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NATIONAL DAM SAFETY PROGRAM. DIVERTING RESERVOIR DAM (NY 00056)--ETC(U)
SEP 78 J J WILLIAMS DACW51-78-C-0035
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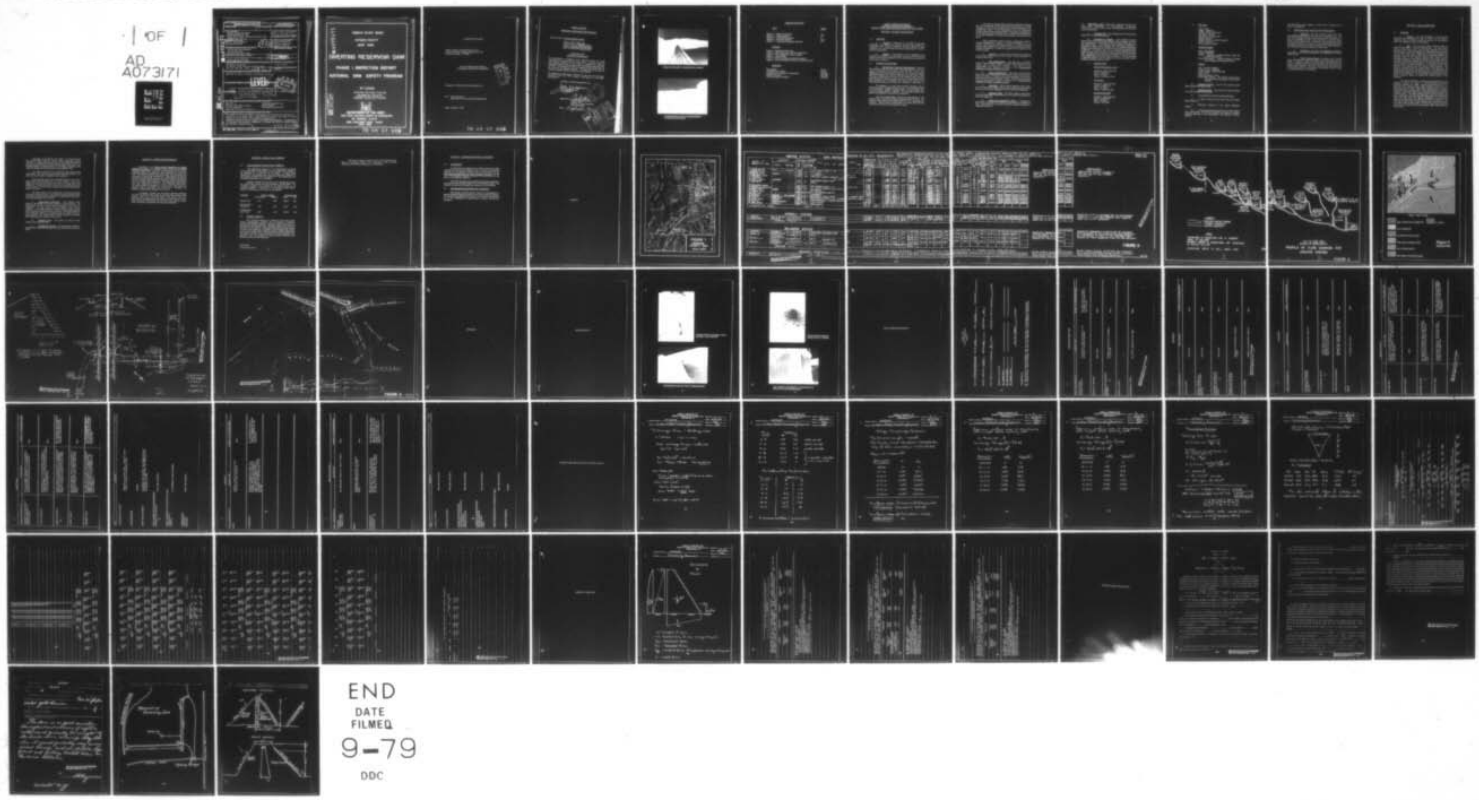

