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NATIONAL DAM SAFETY PROGRAM. MIDDLE BRANCH DAM (NY 00034), HUDS--ETC(U)
SEP 78 J J WILLIAMS DACW51-78-C-0035

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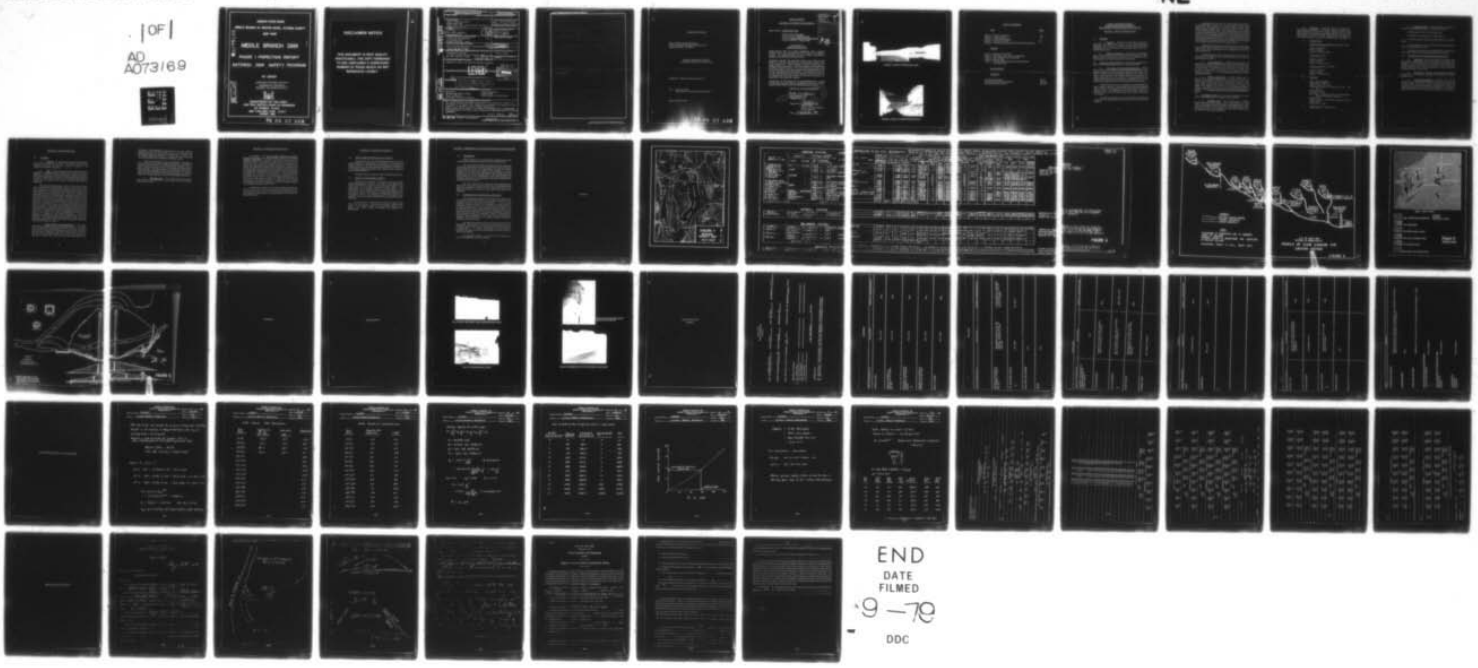

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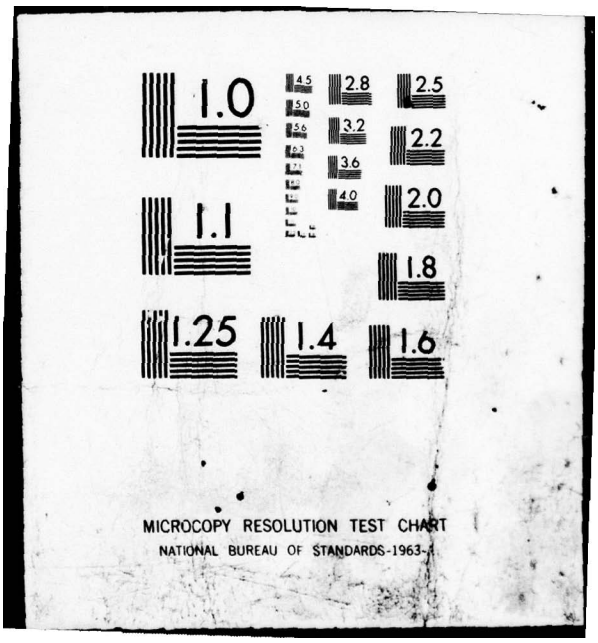
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HUDSON RIVER BASIN

MIDDLE BRANCH OF CROTON RIVER, PUTNAM COUNTY

NEW YORK

MIDDLE BRANCH DAM

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NY 00034

CONTRACT NO. DACW 51-78-C-0035

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

AUGUST 1978

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Hudson River Basin, Putnam County, New York
Inventory No. N.Y. 34

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National Dam Safety Program

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Dam Safety
National Dam Safety Program
Visual Inspection
Hydrology, Structural Stability
Middle Branch Dam
Putnam County
Middle Branch of Croton River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.
Middle Branch Dam was judged to be unsafe, non-emergency due to seepage and saturated ground at junction of west abutment and downstream slope of the earth embankment.

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HUDSON RIVER BASIN

Name of Dam: Middle Branch Dam
County and State: Putnam County, New York
Inventory Number: NY 00034

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by: O'Brien & Gere Engineers, Inc.

For: New York State
Department of Environmental Conservation

Date: August 17, 1978

PHASE I REPORT

NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Middle Branch Dam

State Located: New York
County Located: Putnam County
Stream: Middle Branch of the Croton River
Date of Inspection: July 17, 1978

ASSESSMENT OF GENERAL CONDITIONS

Middle Branch Dam is an earth embankment with a masonry corewall, about 615 feet long and 94 feet high at its maximum section. An ungated spillway and outlet channel, excavated in bedrock, are located west of the structure.

Significant seepage and saturated ground were noted at the junction of the west abutment and the downstream slope of the earth embankment. This condition should be monitored on a regular basis to determine if the flow increases or if discoloration and fines migration develop. The trees and brush growing on the downstream slope near the west abutment have a deleterious effect on the compacted earth embankment. This vegetation should be cut near the ground surface so that conditions of the abutment can be assessed, and the root systems of the trees investigated to determine if they should be removed.

Examination of the results of the hydrologic/hydraulic analysis indicates that the dam would be overtopped by all floods exceeding approximately 58 per cent of the Probable Maximum Flood.

O'BRIEN & GERE ENGINEERS, INC.

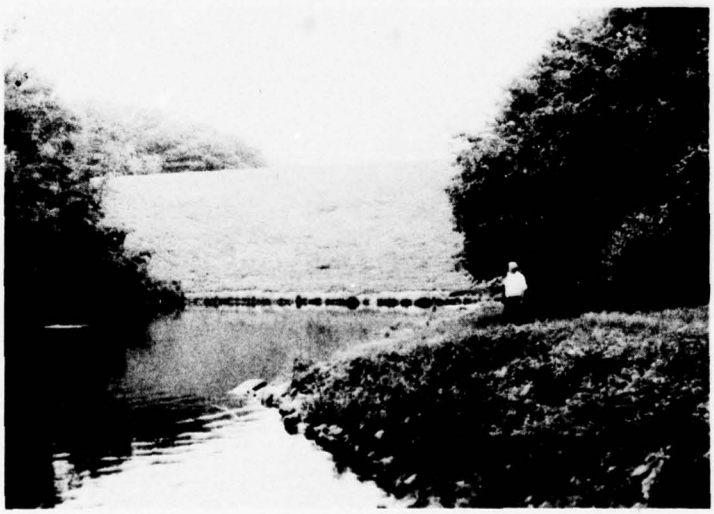
John J. Williams

John J. Williams, P.E.
Vice President

Approved by: Clark H. Benn
Clark H. Benn
Colonel, Corps of Engineers
District Engineer

Date: 21 September 1978

OVERALL VIEW OF UPSTREAM SLOPE



OVERALL VIEW OF DOWNSTREAM SLOPE

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM MIDDLE BRANCH DAM ID# 00034

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority - This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract #1467.021 between O'Brien and Gere Engineers, Inc. and the New York State Department of Environmental Conservation.

b. Purpose of Inspection - The purpose of this inspection is to evaluate the structural and hydraulic conditions of Middle Branch Dam and appurtenant structures, and to determine if the Dam constitutes a hazard to human life or property.

1.2 PROJECT DESCRIPTION (from information supplied by the New York City Department of Environmental Protection)

a. Description of Dam and Appurtenances - Middle Branch Reservoir is located in southeastern Putnam County and is about 1½ miles west of the Village of Brewster, New York. The dam is constructed across the Middle Branch of the Croton River which is also blocked by the Croton Falls Dam located about 2¼ miles downstream and to the southwest. The upper reaches of the Croton Falls impoundment extends to the downstream toe of the Middle Branch Dam and forms the stilling pond for outlet works.

Middle Branch Dam is a homogeneous, earth embankment with a masonry corewall. The structure has a maximum height of about 94 feet, is approximately 615 feet long and has a top width of about 50 feet. The upstream face of the dam is about 4.5 horizontal to 1 vertical; the downstream slope is about 3 horizontal to 1 vertical.

The spillway, located west of the embankment, consists of a 100 feet wide ungated flat crested, cut stone weir and an outlet channel.

Discharge from the reservoir is accomplished through two uncontrolled inlets located in a stone masonry intake tower upstream of the embankment. The flow passes through a brick lined, horseshoe shaped tunnel (8 feet by 8 feet) to a vault which houses two 36 inch gate valves. Two conduits, housed in a similarly constructed tunnel, continue downstream and, after passing through a stone masonry gatehouse adjacent to the downstream toe of slope, the two pipes bifurcate to four 20 inch diameter pipes. These pipes continue about 120 feet to the stilling basin where each one terminates as a vertical fountain-type orifice. Refer to Figure 5 for a plan and section drawing of the outlet works.

Middle Branch Reservoir is part of the Croton Water Supply System; the Dam and Appurtenance Structures are owned by the City of New York and operated by the Department of Environmental Protection.

The Middle Branch Dam, originally called Tilly Foster, was designed by The Aqueduct Commissioners, City of New York and was completed in 1878.

b. Size Classification - Middle Branch Reservoir was designed for a storage volume of 4.005 billion gallons (12,300 acre-feet) at the maximum operating pool elevation of 371.55 feet mean sea level (MSL). The dam has a maximum height of 94 feet. Both of these criteria place the structure in the intermediate size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

c. Hazard Classification - Middle Branch Dam is located about $2\frac{1}{4}$ miles upstream of the Croton Falls Dam. A failure or overtopping of the Middle Branch structure would allow flood waters to discharge into the downstream reservoir. This might cause failure or overtopping of the Croton Falls Dam and result in the possible loss of many lives and extensive property damage. Therefore, the structure is in the high hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams.

