UNSAFE, Non-Emergency

m. EMERGENCY ACTIONS TAKEN:
Governor notified of this condition by District Engineer's letter of 30 Mar 79

j. DESCRIPTION OF DANGER INVOLVED:
Overtopping and failure of the dam significantly increases hazard potential to loss of life and property downstream of dam.

n. REMEDIAL ACTIONS TAKEN:
N.J.D.E.P. will notify dam's owner upon receipt of our letter

k. RECOMMENDATIONS GIVEN TO GOVERNOR:
Letter to Governor will recommend the owner do the following:
a. Engage the services of a qualified professional consultant to more accurately determine the spillway adequacy by using more detailed and sophisticated hydrologic and hydraulic analyses, and remedial measures required to prevent overtopping of the dam.

b. In the interim, a detailed emergency operation plan and downstream warning system should be developed. Also, round-the-clock surveillance should be provided during periods of unusually heavy precipitation.

o. REMARKS:
Final Report, to be issued within six weeks, will have WHITE cover

W. H. Zink 3/30/79
W. H. ZINK, Coordinator
Dam Inspection Program
U.S.A.E.D., Philadelphia

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	COLUMBIA DAM
ID NUMBER:	FED ID No NJ00124
STATE LOCATED:	NEW JERSEY
COUNTY LOCATED:	WARREN
STREAM:	PAULINS KILL RIVER
RIVER BASIN:	DELAWARE
DATE OF INSPECTION:	DECEMBER 1978

ASSESSMENT OF GENERAL CONDITIONS

Columbia Lake Dam is 70 years old and in poor overall condition. Leakage is occurring around the left abutment. The crest of the spillway may have cracked and displaced and the toe of the spillway may also be cracked. Upstream and downstream riprap has deteriorated and there is debris at the upstream side of the abandoned power house and on the spillway. Numerous trees and bushes are in the immediate downstream channel. There is no information concerning the engineering properties of the dam and foundation materials. Considerable concrete cracking and deterioration has occurred at both sides of the dam. The spillway, as determined by CE Screening criteria is seriously inadequate. We estimate the dam can adequately pass only 18% of the PMF.

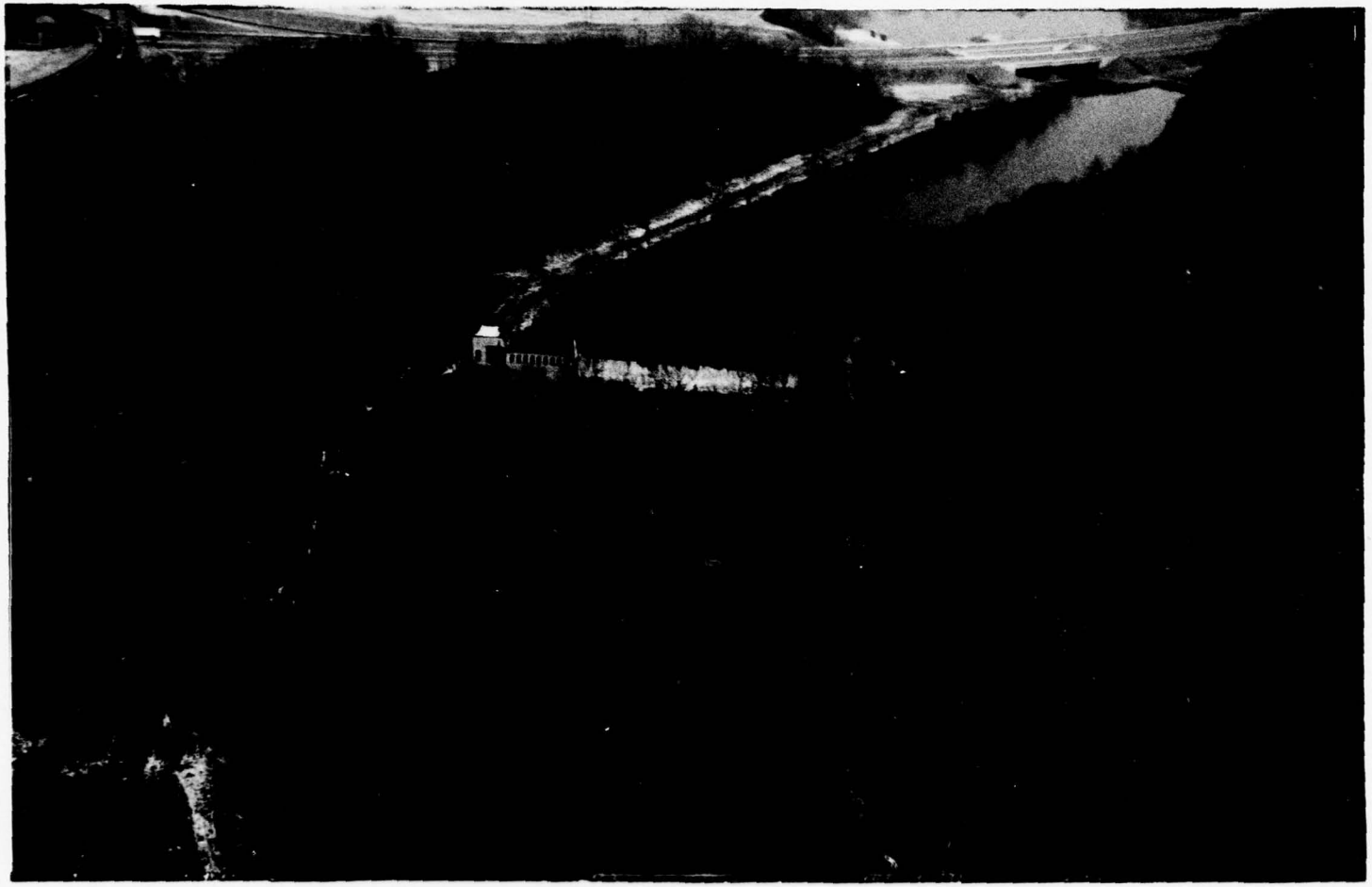
We recommend the openings controlling the water into the abandoned power house be investigated and made functional so that Columbia Lake can be lowered. This should be done very soon. The water level behind the spillway should be lowered and the upstream and downstream condition of the spillway

inspected. This should be done very soon. Cracks and deterioration of concrete of the power house at the right abutment of the dam and at the entrance and interior of the spillway should be repaired. This should be done soon. The leakage occurring around the left abutment should be investigated by means of borings and piezometers and remedial grouting should be provided. This should be done soon. The amount of sediment that has accumulated behind the dam should be evaluated soon. The engineering properties of the dam and foundation materials should be investigated by means of borings and tests. This information should be used in analyzing the stability of the dam under different stress conditions using present day conventional procedures. This should be done in the near future. The upstream and downstream riprap should be repaired and areas of the abutments where erosion has occurred should be backfilled and suitably protected against further erosion. This should be done in the near future. Trees and bushes should be removed from downstream channel. This should be done in the near future.

The spillway capacity as determined by CE Screening criteria is seriously inadequate. We estimate the dam can adequately pass only 18% of the PMF. The actual capacity of the spillway should be determined using more precise and sophisticated methods and procedures. If necessary, steps should be taken to increase the spillway capacity. 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
COLUMBIA DAM

13 December 1978

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	COLUMBIA DAM
ID NUMBER:	FED ID No NJ00124
STATE LOCATED:	NEW JERSEY
COUNTY LOCATED:	WARREN
STREAM:	PAULINS KILL RIVER
RIVER BASIN:	DELAWARE
DATE OF INSPECTION:	DECEMBER 1978

LANGAN ENGINEERING ASSOCIATES, INC.

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

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NATIONAL DAM SAFETY REPORT

COLUMBIA DAM FED ID No. NJ00124

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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 Columbia Lake Dam 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 the 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 Columbia Lake Dam 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 report to imply that a dam meeting or failing to meet the screening criteria, is per se, certainly adequate or inadequate.

1.2 Project Description

Columbia Lake Dam is a 70 year old, 18-ft high, 330-ft long Ambursen type concrete gravity dam. The spillway is an ogee shaped overfall with a 15-ft-long crest. The interior of the spillway is hollow. Access to the interior of the spillway is by way of iron-bar gate at the downstream left abutment of the dam. Available drawings show there is a 70-ft-long concrete wall perpendicular to the left sidewall of the dam. The wall extends under the railroad tracks that are located along the left abutment. At the right of the spillway is an abandoned hydroelectric power house that is reported to have three 14ft-wide flumes that are now closed. There is a New Jersey Power and Light substation at the right abutment. At the right side and on the crest of the spillway are concrete pedestals and steel channels that were formerly used for sluice gates. Records indicate the gates have been removed since at least 1928.

The dam is located on the Paulins Kill River near the Delaware River in Knowlton Township, Warren County, New Jersey, at North Latitude 40° 55.4' and West Longitude 75° 5.2'. Columbia Lake is upstream of the dam. A regional vicinity map is given in Fig 1 and essential features of the dam are given in Fig 2.

Columbia Dam is classified as being "Small" on the basis of its maximum reservoir storage volume of 900 ac-ft which is more than 50 ac-ft, but less than 1,000 ac-ft. It is classified as "Small" on the basis of its total height of 18 ft which is less than 40 feet. The dam is therefore, classified as "Small" in size.

In the National Inventory of Dams, Columbia Dam 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 shows the downstream potential damage center includes a well traveled State Highway (Rte. 46) across the Paulins Kill River and nearby residential buildings, which are located about 1/4 mile from the dam. Breach of the dam could cause excessive damage to residences and be hazardous to people utilizing Route 46. Accordingly, it is proposed not to change the Hazard Classification Potential.

The dam is owned by the N.J. Div. of Forests & Parks, Labor and Industry Bldg., Rm.806, P.O. Box 1420, Trenton, N.J. 08625. The original purpose of the dam was power generation and its present purpose is the impoundment of Columbia Lake.

No essential information is available concerning the design and construction history of the dam.

Normal operational procedures consist of daily patrolling of the dam area by Forests and Parks Rangers.

1.3 Pertinent Data

a.	Drainage Area:	175 sq mi
	Normal water surface area :	50 acres
b.	Discharge at Dam site	
	Maximum known flood at dam site:	Unknown
	Ungated spillway capacity at maximum pool elevation:	10890 cfs
	Total spillway capacity at maximum pool elevation:	10890 cfs
c.	Elevation (ft above MSL)	
	Top dam:	El. 291 (wing wall section at left abutment) El. 285 (spillway section)
	Maximum pool-design surcharge: (assumed to be top of dam)	El. 291
	Spillway crest:	El. 285

	Streambed at centerline of dam:	Approx. El. 267
	Maximum tailwater:	Approx. El. 273 at time of inspection
d.	Reservoir	
	Length of maximum pool:	Approx. 4500 ft
	Length of normal pool:	Approx. 4200 ft
e.	Storage (acre-feet)	
	Spillway crest:	600 AF (estimated)
	Top of dam:	913 AF (estimated)
f.	Reservoir Surface (acres)	
	Top of dam:	54 ac. ±
	Spillway crest:	50 ac. ±
g.	Dam	
	Type:	Concrete gravity, Ambursen Type
	Length:	330 ft
	Height:	18 ft (at spillway section, known maximum height)
	Top Width:	1 ft - 2 in
	Side Slopes :	U/S 1½ hor to 1 vert, D/S 1 hor to 1½ vert
	Zoning:	None observed
	Impervious Core:	None observed
	Cutoff:	None observed; Unconfirmed U/S sheetpiling shown on 1909 Dwg.
	Grout curtain:	None observed
h.	Spillway	
	Type:	Ogee shaped overfall
	Length of weir:	154 ft (190 ft effective including removed old gated section)

Crest elevation:	El. 285
U/S channel:	None observed
D/S channel:	Paulins Kill River

i. Regulating Outlets

Three 14-ft-wide flumes in power house that are no longer used. There are gate valves of unknown size. The locations of the handles is not known and it is uncertain whether or not the gates can be operated.

SECTION 2 ENGINEERING DATA

2.1 Introduction

There is no essential information available concerning the design and construction of the dam. A drawing dated 11 August 1909 shows interlocking steel piling driven below the upstream toe. The depth of piling is not shown and it is described as 12" x 35 lbs per foot driven to solid rock or hardpan. The dam is described on the drawing as a Ransom Hollow Dam, designed by The Hydraulic Properties Co., 60 Broadway, New York, with Meikleham & Dinsmore Engineers, and Wm. Ransom, Inventor.

Operation of the dam is the responsibility of the N.J. Div. of Forests & Parks. There are no operating procedures and Rangers patrol the dam area daily.

There is insufficient available engineering information to adequately evaluate Columbia Dam.

2.2 Regional Geology

Columbia Dam is located in the Valley and Ridge Province. This province encompasses one-twelfth of the land area of the state - chiefly in Warren and Sussex Counties. It is characterized by a series of nearly parallel ridges and valleys that trend northeast-southwest. The ridges are underlain with northwest dipping Silurian and Devonian sandstones and conglomerates. The upper Delaware Valley is underlain with weak Devonian limestones and shales while the Kittatinny Valley is underlain with folded Cambrian and Ordovician limestones and shales. Kittatinny Mountain is the most prominent topographic feature and its nearly even crest averages 1600 to 1800 feet in elevation.

The Valley and Ridge Province is divided into western, middle, and eastern sections that include the Upper Delaware Valley, Kittatinny Mountain, and Kittatinny Valley. The Upper Delaware Valley encompasses the region west of Kittatinny Mountain that has been eroded in Devonian limestones and shales. Kittatinny Mountain makes up the middle section of the Province and forms the eastern border of the Upper Delaware Valley and the northwestern border of Kittatinny Valley. The ridge is underlain with the very resistant lower Silurian Shawangunk conglomerate and High Falls sandstone. The northeastern side is bordered by the escarpments of the Shawangunk conglomerate, which rise steeply from the Kittatinny Valley floor. The Shawangunk conglomerate has been extensively broken up into large rock fragments by mechanical weathering and frost action and forms mass wasted talus slopes along the ramparts of the eastern escarpment. These talus slopes are extensively developed in the Delaware Water Gap.

The Kittatinny Valley area is a broad northeast-southwest lowland where the Harrisburg Peneplain is well developed. The valley is 10 to 13 miles wide and lies between the New Jersey Highlands on the east and Kittatinny Mountain on the west. The Wisconsin ice sheet covered all of the Valley and Ridge Province and deposited a terminal moraine south of the province near Belvidere. Much of the land surface north of the terminal moraine consists of a thin sheet of glacial till and ice-scoured bedrock surfaces. In addition, fluvial deposits of stratified drift consisting of eskers, kames, kame terraces, and deltas mantle many of the areas of the valley bottoms. Discontinuous recessional moraines were deposited during stillstands in the ice retreat. These moraines now form a discontinuous low band of hills across nearly all of Sussex County.

Glacial till covers large areas of the Valley and Ridge Province. Generally the till is extremely thin and sometimes present only in patches or as scattered boulders. It is best developed on broad summits, interstream surfaces, and in low passes or cols, and is thinnest or absent on steep slopes, on narrow ridges, and in narrow valleys. The greatest thickness of the till in the Kittatinny Valley is over 100 feet just on the edge of the valley at Ogdensburg. Estimates of the thickness range from 8 to 10 feet along the west slope of Kittatinny Mountain; 2 to 3 feet along the crest of Kittatinny Mountain; 5 to 10 feet on the limestone belts of Kittatinny Valley; 8 to 12 feet on the shale belts of Kittatinny Valley; and from 5 to 20 feet in Vernon Valley. The composition of till is largely of local origin and reflects the character of the underlying rock. It is generally compact because of the high clay content derived from the weathered shales and has many resistant boulders of Shawangunk conglomerate as well as erratics derived from more distant sources.

SECTION 3 VISUAL INSPECTION

Columbia Dam is 70 years old and in poor overall condition. There is spalled concrete and cracks in the right concrete abutment. There is serious spalling and deterioration of concrete at the left abutment and at the entrance to the interior of the spillway. The interior of the spillway was not accessible

due to flooding and debris obstructing the entrance. Hence, an inspection of the interior was not possible. There is debris on the spillway crest and upstream of the abandoned power house. The upstream and downstream riprap on the banks of the river has deteriorated. Seepage estimated at about 5 gpm is occurring around the left abutment. About four inches of water was flowing over the spillway at the time of our inspection. Consequently, an inspection of the surface and toe of the spillway could not be made. However, the surface of the water flowing over the spillway indicated the possibility that the concrete along the crest and at the toe may have cracked and displaced about 5 in to 8 in. This should be visually inspected with the lake water level lowered below spillway crest level. Because of the age of the dam it is likely there has been a considerable accumulation of sediment behind the dam.

SECTION 4 OPERATIONAL PROCEDURES

Operation of Columbia Dam is the responsibility of the N.J. DEP Div. of Forests and Parks. There are no operational procedures. Rangers patrol the dam area daily.

SECTION 5 HYDRAULIC/HYDROLOGIC

The hydraulic/hydrologic evaluation is based on a Spillway Design Flood (SDF) equal to the full Probable Maximum Flood (PMF) chosen 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 22.4 inches (200 square mile - 24 hour). Hydrologic computations are presented in Appendix 4. The PMF peak inflow determined for the subject watershed is 59,879 cfs.

The capacity of the spillway is 10,890 cfs which is significantly less than the SDF.

Flood routing for the PMF indicates the left concrete abutment wall section of the dam will overtop by approximately 10 ft. For 1/2 PMF, the same will overtop by approximately 5 feet. We estimate the dam can adequately pass 18% of the PMF.

The downstream potential damage center, a well traveled State Highway across the Paulins Kill River and nearby residential buildings, are located about 1/4 miles downstream of the dam. Based on our visual inspection of the immediate downstream topography and knowledge of the dam it is our opinion that the dam cannot pass 1/2 PMF without overtopping and causing failure, and thus, significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

Due to the unknown sizes of the gates for the regulating outlets and the uncertainties in their operations, drawdown analysis has not been performed.

SECTION 6 STRUCTURAL STABILITY

There is no essential information available concerning the engineering properties of the dam and foundation. Consequently, the degree of stability of the dam cannot be quantitatively evaluated using analytical methods. The possible presence of cracked and displaced concrete along the crest and at the toe of the spillway is a serious matter and requires further investigations.

Based upon our visual inspection it is our opinion the dam is marginally stable under static loading and likely to be unstable under design earthquake loading.

SECTION 7 ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Assessment

Columbia Lake Dam is 70 years old and in poor overall condition. Leakage is occurring around the left abutment. The crest of the spillway may have cracked and displaced and the toe of the spillway may also be cracked. Upstream and downstream riprap has deteriorated and there is debris at the upstream side of the abandoned power house and on the spillway. Numerous trees and bushes are in the immediate downstream channel. There is no information concerning the engineering properties of the dam and foundation materials. Considerable concrete cracking and deterioration has occurred at both sides of the dam. The spillway, as determined by CE Screening criteria is seriously inadequate. We estimate the dam can adequately pass only 18% of the PMF.

7.2 Recommendations/Remedial Measures

We recommend the following remedial measures:

1. Investigate and make functional the openings controlling the water into the abandoned power house so that Columbia Lake can be lowered. This should be done very soon.

2. Lower the water level behind the spillway and inspect the upstream and downstream condition of the spillway. This should be done very soon.

3. Repair cracks and deterioration of concrete of the power house at the right abutment of the dam and at the entrance and interior of the spillway at the left abutment. This should be done soon.

4. Investigate by means of borings and piezometers the leakage occurring around the left abutment and provide remedial grouting if necessary. This should be done soon.

5. An evaluation should be made of the amount of sediment that has accumulated behind the dam. This should be done soon.

6. Investigate by means of borings and tests the engineering properties of the dam and foundation materials. This information should be used in analyzing the stability of the dam under different stress conditions using present day conventional procedures. This should be done in the near future.

7. Upstream and downstream riprap should be repaired and areas of the abutments where erosion has occurred should be backfilled and suitably protected against further erosion. This should be done in the near future.

8. Trees and bushes in the downstream channel should be removed. This should be done in the near future.

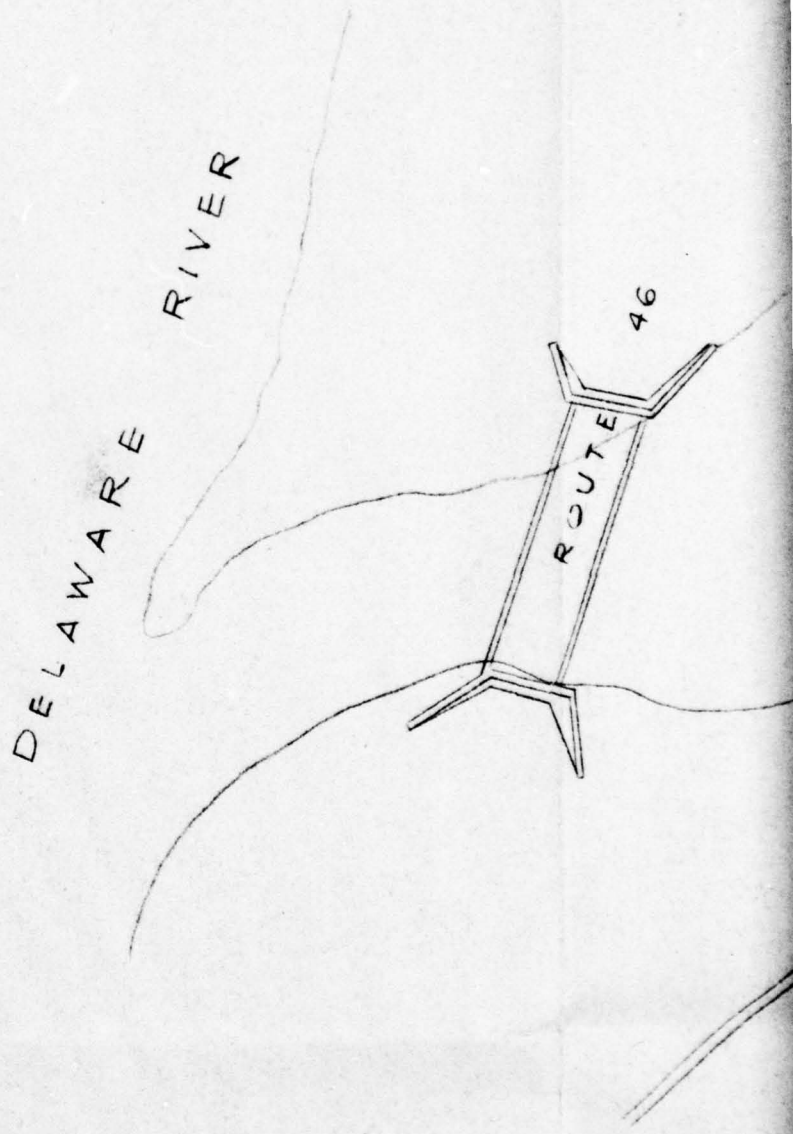
9. The spillway capacity as determined by CE screening criteria is seriously inadequate. We estimate the dam can adequately pass only 18% of the PMF. The actual capacity of the spillway should be determined using more precise and sophisticated methods and procedures. If necessary, steps should be taken to increase the spillway capacity. 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.