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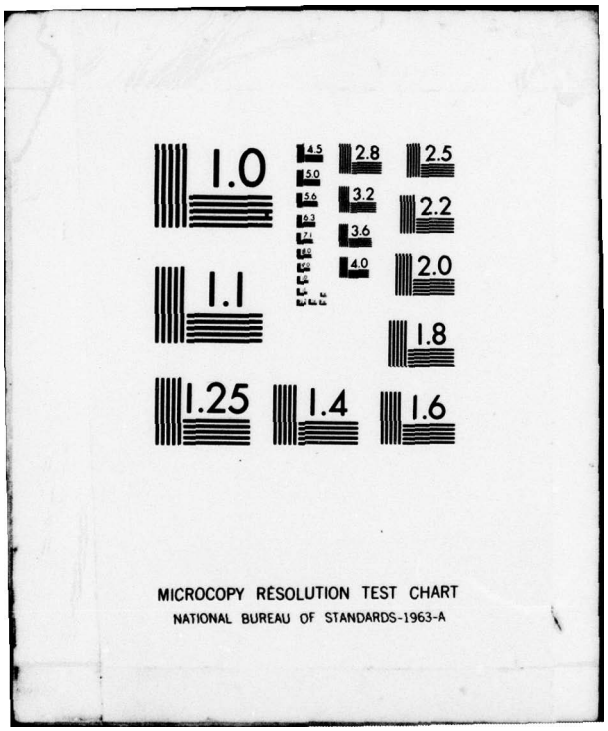
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Diverting Reservoir Dam
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Inventory No. N.Y. 56

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Diverting Reservoir Dam
Putnam County
East Branch 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.
Diverting Reservoir Dam was judged to be unsafe,non-emergency. Strengtening of the dam of the dam was recommended to increase the factor of safety during the probable maximum flood.

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HUDSON RIVER BASIN

PUTNAM COUNTY

NEW YORK

DIVERTING RESERVOIR DAM

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NY 00056

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CONTRACT NO. DACW 51-78-C-0035

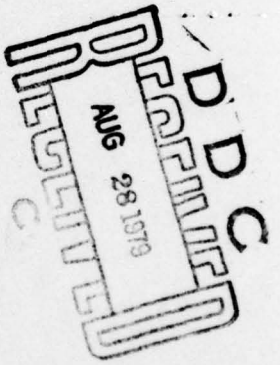
DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

JULY 1978

HUDSON RIVER BASIN

Name of Dam: Diverting Reservoir Dam
County and State: Putnam County, New York
Inventory Number: NY 00056

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



Prepared by: O'Brien and 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: Diverting Reservoir Dam

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

ASSESSMENT OF GENERAL CONDITIONS

No indications of instability were observed during the visual inspection of the Diverting Reservoir Dam. However, review of the stability analyses for the spillway indicates that adequate factors of safety are not present under the loading associated with the PMF: the foundation reaction is outside of the middle third of the base for all loadings analyzed. Strengthening of the dam to provide adequate factors of safety is recommended.

The spillway is hydraulically adequate to pass the peak discharge associated with the PMF without overtopping of the earth embankment.

O'BRIEN & GERE ENGINEERS, INC.