1.3 PERTINENT DATA (from information supplied by the City of New York, Department of Environmental Protection)

a. Drainage Area - The drainage area of Middle Branch Reservoir is 21.31 square miles. Lake Carmel is included within the drainage area and is located on the Middle Branch of the Croton River about 5 miles upstream of the Middle Branch Dam. The surface area of the reservoir at maximum operating pool (Elevation 371.55) is about 428.2 acres.

b. Discharges - Discharge from the reservoir is accomplished by means of two 36 inch manually operated gate valves located in the outlet gatehouse. Invert elevation of the outlet tunnel at the intake tower is 306.0 feet MSL. The maximum pool elevation of 375.55 feet MSL was recorded on October 16, 1955 and corresponds to a discharge of 2,640 cfs over the spillway.

c. Reservoir Data

Maximum Operating Pool (Reservoir at El. 371.55)

Length - 11,000 feet
Area - 428 acres
Volume - 12,300 acre-feet

Top of Dam (El. 380)

Length - 11,050 feet
Area - 429 acres
Volume - 16,150 acre-feet

Maximum Pool (PMF El. 382.75)

Length - 11,100 feet
Area - 430 acres
Volume - 17,100 acre-feet

d. Dam Data

Type - earth embankment
Top Elevation - 380 feet
Height - 94 feet (maximum)
Streambed elevation at centerline of dam - 303 feet
Length - 615 feet
Top Width - 50 feet
Side Slopes - upstream slope 4.5:1 (horizontal: vertical), downstream slope (3:1)
Zoning - none
Impervious Core - 8 feet thick masonry corewall
Cutoff - none
Grout Curtain - none

e. Outlet Works - See Section 1.2.a.

f. Engineering Data - The information available for review of Middle Branch Reservoir included the following:

1) Data Table - New York City Reservoirs,

2) Profile of Flow Diagram for Croton System,

3) Plan and Section Drawings of Dam, Spillway and Outlet Works,

4) Dam Report by the Conservation Commission, State of New York, dated August 6, 1915,

5) "Report of a Structure Impounding Water", State of New York, Department of State Engineer and Surveyor (undated).

1.4 OPERATING AND MAINTENANCE PROCEDURES

a. Operation - Two 36 inch diameter drain pipes, used for drawdown are controlled by means of gate valves located in the gatehouse at the downstream toe. According to Mr. John Birrell, Section Engineer, New York City Department of Environmental Conservation, the valves are exercised every six months. Reservoir elevation readings are taken daily.

b. Maintenance of Dam and Operating Facilities - According to Mr. Birrell, maintenance is performed on a "most needed" basis.

c. Flood Warning System - According to Mr. Birrell, inspection crews are placed on round the clock duty during periods of high runoff. Reservoir levels or unusual observations are reported to Mr. Birrell and the Deputy Chief Engineer. Mr. Birrell would contact local police and the Civil Defense for evacuation of downstream areas in the event of impending failure or overtopping.

SECTION 2 - VISUAL INSPECTION

2.1 FINDINGS

a. General - The field inspection of the Middle Branch Dam took place on July 17, 1978. The reservoir water surface elevation was about 370 feet MSL during the inspection. No underwater areas were inspected.

b. Dam - The riprap protecting the upstream slope is composed of subangular stone ranging from 6 inches to 2 feet in diameter. A number of shallow depressions exist in the upstream slope protection giving the surface a gently undulating character. A copse of small trees and brush, on an otherwise clear slope, is growing at the junction of the riprap and grass near the west abutments.

The grass covering the upper portion of the upstream slope, crest of embankment and downstream slope is mowed a few times a year according to Mr. John Birrell, Section Engineer, New York City, Department of Environmental Protection. No misalignments were observed on the downstream slope. However, a large area of saturated ground and several springs discharging rust-colored water were noted along the west abutment. This wet condition extends from about 20 feet below the crest of the dam to the toe of the downstream slope and is characterized by a lush growth of trees and brush. The seepage has cut a channel which conducts the flow down the intersection between the downstream slope and natural valley abutment. The total visible discharge at the toe of slope was estimated to be about 0.5 cubic feet per second (cfs) at time of inspection. The eastern end of the downstream slope and abutment area is also covered with trees and underbrush but there is no evidence of seepage or wet ground conditions. The outlet gatehouse is constructed within the downstream slope at the east abutment. The riprap protecting the downstream toe consists of large, flat stones (1 to 3 feet in diameter). Some grass and bushes are growing between the stones.

c. Intake Tower and Appurtenances - The stone masonry of the intake tower is in very good condition. According to Mr. Birrell, there are stoplog slots for each of the two inlets in the tower; the access hatch to the interior of the tower was bolted down at time of inspection. Mr. Birrell stated that the valves in the vault have not been operable for twenty years and that an attempt to operate them a few years ago was unsuccessful. The

downstream outlet gatehouse appeared to be in good condition; however, one of the two valves housed in the structure was discharging water in a fountain-like fashion from its stuffing box. Mr. Birrell stated that attempts to repack the valve have been unsuccessful and that it is scheduled for further repairs.

The cut stone blocks forming the spillway crest appear in good condition, but have been slightly undermined. Although the reservoir level was about six inches below the spillway crest at time of inspection, the joints were allowing some discharge into the outlet channel. The upper reach of the discharge channel has a very mild slope and supports a heavy growth of brush. The bedrock, which forms the base of the outlet channel, provides a non-uniform surface for energy dissipation at the exit of the spillway channel.

d. Reservoir Area - The natural ground surrounding the reservoir has a moderate to steep slope and is well covered with trees and brush.

SECTION 3 - HYDROLOGY/HYDRAULICS

According to the Recommended Guidelines for Safety Inspection of Dams, the Spillway Design Flood is the Probable Maximum Flood (PMF). The PMF was calculated from the 6 hour Probable Maximum Precipitation (PMP), using a loss rate of 0.1 inches per hour. The flood hydrograph was constructed from the Snyder unit hydrograph using average coefficients. Flood routing through the reservoir was performed assuming the gated outlets to be closed and the initial water surface elevation equal to the crest of the spillway. The peak inflow and outflow rates were calculated as 18,900 cfs and 18,200 cfs respectively. The peak outflow corresponds to a stage of 11.2 feet above the spillway crest (2.2 feet above the top of dam). Inflow and outflow peak rates for one-half of the PMF were calculated as 9,490 cfs and 7,300 cfs respectively. The spillway capacity was determined to be 8,910 cfs. Although the spillway capacity is insufficient to pass the PMF, it will safely discharge at least $\frac{1}{2}$ PMF.

A drawdown analysis was performed assuming discharge from the two 36 inch diameter pipes and the starting water surface at the spillway crest, and 2 cfs per square mile inflow (42.6 cfs). According to the calculations, complete drawdown of the reservoir would take 55 days.

SECTION 4 - STRUCTURAL STABILITY

4.1 VISUAL OBSERVATIONS AND DATA REVIEW

Visual inspection of the Middle Branch embankment did not reveal evidence of misalignments or settlement in the crest and slopes of the dam. However, the discolored seepage and saturated ground observed at the west abutment indicate the existence of uncontrolled seepage and possible fines migration which could lead to an unstable condition.

No design data was made available for Middle Branch Dam.

4.2 GEOLOGY AND SEISMIC STABILITY

Middle Branch Reservoir is located in the New England Uplands physiographic province. The rocks in this province are either metamorphic or igneous, and the land forms show a close relationship to the relative durability of these rocks. The embankment was constructed across the Middle Branch of the Croton River and is founded upon Precambrian metamorphic biotite and granitic gneiss. The spillway and discharge channel were constructed in the bedrock forming the north valley slope and are separated from the west dam abutment by an outcrop of the same formation.

No fault zones or lineaments are known to exist in the vicinity of the reservoir. The structure is located in Seismic Risk Zone 1 of the Seismic Zone Map of Contiguous States and it appears that static stability conditions are adequate for earthquakes.

SECTION 5 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

5.1 ASSESSMENT

Visual inspection and analysis of the available information reveals that the embankment has a potential piping problem.

The uncontrolled seepage and saturated ground along the downstream slope near the west abutment is indicative of possible fines migration through the embankment or along the contact between the structure and natural valley abutment. It is also possible that the rust colored seepage is from discharge channels which may have formed through joints in the bedrock abutment. The discoloration may be attributable to iron oxides resulting from chemical weathering of ferromagnesian minerals contained within the local bedrock formation.

The root systems of the trees and brush growing on the downstream face near the west abutment have a deleterious effect upon the compacted materials in the embankment and provide seepage paths which may lead to future piping and failure of the structure.

5.2 RECOMMENDATIONS/REMEDIAL MEASURES

The uncontrolled seepage on the downstream slope of the west abutment should be monitored on a regular basis to see if flow increases or if fines migration can be detected. If either of these conditions develop, a subsurface investigation program should be initiated at several sections of the embankment with emphasis in the west abutment areas. The investigation should include, but not be limited to, the determination of the composition and in situ properties of the embankment, corewall and foundation materials, and to detect possible fines migration. Results of this program should be used to establish if the materials are satisfactory as designed and constructed; and to perform seepage and stability analyses of the embankment.

The trees and brush growing on the western portion of the downstream slope should be cut near the ground surface so that conditions at this location can be further assessed and monitored on a regular basis. A further investigation should be made to determine the extent of the root systems before remedial measures can be recommended.

The inoperable valves in the vault and the leaking gate valve in the gatehouse should be repaired.