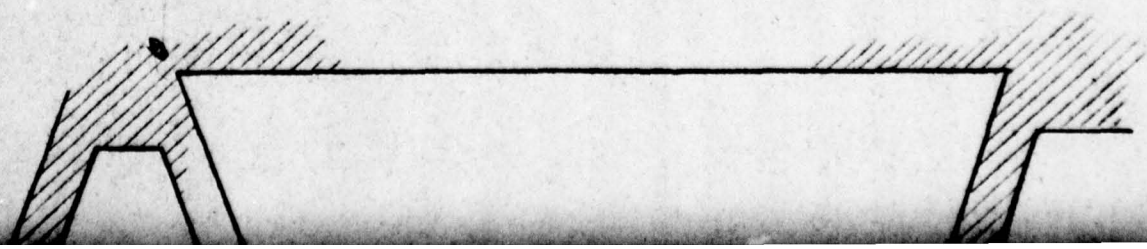
1 in ≃ 5.2 mi

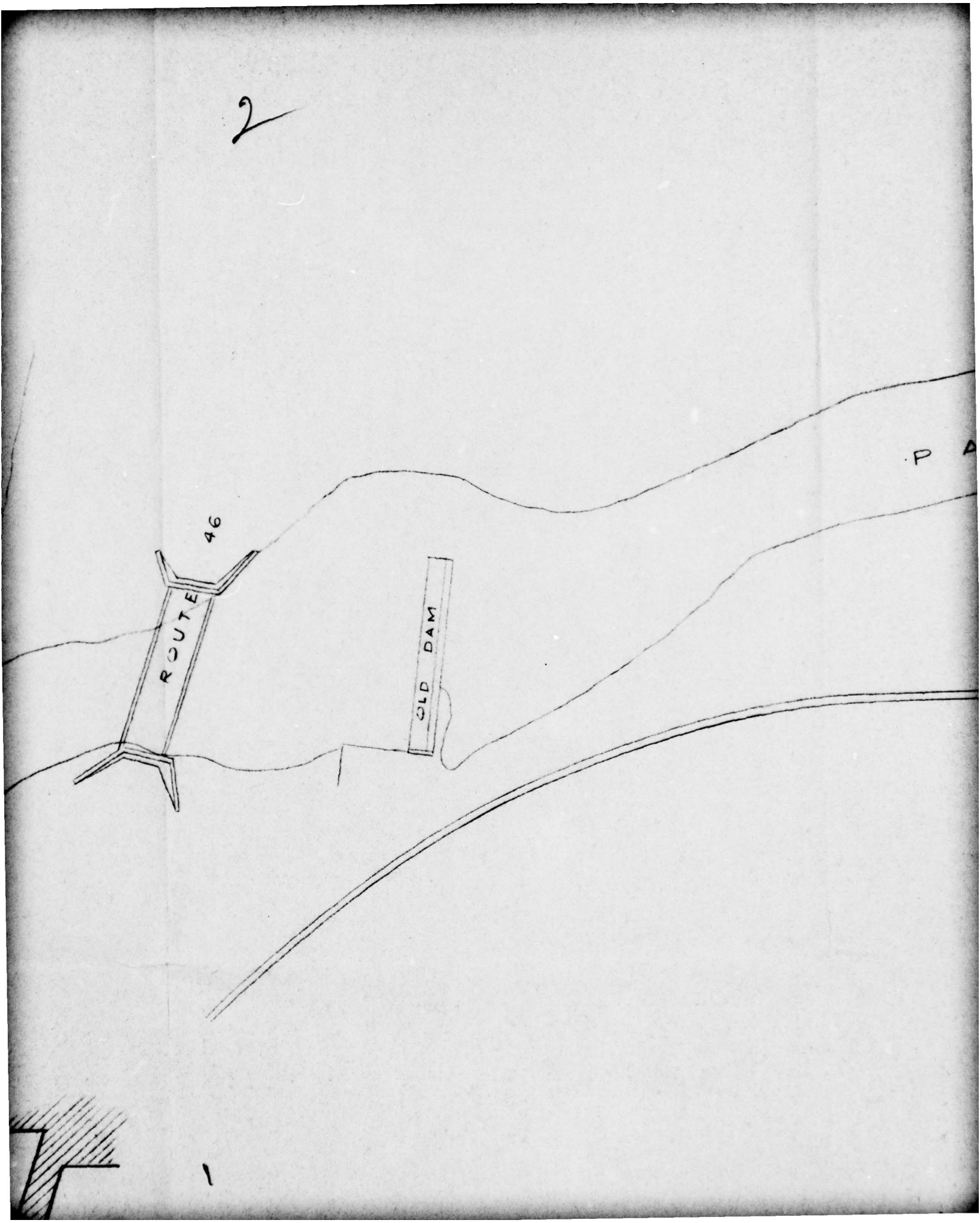
REGIONAL VICINITY MAP
COLUMBIA DAM

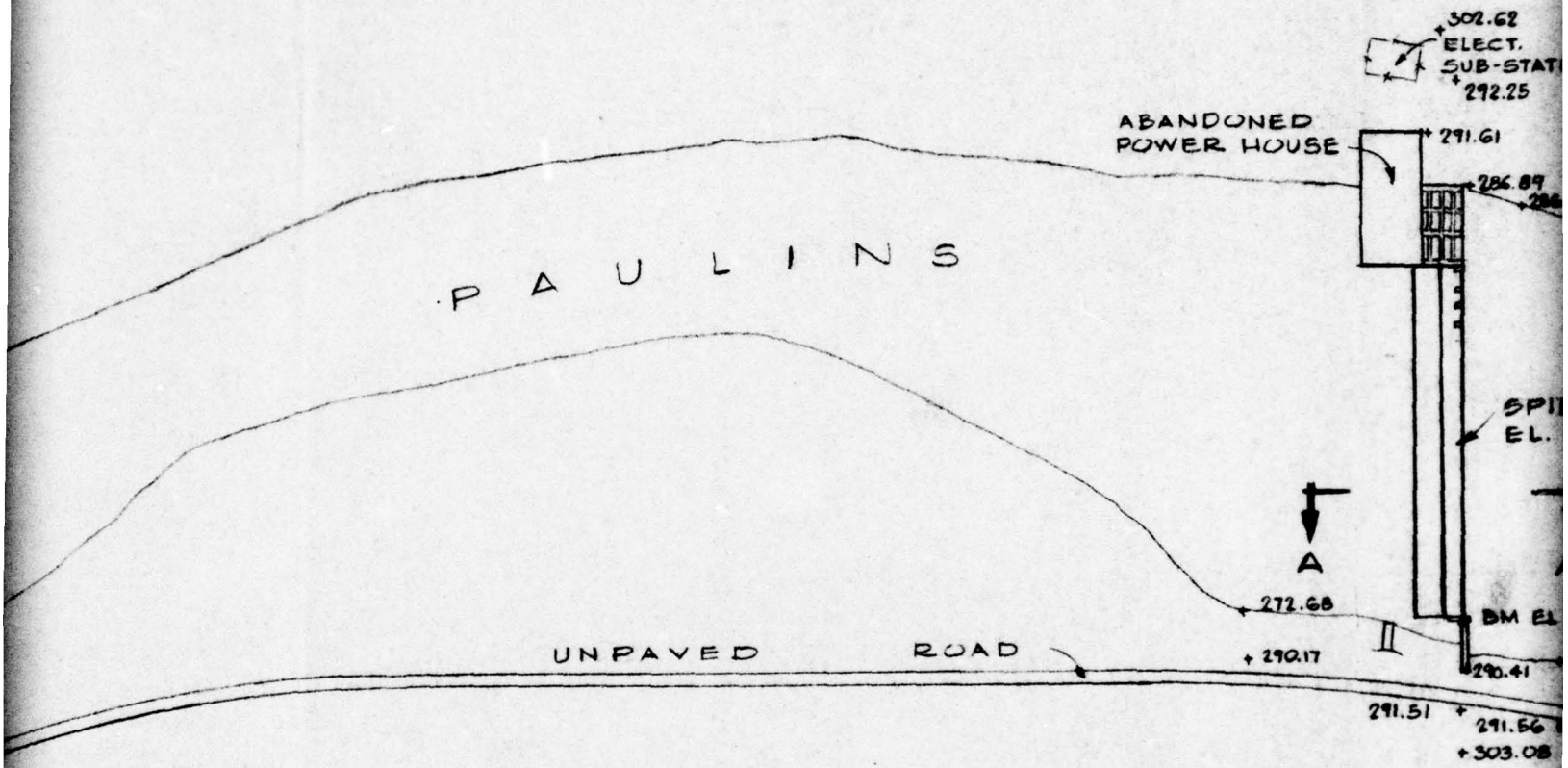
Fig. 1

1



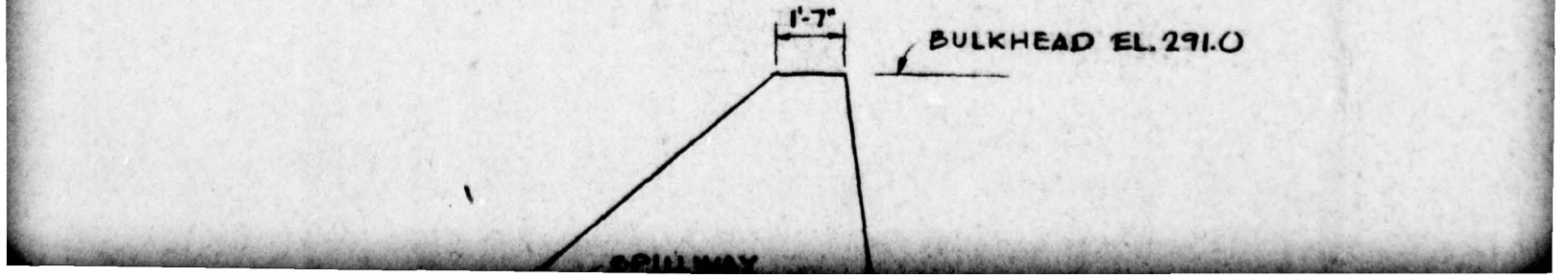


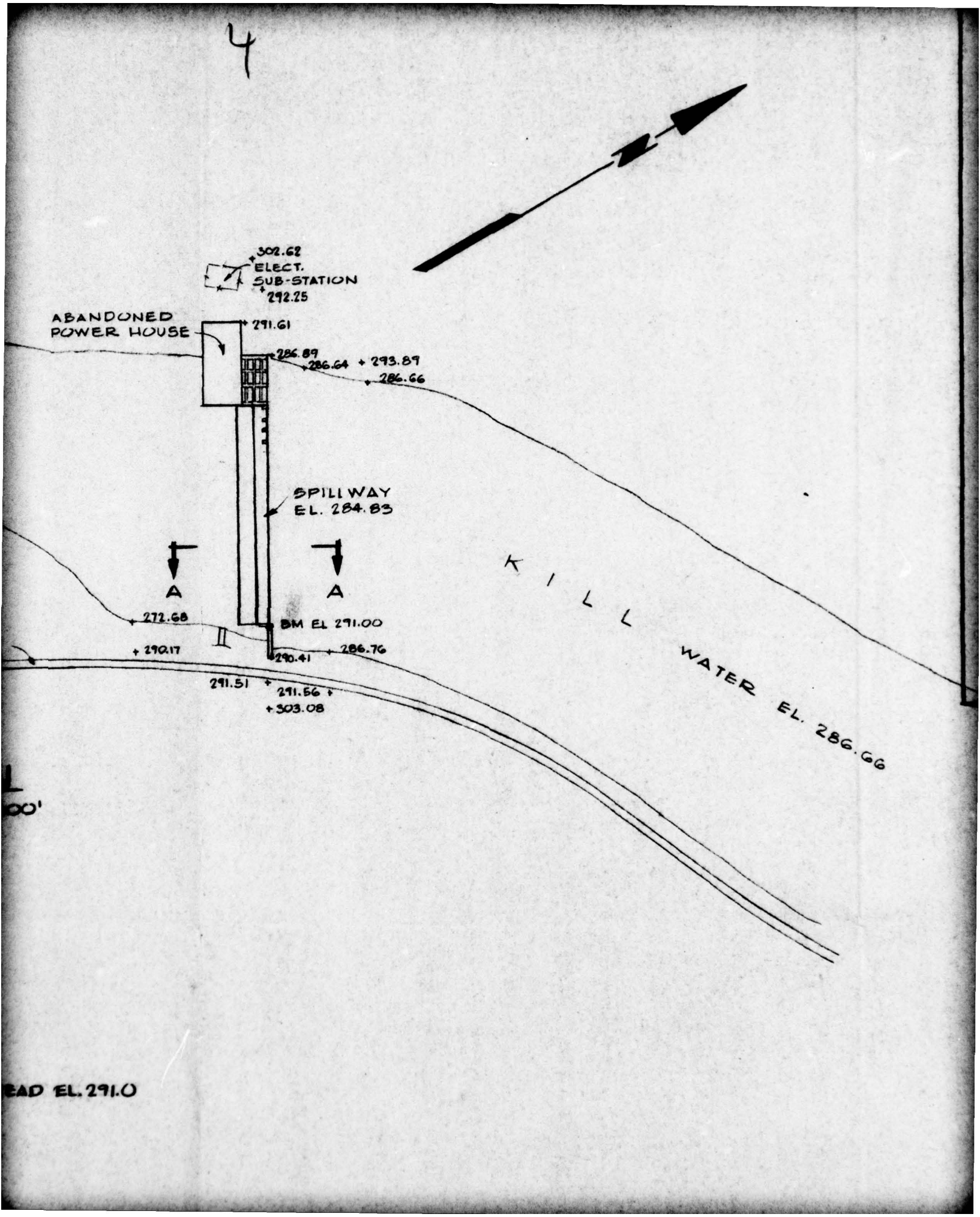

2
ROUTE 46
OLD DAM
P A
1



PLAN

SCALE: 1"=100'




4
302.62
ELECT.
SUB-STATION
292.25
ABANDONED
POWER HOUSE
291.61
286.89
286.64
293.89
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SPILLWAY
EL. 284.83
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A
272.68
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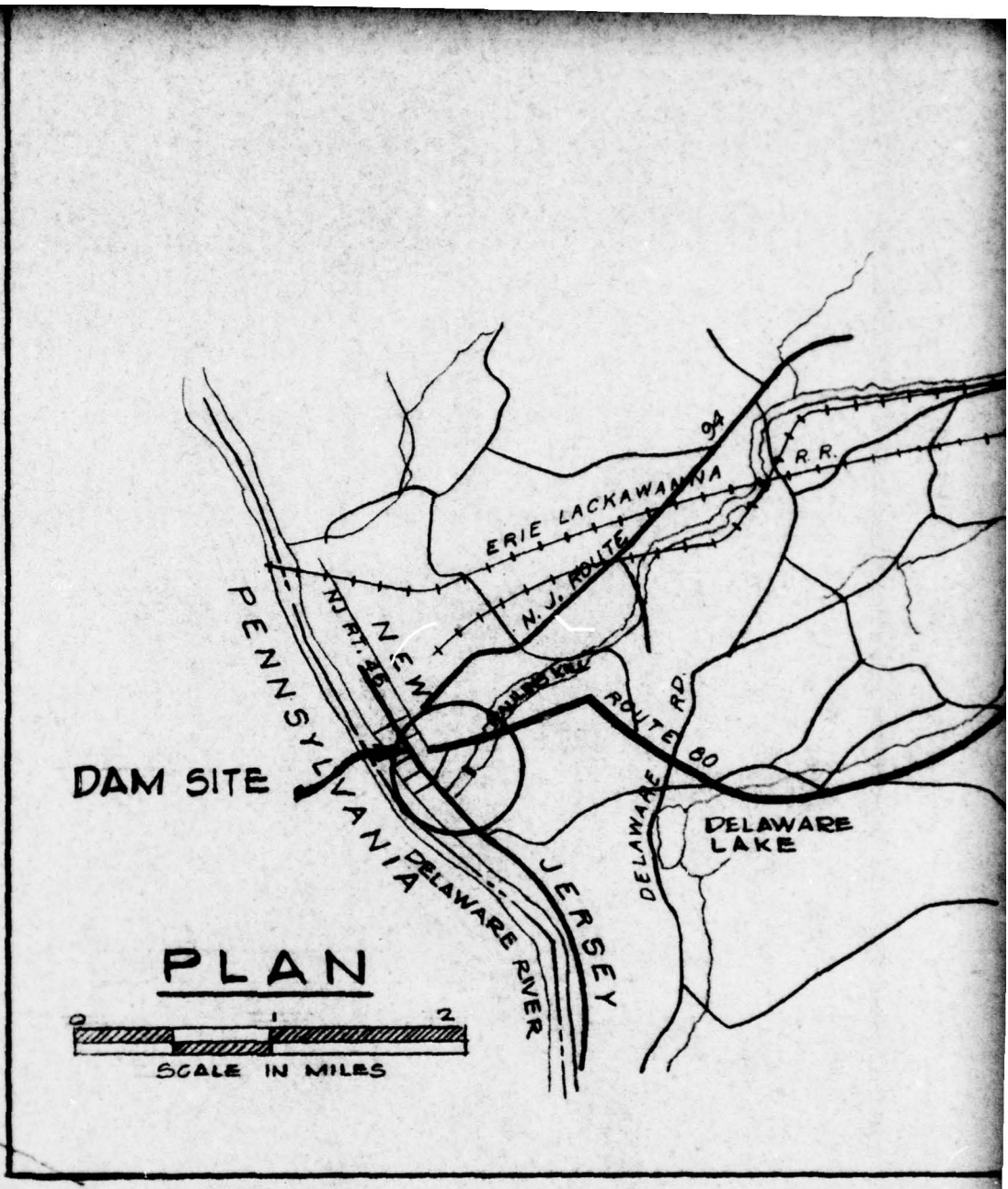

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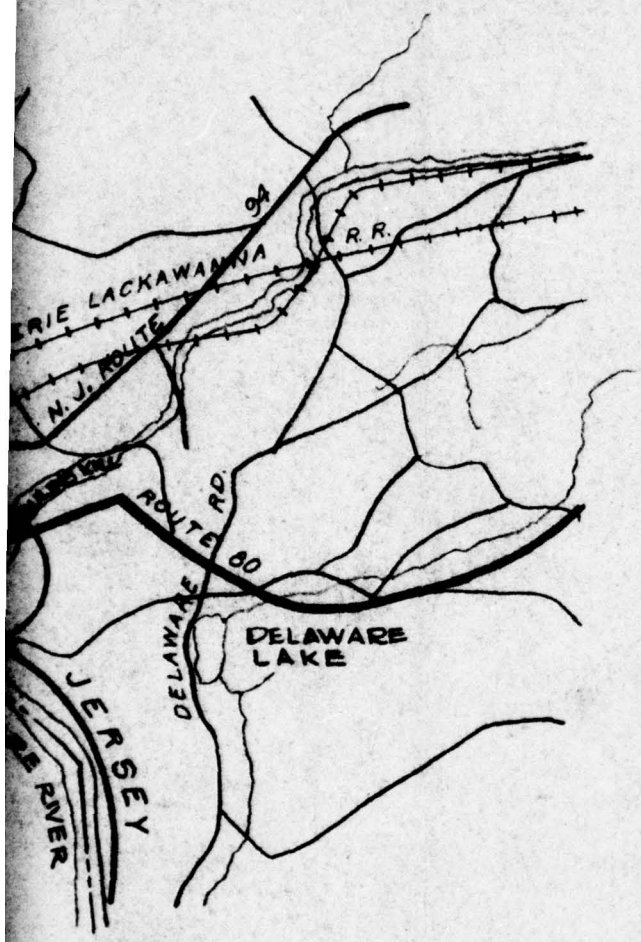
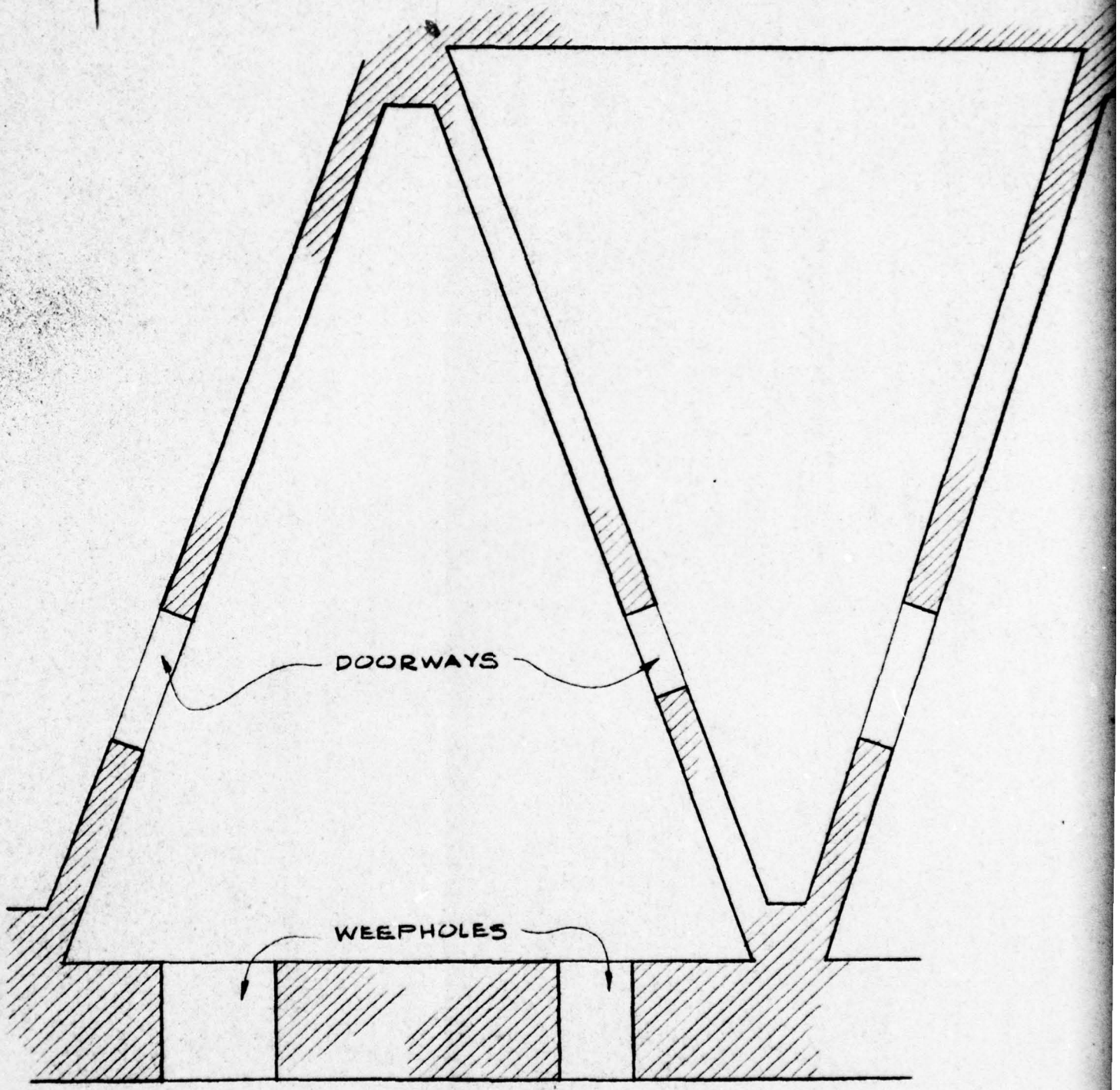
WATER EL. 286.66