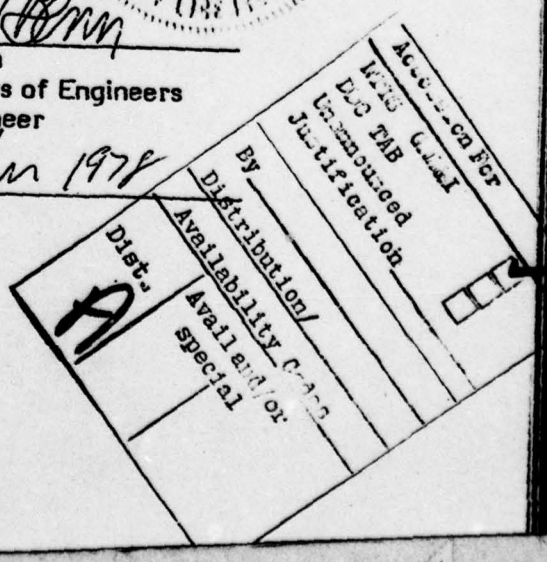
John J. Williams

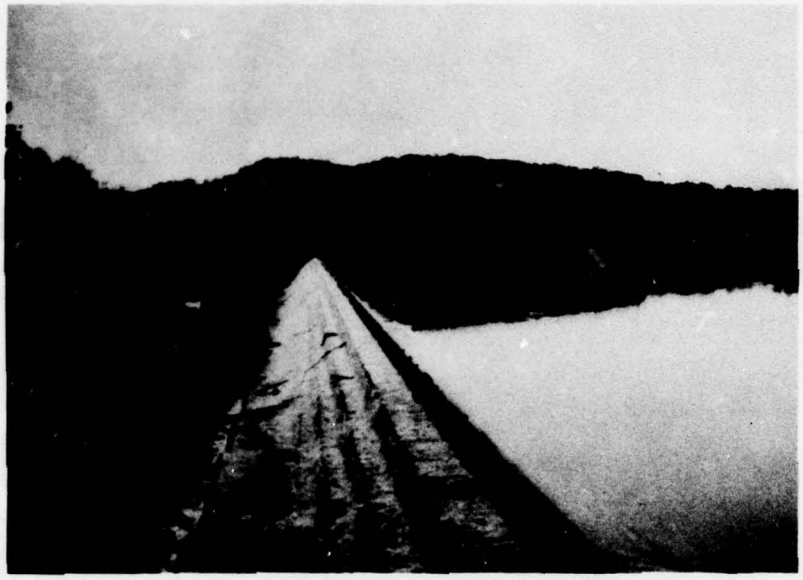
John J. Williams, P.E.
Vice President

Approved by: Clark H. Benn

Clark H. Benn
Colonel, Corps of Engineers
District Engineer

Date: 18 September 1978





VIEW OF SPILLWAY LOOKING SOUTHWEST

DOWNSTREAM FACE OF EMBANKMENT
LOOKING SOUTH EAST

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM DIVERTING RESERVOIR DAM ID# NY 00056

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 & Gere Engineers, Inc., and the New York State Department of Environmental Conservation.

b. Purpose - The purpose of this inspection is to evaluate the structural and hydraulic conditions at the Diverting Reservoir Dam and to determine if the dam constitutes a hazard to human life or property.

1.2 PROJECT DESCRIPTION

a. Description of Dam and Appurtenances - (Information obtained from the New York State Department of Environmental Conservation (N.Y.S.D.E.C.) and the City of New York Department of Environmental Protection) The structures include a 1000-foot spillway with concrete abutments at each end; a 1000-foot earth embankment with two 30 inch reservoir drain pipes and associated intake structure; gate chamber and stilling basin; and a gate structure used to separate and control the levels of the Diverting Reservoir and the Croton Falls Reservoir. (See Figure 5).

The spillway is a cut stone masonry structure with a maximum height of approximately 40 feet. The downstream face of the spillway is stepped at approximately 3 foot intervals; flow over the spillway forms a cascade. The discharge channel then directs flow parallel to the crest of the spillway.

The earth embankment, constructed perpendicular to the spillway, has a maximum height of approximately 50 feet. The slopes of both faces of the embankment are 2 to 1 (horizontal to vertical). Carmel Road is constructed on a bench about 30 feet wide, near the center of the downstream slope.