FIGURES

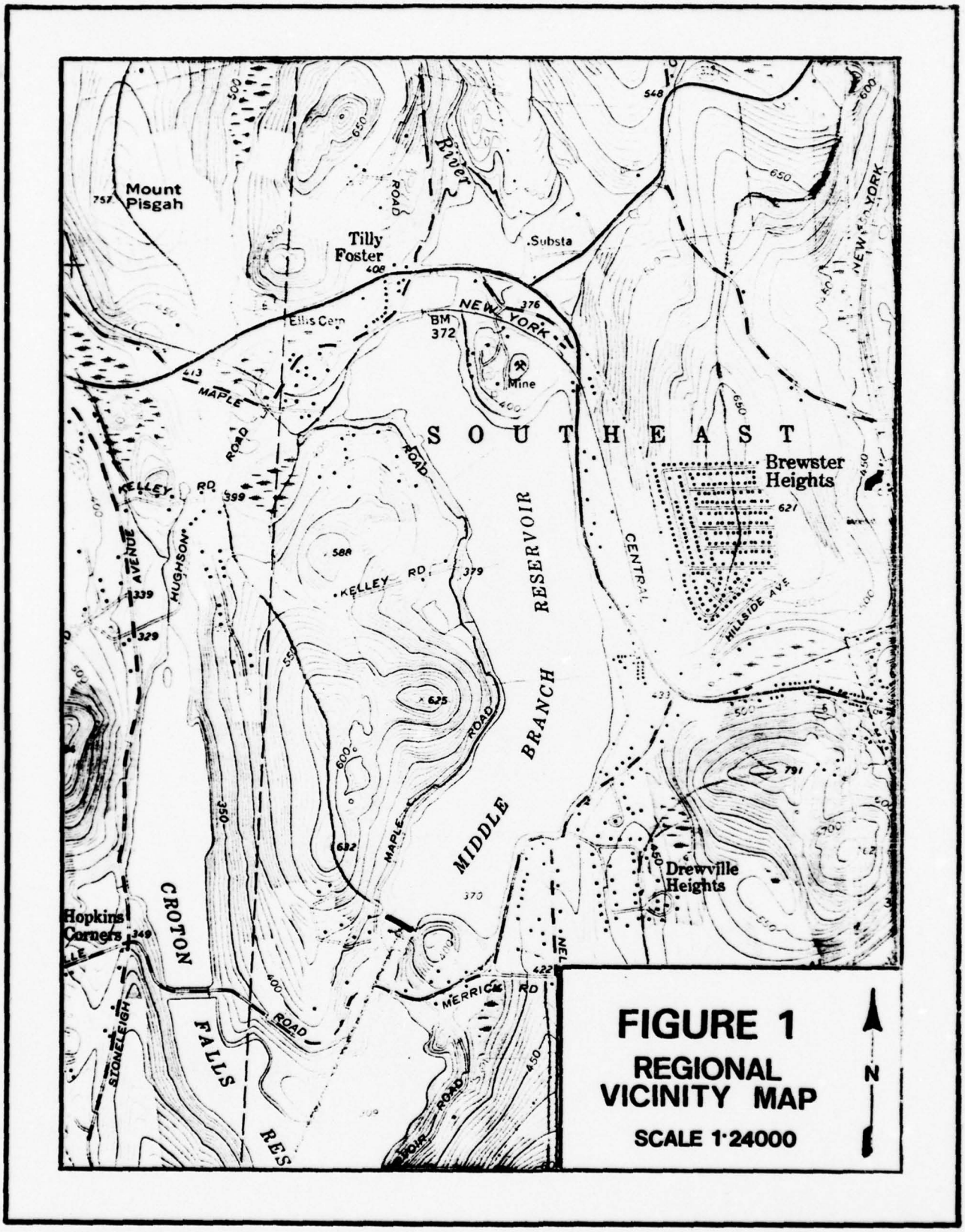


FIGURE 1

REGIONAL VICINITY MAP

SCALE 1:24000

CROTON SYSTEM DATA

Name of Reservoir	Location: Town	Location: County	Drainage Area: Sq Mi	Drainage Area: Includes Items	Date Put in Service	Kind
1 BOYDS CORNERS	KENT	PUTNAM	23.46	1	1873	MASONRY, EARTH
2x BARRETTS POND			0.5[illegible]	2	[illegible]	EARTH
3x LAKE GLENEIDA	CARMEL	"	0.68	3	1870	EARTH
4 WEST BRANCH (Carmel)	"	"	42.87	1 to 4	1895	EARTH, MASONRY
5 WEST BRANCH	"	"				"
6 MIDDLE BRANCH	SOUTHEAST	"	21.31	5	1878	EARTH, MASONRY
7 BOG BROOK	"	"	3.67	6	1892	" "
8 EAST BRANCH (Sodom)	"	"	80.26	6 & 7	1891	MASONRY, EARTH
9 CROTON FALLS (Diverting)	"	"	87.58	6 to 8	1911	EARTH, CONCRETE
10x LAKE GILEAD	CARMEL	"	0.62	9	1870	EARTH
11 CROTON FALLS	"	"	168.64	4,5,8,9,10	1911	CYCLOPEAN MA[illegible]
12x LAKE KIRK	"	"	2.84	11	1870	EARTH
13 AMAWALK	SOMERS	WESTCHESTER	19.13	10 to 12	1897	EARTH, MASONRY
14 TITICUS	NORTH SALEM	"	23.33	13	1893	MASONRY, EARTH
15 CROSS RIVER	BEDFORD	"	29.80	14	1908	CYCLOPEAN MA[illegible]
16 MUSCOOT	SOMERS & BEDFORD	"	315.73	10 to 15	1905	MASONRY
17 NEW CROTON	CORTLAND	"	375.00	1 to 16	1905	MASONRY
x Controlled Lakes			CROTON TOTALS			

CATSKILL SYSTEM

Name of Reservoir	Location: Town	Location: County	Drainage Area: Sq Mi	Drainage Area: Includes Items	Date Put in Service	Kind
1 ASHOKAN	OLIVE BRIDGE	ULSTER	2[illegible].00	1	1915	MASONRY
2 SCHOHARIE	GILBOA	GREENE	314.00	2	1926	MASONRY
CATSKILL TOTALS						

DELAWARE SYSTEM

Name of Reservoir	Location: Town	Location: County	Drainage Area: Sq Mi	Drainage Area: Includes Items	Date Put in Service	Kind
1 NEVERSINK	NEVERSINK	SULLIVAN	93.0	1	1953	EARTH, CONCRE[illegible]
2 PEPACTON	COLCHESTER ANDES & MIDDLETOWN	DELAWARE	372.0	2	1954	" "
3 CANNONSVILLE	DEPOSIT, TOMPKINS & WALTON	DELAWARE	450.0	3	1967	" ROLLE[illegible]
4 RONDOUT	WARWARSING, NEVERSINK	ULSTER, SULLIVAN	95.0, [illegible]	1 to 4	1951	" CONCRE[illegible]
DELAWARE TOTALS						

KENSICO RESERVOIR

Name of Reservoir	Location: Town	Location: County	Drainage Area: Sq Mi	Drainage Area: Includes Items	Date Put in Service	Kind
KENSICO	[illegible] NO CASTLE	WESTCHESTER	13.33		1915	MASONRY

A PERTAINING TO N.Y. CITY RESERVOIRS

THE IMPOUNDING RESERVOIRS BELONG TO T
OPERATING LEVEL & 568.0 BILL GAL. (AVAILA

of Dam	Capacity (Bill Gal.): Total Available (Above Sill or Outlet)	Capacity (Bill Gal.): Vol Dept Ft Above Min Op Level	Area of Water Surface at Spillway Elev.: Sq Mi	Area of Water Surface at Spillway Elev.: Acres	Length of Shoreline Miles	Elev. of Spillway M.S.L. Sandy Hook Feet	Elev. of Pt. of Max Depl (Min Oper Level) Feet	Elev. of Sill or Outlet Feet	Depth Spillway to Outlet Feet
[illegible] WINGS	1.696		0.464	296.9	6.2	560.05		536.7	43.4
	0.170		0.106	[illegible]	.4	778.55		768.6	10.0
	0.165		0.264	168.9	2.2	504.55		499.6	5.0
[illegible] CORE & SPILLWAY	10.070		1.692	1082.8	15.6	503.2		455.6	47.0
AUXILIARY DAM						514.55 Top		466.1	
[illegible] CORE	4.005		0.669	428.2	6.82	371.55		310.5	61.1
"	4.400		0.640	399.0	4.9	416.55	UNKNOWN	365.1	51.5
[illegible] WINGS	5.243		0.898	556.8	10.5	416.55		351.8	65.0
[illegible]TE CORE & SPILLWAY	0.886		0.240	153.6	4.2	309.55		275.8	33.0
	0.360		0.191	122.2	2.1	496.55		480.6	16.0
[illegible]SONRY	14.192		1.660	1082.4	18.0	309.4		214.8	95.0
	0.565		0.158	101.1	3.1	582.55		[illegible]	18.0
[illegible] CORE	6.692		0.947	606.1	8.5	399.55		334.6	65.0
[illegible] WINGS W/ MASONRY CORE	7.167		1.046	669.4	8.1	324.5		249.6	75.0
[illegible]ASONRY, CONCRETE FACES	10.308		1.202	769.2	12.9	329.55		224.6	108.0
	4.914		1.822	1166.1	35.0	190.55		164.6	30.0
	25.787		3.550	2259.2	38.0	195.55		159.6	36.0
	94.637	86.6	15.531	9911.0	177.52				
	127.858	122.9	12.99	8315.2	40.2	[illegible]	UNKNOWN	[illegible] 308.80	[illegible] 37.73
	19.583	17.6	1.79	1145.0	16.5	1130.0	"	1050.0	80.00
	147.441	140.5	14.78	9460.2	56.5				
[illegible]ETE CORE	35.466	34.9	2.3	1470	16.5	1440.00	1319.03	1314.00	126.00
"	143.701	140.2	8.9	5700	53.5	1280.00	1152.00	1143.00	137.00
[illegible]D FILL	96.726	95.7	7.5	4800	53.5	① 1150.00 ② 1158.00	1040.00	1035.00	① 115.00
[illegible]ETE CORE	50.048	49.6	3.25	2030	17.0	840.00	723.00	720.00	120.00
	325.941	320.4	21.95	14030	140.5	① LOW WEIR ② HIGH "			
[illegible] A SAFETY OR INTERMEDIATE STORAGE RES FOR ALL OF THE CATSKILL & DELAWARE SUPPLIES									
	30.573	UNKNOWN	3.47	2210.3	30.0	357.00	UNKNOWN	295.32	61.63

... THE CROTON, CATSKILL & DELAWARE SYSTEMS TOTALLING 547.5 BIL. GAL. ABOVE MIN.
...ILABLE ABOVE SILL. AN ADDITIONAL 30.6 BILL. GAL. IS STORED IN A SAFETY STORAGE RES. KENSI...

...pth ...way ...uliet ...et	Dead Storage Billion Gallons	Length of Spillway Feet	Max Depth Below Spillway Feet	Max Hgt of Main Dam: Above Lowest Foundation Feet	Max Hgt of Main Dam: Above Natural Surface Feet	Width of Dam Feet: Top	Width of Dam Feet: Bott.	Length of Dam Feet: Total	Length of Dam Feet: Masonry Portion
.4	UNKNOWN	135.0	UNKNOWN	78.0	57.0	6.60	53.60	670.0	670.0
.0									
.C									
.0		260.0		66.0	62.0	15.00	307.50	1794.5	260.0
		NO SPILLWAY		65.0	50.0	23.00	240.00	741.0	
.1		100.0		94.0		50.00	660.00	615.0	100.0
.5				N 60.8 S 33.8	47.8 23.8	[illegible] 72.00	[illegible] 173.38	1358.8 1358.8	
.0		500.0		98.0	78.0	12.00	53.00	1100.0	500.0
.0		1000.0		51.0	45.0	15.00	240.00	2190.0	1000.0
.0									
.0		700.0		173.0	113.0	23.00	118.00	1300.0	1100.0
.0									
.0		50.0			62.0	55.00	656.00	1270.0	50.0
.0		230.0		135.0	104.0	23.70	75.21	1319.0	[illegible]
.0		240.0		170.0	126.0	23.00	116.30	1060.0	670.0
.0		950.0		56.0		4.00	40.00	1150.0	1153.0
.0		1000.0		297.0	174.0	18.00	206.00	2168.0	2168.0

REMA...

Most of the Cr... carried by th... Aqueduct

...78	4.137	950.0	[illegible]	252.0	210.0	26.33	200.00	4650.0	1000.0
...00		1324.0	150.0	182.0	155.0	15.00	158.00	2280.0	2000.0

Schoharie wate... Tunnel to A... enter the Catskil...

.00	1.680	600.0	175.00	345.0	195.0	60.00	1392.00	2620.0	NONE
.00	6.000	800.0	180.00	304.0	204.0	60.00	1460.00	2450.0	"
.00	1.892	D 240.0 D 560.0	76.00 S 7 W 2.00	196.0	179.0	45.00	1312.00	2600.0	"
.00	2.387	600.0	175.00	375.0	195.0	60.00	1392.00	2400.0	"

Neversink, Pep... are conveyed ... & W. Delaware ... Thence all Fou...

...ES ALSO SOME OF THE CROTON SUPPLY (SEE REMARKS).

63	UNKNOWN	50.0	155.50	307.0	168.0	23.00	235.00	1643.0	1643.0

Of the Croton S... plus pumpag... Falls flows in...

2 1'

3

Comp J.J.D
Drawn J.P.D.

MARKS
Croton Supply is
the New Croton

er is conveyed by the Shandaken
Croton Res. Thence both supplies
Will Aqueduct.