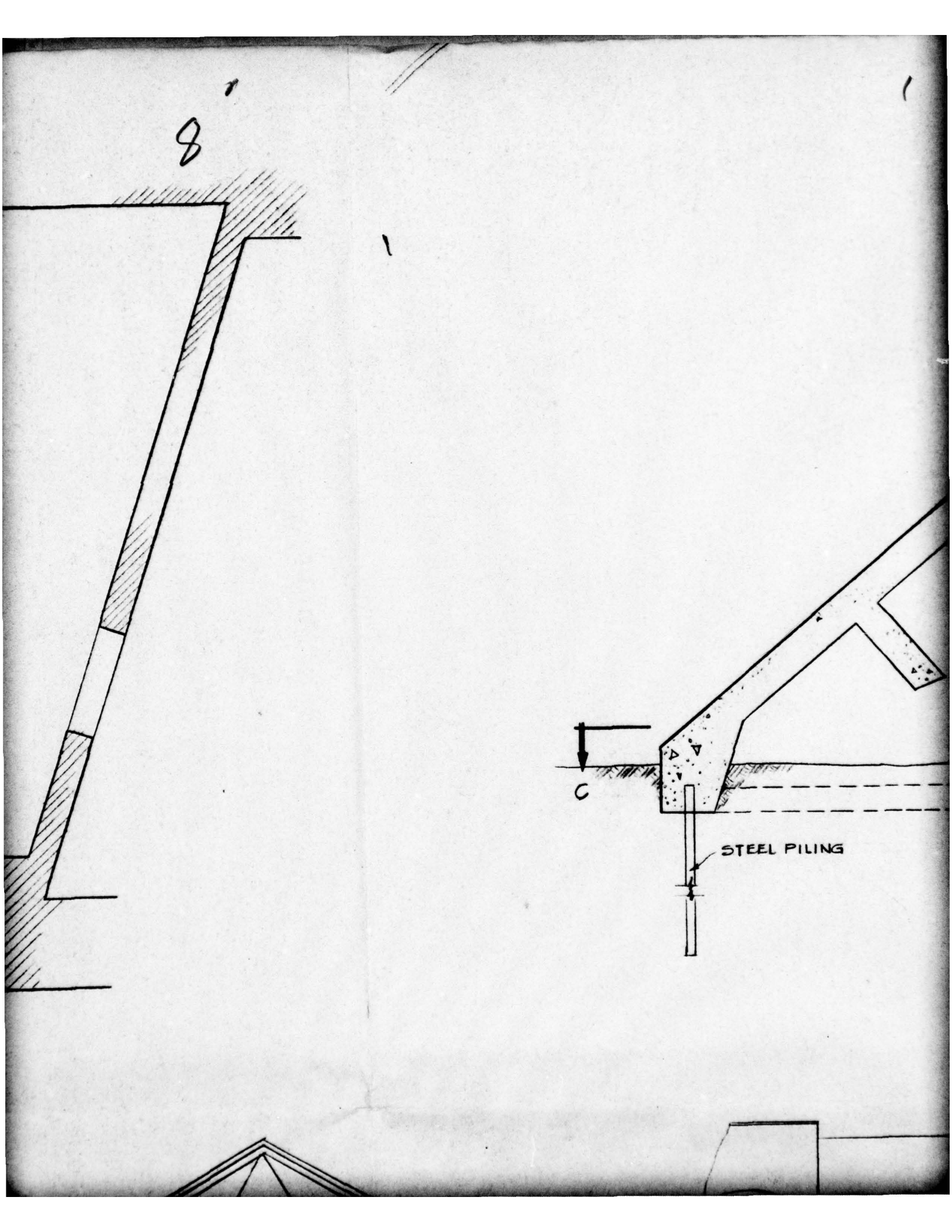

94
R.R.
ERIE LACKAWANNA
N. J. ROUTE
ROUTE 80
RD.
DELAWARE
DELAWARE LAKE
JERSEY
E RIVER

7



SECTION C-C

N. T. S.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STEEL PILING

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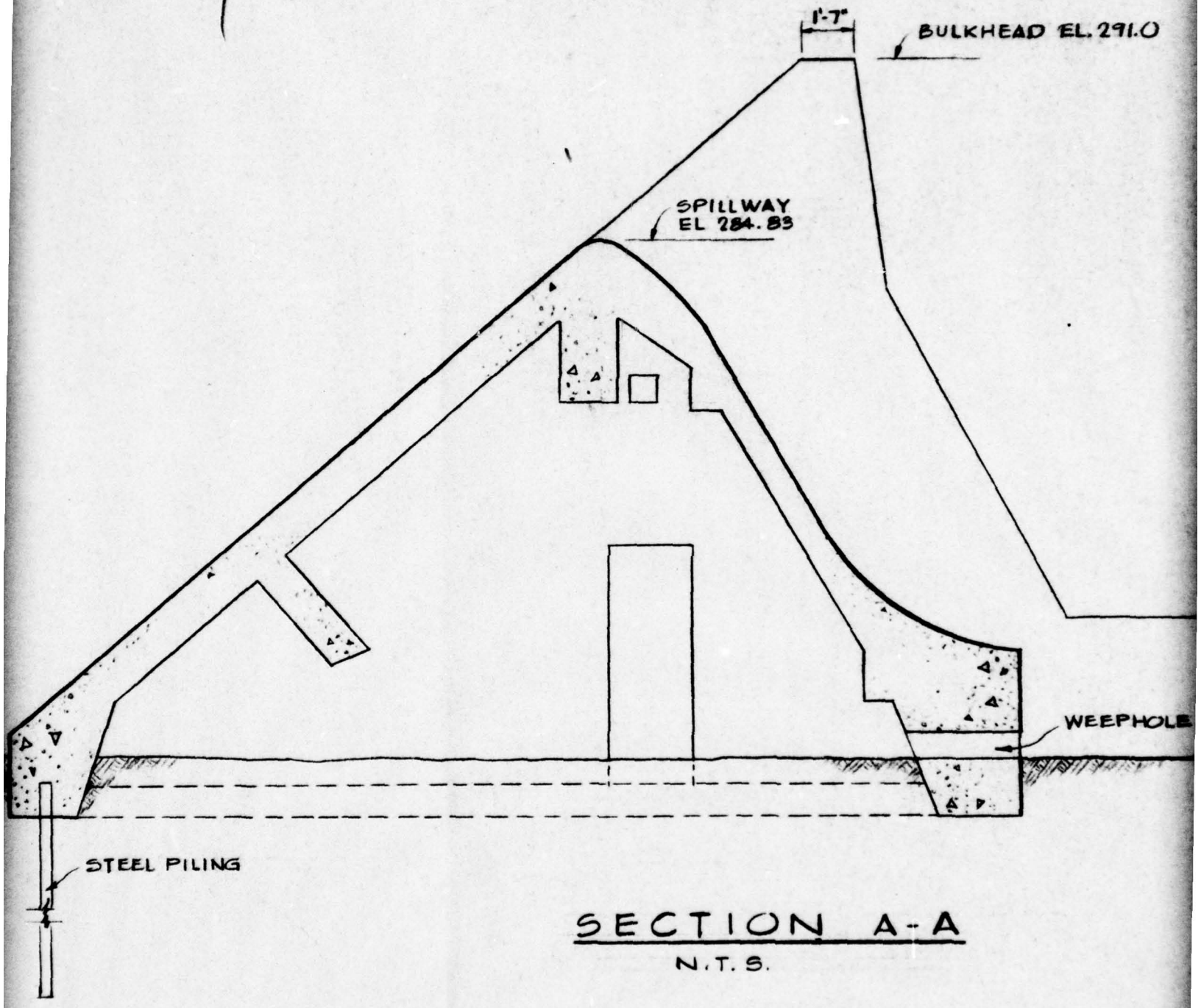

SECTION A-A

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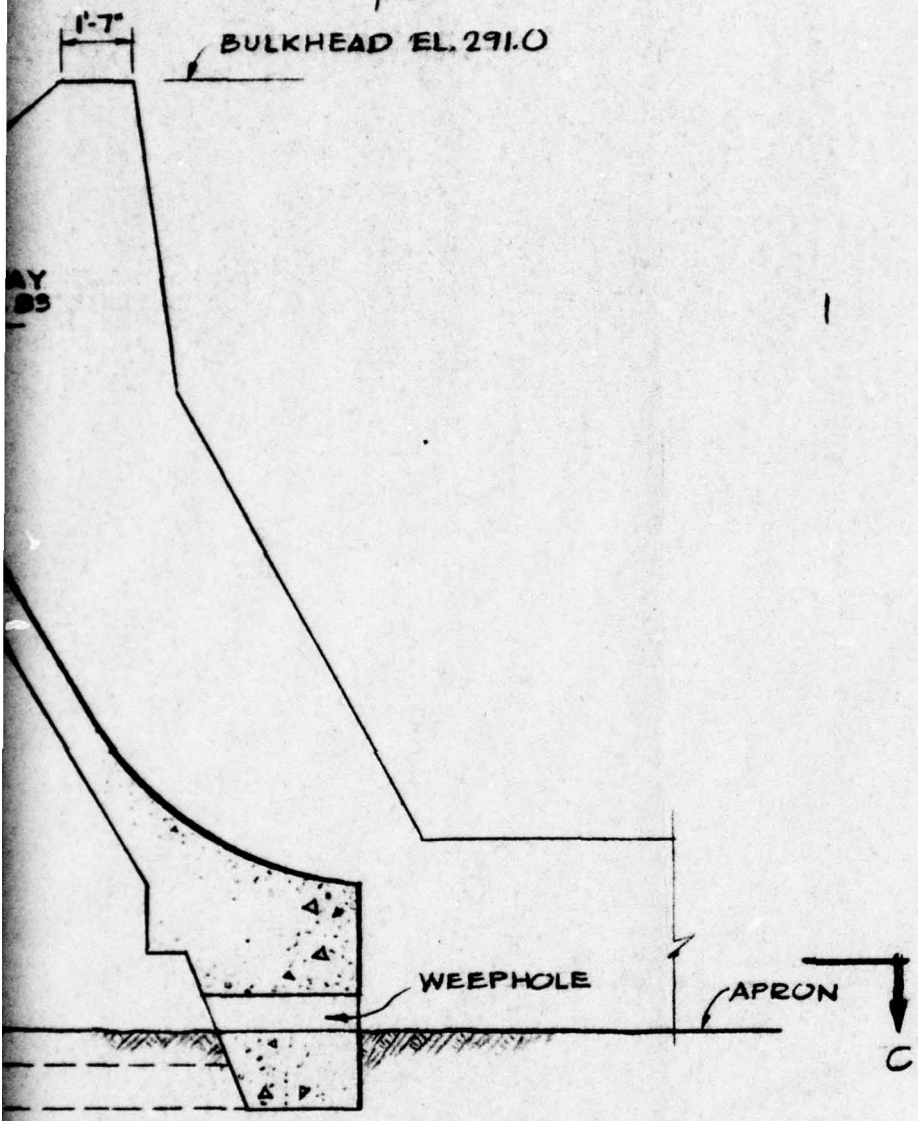
B

16



ON A-A

NOTE :

THE ELEVATIONS SHOWN WERE OBTAINED USING A SURVEYOR'S TRANSIT AND LEVEL. THEY ARE APPROXIMATE. THE BENCHMARK ELEVATION OF 291.00 ON THE BULKHEAD WALL WAS USED AS INDICATED ON THE DRAWINGS BY MEIKLEHAM & DINSMORE ENGINEERS, 25 BROAD ST., NEW YORK, REVISED 11/2/09 AND THE DWGS. FOR THE NEW JERSEY POWER & LIGHT CO., DOVER, N.J. BY W.S. BARSTOW MANAGEMENT ASS'N, ENGINEERING DEPT., READING, PENNA. DATED AUG 25, 1926. INFORMATION SHOWN BELOW GROUND AND WATER LEVEL ARE INFERRED ON THE BASIS OF SAID DWGS.

12

E OBTAINED USING A SURVEYOR'S
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POWER & LIGHT CO., DOVER, N.J.
ASS'N, ENGINEERING DEPT.,
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EL ARE INFERRED ON THE

DATE	DESCRIPTION	NO.
REVISIONS		

SECTION C-C

N. T. S.

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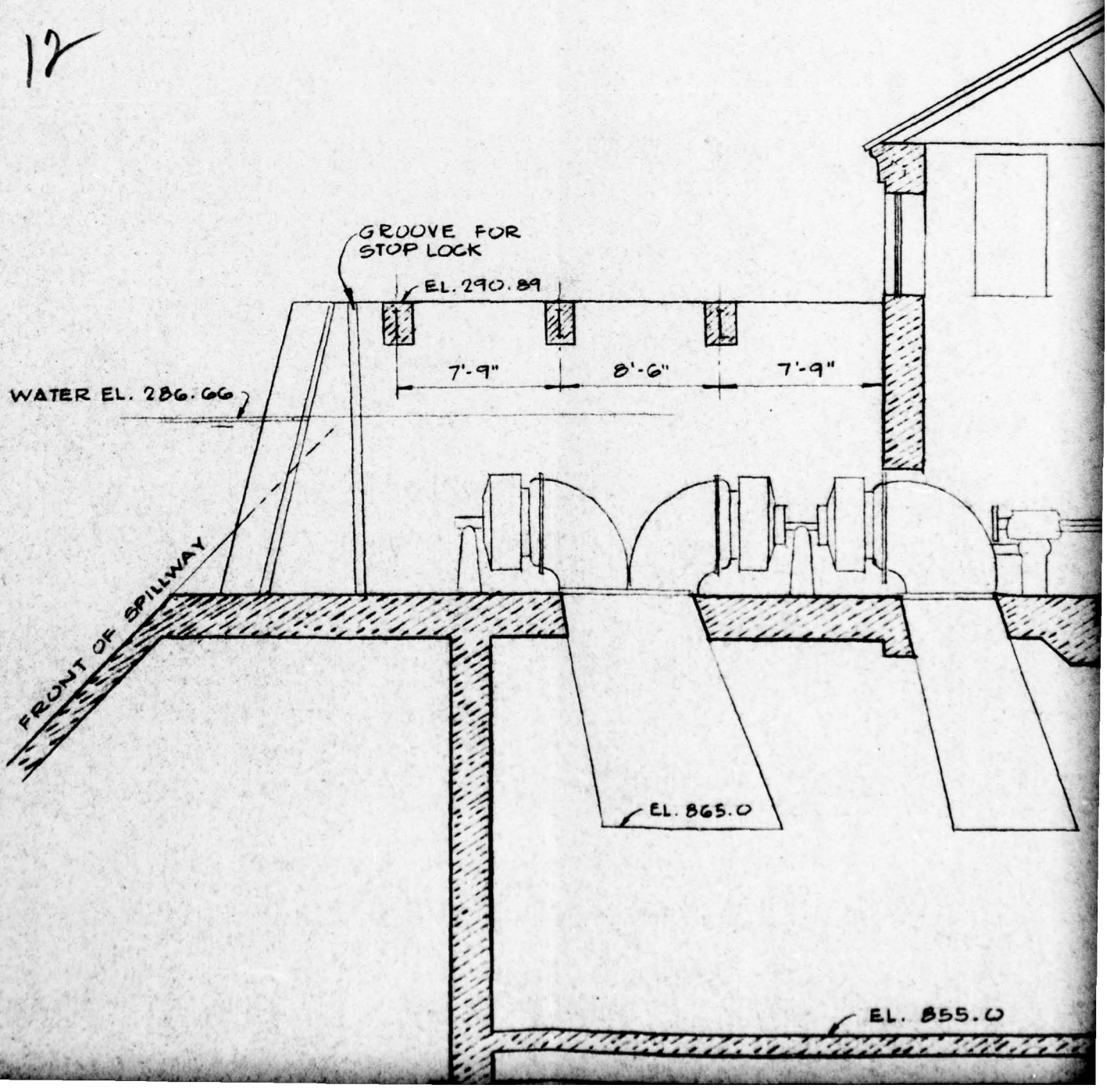

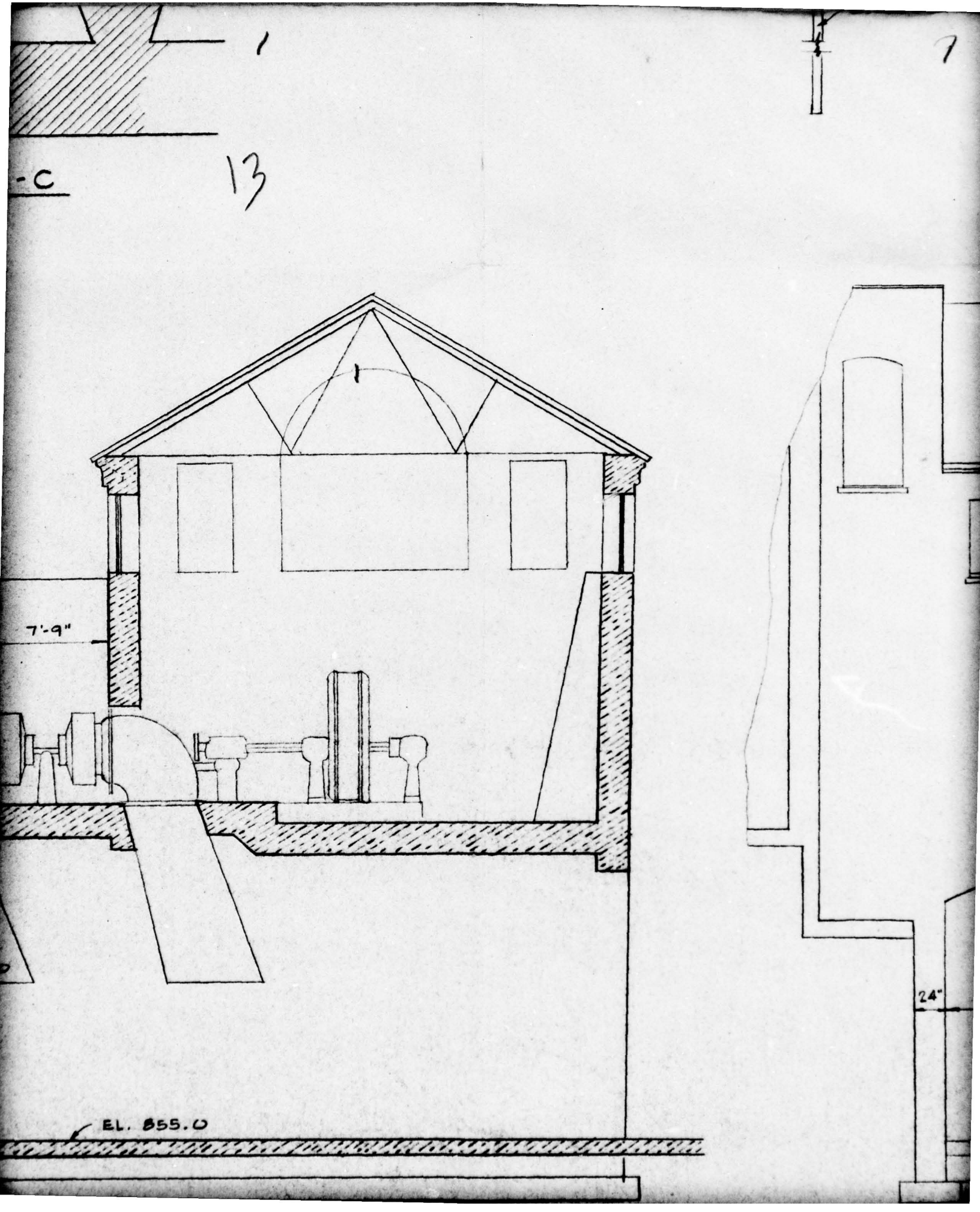
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SECTION A-A

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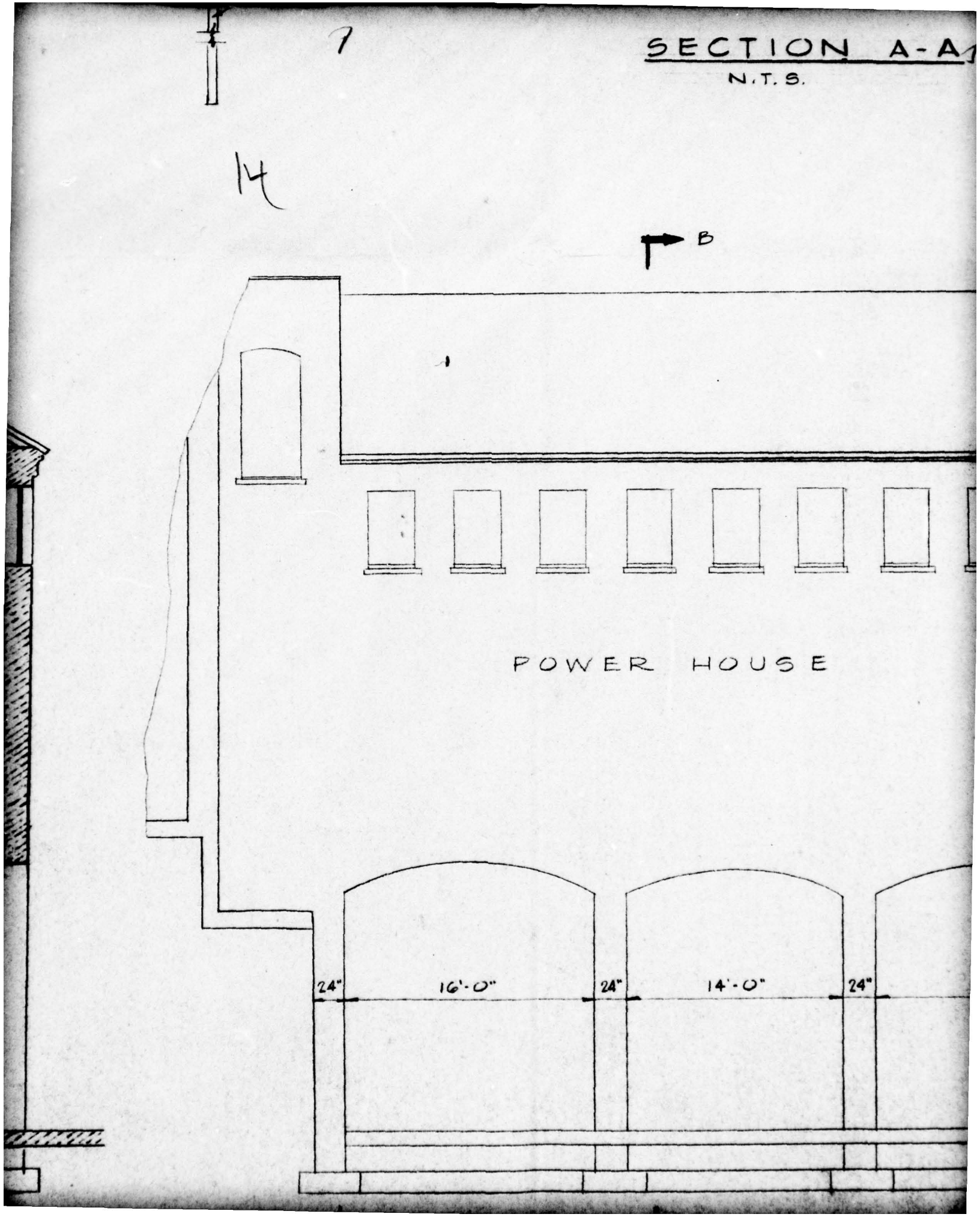

ECTION A-A1

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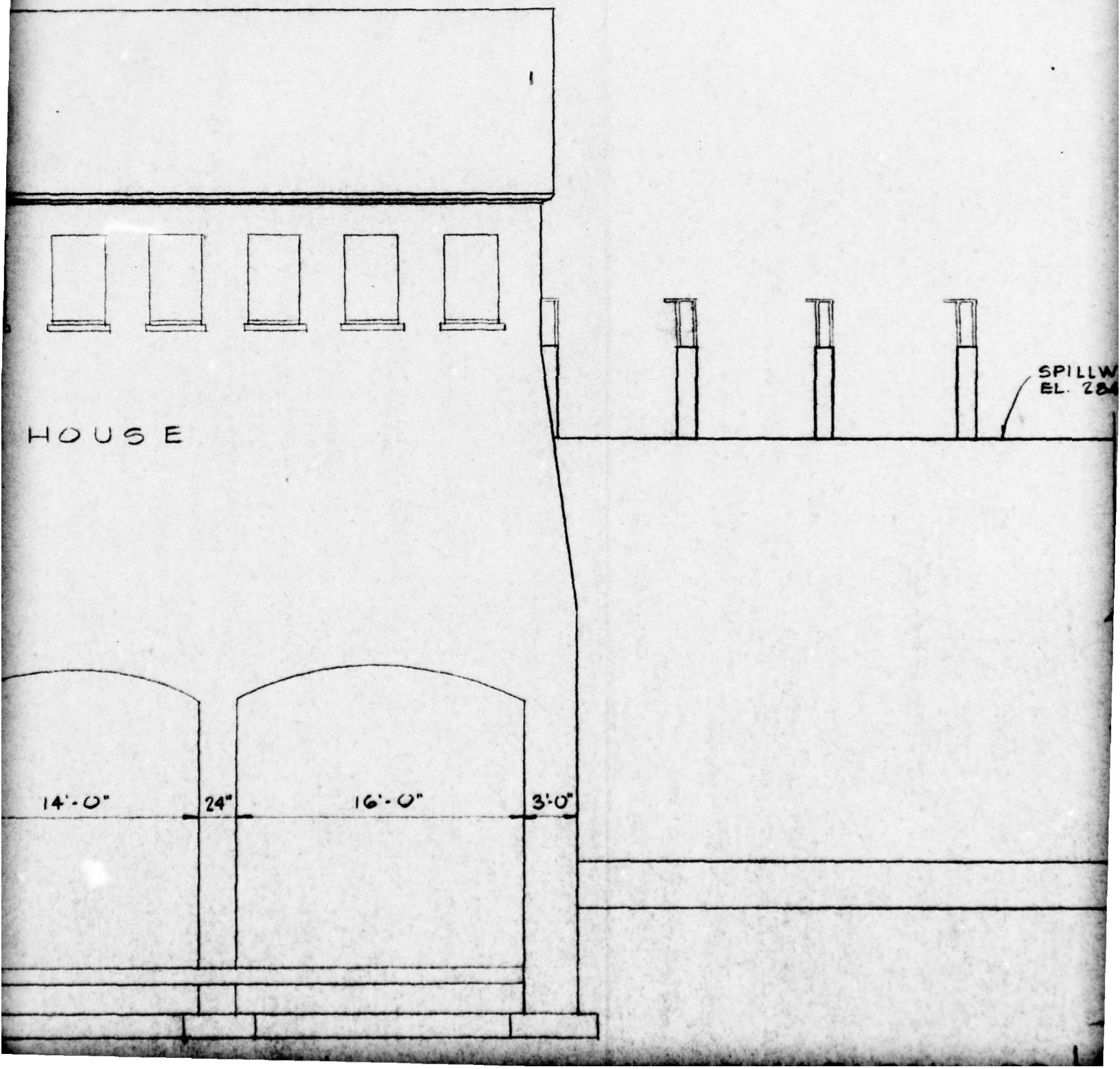
B