Two 30 inch reservoir drain pipes are constructed through the earth embankment about 300 feet from the spillway. An intake structure for the pipes is located about 75 feet upstream of the embankment crest. At the downstream toe is an underground concrete gate chamber, approximately 20 feet deep, containing two 30 inch spur-gear operated gate valves. About 50 feet downstream of the gate chamber is a circular stilling basin for flow from the pipes.

Three submerged arched culverts, constructed under a railroad embankment, connect the Diverting Reservoir to the Croton Falls Reservoir diversion channel. A control structure provided with stoplog slots, located on the Croton Falls side of the railroad embankment, is used for separation and control of the reservoir levels.

b. Location - The Diverting Reservoir Dam is located on the East Branch Croton River about 2 miles southwest of Brewster, New York.

c. Size Classification - The dam has a maximum height of approximately 50 feet. The impoundment capacity of the normal pool is about 2700 acre-feet. The dam is in the intermediate size category as defined in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification - The town of Croton Falls, New York, is located along the West Branch Croton River within 2 miles of the dam. A failure of the dam could result in the loss of many lives and extensive economic losses. Therefore, the structure is in the high hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams.

e. Ownership - The Diverting Reservoir Dam is part of the Croton Water Supply System, and is owned and operated by the City of New York, Department of Environmental Protection.

f. Purpose of Dam - The dam is used to divert flow from the East Branch Croton River to the Croton Falls Reservoir for water supply use.

g. Design and Construction History - According to information furnished by N.Y.S.D.E.C., the dam was completed in 1911. No information was made available concerning design and construction history.

1.3 PERTINENT DATA (Information obtained from the New York State Department of Environmental Conservation (N.Y.S.D.E.C.) and the City of New York Department of Environmental Protection)

a. Drainage Area - The drainage area to the Diverting Reservoir is about 88 square miles.

b. Discharge at Damsite - The maximum pool of record was 1.25 feet above the spillway crest on October 16, 1955. This corresponds to a discharge of approximately 4,300 cubic feet per second (cfs). The maximum non-overtopping discharge is estimated at approximately 105,000 (cfs). The combined discharge capacity at normal pool for the 30 inch outlet pipes is approximately 200 cfs. A 150 foot weir near the railroad embankment (See Figure 5), has a crest elevation of approximately 305.0 feet above MSL, according to Mr. John Birrell, Engineer for the City of New York, Department of Environmental Protection. The weir provides a separation between the two reservoirs when the reservoir water surfaces are below Elevation 305.0.

c. Reservoir Data

Normal Pool (spillway crest)

Elevation - 309.55 feet MSL
Length - 8,000 feet
Area - 147 acres
Volume - 2,700 acre-feet

Top of Dam

Elevation - 320.0 feet MSL
Length - 12,000 feet
Area - 161 acres
Volume - 4,300 acre-feet

Maximum Pool (PMF)

Elevation - 316.0 feet MSL
Length - 10,500 feet
Area - 156 acres
Volume - 3,675 feet

d. Dam Data

Type - earth
Length - 1,000 feet
Height - 50 feet (maximum)
Top Width - 20 feet
Side slopes - 2:1 both faces
Zoning - unknown
Impervious core - concrete corewall
Cutoff - unknown
Grout curtain - unknown

e. Diversion Channel

Type - open channel
Length - 3,000 feet
Access - through 3 arched culverts under the railroad embankment
Regulating facility - control structure provided with stoplog slots and approach weir

f. Spillway

Type - cut stone masonry
Length of weir - 1,000 feet
Crest elevation - 309.55 feet MSL
Gates - none
Upstream channel - none
Downstream channel - East Branch Croton River; channel directs flow parallel to the crest of the dam.

g. Regulating Outlets - Two 30 inch reservoir drain pipes equipped with gate valves.

h. Engineering data - The information made available for review included the following:

1) A plan sketch of the dam and appurtenances,

2) A table of data for the New York City Water Supply Reservoir,

3) Schematic drawings of the Croton Reservoir System,

4) An inspection report, prepared by the State of New York, Department of the State Engineer and Surveyor, undated, including sketches of the embankment and spillway in cross-section.