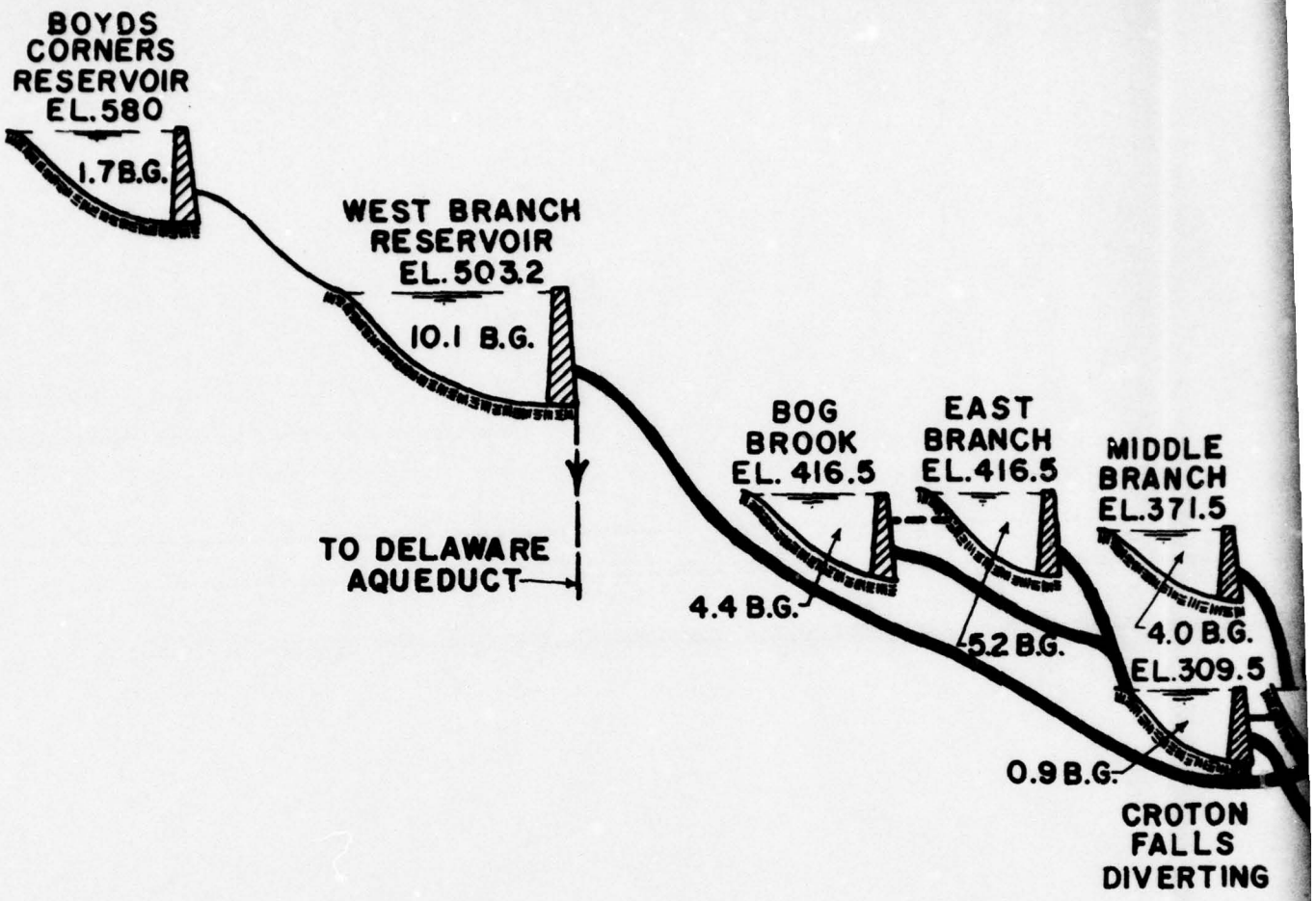
raction & Cannonsville supplies
via the Neversink, East Delaware
Tunnels to the Rondout Res.
ur supplies enter the Del. Aqueduct.

FIGURE 2

Supply, all of the West Branch
Upper Croton Cross River & Croton
to Kensico Reservoir

Acc NS

4



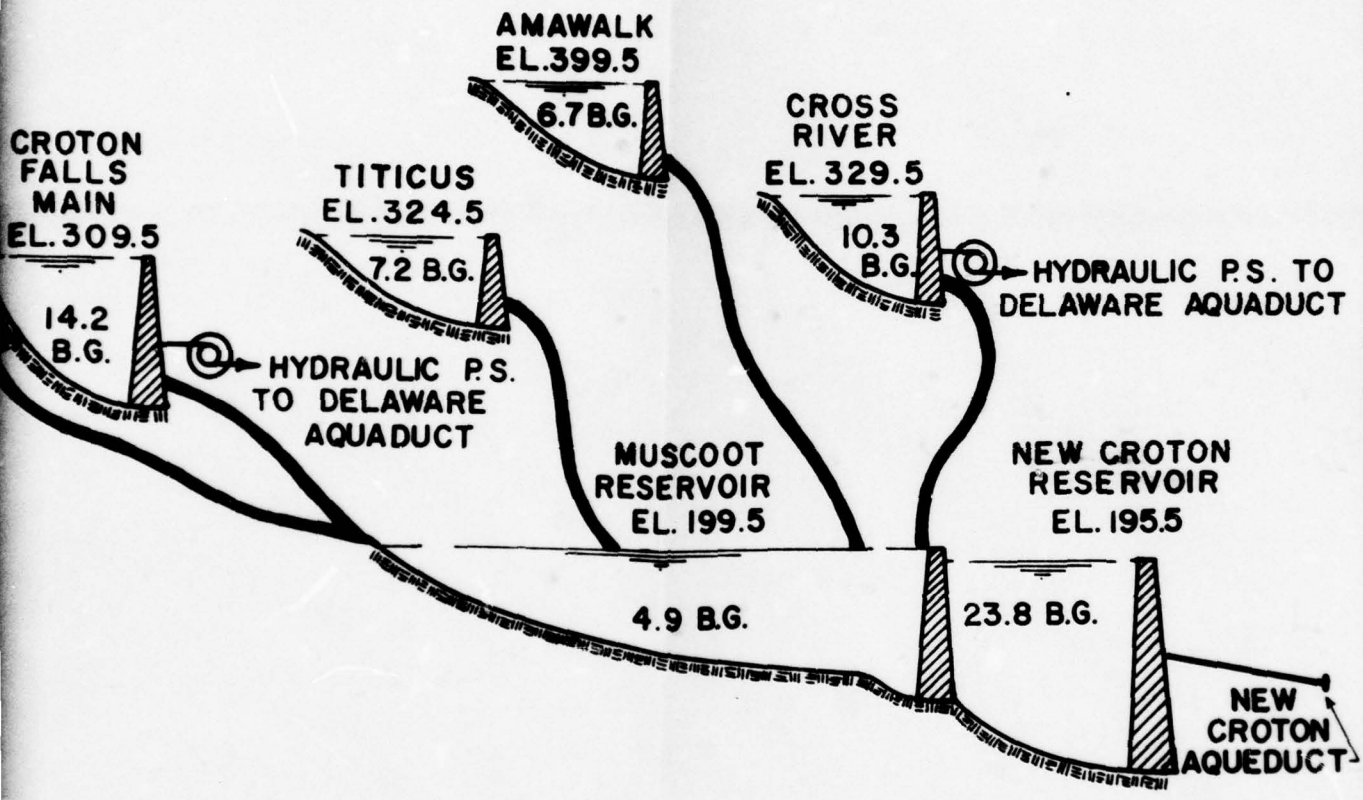
LEGEND

= NATURAL WATER COURSE.
= TUNNEL AQUEDUCT.
= GRADE AQUEDUCT.

NOTE

ELEVATIONS OF RESERVOIRS ARE AT MASONRY CREST OF SPILLWAY.
FIGURES SHOWN IN RESERVOIRS ARE CAPACITIES IN BILLION GALLONS.

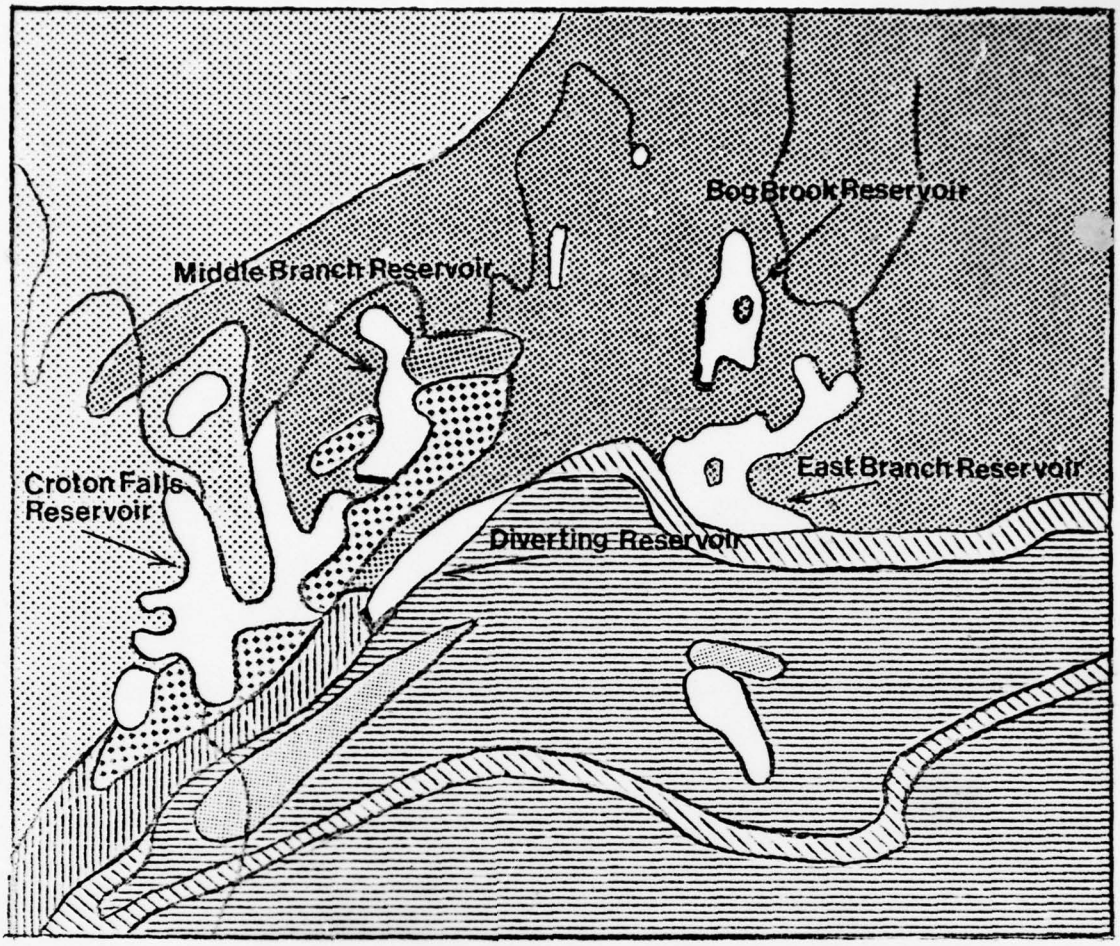
ELEVATIONS REFER TO M.S.L. SANDY HOOK.