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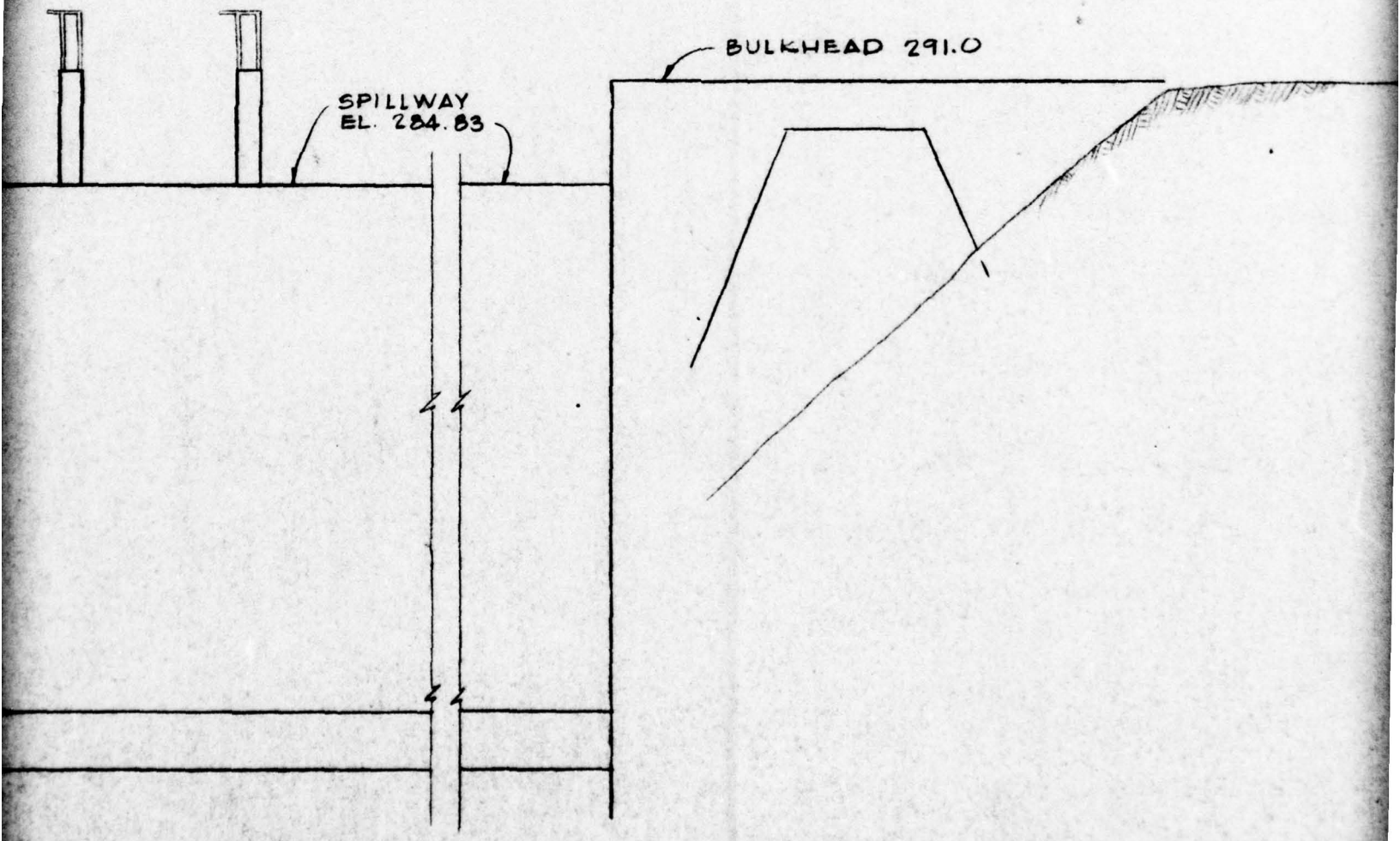

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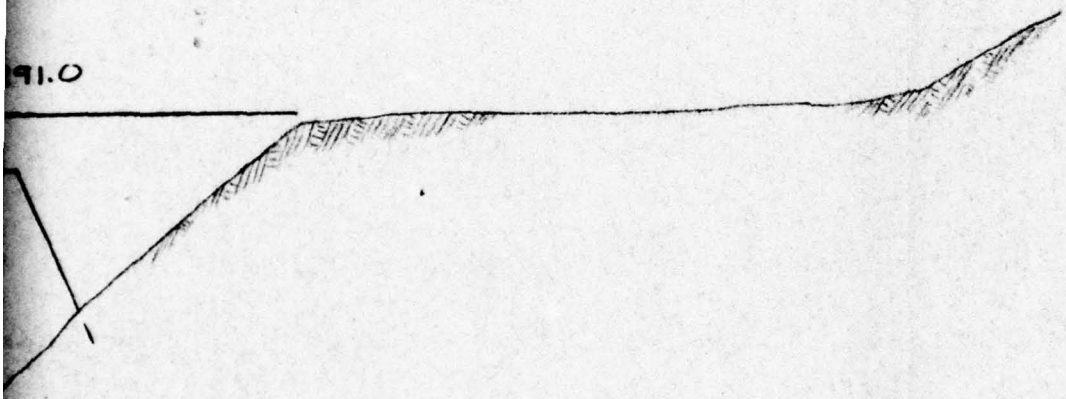

DATE	DESCRIPTION
	REVISIONS

PROJECT

PHAS

INSPECTION & E
NEW JERSEY of

DRAWING TITLE

COLUMBIA

FEBRUARY
FED. I.D. NO.

JOB NO. J-7058	DR
DATE 16 FEB 1979	
SCALE AS NOTED	

DATE	DESCRIPTION	NO.
REVISIONS		

18

PROJECT

PHASE I

INSPECTION & EVALUATION
of
NEW JERSEY DAMS

DRAWING TITLE

COLUMBIA DAM

FEBRUARY 1979
FED. I.D. NO. NJ00124

JOB NO.	DRAWING NO.
J-783B	FIG 2
DATE 16 FEB 1979	
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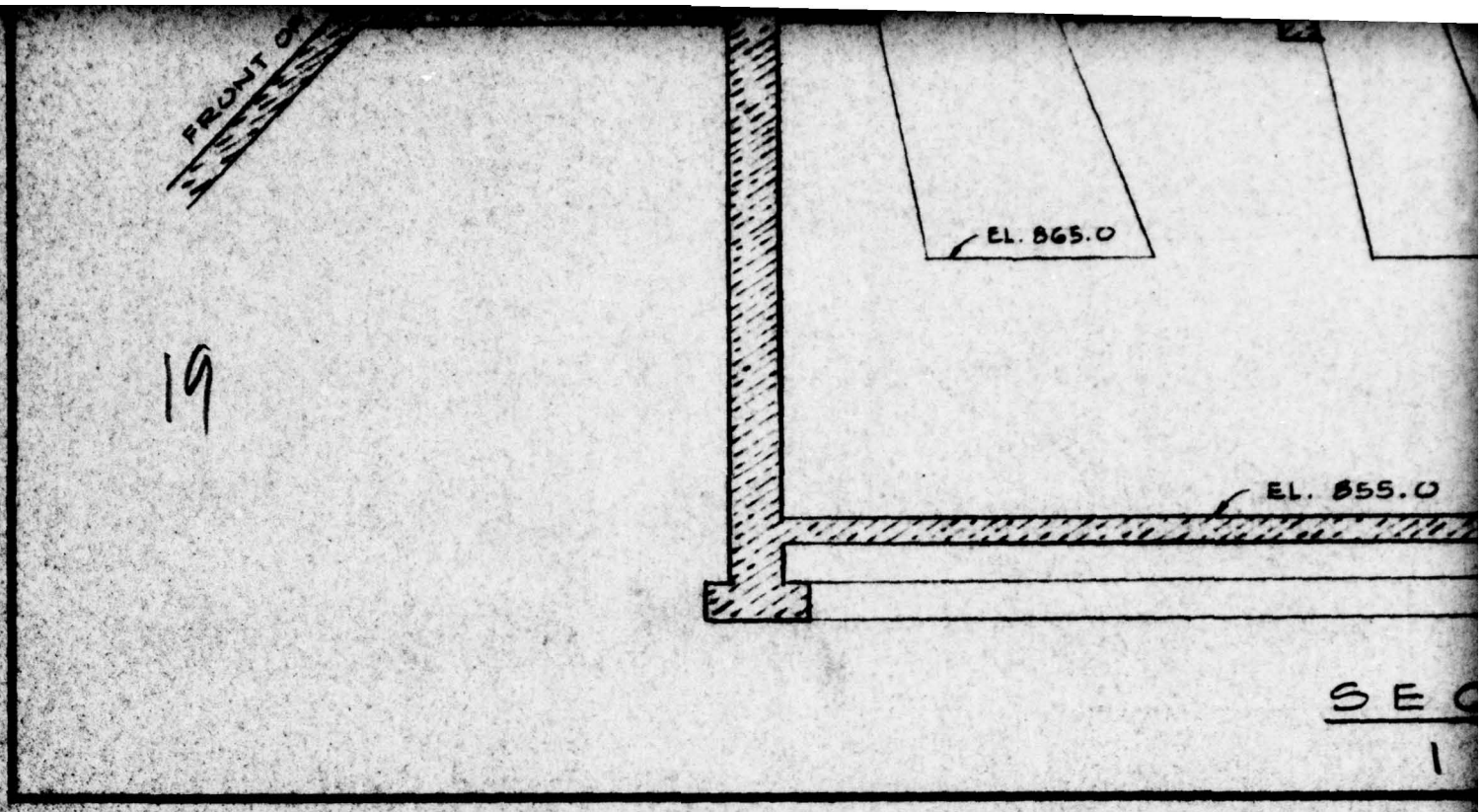

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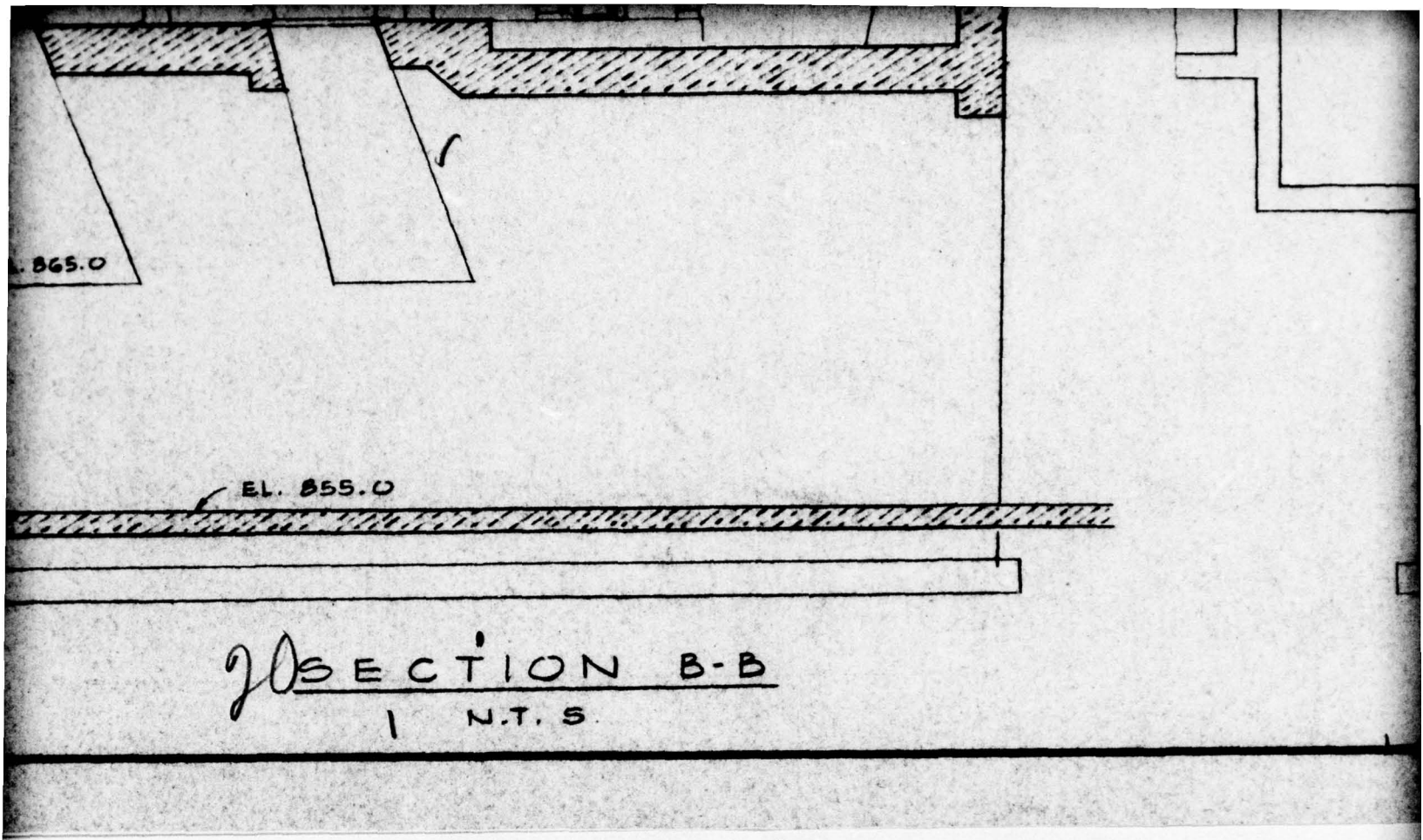

SECTION B-B

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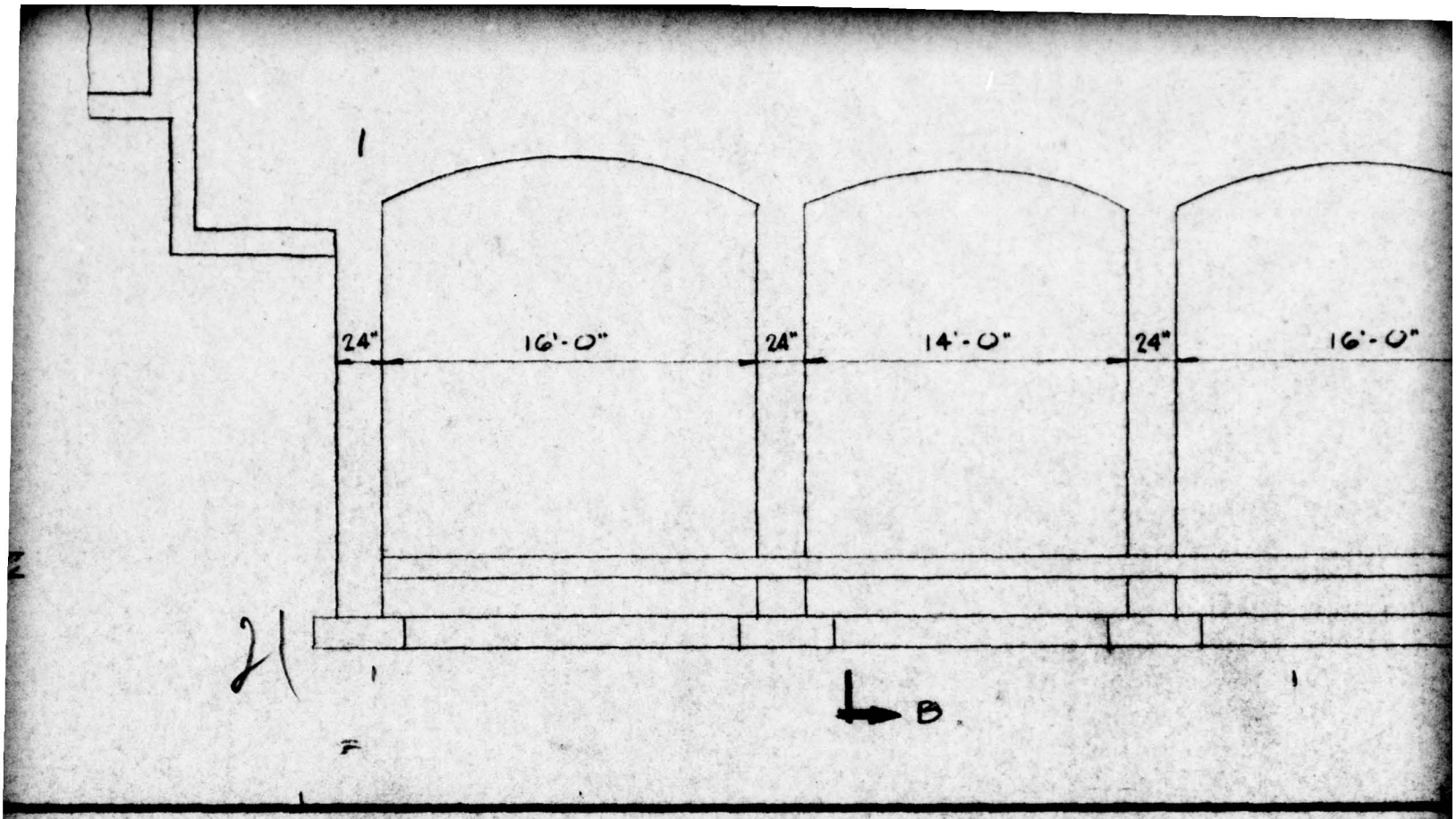
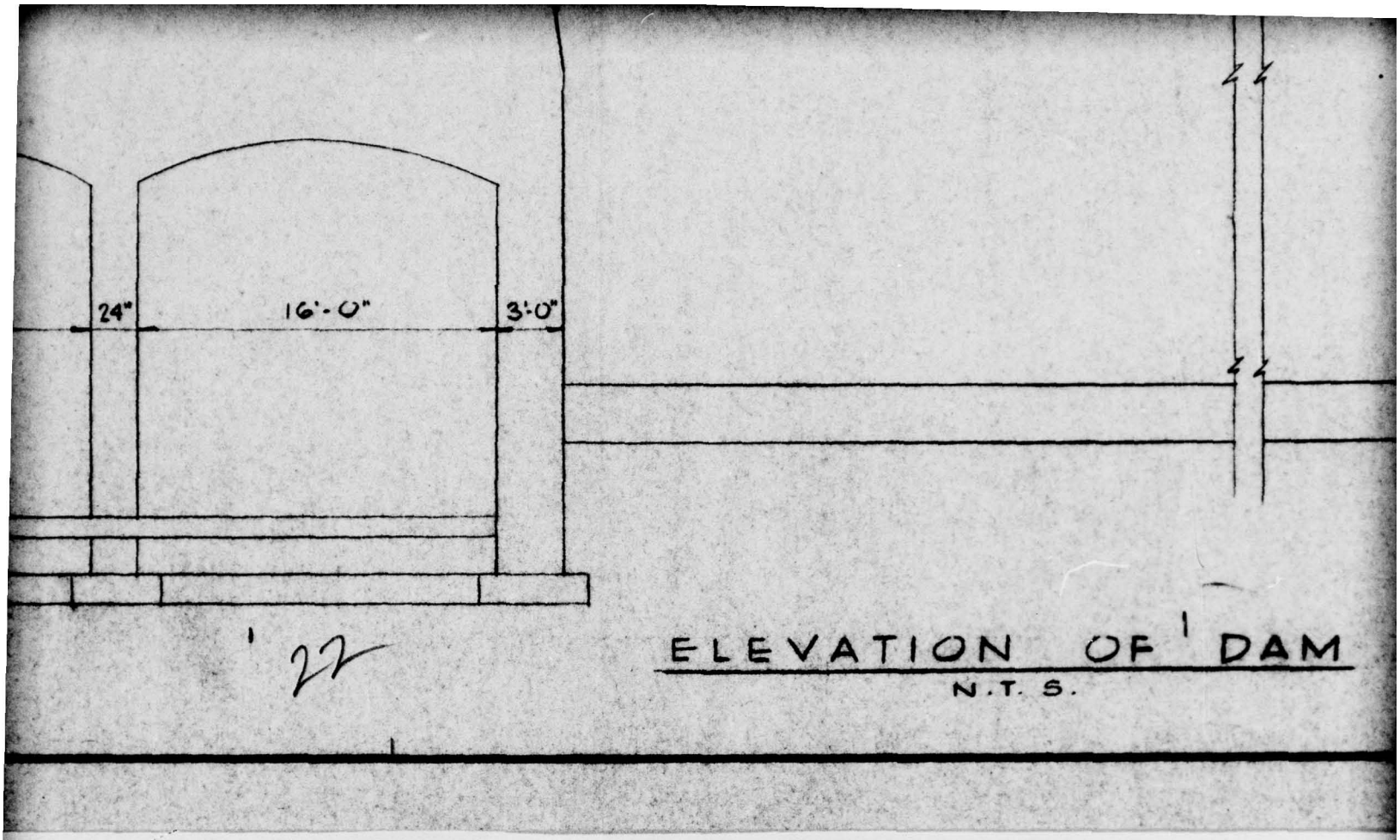
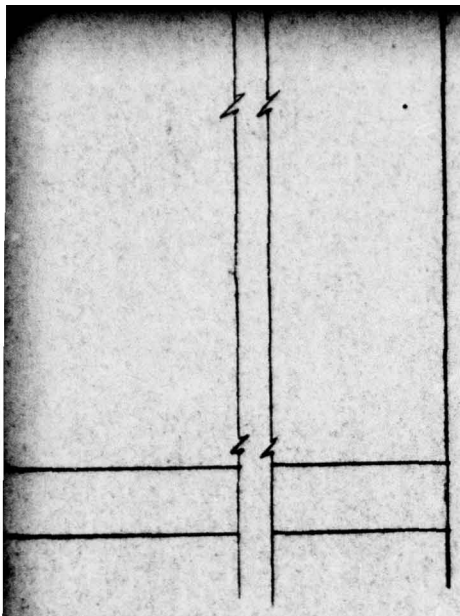

24"
16'-0"
24"
14'-0"
24"
16'-0"
B



27

ELEVATION OF DAM

N.T.S.



23

OF DAM

PROJECT

PHASE I

INSPECTION & EVALUATION of NEW JERSEY DAMS

DRAWING TITLE

COLUMBIA DAM

FEBRUARY 1979

FED. I.D. NO. NJ00124

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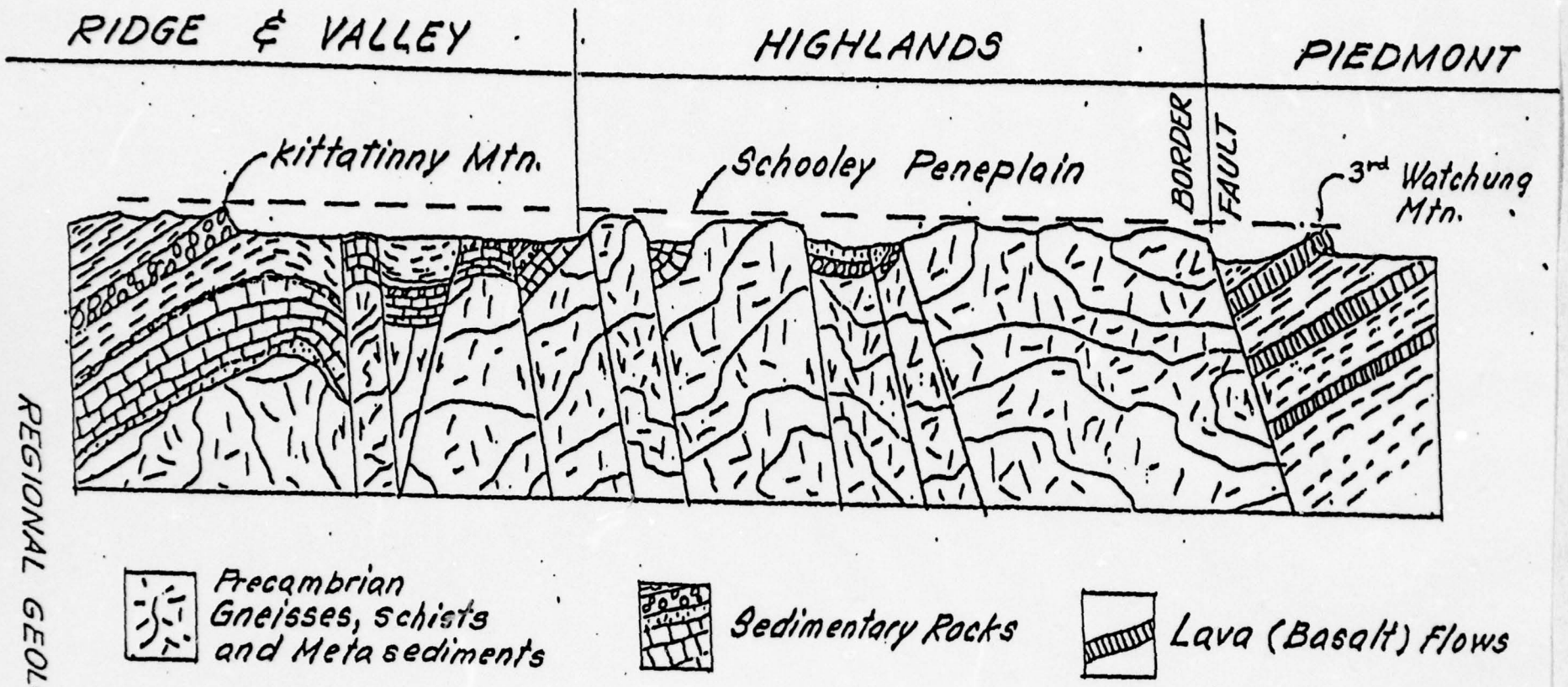
SCALE AS NOTED	
DRN. BY J.R.	
CHKD. BY D.J.L.	



REGIONAL GEOLOGIC FEATURES

Fig. 3

Schematic Cross-section of Ridge & Valley Physiographic Province (After Wolfe, 1977)

APPENDIX I

CHECK LIST

VISUAL INSPECTION

COLUMBIA DAM

CHECK LIST
VISUAL INSPECTION
Phase I

NAME DAM Columbia Dam COUNTY Warren STATE New Jersey COORDINATORS N.J.D.E.P.