The information made available is limited, but is adequate for a Phase I investigation.

1.4 OPERATING AND MAINTENANCE PROCEDURES

a. Operation - The dam is used to divert flow from the East Branch Croton River into the Croton Falls Reservoir. Two 30 inch drain pipes, operable for drawdown and low flow augmentation, are controlled by gate valves located in a chamber downstream of the embankment. According to Mr. Birrell, the valves are exercised every six months and are adjusted periodically to maintain a minimum conservation discharge of 5 million gallons per day. 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, crews are placed on round the clock duty during periods of high runoff. Reservoir levels are checked hourly, and high reservoir levels or unusual observations are reported to Mr. Birrell and the Deputy Chief Engineer. Mr. Birrell would contact local police and Civil Defense units for evacuation of downstream areas for cases of impending failure or overtopping.

SECTION 2 - VISUAL INSPECTION

2.1 FINDINGS

a. General - The field inspection of the Diverting Reservoir Dam took place on July 17, 1978. At the time of inspection, about 2 inches of water was flowing over the spillway crest. No underwater areas were inspected.

b. Dam - The cut stone masonry spillway shows no apparent horizontal or vertical misalignment. The stone blocks have worn less than 1 inch. The silt level appears to be at the spillway crest. A sketch included in an inspection report, prepared by the State of New York, Department of the State Engineer and Surveyor, (no date), shows a rolled earth embankment abutting the upstream face of the masonry spillway (See Figure 5). The northeast abutment of the spillway appears to be in good condition. No serious cracking or spalling of the concrete was observed. The concrete of the southwest abutment of the spillway has undergone surface spalling at several locations. A horizontal crack in the abutment was observed near the spillway crest elevation. The crack is continuous about the visible portion of the abutment. No seepage was observed in the abutment areas. The observed crack and localized surface spalling do not appear to adversely affect the safety of the abutment. An outcropping of what appears to be a tough micaceous gneiss or schist was observed next to the abutment.

The earth embankment is constructed perpendicular to the spillway, as shown on Figure 5. The horizontal and vertical alignment appear to be good. Riprap slope protection for the upstream face consists of large, near rectangular stone (12 to 15 cubic feet), set in place with smaller angular stone and gravel wedged between the large stone. The riprap appears in excellent condition. Brush was noted at several locations near the top of the upstream slope. A concrete retaining wall is constructed along the earth embankment near the railroad embankment. The wall extends about 100 feet along the railroad embankment and along the reservoir shoreline for about 150 feet as shown on Figure 5. Mr. John Birrell stated that a broad crested weir is constructed from the ends of the retaining wall. Mr. Birrell said that the weir is about 150 feet long, with the crest elevation about 5 feet below the normal pool.

According to Mr. Birrell, the reservoir is connected with the Croton Falls Reservoir through three submerged, arched culverts. A stoplog control structure on the Croton Falls side of the culverts is provided with four openings about 8 feet wide. This structure appears in good condition. No cracking or spalling of the concrete surfaces was detected during the inspection visit.

The upper portion of the downstream slope appears well maintained. The grass had recently been cut; the surface of the slope was smooth and no misalignment was apparent.

Some standing water was observed along the toe of the upper slope (the upstream side of Carmel Road). This water appears to be from the heavy rains from the night before the inspection. Carmel Road forms a bench in the embankment about 30 feet wide. A stone wall is constructed along the downstream edge of the bench.