CITY OF NEW YORK
BUREAU OF WATER SUPPLY

PROFILE OF FLOW DIAGRAM FOR CROTON SYSTEM

FIGURE 3



Scale: 1 inch = 1.7 miles

bqpc - biotite, quartz, plagioclase

Xi - marble

Am - Amphibolite

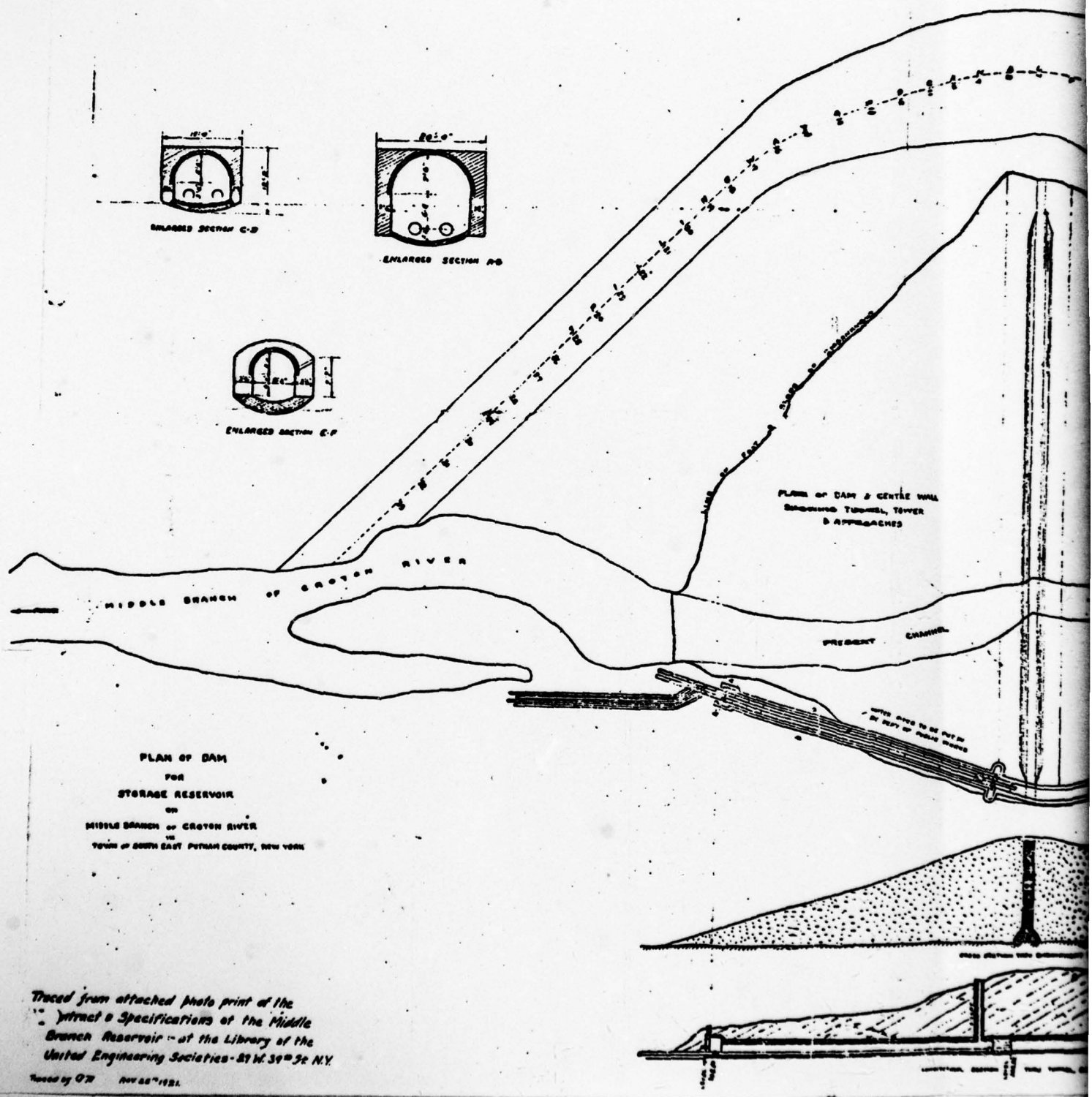
bg - biotite, granitic gneiss

qtcs - quartz, feldspar, gneiss

Xm - schistose gneiss

Xgb - gabbro, hornblende, gneiss

Figure 4
Geologic Map



PLAN OF DAM

FOR

STORAGE RESERVOIR

ON

MIDDLE BRANCH OF CROTON RIVER

IN

TOWN OF SOUTH EAST PUTNAM COUNTY, NEW YORK

Traced from attached photo print of the Contract & Specifications of the Middle Branch Reservoir at the Library of the United Engineering Societies - 29 W. 39th St. N.Y.

Traced by O.T. Nov 25th 1921.

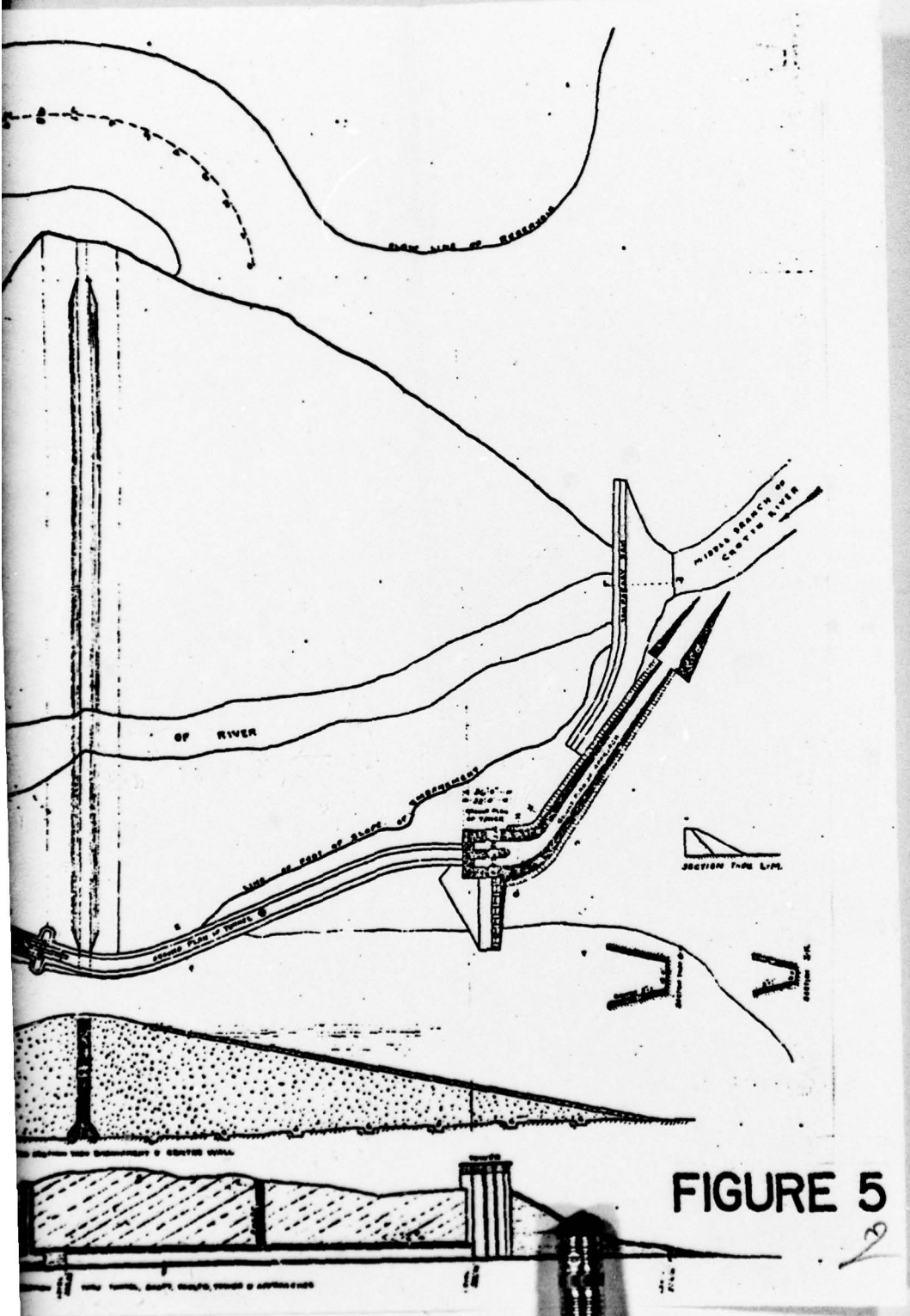


FIGURE 5

APPENDIX

PHOTOGRAPHS

SOUTHEAST ABUTMENT AND DOWNSTREAM SLOPE

TOE OF DOWNSTREAM SLOPE

WATER DISCHARGING FROM
36 INCH GATE VALVE

HEAVY OVERGROWTH AT NORTHWEST ABUTMENT

FIELD INSPECTION
REPORT

Check List
Visual Inspection
Phase 1

Name Dam Middle Branch Dam County Putnam State New York Coordinators --------

Date(s) Inspection July 17, 1978 Weather Overcast Temperature 75°

Pool Elevation at Time of Inspection 370 M.S.L. Tailwater at Time of Inspection ------ M.S.L.

Inspection Personnel:

Mr. George Elias

Mr. David Campbell

Mr. Steve Snider

Mr. Steve Snider Recorder

Accompanied by:

Mr. John Birrell - Section Engineer, New York City Department of Environmental Protection
Mr. Edward Stoorza - Section Foreman, New York City Department of Environmental Protection

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None noted.	None.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noted.	None.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None noted.	None.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	None noted.	None.
RIPRAP FAILURES	None noted.	None.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Some seepage noted at the west abutment. Ground surface was moist and saturated in some locations.	A study should be undertaken to determine the cause and source of seepage.
ANY NOTICEABLE SEEPAGE	See above.	See above.
STAFF GAGE AND RECORDER	N/A	
DRAINS	N/A	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	N/A	
INTAKE STRUCTURE	Stone deck of intake tower prohibits access to interior of structure.	None.
OUTLET STRUCTURE	One of the gate valves was discharging water from its stuffing box.	Repair gate valve.
OUTLET CHANNEL	Discharge from the outlet conduits flows directly into the Croton Falls Reservoir.	None.
EMERGENCY GATE	See "Outlet Structure"	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	No problems noted.	None.
SEDIMENTATION	None noted.	None.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The cut stone blocks forming the spillway crest have been slightly undermined.	None.
APPROACH CHANNEL	No problems noted.	None.
DISCHARGE CHANNEL	Heavy growth of brush on upper reach of channel.	None.
BRIDGE AND PIERS	N/A	

ITEM	REMARKS
MONITORING SYSTEMS	Personnel from the New York City Department of Environmental Protection operate and monitor operation of the reservoir.
MODIFICATIONS	None.
HIGH POOL RECORDS	Maximum pool of record was 375.55 feet MSL recorded on October 16, 1955.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None available.
MAINTENANCE OPERATION RECORDS	None available.

HYDROLOGIC/HYDRAULIC CALCULATIONS

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 1 OF 8
DATE 7/19/78
COMP. BY LW
CHECKED BY DBC

NAME OF CLIENT NYSDEC
PROJECT MIDDLE BRANCH RESERVOIR

PMP east of the 105° meridian for an area of 10 sq. miles and 6 hou
duration is 24" according to Design of Small Dams, SCS, Fig. 15

Drainage Area = 21.31 sq. miles

Reduction in order to provide for imperfect "fit" of storm isohyetal patterns to the shape of a particular basin.

Reduction Factor - 18.6 %

6-hr. PMP = 24 inches * 0.814 = 19.536

Figure 16, Zone 1:

6 hr. PMP = 19.536 * 0.92 = 18.0 inches

12 hr. PMP = 19.536 * 1.04 = 20.3 inches → -18.0 = 2.3

24 hr. PMP = 19.536 * 1.13 = 22.0 inches → -20.3 = 1.7"

$$t_p = C_t (L * L_{ca})^{0.3}$$
$$= 2.0 (15 * 7)^{0.3} = 8.08 \text{ hr.}$$

$t_r = t_p / 5.5 = 1.47$ hrs. Use: $t_R = 1.5$ hrs.

$t_{PR} = t_p + 0.25 (t_R - t_r) = 8.08 + 0.25(1.5 - 1.47) = 8.09$ hrs.