DATE(s) INSPECTION 12/14/78 WEATHER Partly cloudy TEMPERATURE 30° F

POOL ELEVATION AT TIME OF INSPECTION 286.66* M.S.L. TAILWATER AT TIME OF INSPECTION 273+* M.S.L.

* Referenced to BM El. of 291 (See Fig 2)

INSPECTION PERSONNEL:

D. Leary (12/14/78)	P. Yu (1/9/79)	
J. Richards (12/14/78)	J. Gurkovich (1/9/79)	
J. Rizzo (1/9/79)		

James Richards RECORDER

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Trees overturned in channel. Four small islands with trees ranging in size from brush to 6" diameter trees in channel.	Overturned trees should be removed. Trees and brush on islands should be removed.
SLOPES	Erosion 2 ft to 3 ft deep in several areas on downstream slopes. Riprap at right bank of channel deteriorated.	Eroded area should be suitably filled and deteriorated riprap should be replaced.
APPROXIMATE NO. OF HOMES AND POPULATION	2 homes near river about 1/4 miles downstream based on USGS Topo Map. Population estimated at 12. Numerous homes along Rt. 46 a little further downstream.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Right concrete abutment has a 1/8" opened crack. Rebar is exposed and an 1/8" bulge toward left. Left concrete abutment has water leaking in several areas, erosion over 1 ft depth at soil/concrete junction.	Abutment wall cracks and leaks should be repaired. Eroded areas should be repaired.
DRAINS	None observed.	
WATER PASSAGES	Debris in upstream passages.	Debris should be removed.
FOUNDATION	Not observable.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Concrete spalled & cracked on right abutment. Left abutment surface cracks cover most of concrete surface and concrete has deteriorated in several downstream areas.	Deteriorated, spalled and/or cracked concrete should be repaired.
STRUCTURAL CRACKING	Crack on right abutment approx. 5 ft long from top of abutment down left side. Cracks on left abutment in several areas.	Cracked concrete should be repaired.
VERTICAL AND HORIZONTAL ALIGNMENT	Left abutment appears to have experienced some movement.	Movement of left abutment should be further investigated.
MONOLITH JOINTS	Not observed.	
CONSTRUCTION JOINTS	Several joints on left abutment have opened.	Opened joints should be repaired.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Abandoned power house could be used as outlet works.	Cracked and spalled concrete needs repair and entrance channels should be cleaned.
INTAKE STRUCTURE	Concrete spalled in many areas. Piers have rebar exposed. Cracks on left and right walls of structure from crest to 10 ft and 5 ft, respectively, below intake sill.	Spalled concrete should be repaired. Exposed rebars should be covered. Cracks should be repaired.
OUTLET STRUCTURE	Top concrete on left wall broken off 3 ft length by 1' width by 4 in - 8 in depth. Concrete spalled and deteriorated. Construction joint opened and concrete spalled.	Concrete should be repaired. Joint and spalled concrete should be repaired.
OUTLET CHANNEL	Erosion at right side of channel.	Eroded areas should be repaired.
EMERGENCY GATE	None observed.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARK OR RECOMMENDATIONS
SLOPES	Several small eroded areas, generally appears satisfactory.	
SEDIMENTATION	Not observed.	Amount of sedimentation likely to be considerable. Should be measured.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete along crest appears to have crack and about 5 to 8 inch displacement. Water flowing over crest at time of observation.	
APPROACH CHANNEL	Wood, brush, tree stumps, and leaves in channel.	Debris should be removed.
DISCHARGE CHANNEL	Dead trees across channel from island to island.	Trees should be removed.
BRIDGE AND PIERS	At left of abandoned power house cracks running width of pier and concrete spalled on all 4 piers on downstream side.	Cracked and spalled concrete should be repaired.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed.	
OBSERVATION WELLS	None observed.	
WEIRS	None observed.	
PIEZOMETERS	None observed.	
OTHER		

APPENDIX 2

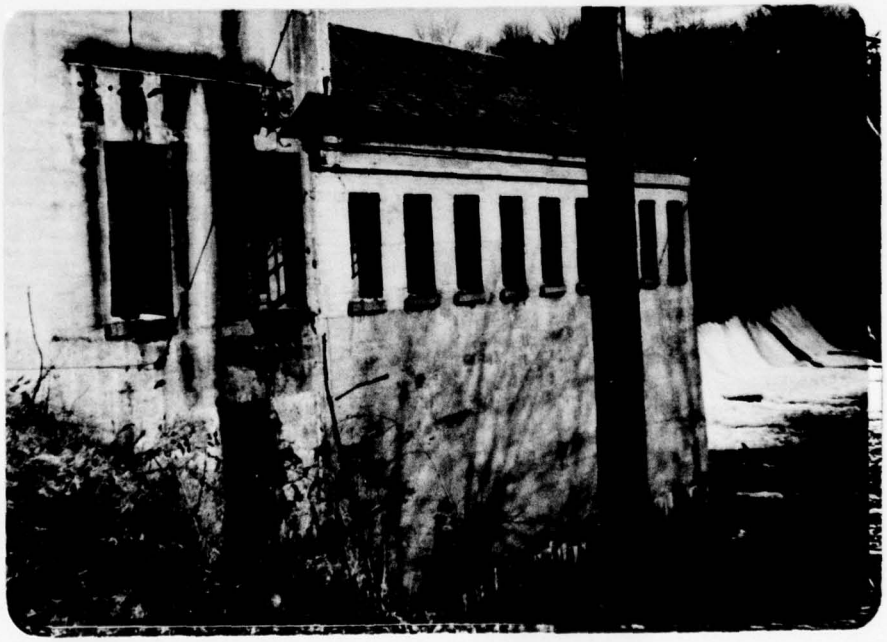
PHOTOGRAPHS

COLUMBIA DAM

Spillway and entrance to interior of spillway at right of photo. 14 December 1978

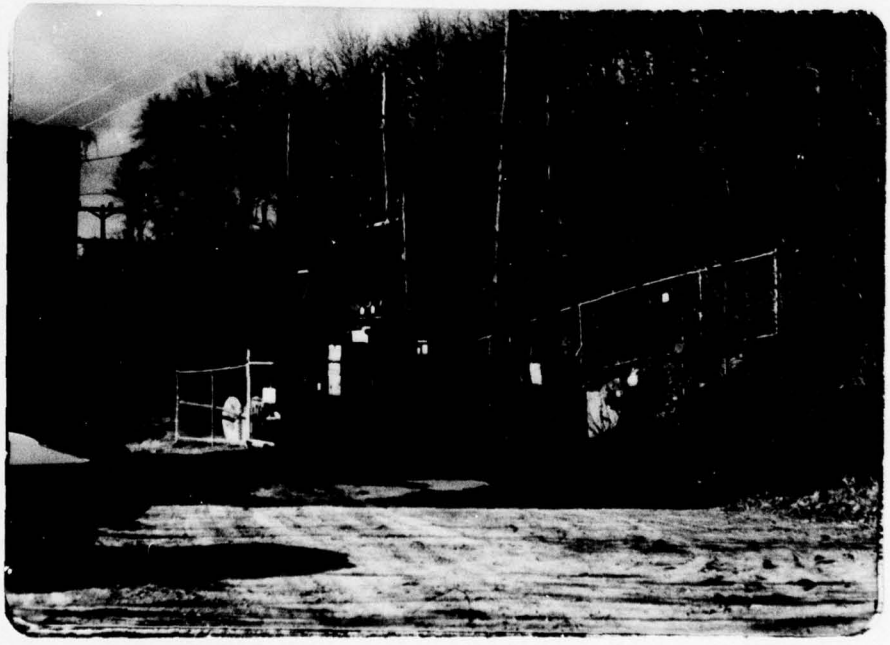
Abandoned Power House and spillway apron. Looking west. 14 December 1978

Paulinskill River. Looking upstream. 14 December 1978



Abandoned Power House and spillway. Looking East. 14 December 1978

Interior of abandoned power house. 14 December 1978



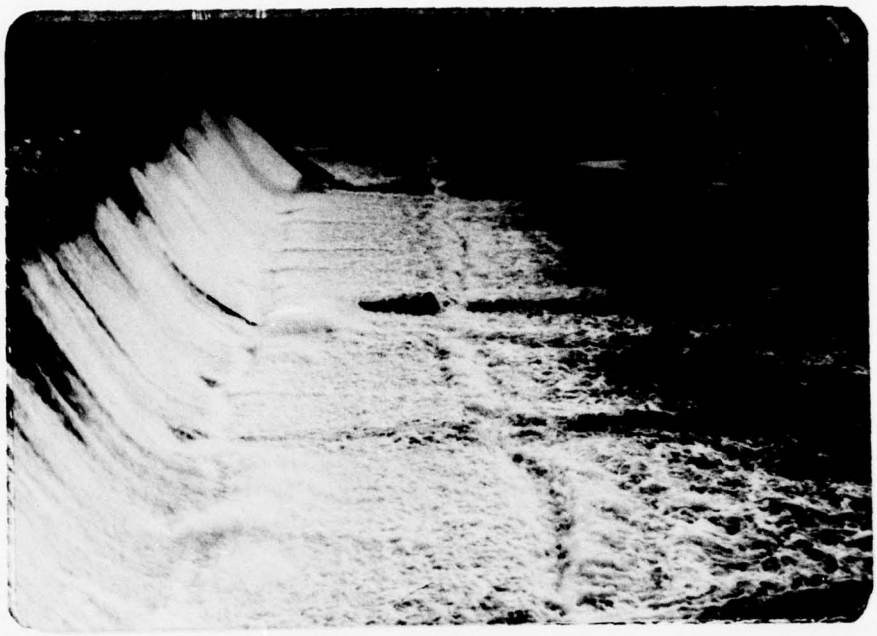
New Jersey Power & Light Company. 14 December 1978
Columbia substation at right abutment.

Cracked and deteriorated concrete at right abutment upstream of Power House. 14 December 1978

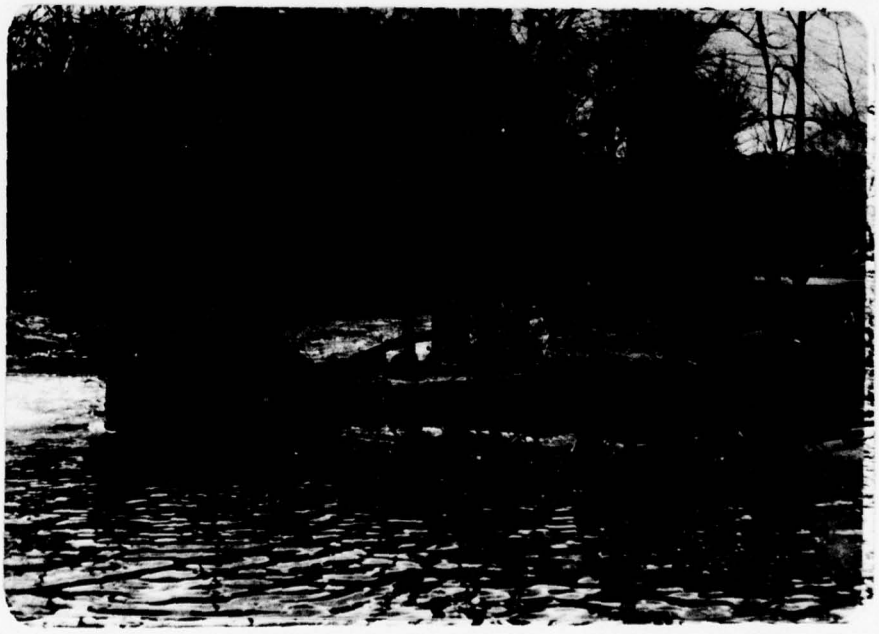
Debris upstream of Power House and at right side of spillway. 14 December 1978

Debris at right side of spillway. 14 December 1978

Top of right side of spillway. Note displacement of concrete below water. 14 December 1978



Spillway. Looking east. Note possible displacement of concrete below water at bottom of spillway. 14December 1978



Uprooted tree in downstream channel. 14 December 1978

Deteriorated riprap at upstream right abutment. 14 December 1978

Deteriorated riprap along right bank of downstream channel. 14 December 1978

Left abutment and top of entrance to interior of spillway. 14 December 1978

Tree trunk at top of spillway. 14 December 1978

Deteriorated concrete at entrance to interior of spillway.

14 December 1978

APPENDIX 3

HYDROLOGIC COMPUTATIONS

COLUMBIA DAM

LANGAN ENGINEERING ASSOCIATES, INC.

HYDROLOGIC COMPUTATIONS
COLUMBIA DAM

Location: Warren County, N.J.

Drainage Basin: 175 sq. mi.

Area of Lake: 50 Acres

Classification: size – small
hazard – high

Spillway Design Flood:

In accordance with evaluation guideline, ½ PMF to PMF should be used, PMF is chosen.

PMP

1. Dam located in zone 6 border (close to zone 1)
   PMP = 22.4 inches (200 sq. mi – 24 hrs)
2. PMF must be adjusted for basin size

Duration	% Factor (for 175 sq. mi) Zone 6	Zone 1	Average	Reduction Factor*
0-6	84	77	81	
0-12	92	92	92	0.885
0-24	103	103	103	
0-48	117	108	112	

* p. 48 'D.S.D.'

BY Dy DATE 2-14-79 / 3-22-79 Columbia Dam JOB NO. J-783B

CKD GED DATE 4.5.79 SHEET NO. 1 OF 8

LANGAN ENGINEERING ASSOCIATES, INC.

Unit Hydrograph

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

$C_t = 2.82$, $C_p = 0.62$

Snyder Lag time

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

from drainage area

$L_{ca} = 96000 ft \doteq 18.2 mi$

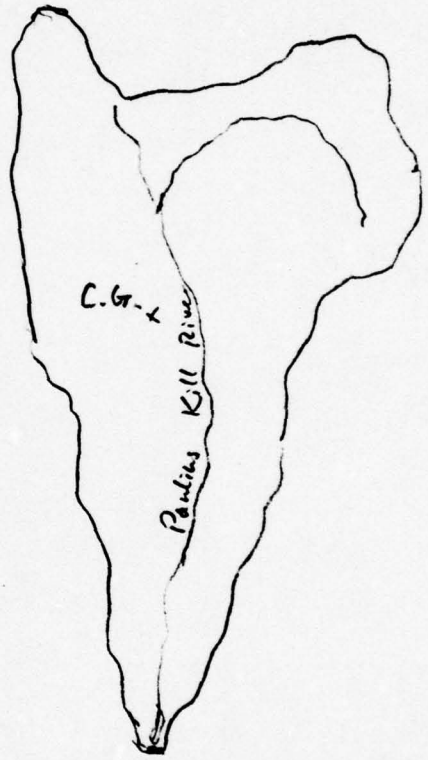
$L = 192000 ft \doteq 36.4 mi$

$\therefore t_p = 2.82 (18.2 \times 36.4)^{0.3}$

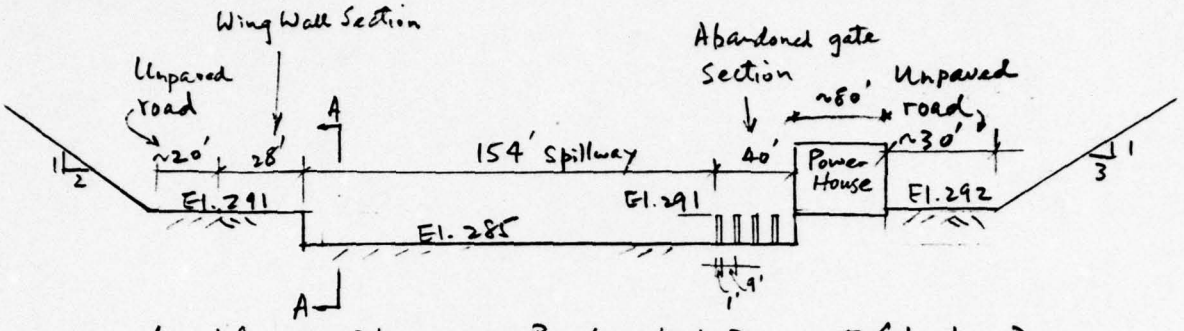
$\doteq 19.8 hrs.$

$\therefore \underline{t_p = 19.8 hrs}$

$\underline{C_p = 0.62}$

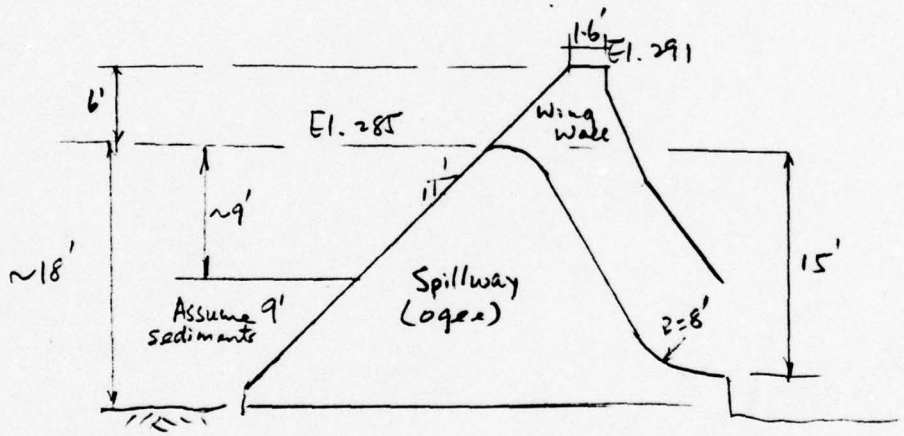


SPILLWAY CAPACITY



Simplified profile across Paulins Kill River at Columbia Dam

(Direction = Looking D/S)



Section A-A (spillway & wingwall section)

For Spillway section :

a. Determine Co for discharge equation for "Design of Small Dams"

b. Based on the shape of the section, assume design head. $H_o = 6'$; $P = 9'$

c. Obtain Co from Fig. 249 on pg. 378 of "D.S.D." — $C_o = 3.92$

d. Determine the coefficient-head relation from Fig. 250 & 251 of 'D.S.D.'

e. Effective length of spillway $L = 154 + 4 \times 9$

$= 190 ft$

$\therefore Q = 190\, C H^{3/2}$

For wing wall section :

a. Take average C for weir equation = 3.3

b. There is a section approx. 20 ft along the south-east edge (left edge when looking downstream) of the power house which will discharge flood water when pool elevation is above El. 291 which is the same as the crest of the wing wall. (See plan on fig. 2 and photos included in the report) Therefore include this section into the effective length of the wing wall section

$\therefore L = 28 + 20 = 48$ ft. , $\therefore Q = 3.3 \times 48 H^{3/2} = 158.4 H^{3/2}$

For unpaved road on both ends of the dam

Assume discharge obeys weir equation

use $C = 2.6$

Take effective length for road at left end = 25', $\therefore Q = 65 H^{3/2}$

Take effective length for road at right end = 35', $\therefore Q = 91 H^{3/2}$

NOTE: The lengths used in calculation are the estimated effective lengths available for discharge.

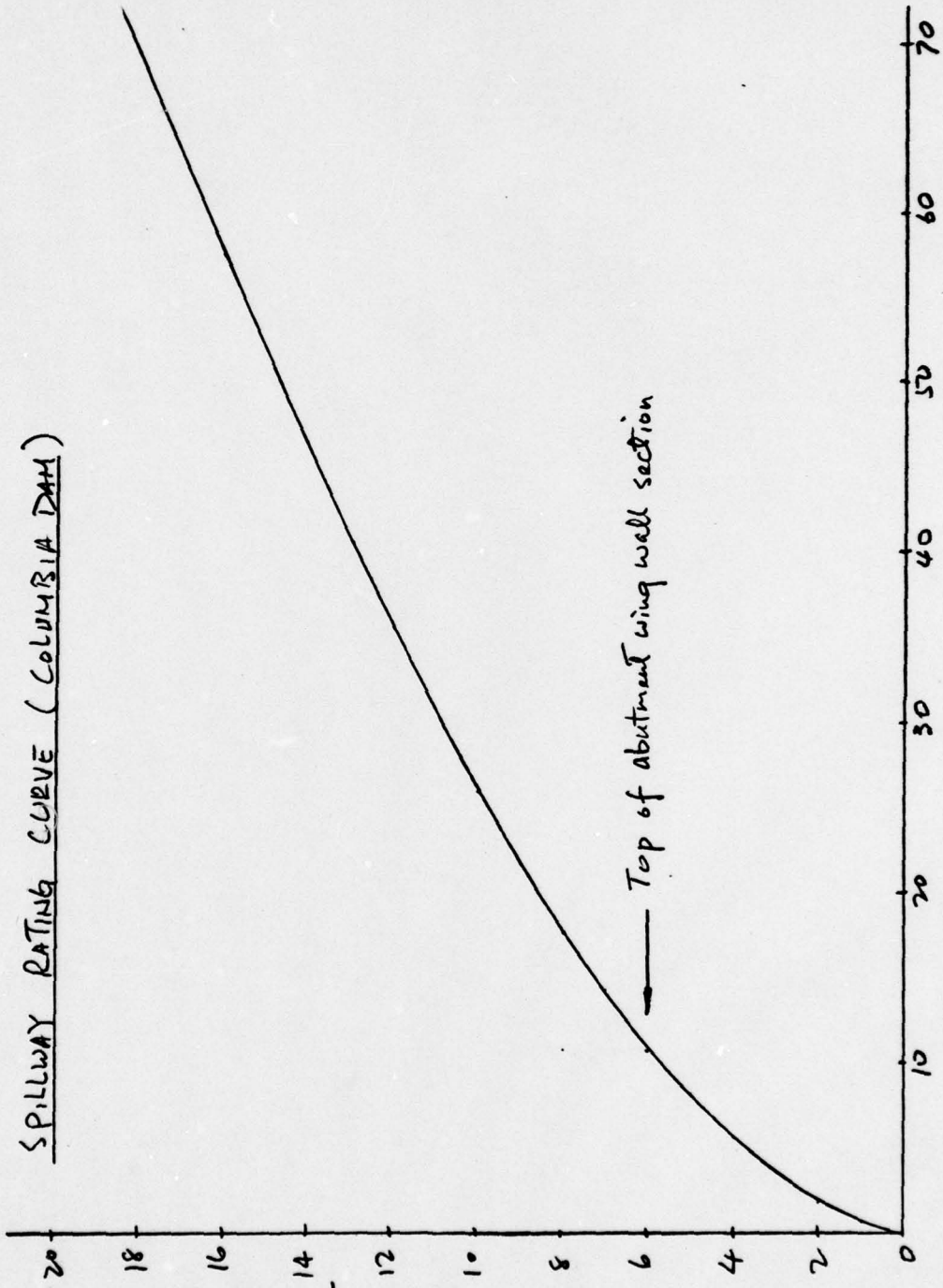
LANGAN ENGINEERING ASSOCIATES, INC.

BY Dmf DATE 2-15-79 Columbia Dam
CKD [illegible] DATE 4.5.79 JOB NO. T-7838
SHEET NO. 5 OF 8

Elev. (ft)	Spillway								Wing Wall Section		Unpaved Road at left end		Unpaved Road at right end		Total Q (cfs) $=Q_S+Q_W+Q_{RL}+Q_{RR}$
	H (ft)	H/H_o	C/C_o	C	P/H	C_{adj}/C	C_{adj} *	Q_S (cfs)	H (ft)	Q_W (cfs)	H (ft)	Q_{RL} (cfs)	H (ft)	Q_{RR} (cfs)	
285	0							0							0
286	1	0.17	0.82	3.21	9	.992	3.18	604							604
287	2	0.33	0.88	3.45	4.5	.992	3.42	1838							1838
288	3	0.5	0.92	3.61	3	.992	3.58	3534							3534
289	4	0.67	0.95	3.72	2.25	.992	3.69	5609							5609
290	5	0.83	0.98	3.84	1.8	.993	3.81	8093							8093
291	6	1	1	3.92	1.5	.994	3.90	10890	0		0				10890
292	7	1.17	1.02	4.00	1.29	.995	3.95	13899	1	158	1	65	0		14122
293	8	—	—	—	—	—	3.95	16982	2	448	2	184	1	91	17705
294	9	—	—	—	—	—	3.95	20264	3	823	3	338	2	257	21682
295	10	—	—	—	—	—	3.95	23733	4	1267	4	520	3	473	25993
296	11	—	—	—	—	—	3.95	27380	5	1771	5	727	4	728	30606
297	12	—	—	—	—	—	3.95	31198	6	2328	6	955	5	1017	35498
298	13	—	—	—	—	—	3.95	35178	7	2934	7	1204	6	1337	40653
299	14	—	—	—	—	—	3.95	39314	8	3584	8	1471	7	1685	46054
301	16	—	—	—	—	—	3.95	48032	10	5009	10	2055	9	2457	57553
303	18	—	—	—	—	—	3.95	57314	12	6585	12	2702	11	2878	69479

* C values for corresponding heads adjusted for inclined upstream slope, use maximum of 3.95

LANGAN ENGINEERING ASSOCIATES, INC.