The lower slope of the embankment is heavily overgrown with small trees and brush. No saturated areas, standing water, movement of embankment materials, or misalignments were noted on the embankment or near the toe.

c. Appurtenance Structures - The concrete gate chamber downstream of the toe appears in good condition. No deterioration of the concrete was evidenced at the time of inspection. The gate valves and stems appear to be in good condition. The intake structure is located about 75 feet into the reservoir and is not provided with a walkway. A detailed inspection of the structure could not be made; however, it appears to be in good condition. Mr. Birrell stated that the structure is provided with stoplog slots for upstream flow control.

d. Reservoir Area - The slopes are mild and well covered with trees and brush.

e. Downstream Channel - The downstream channel is uninhabited for one-half mile and is heavily covered with trees and brush.

SECTION 3 - HYDROLOGIC/HYDRAULIC

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 12 hour Probable Maximum Precipitation, using a loss rate of .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 diversion channel closed to isolate the Diverting Reservoir from the Croton Falls Reservoir. The peak inflow and outflow rates were calculated as 51,719 cfs and 51,688 cfs respectively. The peak outflow corresponds to a stage of 6.5 feet above the spillway crest (4 feet below the top of dam). Therefore, the spillway is hydraulically adequate for the PMF.

A drawdown analysis was performed assuming discharge from the two-30 inch outlet pipes, the starting water surface at the spillway crest, and 2 cfs per square mile inflow (175 cfs). According to the calculations, the reservoir cannot be drawn down below elevation 299.0 (about 10 feet below the spillway crest). Sixty-five days are required for the maximum drawdown.

SECTION 4 - STRUCTURAL STABILITY

4.1 EVALUATION OF STRUCTURAL STABILITY

The embankment slopes of 2 to 1 (horizontal to vertical), with a wide bench at the middle of the downstream face, appear to be adequate for a structure of this height. A more exact assessment is not possible since data concerning the condition of the concrete corewall and the properties of the embankment and foundation materials are not available.

Stability analyses were performed for the spillway section for normal pool, normal pool and earthquake, and the PMF. The foundation reactions were outside of the central third for all analyzed loadings. A synopsis of the results is listed below. Details of the analyses are located in the appendix.

Condition	Factor of Safety		Pressures (psi)	
	Overturning	Sliding*	Heal	Toe
Normal Pool	1.41	7.09	6.25(T)	43.5
Normal Pool & Earthquake	1.35	6.67	9.3(T)	46.6
Probable Maximum Flood	1.09	6.76	17.1(T)	43.3

4.2 SEISMIC STABILITY

The Diverting Reservoir is located in the New England Uplands physiographic province, and is founded on Paleozoic granites and schistose gneisses. Outcrops of both formations were noted during the inspection visit: schistose gneiss at the southeast abutment of the spillway, and granite along the diversion channel to Croton Falls Reservoir. According to the "Geologic Map of New York, Lower Hudson Sheet", ancient faulting has been mapped near the western boundary of the reservoir and to the northwest of the abutment area. No evidence of these structural features were observed during the field inspection.

*With shear

(T) indicates tension

The dam is located in Seismic Zone 1 of the "Seismic Zone Map of Contiguous States", and satisfactory static stability conditions are considered adequate for earthquakes.