6 HR. - 18 inch PMP Distribution

Time (hrs)	Fig. 18 (Zone C) % of 6hr. PMP	Accumulate PMP	Increment
0-1.5	57.0	10.3	10.3
1.5-3.0	76.0	13.7	3.4
3.0-4.5	88.0	15.9	2.2
4.5-6.0	100.0	18.0	2.1
6.0-7.5			0.6
7.5-9.0			0.6
9.0-10.5			0.6
10.5-12.0			0.5
12.0-13.5			0.3
13.5-15.0			0.2
15.0-16.5			0.2
16.5-18.0			0.2
18.0-19.5			0.2
19.5-21.0			0.2
21.0-22.5			0.2
22.5-24.0			0.2

THIRD QUARTILE DISTRIBUTION

Time (hrs.)	Adjusted PMP Increments	Σ PMP
0-1.5	0.2	0.2
1.5-3.0	0.2	0.4
3.0-4.5	0.2	0.6
4.5-6.0	0.2	0.8
6.0-7.5	0.2	1.0
7.5-9.0	0.3	1.3
9.0-10.5	0.6	1.9
10.5-12.0	0.6	2.5
12.0-13.5	2.1	4.6
13.5-15.0	3.4	8.0
15.0-16.5	10.3	18.3
16.5-18.0	2.2	20.5
18.0-19.5	0.6	21.1
19.5-21.0	0.5	21.6
21.0-22.5	0.2	21.8
22.5-24.0	0.2	22.0

Discharge capacity for outlet pipes:

$$H = \frac{V^2}{2g} + K_e \frac{V^2}{2g} + K_b \frac{V^2}{2g} + K_v \frac{V^2}{2g} + h_f$$

H = available head

K_e = entrance loss coefficient

K_b = bend loss coefficient

K_v = value loss coefficient

$$h_f = 2.87\, n^2 \frac{L V^2}{d^{4/3}} \qquad (6\text{-}262)\ \text{Brater}$$

$$= 2.87\,(0.013)^2 \frac{500\,(2g)}{\left(\frac{30}{12}\right)^{4/3}} \cdot \frac{V^2}{2g} = 4.6 \frac{V^2}{2g}$$

$K_e = 0.5 \qquad K_b = 0.08 \qquad K_v = 0.07$

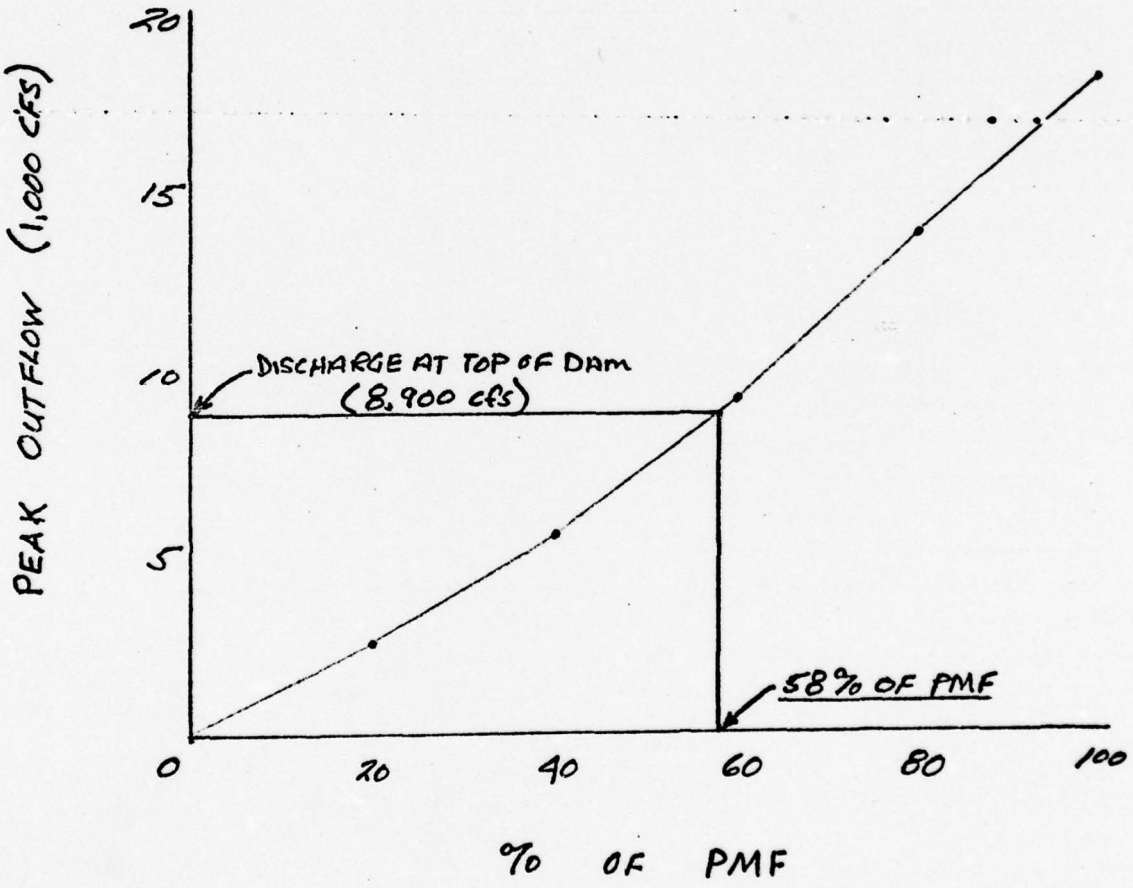
$$H = 6.25 \frac{V^2}{2g}$$

$$= 6.25 \cdot \frac{Q^2}{2\pi g \left(\frac{30}{12}\right)^2} = 0.0049427\, Q^2$$

$$Q = 14.1\, H^{1/2}$$

Area of water surface at Spillway Crest is 428.2 acres

ΔH (ft.) Above spillway crest	$Q_{spillway} = (3.3)100 H^{3/2}$	STORAGE (A-F) Above spillway crest	$Q_{dam} = (3.3)615(H-9)^{3/2}$	ΣQ
0	0	0	0	0
1	330	428.2	0	330
2	933	856.4	0	933
3	1715	1284.6	0	1715
4	2646	1712.8	0	2640
5	3690	2141.0	0	3690
6	4850	2569.2	0	4850
7	6112	2997.4	0	6112
8	7467	3425.6	0	7467
9	8910	3853.8	0	8910
10	10436	4282.0	2030	12466
11	12039	4710.2	5740	17779
12	13718	5138.4	10546	24264


PEAK OUTFLOW (1,000 CFS)
20
15
10
5
0
DISCHARGE AT TOP OF DAM
(8,900 CFS)
58% OF PMF
20
40
60
80
100
% OF PMF

Capacity = 4.005 Billion gallons

= 4005 Million gallons

= 4005 (3.0689) Acre-Feet

= 12,291 A-F

Size Classification - Intermediate

Storage : $1000 \leq 12,291 < 50,000$ A-F

HEIGHT : $40 \leq 94 < 100$ Feet

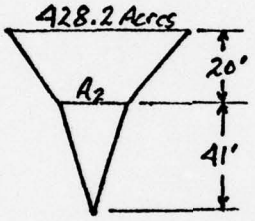
Maximum spillway capacity without overtop the Dam is 8910 cfs; about 74% of PMF · Outflow Peak Discharge

Depth - spillway to outlet = 61 feet

Volume of reservoir = 12,291 acre-feet

$Q = 2(14.1)\,H^{0.5}$ $\quad Q_B$ (Base Flow) = 2(cfs/sq.mile) 21.3 (sq.mile)

= 42.6 CFS



$V = 12291 = (428.2 + A_2)/2(20) + A_2/2(41)$

$A_2 = 262.6$ acres

(ft.) ΔH	(ft.) $H_{Avg.}$	(cfs) $Q_{Avg.}$	(cfs) Q_{Net}	(acres) Avg. Area	(hrs.) Δt	(hrs.) $\Sigma \Delta t$
10	56	211	168	386.8	278	278
10	46	191	148	304.0	249	527
10	36	169	126	231.0	222	749
10	26	144	101	167.0	200	949
10	16	113	70	102.0	176	1125
11	5.5	66	23	35.0	203	1328

$\therefore$ TIME OF DRAWDOWN = 1328/24 $\cong$ 55 Days

HEC-1 VERSION DATED JAN 1973
UPDATED AUG 74
CHANGE NO. 01

NATIONAL DAM INSPECTION PROGRAM
MIDDLE BRANCH RESERVOIR
PMF HYDROGRAPH

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
50	1	30	1	0	0	0	0	2	0

JOPER NRT
5 0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1
RTIOS= .20 .40 .60 .80 1.00

SUB-AREA RUNOFF COMPUTATION

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	0

HYDROGRAPH DATA

IHYDG	IJHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	1	21.31	0.00	0.00	0.00	0.000	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
16	0.00	0.00	0.00

PRECIP PATTERN

.20	.20	.20	.20	.20	.30	.60	.60	2.10	3.40
10.30	2.20	.60	.50	.20	.20				

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	1.00	0.00	0.00	1.00	0.00	.10	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 8.09 CP= .63 NTA= 0

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 6.30 AND R= 4.89 INTERVALS

UNIT HYDROGRAPH 30 END-OF-PERIOD ORDINATES, LAG= 8.07 HOURS, CP= .63 VOL= 1.00

76.	277.	545.	814.	1006.	1072.	985.	815.	663.	540.
440.	358.	292.	238.	193.	158.	128.	104.	85.	69.
56.	46.	37.	30.	25.	20.	16.	13.	11.	9.

END-OF-PERIOD FLOW

	TIME	RAIN	EXCS	COMP Q
1	1 30	.20	.05	4.

1	7	30	.20	.05	136.
1	8	60	.30	.15	197.
1	10	30	.60	.45	297.
1	11	60	.60	.45	475.
1	13	30	2.10	1.95	868.
1	14	60	3.40	3.25	1754.
1	16	30	10.30	10.15	3883.
1	17	60	2.20	2.05	7553.
1	19	30	.60	.45	11906.
1	20	60	.50	.35	15894.
1	22	30	.20	.05	18450.
1	23	60	.20	.05	18976.
2	1	30	0.00	0.00	17464.
2	2	60	0.00	0.00	14846.
2	4	30	0.00	0.00	12290.
2	5	60	0.00	0.00	10082.
2	7	30	0.00	0.00	8233.
2	8	60	0.00	0.00	6710.
2	10	30	0.00	0.00	5465.
2	11	60	0.00	0.00	4450.
2	13	30	0.00	0.00	3624.
2	14	60	0.00	0.00	2951.
2	16	30	0.00	0.00	2403.
2	17	60	0.00	0.00	1957.
2	19	30	0.00	0.00	1593.
2	20	60	0.00	0.00	1297.
2	22	30	0.00	0.00	1056.
2	23	60	0.00	0.00	860.
3	1	30	0.00	0.00	700.
3	2	60	0.00	0.00	569.
3	4	30	0.00	0.00	463.
3	5	60	0.00	0.00	376.
3	7	30	0.00	0.00	303.
3	8	60	0.00	0.00	244.
3	10	30	0.00	0.00	184.
3	11	60	0.00	0.00	126.
3	13	30	0.00	0.00	30.
3	14	60	0.00	0.00	9.
3	16	30	0.00	0.00	4.
3	17	60	0.00	0.00	1.
3	19	30	0.00	0.00	0.
3	20	60	0.00	0.00	0.
3	22	30	0.00	0.00	0.
3	23	60	0.00	0.00	0.
4	1	30	0.00	0.00	0.
4	2	60	0.00	0.00	0.
		SUM	22.00	19.60	178838.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	18976.	17696.	10174.	3726.	178838.
INCHES		7.72	17.76	19.52	19.52
AC-FT		9779.	20190.	22181.	22181.