BY DMJ DATE ____ Columbia Dam JOB NO. J-783 B

CKD GED DATE 4-5-79 SHEET NO. 6 OF 8

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 = 50 Acres

Length of equivalent square = 1476 ft

Take average side slope = 1V.:5H.

∴ for every foot of water above the crest of spillway, the length of equivalent square increases by

$= 1 \times 5 \times 2 = 10$ ft

Elev. (ft)	H (ft)	Length of equivalent square (ft)	Area of Lake (Acres)
285	0	1476	50
286	1	1486	50.7
287	2	1496	51.4
288	3	1506	52.1
289	4	1516	52.8
290	5	1526	53.5
291	6	1536	54.2
292	7	1546	54.9
293	8	1556	55.6
294	9	1566	56.3
295	10	1576	57.0
296	11	1586	57.7
297	12	1596	58.5
98	13	1606	59.2
99	14	1616	60.0
301	16	1636	61.4
303	18	1656	63.0

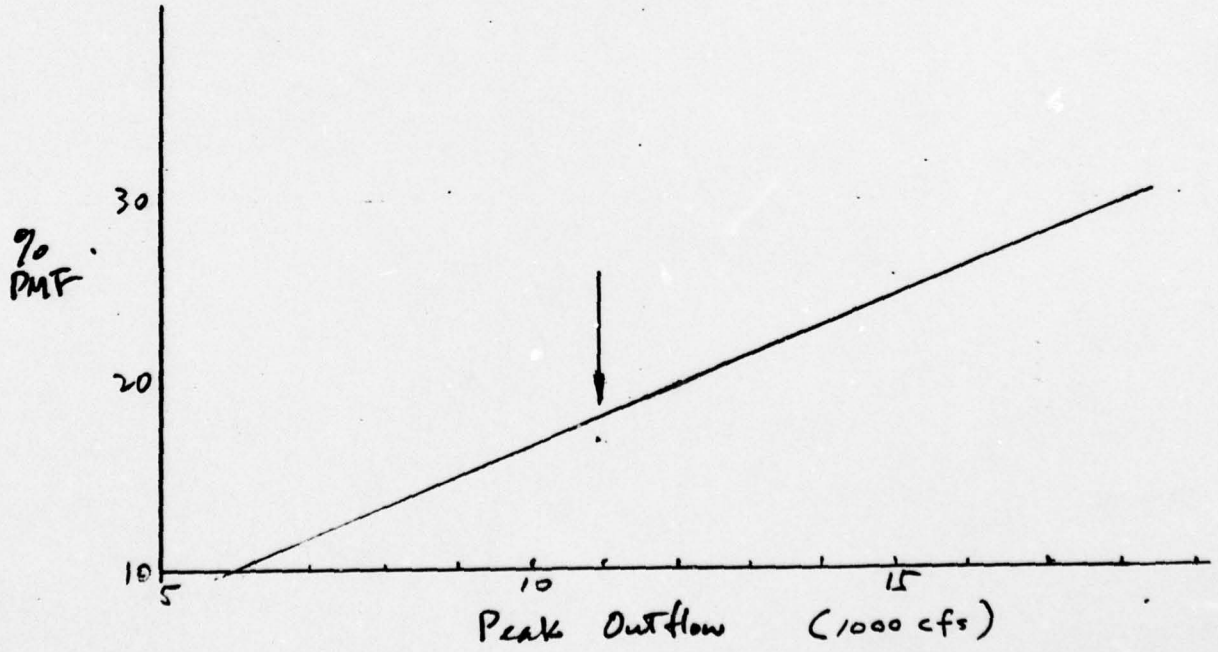
LANGAN ENGINEERING ASSOCIATES, INC.

SUMMARY OF HYDROGRAPH AND FLOOD ROUTING

1. Hydrograph and routing calculated using HEC-1
2. PMF peak inflow for Columbia Lake is 59,879 cfs.
   (routed to 59,872 cfs)
3. Routing indicates the dam (abutment wing wall section) overtops by approx. 10 ft. for PMF and 5 ft for ½ PMF

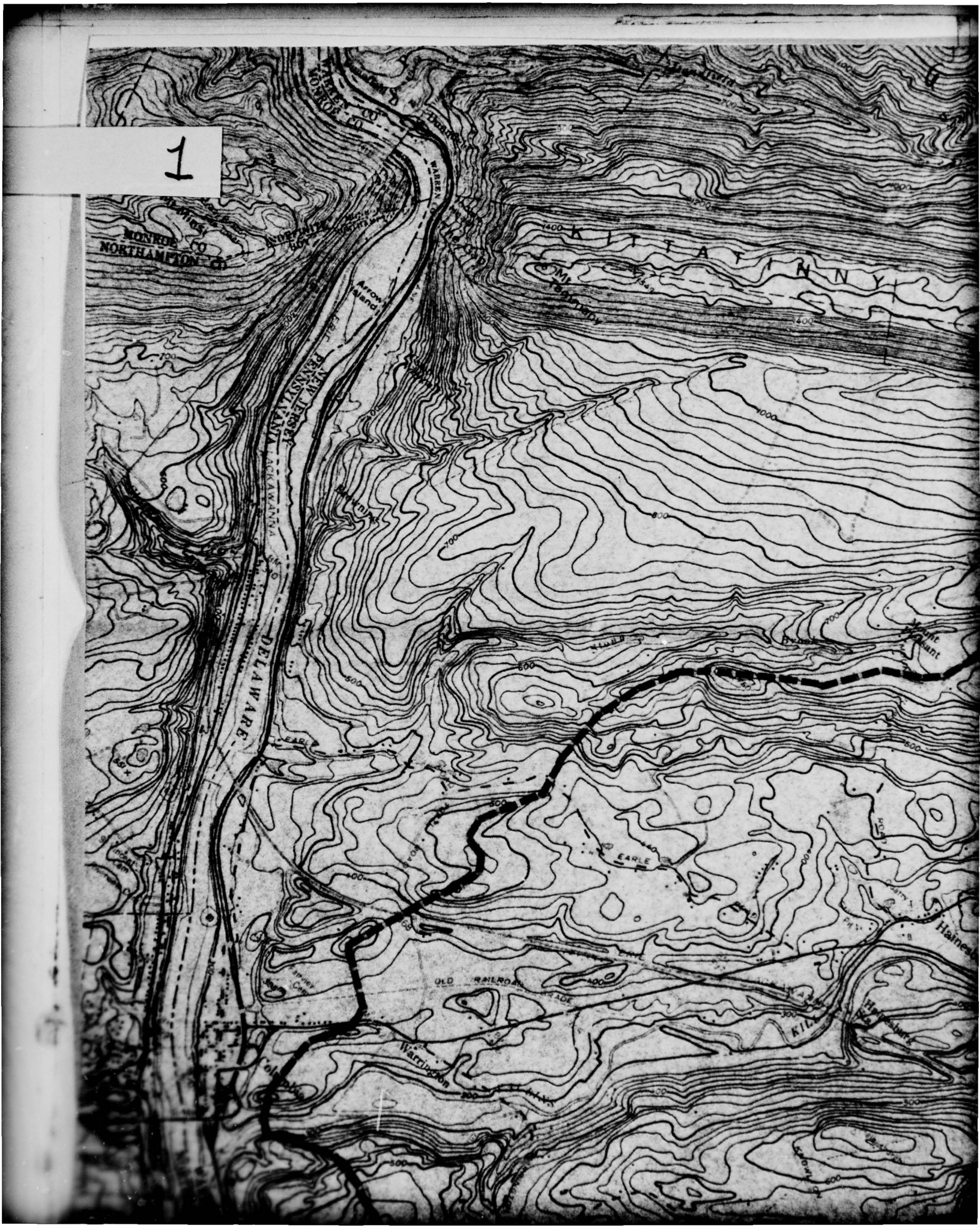
OVERTOPPING POTENTIAL

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



3. Dam overtops at approx. El. 291 with Q = 10890 cfs
   ∴ dam can pass approx. 18 % of PMF.

BY Dry DATE 2-16-79 3-22-79 Columbia Dam JOB NO. J-783 B
SHEET NO. 8 OF 8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MONROE CO
NORTHAMPTON CO
KITTATINNY
Mt Tammany
Arrow Island
NEW JERSEY
PENNSYLVANIA
DELAWARE
EARLE
Mount Bryant
Warrington
OLD RAILROAD GRADE

2
Sunfish Pd
APPALACHIAN
MOUNTAIN
Mount Pleasant
Hainesburg
Yards
ROAD
Vail

3
PAHAQUARRY
MOUNTAIN
KITTATINNY
MOUNTAIN
APPALACHIAN
TRAIL
Yards Creek Reservoir
BLAIRSTOWN
Mount Herman
Yards Creek
Walnut Valley
AIRY TOWN
RAILROAD

MOUNTAIN
Creek
Catfish Pond
Yards
Reservoir
Jacksonburg
1100
1000
1200
1500
900
800
700
600
500
400
300

Pond
APPALACHIAN
Creek
Blair
Princeton Summer
Hardwick
Newport
Lake No-Be-Mo-Sco
Prentiss Grove
Black
Whitcomb
Creek

Fairview Lake
Hardwick
CREEK

7
Crater Lake
Long Pine Pond
Lake
Camp Minnehonk
Kettle Lake
Pine Point
SWARTSWOOD

8
Quick Pond
Five Points
Little
Swartswood Lake
LAKE
Hendershots
Dove I

LAKE
OWASSA
Bear
Swamp
Lake
Kemah
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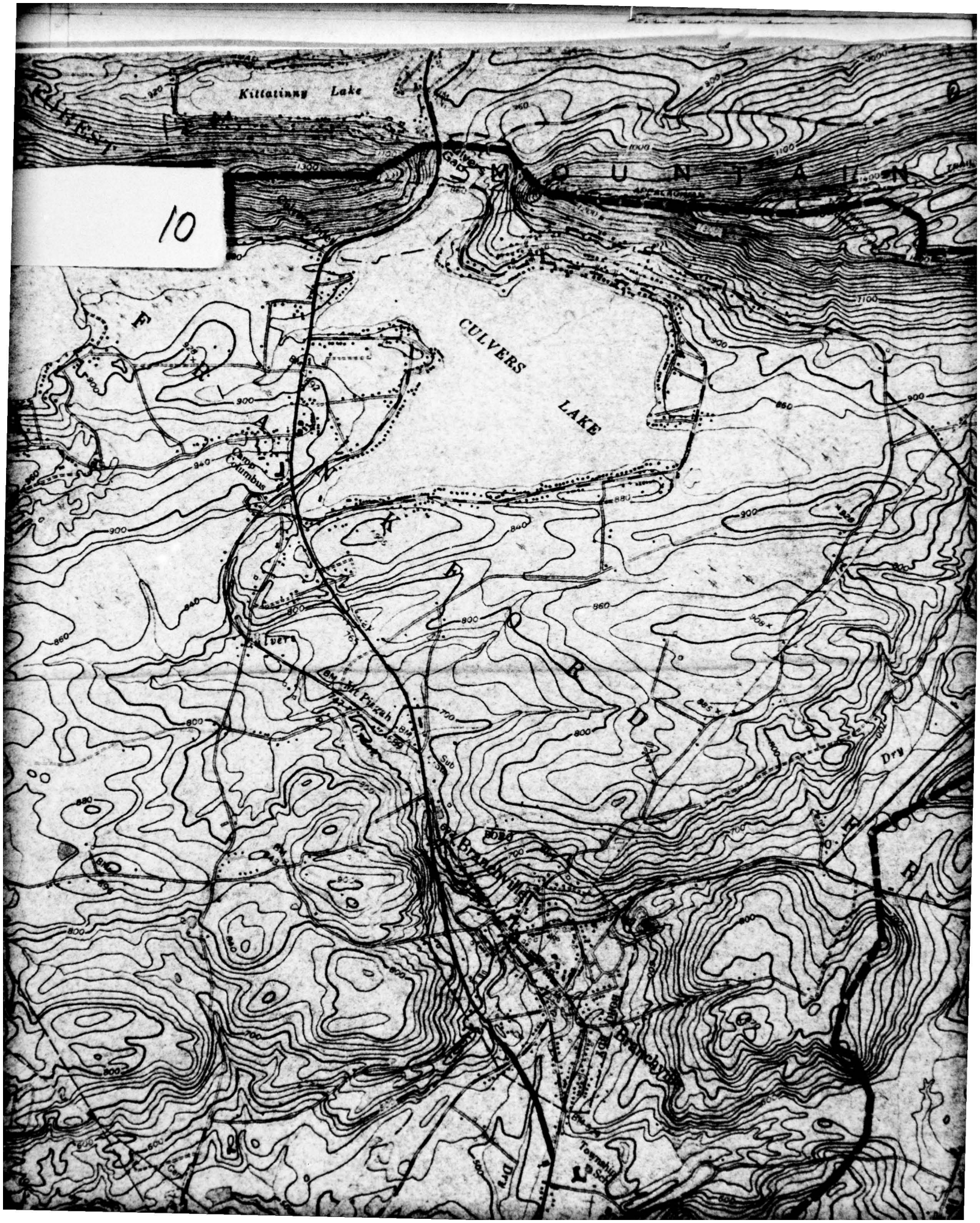
Myrtle
Grove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Papakating
Wykertown

12

B
RAILROAD
Vail
DELAWARE
ROAD
Muddy
Brook
Lakes

14
Lake Susquehanna
Lake Susquehanna Airport
NEW YORK
SUSQUEHANNA
PAULINS
AND
WESTERN
Cedar
Lake
Kanaums
Union Dale
Cooks Pond
Silver Lake
Brook

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NATIONAL DAM SAFETY PROGRAM. COLUMBIA DAM (NJ00124) DELAWARE RI--ETC(U)
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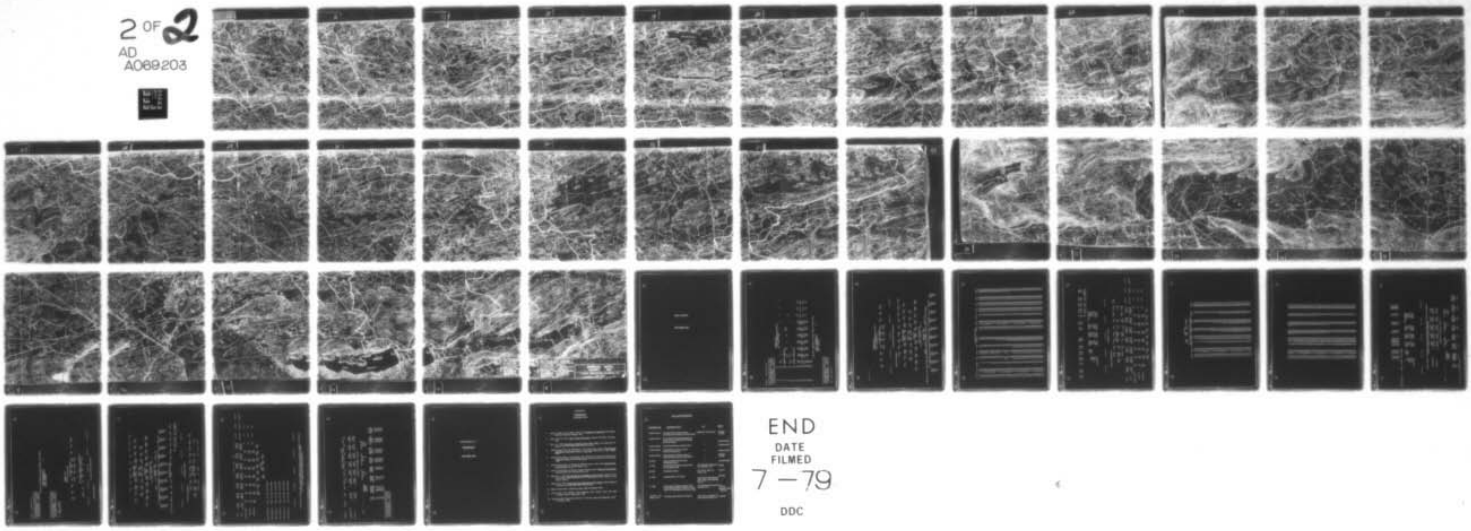

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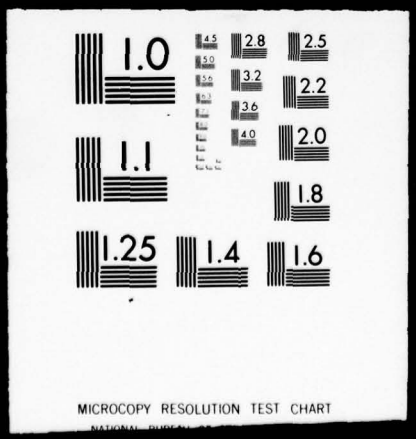

Lake Grassmere
Blenheim
Renwick
Spring Creek
Fairhall
Picton
Havelock
Cloudy Bay
Tory Channel
Queen Charlotte Sound
Pelorus Sound
Kenepuru Sound
Port Underwood
Cook Strait
Wellington
Hutt Valley
Lower Hutt
Upper Hutt
Petone
Eastbourne
Miramar
Seatoun
Karori
Kelburn
Johnsonville
Porirua
Paekakariki
Paraparaumu
Otaki
Levin
Foxton
Shannon
Feilding
Sanson
Bulls
Marton
Hunterville
Taihape
Waiouru
Ohakune
Raetihi
Taumarunui
Ohura
Stratford
Eltham
Hawera
Patea
Wanganui
Waverley
Waitotara
Wanganui River
Whanganui National Park
Mount Ruapehu
Mount Ngauruhoe
Tongariro National Park
Lake Taupo
Turangi
Tokaanu
Waihi
Waihi Beach
Tauranga
Mount Maunganui
Te Puke
Rotorua
Lake Rotorua
Whakatane
Ohope Beach
Opotiki
Gisborne
Tolaga Bay
Ruatoria
Waipiro Bay
Tokomaru Bay
Hicks Bay
East Cape
Cape Runaway
Cape Table
Cape Kidnappers
Napier
Hastings
Havelock North
Clive
Haumoana
Waipukurau
Waipawa
Dannevirke
Norsewood
Pongaroa
Akitio
Castlepoint
Masterton
Carterton
Greytown
Featherston
Martinborough
Lake Wairarapa
Lake Onoke
Pahiatua
Eketahuna
Mount Bruce
Tinui
Te Wharau
Mangaweka
Kaimanawa Mountains
Kaimanawa Forest Park
Rangitikei River
Manawatu River
Manawatu Gorge
Tararua Forest Park
Mount Holdsworth
Mount Hector
Mount Dundas
Mount Crawford
Mount Aorangi
Mount Bruce National Wildlife Refuge
Pukaha
Rimutaka Forest Park
Rimutaka Range
Rimutaka Hill Road
Rimutaka Incline
Remutaka Range
Remutaka Forest Park
Remutaka Hill Road
Orongorongo River
Wainuiomata
Eastbourne
Days Bay
Petone
Lower Hutt
Upper Hutt
Silverstream
Trentham
Kaitoke
Pakuratahi Forest
Pakuratahi River
Hutt River
Wainui Stream
Akatarawa Forest
Akatarawa River
Akatarawa Road
Waikanae
Waikanae River
Waikanae Beach
Paraparaumu Beach
Paraparaumu
Raumati Beach
Raumati South
Paekakariki
Paekakariki Hill Road
Queen Elizabeth Park
Kapiti Island
Kapiti Coast
Porirua Harbour
Porirua
Titahi Bay
Plimmerton
Pukerua Bay
Whitireia Park
Mana Island
Mana
Motukaraka Island
Evans Bay
Oriental Bay
Lyall Bay
Island Bay
Owhiro Bay
Houghton Bay
Karaka Bay
Worser Bay
Seatoun
Miramar
Miramar Peninsula
Strathmore
Kilbirnie
Rongotai
Rongotai Ridge
Mount Victoria
Mount Cook
Mount Albert
Mount Kaukau
Mount Crawford
Mount Aorangi
Mount Hector
Mount Dundas
Mount Holdsworth
Tararua Forest Park
Tararua Range
Tararua Peaks
Tararua Peak
Tararua Forest
Tararua Road
Tararua Forest Road
Tararua Forest Track
Tararua Forest Walkway
Tararua Forest Campsite
Tararua Forest Hut
Tararua Forest Shelter
Tararua Forest Lookout
Tararua Forest Viewpoint
Tararua Forest Picnic Area
Tararua Forest Information Centre
Tararua Forest Visitor Centre
Tararua Forest Ranger Station
Tararua Forest Office
Tararua Forest Headquarters
Tararua Forest Administration
Tararua Forest Management
Tararua Forest Conservation
Tararua Forest Protection
Tararua Forest Preservation
Tararua Forest Restoration
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Tararua Forest Fungus
Tararua Forest Mushroom
Tararua Forest Toadstool
Tararua Forest Mould
Tararua Forest Rot
Tararua Forest Decay
Tararua Forest Humus
Tararua Forest Soil
Tararua Forest Earth
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Tararua Forest Gravel
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Tararua Forest Pass
Tararua Forest Saddle
Tararua Forest Col
Tararua Forest Notch
Tararua Forest Gap
Tararua Forest Opening
Tararua Forest Clearing
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Tararua Forest Expressway
Tararua Forest Bypass
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Tararua Forest Selection
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Tararua Forest Show
Tararua Forest Performance
Tararua Forest Event
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Tararua Forest Celebration
Tararua Forest Festival
Tararua Forest Carnival
Tararua Forest Fair
Tararua Forest Market
Tararua Forest Bazaar
Tararua Forest Sale
Tararua Forest Auction
Tararua Forest Lottery
Tararua Forest Raffle
Tararua Forest Draw
Tararua Forest Competition
Tararua Forest Contest
Tararua Forest Match
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Tararua Forest Activity
Tararua Forest Pastime
Tararua Forest Hobby
Tararua Forest Interest
Tararua Forest Pursuit
Tararua Forest Occupation
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Tararua Forest Trade
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Tararua Forest Uncertainty
Tararua Forest Doubt
Tararua Forest Question
Tararua Forest Answer
Tararua Forest Solution
Tararua Forest Problem
Tararua Forest Difficulty
Tararua Forest Challenge
Tararua Forest Test
Tararua Forest Trial
Tararua Forest Experiment
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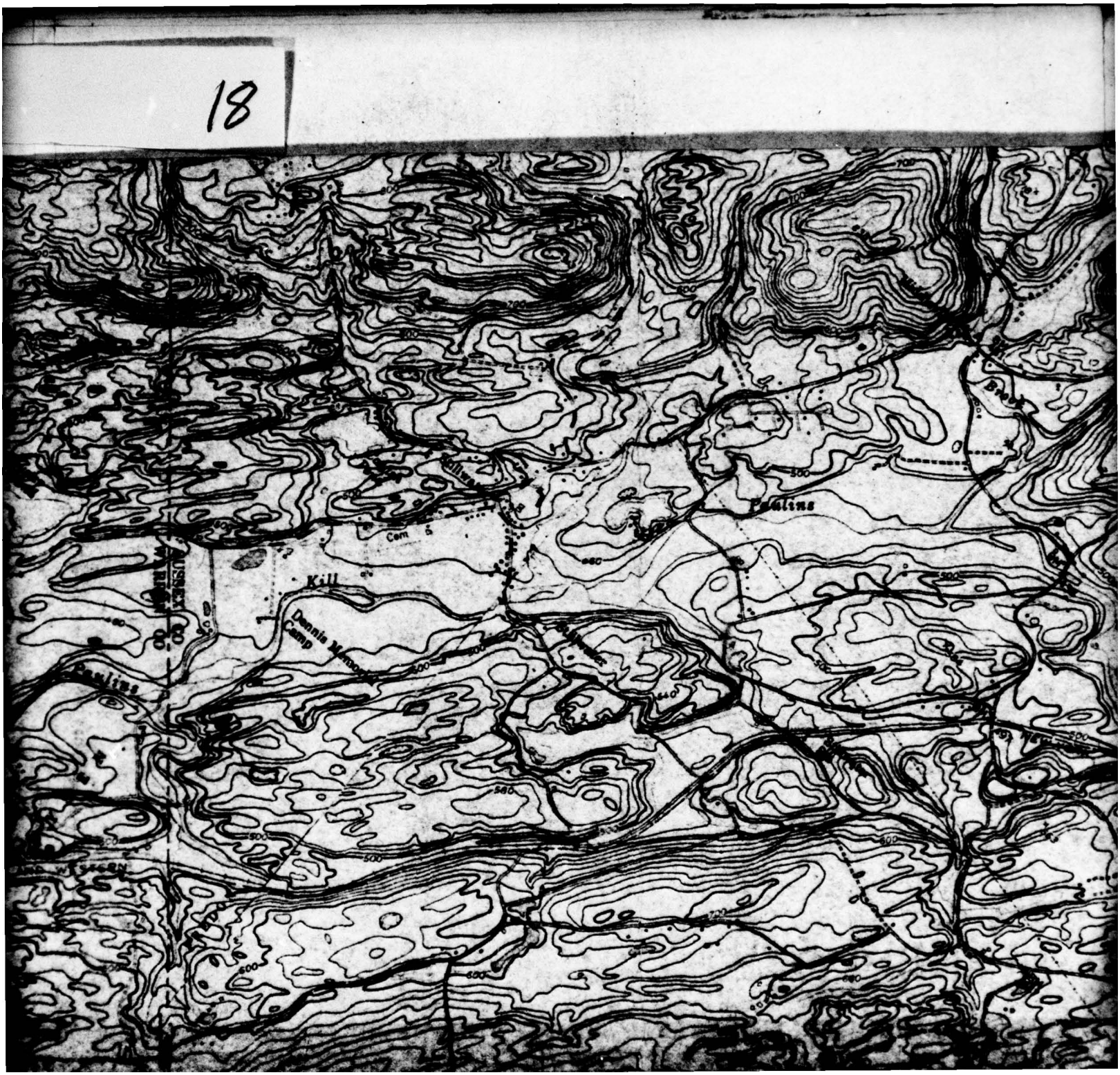
Tararua Forest Site
Tararua Forest Spot