HYDROGRAPH AT STA 1 FOR PLAN 1. RTIO 1

1.	4.	9.	17.	27.	39.	59.	95.	174.	351.
778.	1511.	2381.	3179.	3690.	3795.	3493.	2969.	2458.	2016.
1647.	1342.	1093.	890.	725.	590.	481.	391.	319.	259.
211.	172.	140.	114.	93.	75.	61.	49.	37.	25.
6.	2.	1.	0.	0.	0.	0.	0.	0.	0.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

2.	7.	18.	34.	54.	79.	119.	190.	347.	702.
1555.	3021.	4762.	6358.	7380.	7590.	6986.	5938.	4916.	4033.
3293.	2684.	2186.	1780.	1449.	1180.	961.	783.	637.	519.
422.	344.	280.	228.	185.	150.	121.	97.	74.	51.
12.	4.	2.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7590.	7078.	4070.	1490.	71535.
INCHES		3.09	7.11	7.81	7.81
AC-FT		3512.	8076.	8873.	8873.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

2.	11.	27.	51.	82.	118.	178.	285.	521.	1053.
2333.	4532.	7144.	9537.	11070.	11385.	10479.	8908.	7374.	6049.
4940.	4026.	3279.	2670.	2174.	1770.	1442.	1174.	956.	778.
634.	516.	420.	342.	278.	226.	182.	146.	111.	76.
18.	6.	3.	1.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11385.	10618.	6104.	2235.	107303.
INCHES		4.63	10.66	11.71	11.71
AC-FT		5268.	12114.	13309.	13309.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

3.	14.	36.	69.	109.	158.	238.	380.	694.	1404.
3111.	6043.	9525.	12716.	14760.	15180.	13971.	11877.	9832.	8066.
6586.	5368.	4372.	3560.	2899.	2361.	1922.	1565.	1275.	1038.
845.	688.	560.	455.	371.	301.	242.	195.	147.	101.
24.	7.	3.	1.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	15180.	14157.	8139.	2981.	143070.
INCHES		6.18	14.21	15.61	15.61
AC-FT		7024.	16152.	17745.	17745.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

4.	18.	45.	86.	136.	197.	297.	475.	868.	1754.
3889.	7553.	11906.	15894.	18450.	18976.	17464.	14846.	12290.	10082.
8233.	6710.	5465.	4450.	3624.	2951.	2403.	1957.	1593.	1297.
1056.	860.	700.	569.	463.	376.	303.	244.	184.	126.
30.	9.	4.	1.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	18976.	17696.	10174.	3726.	178838.
INCHES		7.72	17.76	19.52	19.52
AC-FT		8779.	20190.	22181.	22181.

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

HYDROGRAPH ROUTING

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

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	1

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

STORAGE=	0.	428.	856.	1286.	1713.	2141.	2569.	3426.	4282.	5138.

1.	1.	1.	2.	4.	7.	11.	17.	28.	49.
96.	192.	368.	756.	1252.	1764.	2209.	2451.	2513.	2448.
2302.	2111.	1899.	1689.	1510.	1337.	1175.	1025.	898.	801.
710.	627.	551.	483.	422.	368.	324.	299.	276.	254.
232.	211.	192.	175.	159.	144.	131.	119.	108.	98.

STOR

1.	1.	2.	3.	6.	9.	14.	22.	36.	63.
124.	248.	455.	730.	1031.	1308.	1514.	1626.	1654.	1624.
1557.	1469.	1371.	1272.	1173.	1078.	999.	907.	831.	762.
698.	638.	585.	536.	493.	455.	420.	388.	358.	329.
301.	274.	249.	226.	206.	187.	170.	154.	140.	128.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2513.	2428.	1711.	725.	34796.
INCHES		1.06	2.99	3.80	3.80
AC-FT		1205.	3396.	4316.	4316.

STATION 2, PLAN 1, RTIO 2

2.	2.	3.	5.	8.	14.	22.	34.	55.	98.
192.	424.	993.	1953.	3172.	4366.	5244.	5632.	5567.	5219.
4736.	4233.	3716.	3256.	2823.	2447.	2121.	1825.	1583.	1380.
1196.	1031.	895.	792.	698.	613.	536.	468.	406.	351.
313.	285.	259.	236.	214.	195.	177.	161.	146.	133.

STOR

2.	2.	4.	6.	11.	18.	28.	44.	71.	127.
249.	494.	889.	1396.	1930.	2390.	2698.	2825.	2804.	2690.
2527.	2341.	2151.	1964.	1788.	1624.	1474.	1337.	1214.	1102.
1000.	910.	829.	756.	689.	629.	574.	526.	482.	443.
406.	370.	336.	306.	278.	252.	229.	209.	189.	172.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5632.	5416.	3618.	1463.	70228.
INCHES		2.36	6.32	7.66	7.66
AC-FT		2687.	7181.	8710.	8710.

STATION 2, PLAN 1, RTIO 3

2.	3.	4.	7.	13.	21.	32.	51.	83.	147.
288.	761.	1750.	3387.	5403.	7257.	9069.	9401.	8731.	7658.
6893.	6125.	5338.	4611.	3982.	3427.	2946.	2527.	2181.	1870.
1612.	1402.	1212.	1044.	903.	798.	703.	616.	538.	466.
399.	337.	304.	276.	251.	228.	207.	188.	171.	156.

STOR

3.	3.	5.	10.	17.	27.	42.	65.	107.	190.
373.	734.	1302.	2018.	2750.	3357.	3700.	3757.	3642.	3459.
3238.	2987.	2729.	2481.	2249.	2034.	1838.	1661.	1501.	1357.
1223.	1114.	1010.	917.	835.	760.	693.	631.	576.	525.
477.	433.	394.	358.	325.	296.	269.	244.	222.	202.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9401.	8715.	5558.	2204.	105777.
INCHES		3.80	9.71	11.54	11.54
AC-FT		4324.	11031.	13113.	13120.

"OVV"

STATION 2, PLAN 1, RTIO 4

3.	4.	6.	10.	17.	28.	43.	67.	110.	196.
425.	1133.	2610.	4969.	7956.	11684.	13775.	12991.	11633.	10206.
8675.	7332.	6548.	5726.	4931.	4261.	3655.	3150.	2694.	2324.
1997.	1707.	1487.	1289.	1111.	954.	840.	740.	649.	565.
484.	409.	344.	307.	279.	253.	230.	209.	190.	173.

STOR

4.	5.	7.	13.	22.	36.	56.	87.	143.	254.
495.	966.	1699.	2608.	3510.	4148.	4377.	4320.	4139.	3895.
3633.	3382.	3125.	2856.	2596.	2352.	2127.	1921.	1735.	1567.
1416.	1281.	1161.	1052.	954.	868.	790.	719.	654.	595.
537.	484.	438.	398.	362.	329.	299.	271.	247.	224.

		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
	CFS	13775.	12521.	7512.	2345.	141380.
	INCHES		5.47	13.12	15.43	15.43
	AC-FT		6212.	14907.	17535.	17535.

"OVV"

STATION 2, PLAN 1, RTIO 5

4.	4.	7.	12.	21.	34.	54.	84.	138.	245.
594.	1544.	3547.	6689.	11740.	17633.	18174.	16314.	13784.	11845.
10417.	8851.	7416.	6633.	5807.	5005.	4320.	3704.	3194.	2732.
2355.	2024.	1729.	1505.	1305.	1126.	966.	848.	746.	651.
559.	473.	398.	334.	302.	274.	249.	227.	206.	187.

STOR

5.	6.	9.	16.	28.	45.	70.	109.	179.	317.
615.	1192.	2083.	3171.	4158.	4657.	4696.	4561.	4378.	4176.
3931.	3663.	3409.	3153.	2882.	2620.	2374.	2146.	1939.	1751.
1581.	1429.	1293.	1171.	1061.	962.	874.	796.	723.	656.
591.	529.	476.	431.	392.	356.	324.	294.	267.	243.

		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
	CFS	18174.	16476.	9492.	3688.	177012.
	INCHES		7.19	16.57	19.32	19.32
	AC-FT		8174.	18838.	21954.	21955.

PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

			RATIOS APPLIED TO FLOWS				
OPERATION	STATION	PLAN	.20	.40	.60	.80	1.00
HYDROGRAPH AT	1	1	3795.	7590.	11385.	15180.	18976.
		2	0.	0.	0.	0.	0.
ROUTED TO	2	1	2513.	5632.	9401.	13775.	18174.
		2	0.	0.	0.	0.	0.

PREVIOUS INSPECTION REPORTS

Acc. 382

NOTE: [illegible] one of these forms as completely as possible for each dam in your district, return it at once to the [illegible]

STATE OF NEW YORK

CONSERVATION COMMISSION

ALBANY

DAM REPORT

Aug 6th, 1913

CONSERVATION COMMISSION,

DIVISION OF INLAND WATERS.

GENTLEMEN:

I have the honor to make the following report in relation to the structure known as the Middle Branch or Tilly Foster Dam.

This dam is situated upon the Middle Branch of Croton River in the Town of South East, Putnam County, about 2½ miles from the Village of Brewster. The distance up stream from the dam, to the Tilly Foster Railroad Bridge is about 2 miles.

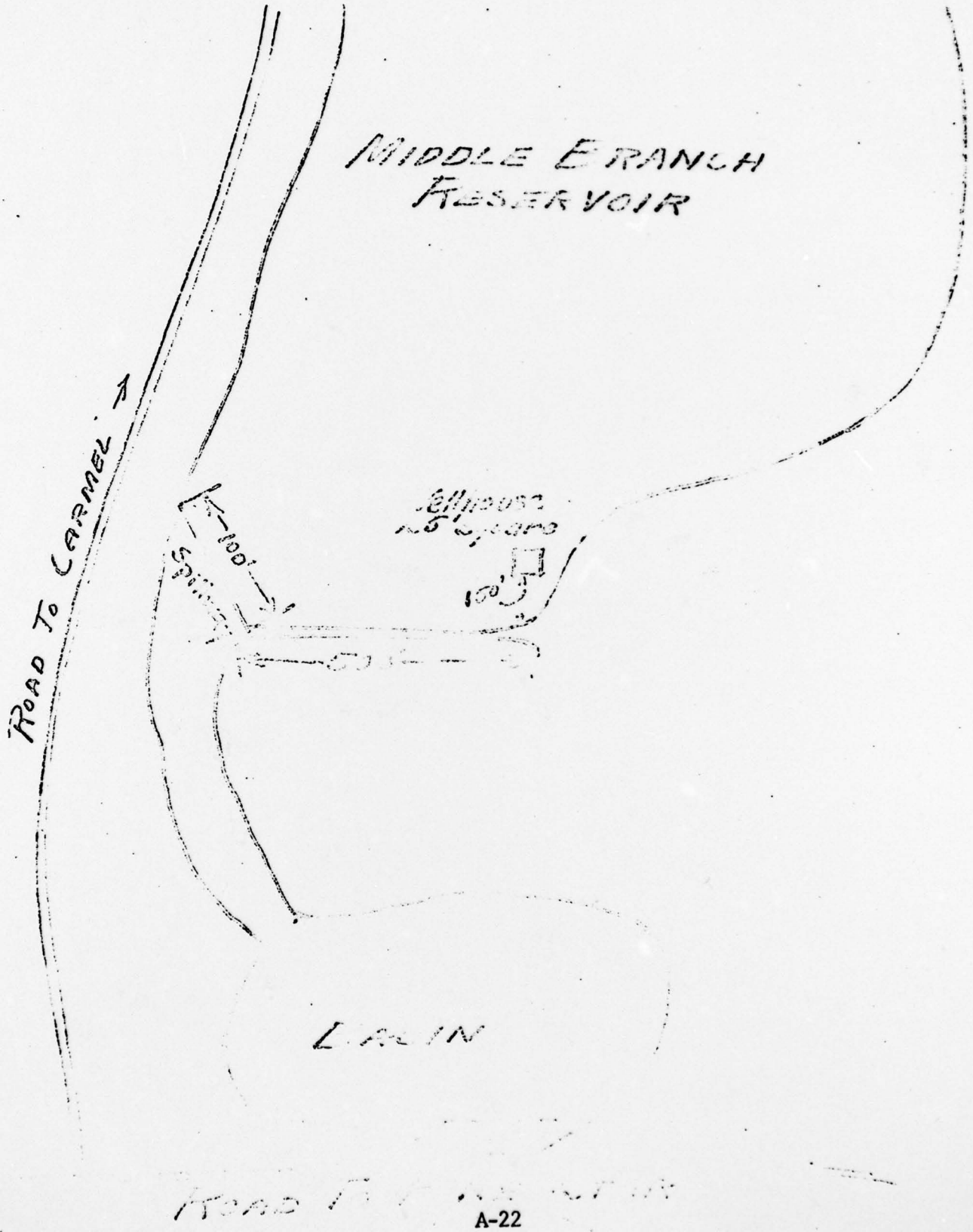
The dam is now owned by New York City and was built in or about the year 1897 and was extensively repaired or reconstructed during the year [illegible].

As it now stands, the spillway portion of this dam is built of [illegible] and the other portions are built of [illegible].

As nearly as I can learn, the character of the foundation bed under the spillway portion of the dam is [illegible] and under the remaining portions such foundation bed is [illegible].

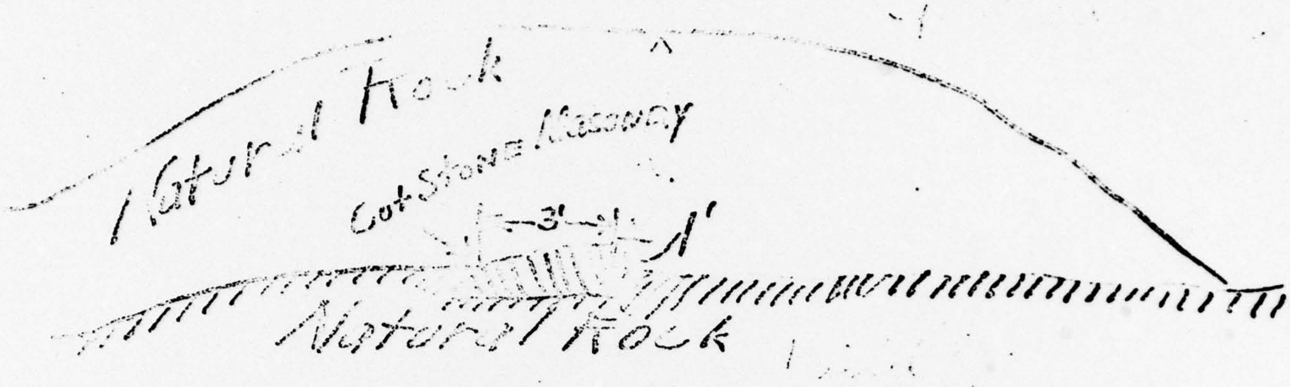
A-21

(In the space below, make a third sketch showing the general plan of the dam, and its approximate position in relation to buildings other conspicuous objects in the vicinity.)

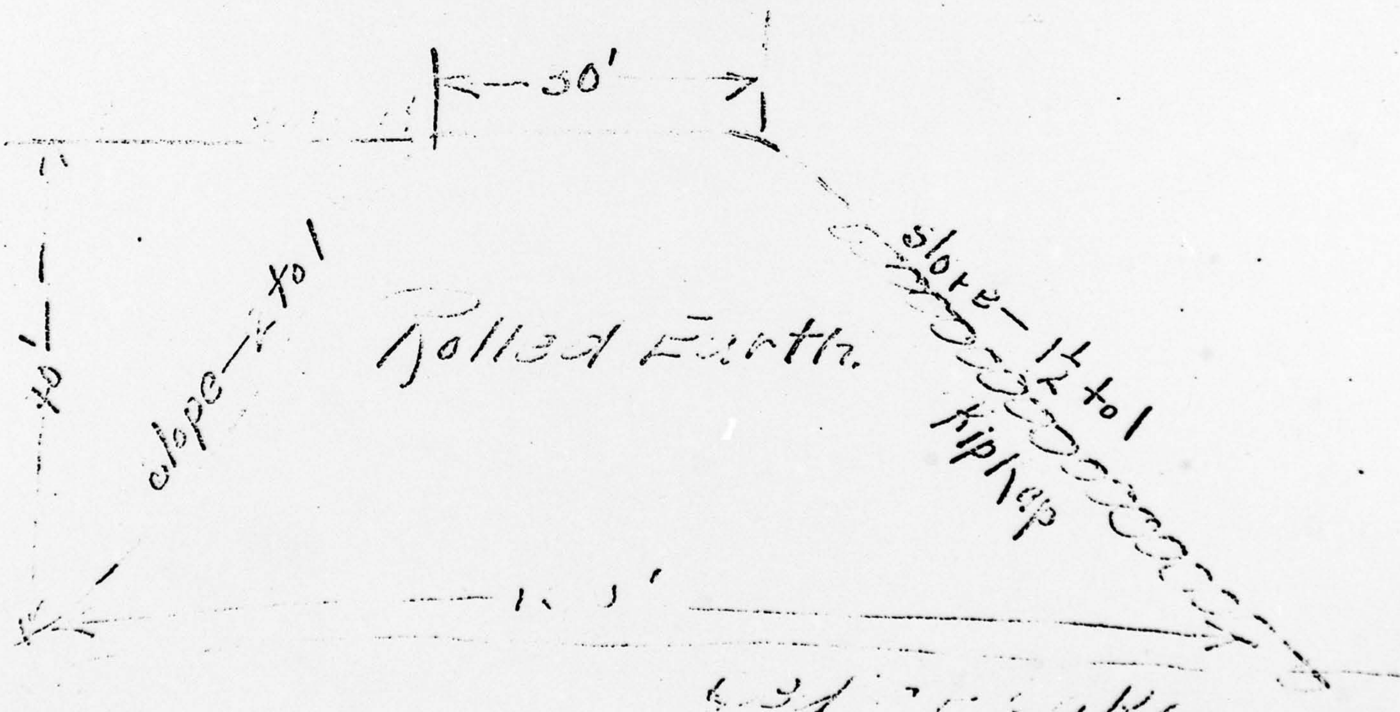


(In the space below, make a sketch showing the form and dimensions of a cross section through the spillway or waste-weir of this dam, and a second sketch showing the same information for a cross section through the other portion of the dam. Show particularly the greatest height of the dam above the stream bed, its thickness at the top, and thickness at the bottom, as nearly as you can learn.)

SPILLWAY SECTION



OTHER SECTION



The total length of this dam is about 600 feet. The spillway or waste-weir portion, is about 100 feet long, and the crest of the spillway is about 8-10 feet below the top of the dam.

The number, size and location of discharge pipes, waste pipes or gates which may be used for drawing off the water from behind the dam, are as follows: Two 30" pipes leading into 4 20" pipes Towerhouse

At the time of this inspection the water level above the dam was 3 ft. 0 in. below ~~above~~ the crest of the spillway.

(State briefly, in the space below, whether, in your judgment, this dam is in good condition, or bad condition, describing particularly any leaks or cracks which you may have observed.)

This dam seemed to be in good condition and [illegible] [illegible] [illegible] [illegible] flood into the [illegible] of the reservoir [illegible] no [illegible] to carry away [illegible] [illegible]

Reported by [illegible]

[illegible]

STATE OF NEW YORK

DEPARTMENT OF

State Engineer and Surveyor

ALBANY

Report of a Structure Impounding Water

To assist in carrying out the provisions of Section 22 of the Conservation Law, being Chapter LXV of the Consolidated Laws of New York State, relating to safeguarding life and property and the erection, reconstruction or maintenance of structures for impounding water, owners of such structures are requested to fill out as completely as possible this report form for each such dam or reservoir owned within the State of New York for which no plans or reports relative thereto are on file in this Department, and to return this report form, together with prints or photographs explanatory thereof to this department. Branch Reservoir

1. The structure is on the Middle Branch flowing into the Croton River in the Town of Carmel County of Putnam and New York

about a mile west from Brewster's Station on the Harlem Division of the N.Y.C.R.R

(Give exact distance and direction from a well-known bridge, dam, village main cross-roads or mouth of a stream)

2. Is any part of the structure built upon or does its pond flood any State lands? No

3. The name and address of the owner is The City of New York

4. The structure is used for impounding water for water supply

5. The material of the right bank, in the direction with the current, is ; at the spillway crest elevation this material has a top slope of inches vertical to a foot horizontal on the center line of the structure, a vertical thickness at this elevation of feet, and the top surface extends for a vertical height of feet above the spillway crest.

6. The material of the left bank is ; has a top slope of inches to a foot horizontal, a thickness of feet and a height of feet.

7. The natural material of the bed on which the structure rests is (clay, sand, gravel, boulders, granite, shale, slate, limestone, etc.)

8. State the character of the bed and the banks in respect to the hardness, perviousness, water bearing, effect of exposure to air and to water, uniformity, etc.

9. If the bed is in layers, are the layers horizontal or inclined?..... If inclined what is th direction of the horizontal outcropping relative to the axis of the main structure and the inclination and directio of the layers in a plane perpendicular to the horizontal outcropping?.....

10. What is the thickness of the layers?.....

11. Are there any porous seams or fissures?.....

12. The watershed at the above structure and draining into the pond formed thereby is 21.31 square mile

13. The pond area at the spillway crest elevation is 430 acres and the pond impounds 535.4 cubic feet of water.

14. The maximum known flow of the stream at the structure was.....cubic feet per second o

.....
(Date)

15. Has the spillway capacity ever been exceeded by a high flow? No

Can any possible flood flow from the pond otherwise than through the wastes noted under 17 and 18 of th report? No If so, give the location, the length and the elevation relative to the spillway crest and th character and slopes of the ground of such possible wastes.....

16. State if any damage to life or to any buildings, roads or other property could be caused by any possib failure of the above structure. Describe the location, the character and the use of buildings below the structu which might be damaged by any failure of the structure; of roads adjacent to or crossing the stream below th structure, giving the lowest elevation of the roadway above the stream bed and giving the shape, the height and th width of stream openings; and of any embankments or steep slopes that any flood could pass over. Also indica the character and use made of the ground below the structure.....

The failure of this dam could cause no great loss of life or damages as it is only about 100 feet up stream from the Croton Falls Reserv

17. WASTES. The spillway of the above structure is 100 feet long in the clear; the waters a held at the right end by a.....the top of which is..... feet above the spillwa crest, and has a top width of.....feet; and at the left end by a....., th top of which is.....feet above the spillway crest, and has a top width of.....feet.

18. There is also for flood discharge 2 pipe 3 30 inches in diameter and the bottom is..... feet below the spillway crest; and a (sluice, gate outlet)..... ...e in the clear by..... feet high, and the bottom is.....feet below the spillway crest.

no

19. APRON. Below the spillway there is an apron ~~xxxxx~~ ...., ...
(Material)

~~xxxxxxxxxxxxxxxxxx feet thick. The downstream side of the apron has a thickness of xxxxxxxxxxx feet~~

~~xxxx width xxxxxxxxxxx feet~~

20. Has the structure any weaknesses which are liable to cause its failure in high flows? ....

....

21. SKETCHES. On the back of this report make a sketch to scale for each different cross-section of the above structure at the greatest depth; giving the height and the depth from the surface of the foundation, the bottom width, the top width (for a concrete or masonry spillway at two feet below the crest), the elevation of the top in reference to the spillway crest, the length of the section, and the material of which the section is constructed; on the spillway section show a cross section of the apron, giving its width, thickness and material, and show the abutment or wash wall at the end of the spillway, giving its heights and thickness. Mark each section with a capital letter. Also sketch a plan; show the above sections by their top lines, giving the mark and the length of each; the openings by their horizontal dimensions; the abutments by their top width and top lengths from the upstream face of the spillway section; and outline the apron. Also sketch an elevation of each end of the structure with a cross section of the banks, giving the depth and width excavated into the banks.

22. WATER SUPPLY. The waters impounded by the above structure have ~~(not)~~ been used for a public water supply since 1878 by City of New York

....

?
535.4