Lake Constance
Creek
Birchen
PARKLINE
WESTERN
HEADRD
NEW YORK
500
460
400

White Lake
White Lake
Duck
Paulins
500
520
480


18
Kill
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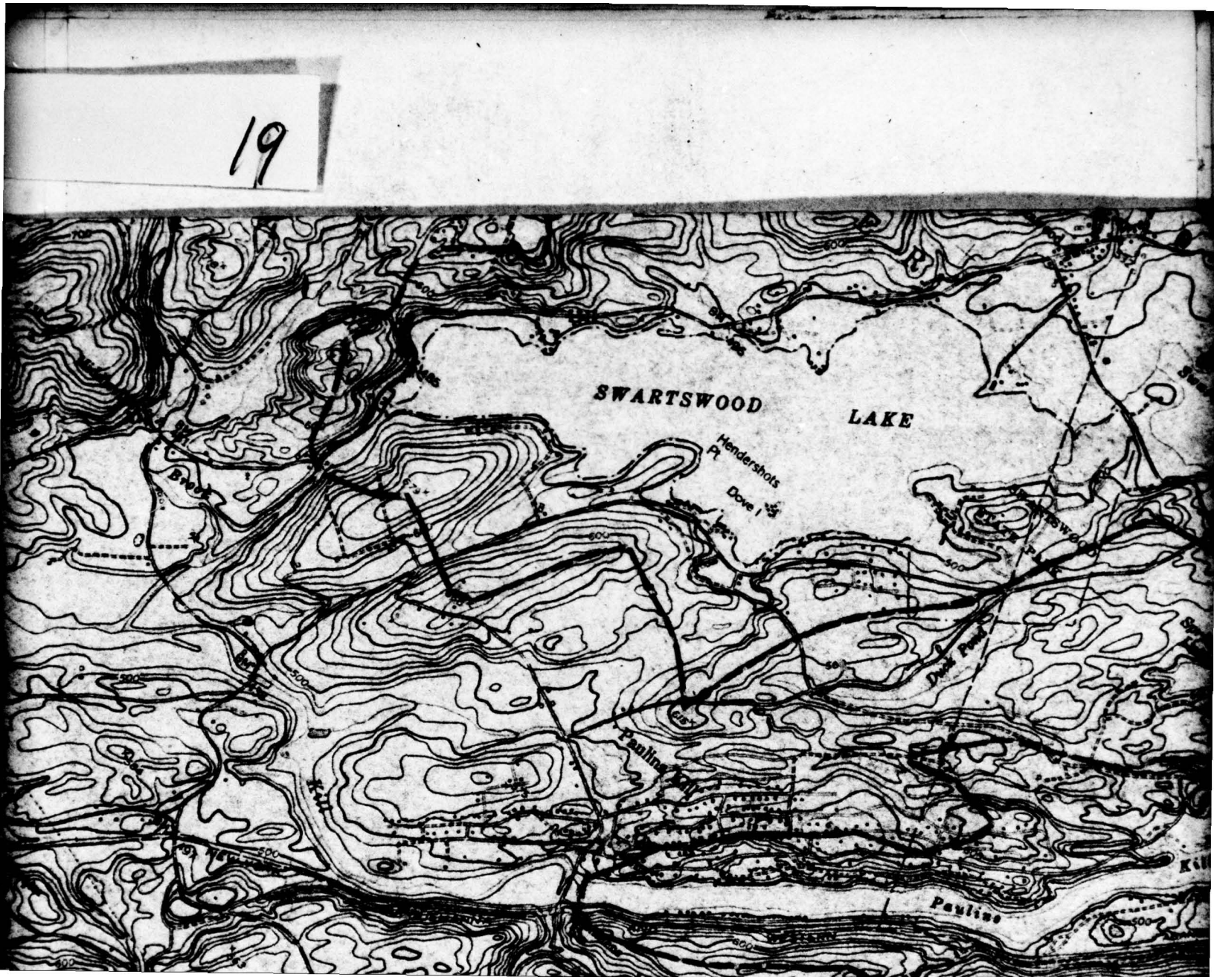
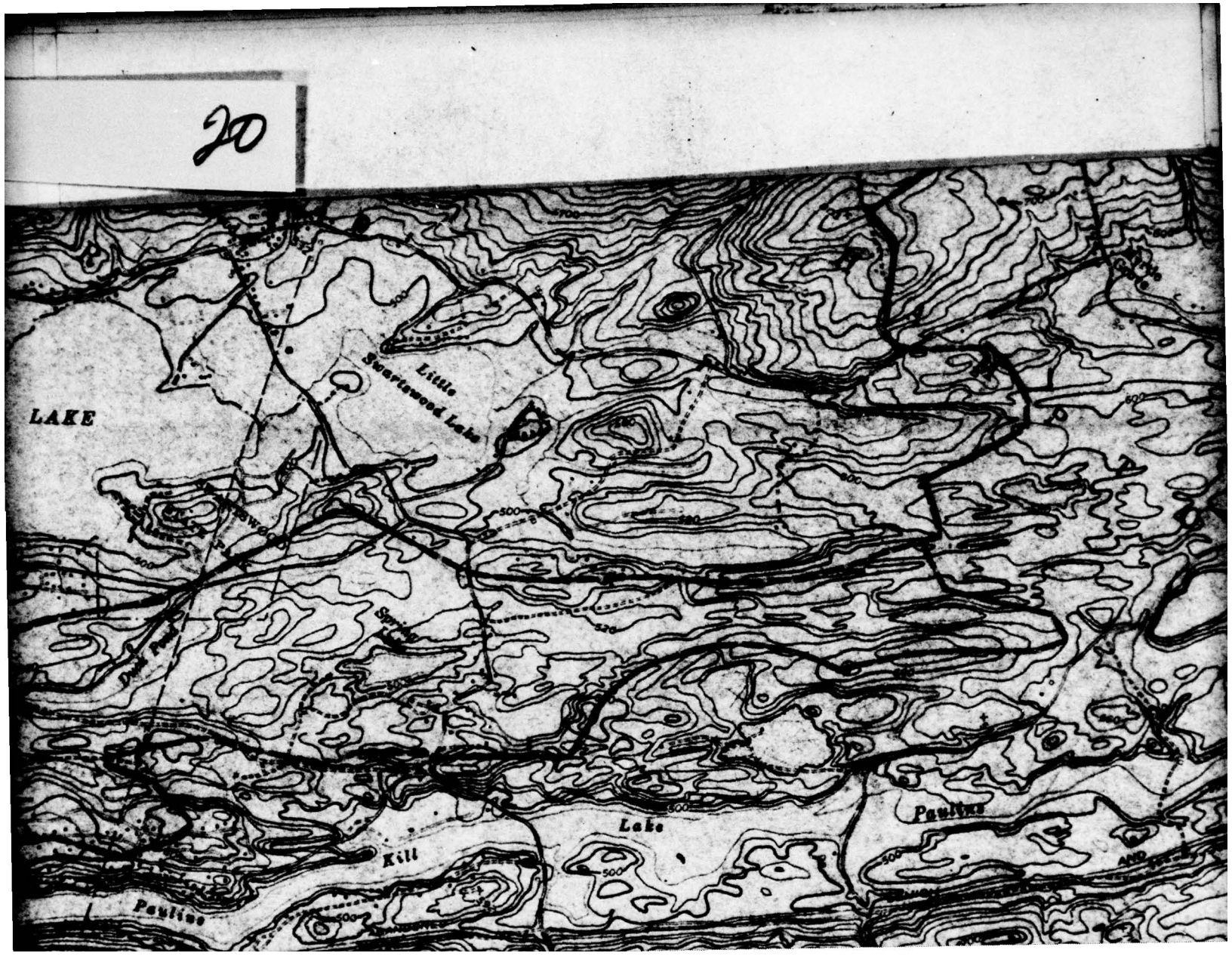



20
LAKE
Little
Swartswood Lake
Lake
Kill
Pauline
Pauline

Paulins
Kill
LEHIGH AND
Paulins
Kill
AND
700
600

Pauline
Pauline
Kill
LEHIGH
LEHIGH
Pauline
RAILROAD
OLD

23

Honey
Beaver
MOUNTAIN
MOUNTAIN

Muddy
Brook
Brookdale
Swamp
Beaver
Honey
Run
Brook
Beaver
Mountain

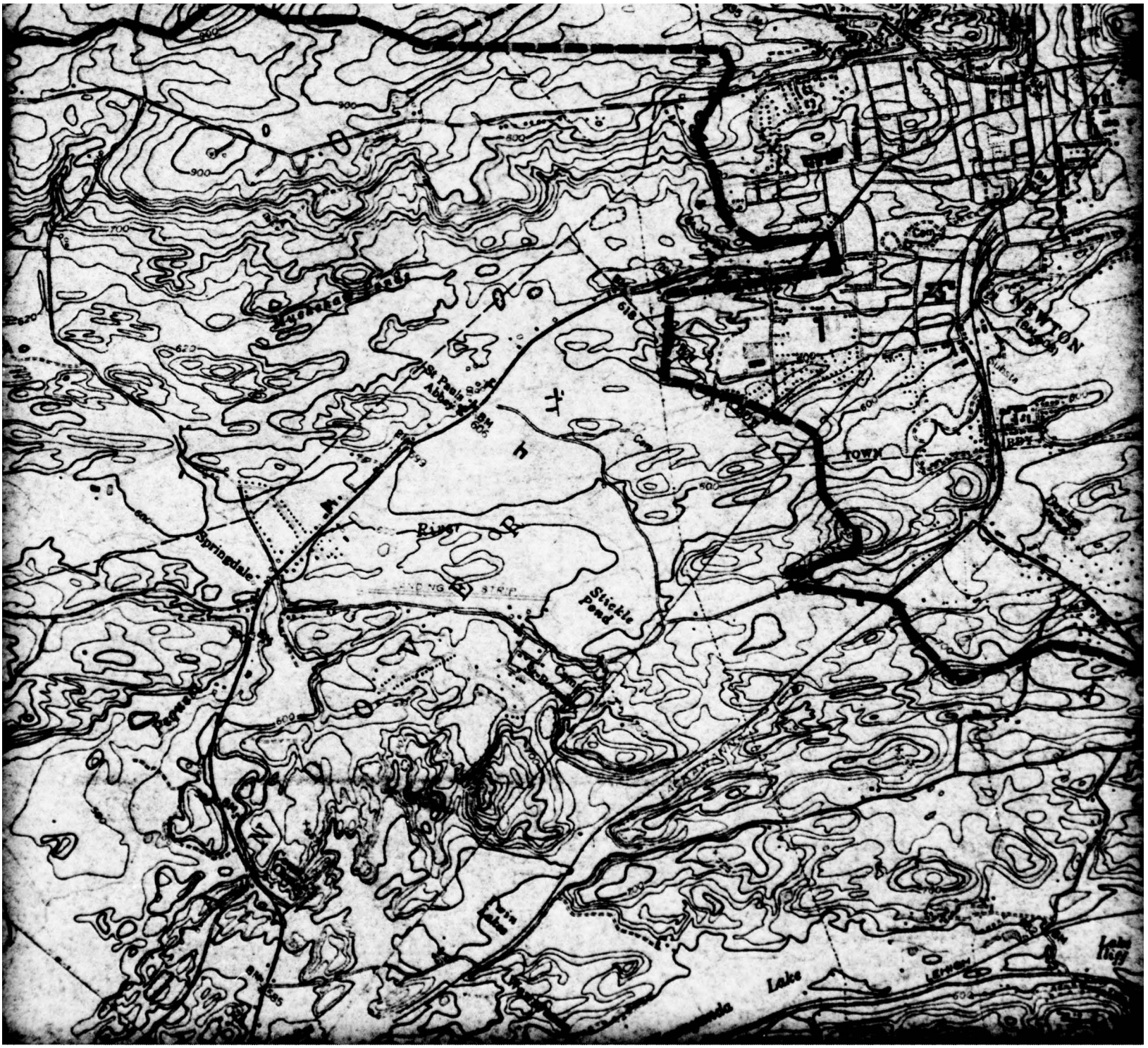
Cooks Pond
Silver Lake
Brook
Beaver
Union
Forest
MOHAWK TRAIL STATE FOREST

Lake Wallenpaupack
Kerns Corners
French Lake
Johnsonburg
Glovers Pd
Southfork
Fire Pond
STATE FOREST
Bear Cr
Bear
Trout
Brook
AMUCE

French Lake
Johnsonburg
Mud Pond
Deer Rocks
Bear
Trout
WARREN
SENECA
REITNGHUYSEN
ROAD

REDON
Hunts Pond
Mill Pond
Kingsbury
Green Pond
ROAD
GUYSEN
Greendell
GR.
E.

Springdale


St Pauls Abbey
Springdale
Stickle Pond
TOWN
Lake

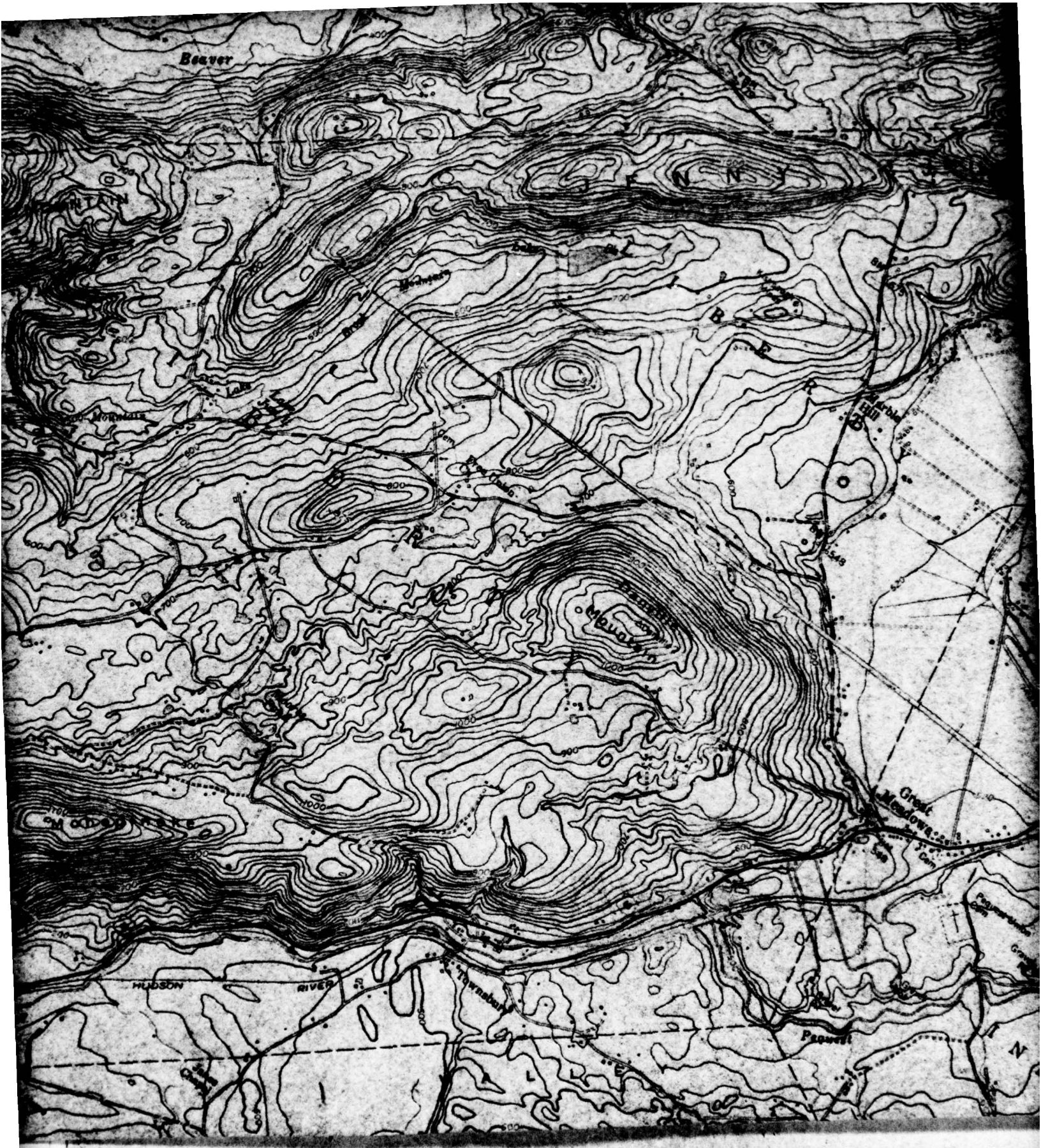
Paulins
OLD RAILROAD GRADE
Lawrence Lake
Golf Course
Pleasantville
Golf Course

Kill
RAILROAD GRADE
OLD RAILROAD GRADE
Hyper-Humus Sta.
Warbasse
Lafayette
Vaughn
Ackerson
GERMANY
Lawrence Lake
RIVER

ABANDONED
RIVER
HUDSON
White Lake
MANY
Hills

HUDSON RIVER
LEHIGH AND
RIVER
Big Springs
Wildcat
Br

Beaver
Lake
Mountain
Lake
Brook
Lake
Peekay
P E Q U E S T
River
HUDSON


Beaver
Mountain
Lake
Mountain
Franconia
Mountain
Great
Meadows
HUDSON
RIVER
Townsend
Prospect
N

37

STATE FOREST
INDEPENDENCE
BEAR
River
SWAMP
Pine Island
520
540
Peapack
LENIGH
AND
HUDSON
RIVER
Great
Meadows
Creek
Grand
River
Peapack
INDEPENDENCE

38

Bear
Trout
Brook
Trout
Creek
BEAR
River
SWAMP
Stevens Island
Bear Swamp
Pequest
RIVER
LEHIGH
AND
HUDSON
Long Bridge

39

Bear
Cr
Trout
Brook
Quaker
Church
546
BM
River
Pequest
ALLAMUCHY
AND
HUDSON
RIVER
Trout
572
Green
Pt
Bridge
Tributary
Brook

40

Treadell
G R E E N
Pequest
Hunterville
Tranquility
Trinca Field
HUDSON
AND
LEHIGH
Tranquility Cb
Lake Tranquility
Cranberry Lake

River
Andover
Andover
Andover Ponds
Rocky Pond
Forest Lake
Panther Lake
Allamuchy Mtn
Cranberry Lake
Whitehall
Hunterville
Furnace
White Pond
Green Pond
Turtle Pond
Brighton
RIVER
HUDSON
LEHIGH AN
HUDSON R
BURRO
BDY
BORO
CREEK
LACK
PRIVATE
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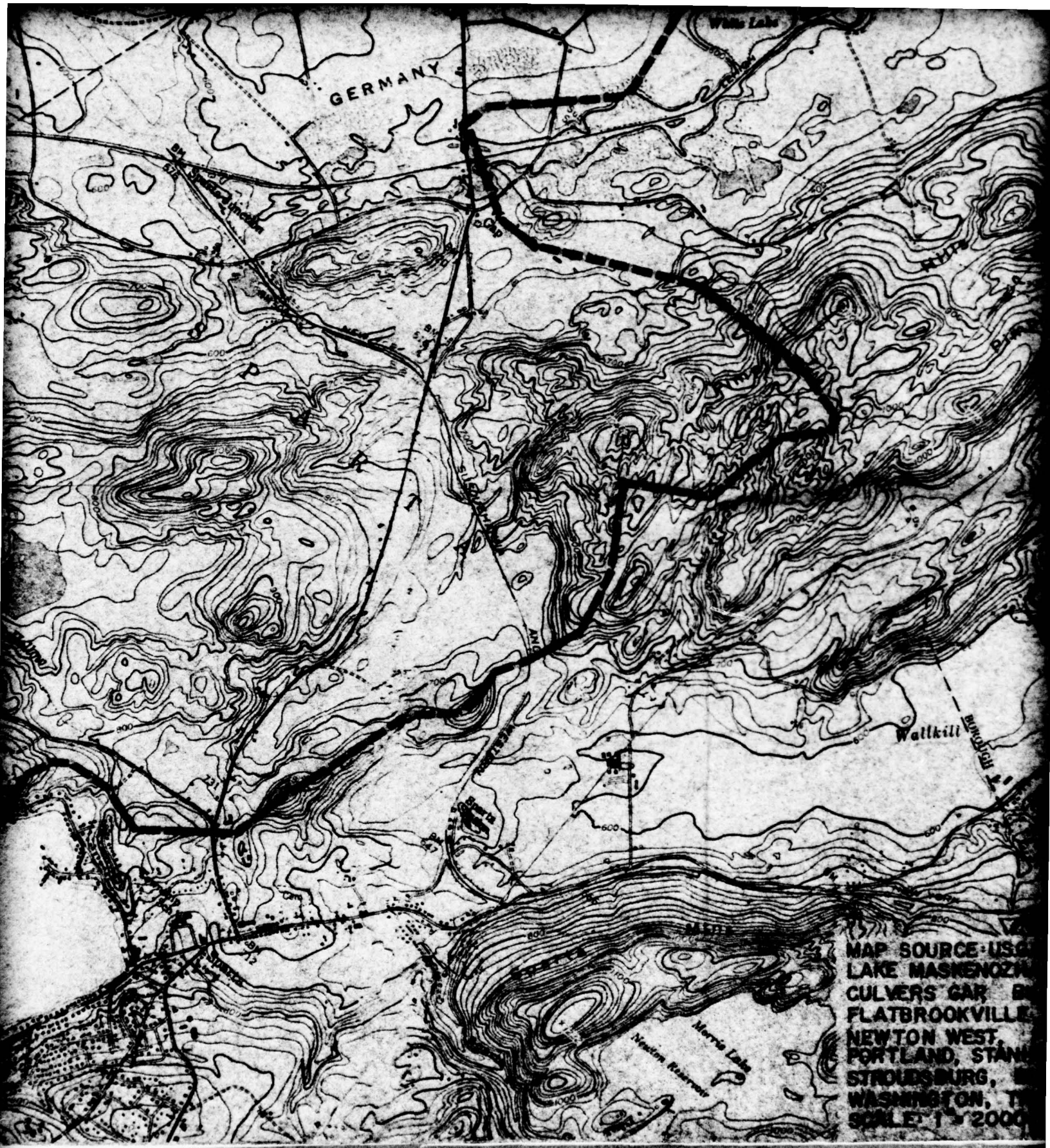
BM
Spg
Ponds
Lake
Mtn

42

Lake
Wawayanda
New
Lake Iliff
Lake Lenape
Pleasant Lake
Rocky Pond
Slag Pond
MUDRON
MURRO
BOT
PRIVATE

43

Laurence Lake
Golf Course
Mulford Station
RIVER
Howells Pond
Lake
Golf Course
Upper Mohawk Lake
LAKE
MOHAWK


GERMANY
Wallkill
Morris Lake
Newton Reservoir
MAP SOURCE: USG
LAKE MASKENOZH
CULVERS GAP
FLATBROOKVILLE
NEWTON WEST,
PORTLAND, STAN
STROUDSBURG,
WASHINGTON, T
SCALE: 1" = 2000

MAP SOURCE: USGS. HAMBURG, LAKE MASKENOZHA, BRANCHVILLE, CULVERS GAP, BUSHKILL, FLATBROOKVILLE, NEWTON EAST, NEWTON WEST, FRANKLIN, PORTLAND, STANHOPE, BELVIDERE, STROUDSBURG, BLAIRSTOWN, WASHINGTON, TRANQUILITY
SCALE: 1" = 2000'

DRAINAGE BASIN
COLUMBIA DAM

LANGAN ENGINEERING ASSOCIATES, INC.

CONSULTING ENGINEERS
[illegible], CLIFTON, N.J.

46

HEC-1 OUTPUT

COLUMBIA DAM

```
COLOUT1    12:29 MAR 22,'79

1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  11 JAN 79
 **********
     1              A                          COLUMBIA DAM
     2              A                          INFLOW HYDROGRAPH AND ROUTING
     3              A                          N.J. DAM INSPECTION
     4              B    100       2        0        0        0        0        0        0        0        0
     5              B1     3
     6              K               1                                          1
     7              K1   COMPUTE HYDROGRAPH
     8              M      1        1      175                        0.885
     9              P              22.4      81       92      103      112
    10              T                                                  1      .15
    11              W    19.8      0.62
    12              X      -2                 1
    13              K       1        2                                         1
    14              K1   ROUTING COMPUTATIONS
    15              Y                                  1
    16              Y1      1                                                          -1
    17              Y4    285      286      287      288      289      290      291      292      293      294
    18              Y4    295      296      297      298      299      301      303
    19              Y5      0      604     1838     3534     5609     8093    10890    14122    17705    21682
    20              Y5  25993    30606    35498    40653    46054    57553    69479
    21              $A     50     50.7     51.4     52.1     52.8     53.5     54.2     54.9     55.6     56.3
    22              $A   57.0     57.7     58.5     59.2     60.0     61.4     63.0
    23              $E    285      286      287      288      289      290      291      292      293      294
    24              $E    295      296      297      298      299      301      303
    25              $$    285
    26              $D    291
    27              K      99
1                                PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                        RUNOFF HYDROGRAPH AT          1
                                        ROUTE HYDROGRAPH TO           2
                                        END OF NETWORK


1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  11 JAN 79
 **********

 RUN  DATE: 79/03/22.
```

TIME= 11.53.27.

COLUMBIA DAM
INFLOW HYDROGRAPH AND ROUTING
N.J. DAM INSPECTION

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	2	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	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	175.00	0.00	175.00	.89	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.40	81.00	92.00	103.00	112.00	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= 19.80 CP= .62 NTA= 0

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

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=10.96 AND R= 9.37 INTERVALS

UNIT HYDROGRAPH 56 END-OF-PERIOD ORDINATES, LAG= 19.83 HOURS, CP= .62 VOL= 1.00

111.	415.	841.	1332.	1864.	2412.	2903.	3272.	3513.	3619.
3558.	3302.	2967.	2667.	2397.	2154.	1936.	1740.	1563.	1405.
1263.	1135.	1020.	917.	824.	740.	665.	598.	537.	483.
434.	390.	351.	315.	283.	254.	229.	206.	185.	166.
149.	134.	121.	108.	97.	87.	79.	71.	63.	57.
51.	46.	41.	37.	33.	30.				

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	2.00	1	.03	0.00	.03	350.	1.05	6.00	51	0.00	0.00	0.00	6853.
1.01	4.00	2	.03	0.00	.03	350.	1.05	8.00	52	0.00	0.00	0.00	6195.
1.01	6.00	3	.03	0.00	.03	350.	1.05	10.00	53	0.00	0.00	0.00	5603.
1.01	8.00	4	.06	0.00	.06	350.	1.05	12.00	54	0.00	0.00	0.00	5071.
1.01	10.00	5	.06	0.00	.06	350.	1.05	14.00	55	0.00	0.00	0.00	4593.
1.01	12.00	6	.06	0.00	.06	350.	1.05	16.00	56	0.00	0.00	0.00	4163.
1.01	14.00	7	.36	0.00	.36	350.	1.05	18.00	57	0.00	0.00	0.00	3777.
1.01	16.00	8	.74	.22	.52	375.	1.05	20.00	58	0.00	0.00	0.00	3430.
1.01	18.00	9	.29	0.00	.29	443.	1.05	22.00	59	0.00	0.00	0.00	3118.
1.01	20.00	10	.04	0.00	.04	538.	1.06	0.00	60	0.00	0.00	0.00	2837.
1.01	22.00	11	.04	0.00	.04	648.	1.06	2.00	61	0.00	0.00	0.00	2585.
1.02	0.00	12	.04	0.00	.04	767.	1.06	4.00	62	0.00	0.00	0.00	2359.
1.02	2.00	13	.29	0.00	.29	890.	1.06	6.00	63	0.00	0.00	0.00	2156.
1.02	4.00	14	.29	0.00	.29	1000.	1.06	8.00	64	0.00	0.00	0.00	1967.
1.02	6.00	15	.29	0.00	.29	1082.	1.06	10.00	65	0.00	0.00	0.00	1803.
1.02	8.00	16	.73	.43	.30	1184.	1.06	12.00	66	0.00	0.00	0.00	1656.
1.02	10.00	17	.73	.43	.30	1385.	1.06	14.00	67	0.00	0.00	0.00	1523.
1.02	12.00	18	.73	.43	.30	1730.	1.06	16.00	68	0.00	0.00	0.00	1405.
1.02	14.00	19	4.17	3.87	.30	2626.	1.06	18.00	69	0.00	0.00	0.00	1298.
1.02	16.00	20	8.51	8.21	.30	5262.	1.06	20.00	70	0.00	0.00	0.00	1202.
1.02	18.00	21	3.37	3.07	.30	10353.	1.06	22.00	71	0.00	0.00	0.00	1116.
1.02	20.00	22	.44	.14	.30	17309.	1.07	0.00	72	0.00	0.00	0.00	1026.
1.02	22.00	23	.44	.14	.30	25314.	1.07	2.00	73	0.00	0.00	0.00	946.
1.03	0.00	24	.44	.14	.30	33850.	1.07	4.00	74	0.00	0.00	0.00	874.
1.03	2.00	25	0.00	0.00	0.00	42311.	1.07	6.00	75	0.00	0.00	0.00	717.
1.03	4.00	26	0.00	0.00	0.00	49733.	1.07	8.00	76	0.00	0.00	0.00	458.
1.03	6.00	27	0.00	0.00	0.00	55294.	1.07	10.00	77	0.00	0.00	0.00	364.
1.03	8.00	28	0.00	0.00	0.00	58721.	1.07	12.00	78	0.00	0.00	0.00	359.
1.03	10.00	29	0.00	0.00	0.00	59879.	1.07	14.00	79	0.00	0.00	0.00	354.
1.03	12.00	30	0.00	0.00	0.00	58446.	1.07	16.00	80	0.00	0.00	0.00	350.
1.03	14.00	31	0.00	0.00	0.00	54586.	1.07	18.00	81	0.00	0.00	0.00	350.
1.03	16.00	32	0.00	0.00	0.00	49596.	1.07	20.00	82	0.00	0.00	0.00	350.
1.03	18.00	33	0.00	0.00	0.00	44727.	1.07	22.00	83	0.00	0.00	0.00	350.
1.03	20.00	34	0.00	0.00	0.00	40288.	1.08	0.00	84	0.00	0.00	0.00	350.
1.03	22.00	35	0.00	0.00	0.00	36257.	1.08	2.00	85	0.00	0.00	0.00	350.
1.04	0.00	36	0.00	0.00	0.00	32620.	1.08	4.00	86	0.00	0.00	0.00	350.
1.04	2.00	37	0.00	0.00	0.00	29352.	1.08	6.00	87	0.00	0.00	0.00	350.
1.04	4.00	38	0.00	0.00	0.00	26414.	1.08	8.00	88	0.00	0.00	0.00	350.
1.04	6.00	39	0.00	0.00	0.00	23774.	1.08	10.00	89	0.00	0.00	0.00	350.
1.04	8.00	40	0.00	0.00	0.00	21402.	1.08	12.00	90	0.00	0.00	0.00	350.
1.04	10.00	41	0.00	0.00	0.00	19270.	1.08	14.00	91	0.00	0.00	0.00	350.
1.04	12.00	42	0.00	0.00	0.00	17353.	1.08	16.00	92	0.00	0.00	0.00	350.
1.04	14.00	43	0.00	0.00	0.00	15631.	1.08	18.00	93	0.00	0.00	0.00	350.
1.04	16.00	44	0.00	0.00	0.00	14083.	1.08	20.00	94	0.00	0.00	0.00	350.
1.04	18.00	45	0.00	0.00	0.00	12692.	1.08	22.00	95	0.00	0.00	0.00	350.
1.04	20.00	46	0.00	0.00	0.00	11442.	1.09	0.00	96	0.00	0.00	0.00	350.
1.04	22.00	47	0.00	0.00	0.00	10319.	1.09	2.00	97	0.00	0.00	0.00	350.

1.05	0.00	48	0.00	0.00	0.00	9309.	1.09	4.00	98	0.00	0.00	0.00	350.	
1.05	2.00	49	0.00	0.00	0.00	8402.	1.09	6.00	99	0.00	0.00	0.00	350.	
1.05	4.00	50	0.00	0.00	0.00	7586.	1.09	8.00	100	0.00	0.00	0.00	350.	
									SUM	22.20	17.07	5.13	993851.	
										(564.)	(434.)	(130.)	(28142.73)	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	59879.	58490.	48589.	25815.	993500.
CMS	1696.	1656.	1376.	731.	28133.
INCHES		3.11	10.33	16.47	17.60
MM		78.97	262.42	418.26	447.13
AC-FT		29003.	96376.	153610.	164215.
THOUS CU M		35775.	118878.	189475.	202556.

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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.	-1

STAGE	285.00	286.00	287.00	288.00	289.00	290.00	291.00	292.00	293.00	294.0
	295.00	296.00	297.00	298.00	299.00	301.00	303.00			
FLOW	0.00	604.00	1838.00	3534.00	5609.00	8093.00	10890.00	14122.00	17705.00	21682.0
	25993.00	30606.00	35498.00	40653.00	46054.00	57553.00	69479.00			
SURFACE AREA=	50.	51.	51.	52.	53.	54.	54.	55.	56.	56.
	57.	58.	59.	59.	60.	61.	63.			
CAPACITY=	0.	50.	101.	153.	206.	259.	313.	367.	422.	478.
	535.	592.	650.	709.	769.	890.	1015.			
ELEVATION=	285.	286.	287.	288.	289.	290.	291.	292.	293.	294.
	295.	296.	297.	298.	299.	301.	303.			

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
285.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
291.0	0.0	0.0	0.

END-OF-PERIOD HYDROGRAPH ORDINATES

MO.DA	HR.MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1.01	2.00	1	2.00	350.	349.	29.	285.6
1.01	4.00	2	4.00	350.	350.	29.	285.6
1.01	6.00	3	6.00	350.	350.	29.	285.6
1.01	8.00	4	8.00	350.	350.	29.	285.6
1.01	10.00	5	10.00	350.	350.	29.	285.6
1.01	12.00	6	12.00	350.	350.	29.	285.6
1.01	14.00	7	14.00	350.	350.	29.	285.6
1.01	16.00	8	16.00	375.	362.	30.	285.6
1.01	18.00	9	18.00	443.	409.	34.	285.7
1.01	20.00	10	20.00	538.	490.	41.	285.8
1.01	22.00	11	22.00	648.	592.	49.	286.0
1.02	0.00	12	24.00	767.	742.	56.	286.1
1.02	2.00	13	26.00	890.	857.	61.	286.2
1.02	4.00	14	28.00	1000.	974.	66.	286.3
1.02	6.00	15	30.00	1082.	1063.	69.	286.4
1.02	8.00	16	32.00	1184.	1156.	73.	286.4
1.02	10.00	17	34.00	1385.	1327.	80.	286.6
1.02	12.00	18	36.00	1730.	1634.	93.	286.8
1.02	14.00	19	38.00	2626.	2409.	119.	287.3
1.02	16.00	20	40.00	5262.	4705.	183.	288.6
1.02	18.00	21	42.00	10353.	9632.	288.	290.6
1.02	20.00	22	44.00	17309.	16612.	405.	292.7
1.02	22.00	23	46.00	25314.	24657.	517.	294.7
1.03	0.00	24	48.00	33850.	33224.	623.	296.5
1.03	2.00	25	50.00	42311.	41751.	721.	298.2
1.03	4.00	26	52.00	49733.	49307.	803.	299.6
1.03	6.00	27	54.00	55294.	54994.	863.	300.6
1.03	8.00	28	56.00	58721.	58565.	901.	301.2
1.03	10.00	29	58.00	59879.	59872.	914.	301.4
1.03	12.00	30	60.00	58446.	58611.	901.	301.2
1.03	14.00	31	62.00	54586.	54896.	862.	300.5
1.03	16.00	32	64.00	49596.	49922.	809.	299.7
1.03	18.00	33	66.00	44727.	45028.	758.	298.8
1.03	20.00	34	68.00	40288.	40580.	708.	298.0
1.03	22.00	35	70.00	36257.	36525.	662.	297.2
1.04	0.00	36	72.00	32620.	32872.	619.	296.5
1.04	2.00	37	74.00	29352.	29580.	580.	295.8
1.04	4.00	38	76.00	26414.	26630.	543.	295.1
1.04	6.00	39	78.00	23774.	23976.	508.	294.5
1.04	8.00	40	80.00	21402.	21581.	477.	294.0
1.04	10.00	41	82.00	19270.	19453.	447.	293.4
1.04	12.00	42	84.00	17353.	17504.	419.	292.9
1.04	14.00	43	86.00	15631.	15799.	393.	292.4

1.04	16.00	44	88.00	14083.	14211.	369.	292.0
1.04	18.00	45	90.00	12692.	12844.	345.	291.6
1.04	20.00	46	92.00	11442.	11554.	324.	291.2
1.04	22.00	47	94.00	10319.	10446.	304.	290.8
1.05	0.00	48	96.00	9309.	9421.	284.	290.5
1.05	2.00	49	98.00	8402.	8503.	267.	290.1
1.05	4.00	50	100.00	7586.	7686.	250.	289.8
1.05	6.00	51	102.00	6853.	6946.	234.	289.5
1.05	8.00	52	104.00	6195.	6276.	220.	289.3
1.05	10.00	53	106.00	5603.	5676.	207.	289.0
1.05	12.00	54	108.00	5071.	5154.	194.	288.8
1.05	14.00	55	110.00	4593.	4660.	182.	288.5
1.05	16.00	56	112.00	4163.	4227.	171.	288.3
1.05	18.00	57	114.00	3777.	3833.	161.	288.1
1.05	20.00	58	116.00	3430.	3483.	152.	288.0
1.05	22.00	59	118.00	3118.	3177.	142.	287.8
1.06	0.00	60	120.00	2837.	2886.	133.	287.6
1.06	2.00	61	122.00	2585.	2631.	126.	287.5
1.06	4.00	62	124.00	2359.	2399.	118.	287.3
1.06	6.00	63	126.00	2156.	2192.	112.	287.2
1.06	8.00	64	128.00	1967.	2001.	106.	287.1
1.06	10.00	65	130.00	1803.	1832.	101.	287.0
1.06	12.00	66	132.00	1656.	1695.	95.	286.9
1.06	14.00	67	134.00	1523.	1555.	90.	286.8
1.06	16.00	68	136.00	1405.	1434.	85.	286.7
1.06	18.00	69	138.00	1298.	1324.	80.	286.6
1.06	20.00	70	140.00	1202.	1225.	76.	286.5
1.06	22.00	71	142.00	1116.	1137.	72.	286.4
1.07	0.00	72	144.00	1026.	1049.	69.	286.4
1.07	2.00	73	146.00	946.	965.	65.	286.3
1.07	4.00	74	148.00	874.	892.	62.	286.2
1.07	6.00	75	150.00	717.	763.	57.	286.1
1.07	8.00	76	152.00	458.	548.	46.	285.9
1.07	10.00	77	154.00	364.	412.	34.	285.7
1.07	12.00	78	156.00	359.	361.	30.	285.6
1.07	14.00	79	158.00	354.	357.	30.	285.6
1.07	16.00	80	160.00	350.	352.	29.	285.6
1.07	18.00	81	162.00	350.	350.	29.	285.6
1.07	20.00	82	164.00	350.	350.	29.	285.6
1.07	22.00	83	166.00	350.	350.	29.	285.6
1.08	0.00	84	168.00	350.	350.	29.	285.6
1.08	2.00	85	170.00	350.	350.	29.	285.6
1.08	4.00	86	172.00	350.	350.	29.	285.6
1.08	6.00	87	174.00	350.	350.	29.	285.6
1.08	8.00	88	176.00	350.	350.	29.	285.6
1.08	10.00	89	178.00	350.	350.	29.	285.6
1.08	12.00	90	180.00	350.	350.	29.	285.6
1.08	14.00	91	182.00	350.	350.	29.	285.6
1.08	16.00	92	184.00	350.	350.	29.	285.6
1.08	18.00	93	186.00	350.	350.	29.	285.6
1.08	20.00	94	188.00	350.	350.	29.	285.6

1.08	22.00	95	190.00	350.	350.	29.	285.6
1.09	0.00	96	192.00	350.	350.	29.	285.6
1.09	2.00	97	194.00	350.	350.	29.	285.6
1.09	4.00	98	196.00	350.	350.	29.	285.6
1.09	6.00	99	198.00	350.	350.	29.	285.6
1.09	8.00	100	200.00	350.	350.	29.	285.6

PEAK OUTFLOW IS 59872. AT TIME 58.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	59872.	58413.	48592.	25817.	993500.
CMS	1695.	1654.	1376.	731.	28133.
INCHES		3.11	10.33	16.47	17.60
MM		78.87	262.43	418.29	447.13
AC-FT		28965.	96380.	153622.	164215.
THOUS CU M		35728.	118883.	189490.	202556.

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1

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	59879.	58490.	48589.	25815.	175.00
		(1695.59)	(1656.25)	(1375.90)	(731.00)	(453.25)
ROUTED TO	2	59872.	58413.	48592.	25817.	175.00
		(1695.38)	(1654.07)	(1375.96)	(731.06)	(453.25)

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	285.00	285.00	291.00
STORAGE	0.	0.	313.
OUTFLOW	0.	0.	10890.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.00	301.39	10.39	914.	59872.	50.00	58.00	0.00

1**********

COLOUT2 12:48 MAR 22,'79

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1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  11 JAN 79
 **********
1                          PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                  RUNOFF HYDROGRAPH AT          1
                                  ROUTE HYDROGRAPH TO           2
                                  END OF NETWORK


1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  11 JAN 79
 **********

 RUN  DATE= 79/03/22.
      TIME= 12.11.08.


                                  COLUMBIA DAM
                                  % PMF
                                  N.J. DAM INSPECTION

                                  JOB SPECIFICATION
      NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
     100        2        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     .40     .30     .20     .10

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

                                  SUB-AREA RUNOFF COMPUTATION

                COMPUTE HYDROGRAPH
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ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	175.00	0.00	175.00	.89	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.40	81.00	92.00	103.00	112.00	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= 19.80 CP= .62 NTA= 0

RECESSION DATA

STRTQ= -2.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 56 END-OF-PERIOD ORDINATES, LAG= 19.83 HOURS, CP= .62 VOL= 1.00

111.	415.	841.	1332.	1864.	2412.	2903.	3272.	3513.	3619.
3558.	3302.	2967.	2667.	2397.	2154.	1936.	1740.	1563.	1405.
1263.	1135.	1020.	917.	824.	740.	665.	598.	537.	483.
434.	390.	351.	315.	283.	254.	229.	206.	185.	166.
149.	134.	121.	108.	97.	87.	79.	71.	63.	57.
51.	46.	41.	37.	33.	30.				

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	22.20	17.07	5.13	993851.
										(564.)	(434.)	(130.)	(28142.73)

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

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. -1							
STAGE	285.00	286.00	287.00	288.00	289.00	290.00	291.00	292.00	293.00	294.0
	295.00	296.00	297.00	298.00	299.00	301.00	303.00			
FLOW	0.00	604.00	1838.00	3534.00	5609.00	8093.00	10890.00	14122.00	17705.00	21682.0
	25993.00	30606.00	35498.00	40653.00	46054.00	57553.00	69479.00			
SURFACE AREA=	50.	51.	51.	52.	53.	54.	54.	55.	56.	56.
	57.	58.	59.	59.	60.	61.	63.			
CAPACITY=	0.	50.	101.	153.	206.	259.	313.	367.	422.	478.
	535.	592.	650.	709.	769.	890.	1015.			
ELEVATION=	285.	286.	287.	288.	289.	290.	291.	292.	293.	294.
	295.	296.	297.	298.	299.	301.	303.			

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
285.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
291.0	0.0	0.0	0.

PEAK OUTFLOW IS 59872. AT TIME 58.00 HOURS

PEAK OUTFLOW IS 29933. AT TIME 58.00 HOURS

PEAK OUTFLOW IS 23941. AT TIME 58.00 HOURS

PEAK OUTFLOW IS 17965. AT TIME 58.00 HOURS

PEAK OUTFLOW IS 11962. AT TIME 58.00 HOURS

PEAK OUTFLOW IS 5983. AT TIME 58.00 HOURS

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1

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 .40	RATIO 4 .30	RATIO 5 .20	RATIO 6 .10
HYDROGRAPH AT	1	175.00	1	59879.	29940.	23952.	17964.	11976.	5988.
		(453.25)		(1695.59)(	847.79)(	678.23)(	508.68)(	339.12)(	169.56)(
ROUTED TO	2	175.00	1	59872.	29933.	23941.	17965.	11962.	5983.
		(453.25)		(1695.38)(	847.59)(	677.93)(	508.72)(	338.73)(	169.42)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	285.00	285.00	291.00
STORAGE	0.	0.	313.
OUTFLOW	0.	0.	10890.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	301.39	10.39	914.	59872.	50.00	58.00	0.00
.50	295.85	4.85	584.	29933.	34.00	58.00	0.00
.40	294.52	3.52	508.	23941.	28.00	58.00	0.00
.30	293.07	2.07	426.	17965.	22.00	58.00	0.00
.20	291.33	.33	331.	11962.	10.00	58.00	0.00
.10	289.15	0.00	214.	5983.	0.00	58.00	0.00

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 11 JAN 79
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APPENDIX 4

REFERENCES

COLUMBIA DAM

APPENDIX 4

REFERENCES

COLUMBIA DAM

1. Brater, Ernest F. and Kings, Horace W. Handbood of Hydraulics 5th Edition, McGraw-Hill Book Company 1963.

2. Chow, Ven Te, Ph.D, Open Channel Hydraulics, McGraw-Hill Book Company, 1959.

3. Eby, C.F., 1976 Soil Survey of Morris County, New Jersey, U.S. Department of Agriculture, Soil Conservation Service, 111 pp.

4. United States Dept. of Agriculture, Soil Conservation Service SCS National Engineering Handbood Section 4 Hydrology NEH-Notice 4-102, August 1972.

5. United States Dept. of Agriculture, Soil Conservation Service, Somerset, N.J. Urban Hydrology for Small Watersheds, Technical Release No. 55, January 1975.

6. United States Dept. of Commerce Weather Bureau, April 1956 Hydrometeorological Report No. 33, Washington, D.C.

7. United States Dept. of Interior, Bureau of Reclamation Design of Small Dams, Second Edition 1973, Revised Print 1977.

8. Widmer, K., 1964, The Geology and Geography of New Jersey, Volume 19, The New Jersey Historical Series, D. Van Nostrand Co., Inc. Princeton, New Jersey, 193 pp.

9. Wolfe, P.E., 1977, The Geology and Landscapes of New Jersey, Crane, Russak & Company, Inc., New York, New York, 351 pp.

10. Dams in New Jersey - Reference Data, dated 22 October 1928.

11. Letter from J.P. Mailler, Chief Engineer, New Jersey Power and Light Company, dated 7 September 1949.

12. Report on Dam Inspection by Norman C. Wittmen, Supervising Engineer, dated 30 January 1956.

Continued REFERENCES

DRAWING NO.	DRAWING TITLE	BY	DATE
Undiscernable	Sectional Plan of Power House at Paulins Kill Showing Re-enforcement	Meikleham & Dinsmore	Revised 11/2/09
Undiscernable	Front Elevation looking upstream of Power house at Paulins Kill showing Re-enforcement	"	Undiscernable
Undiscernable	Undiscernable (shows Section B-B)	"	Undiscernable
Undiscernable	Preliminary Lay-Out of Power House at Paulins Kill	"	Undiscernable
Undiscernable	Side Elevation of Power House at Paulins Kill showing re-enforcement	"	Revised 11/2/09
D-5016	Undiscernable (rear Elevation looking upstream)	"	Undiscernable
C-5364	Section B-B of Ransom Hollow Dam Across Paulins Kill	The Hydraulic Properties Co. 60 Brdwy. N.Y.	8/6/09
B-28-0	Foundation Detail	N.J. Power Light Co. Dover, N.J.	2/12/31
C-5359	Typical Section Thru Dam	" (WS Barstow Management Ass'n, Eng. Dept. Reading Penna.)	8/25/26 "
C-5362	Cross Sect. of Ransom Hollow Dam Across Paulins Kill for Warren County Power Co. Meikleham & Dinsmore Eng.	The Hydraulics Properties Co. 60 Brdwy. N.Y.	8/11/09 Retraced 9/27/ 9/27/26
N.J.P & L -36 Sheet 1 of 3	Columbia Hydro-Electric Property	N.J. Power and Light Co. Pennsylvania Edison Co.	6/20/28