SECTION 5 - ASSESSMENT/REMEDIAL MEASURES

5.1 ASSESSMENT

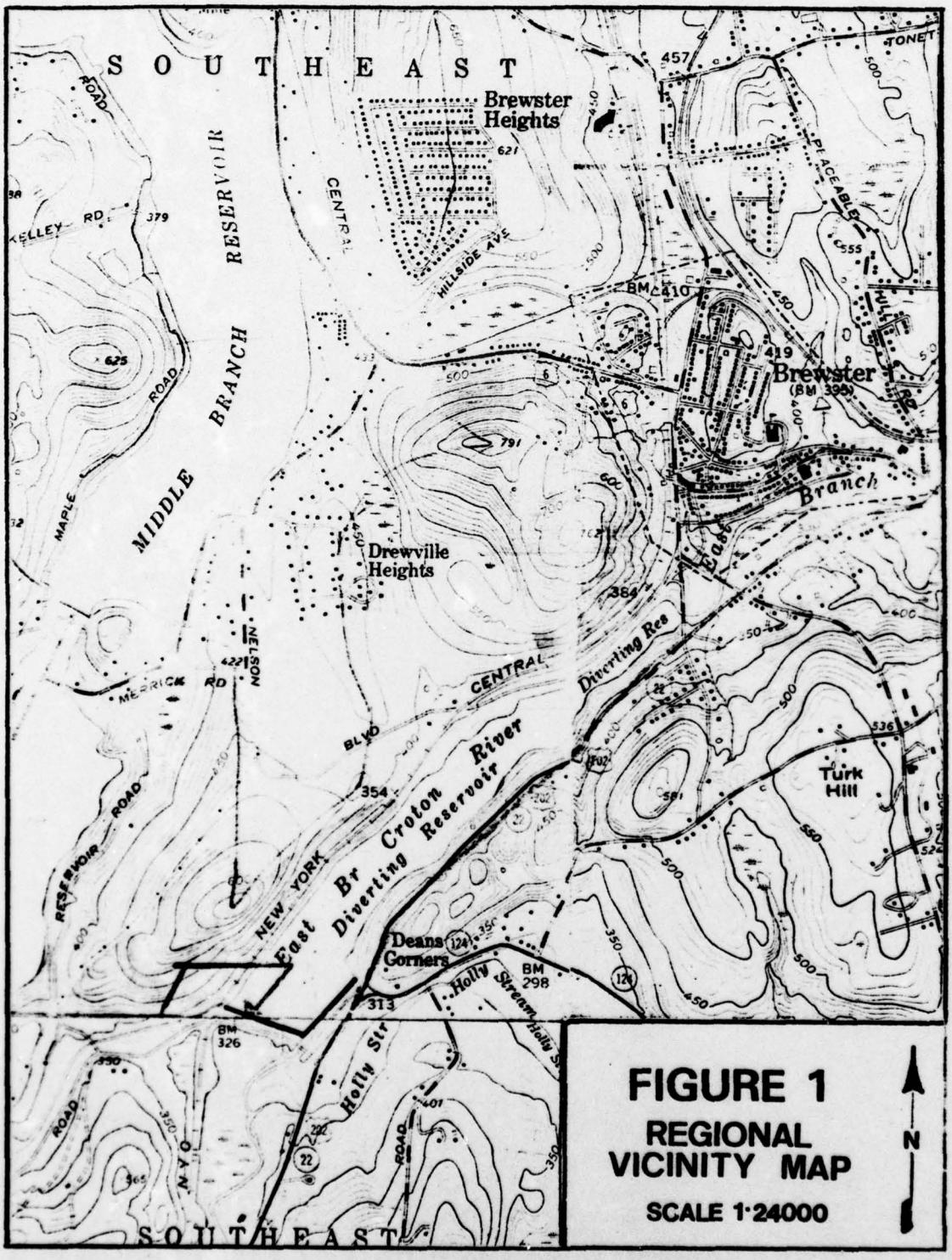
No indications of instability were observed during the field inspection of the Diverting Reservoir Dam. Review of the stability analyses for the spillway indicates that the requirements of the Recommended Guidelines for Safety Inspection of Dams are not met. The foundation reaction is outside of the middle third of the base for all conditions analysed.

The PMF hydrology was analysed assuming the stoplogs to be in place at the control structure for the diverting channel. The spillway is found to be hydraulically adequate for this condition.

5.2 RECOMMENDATIONS/REMEDIAL MEASURES

The gravity overflow section should be strengthened to provide adequate factors of safety for extreme loading conditions. This could be accomplished by making the structure more massive, or by the installation of post-tensioned tendons through the structure.

FIGURES


SOUTHEAST
Brewster Heights
Brewster
(BM 395)
Drewville Heights
Deans Corners
Turk Hill
East Br Croton River Diverting Reservoir
Diverting Res
East Branch
MIDDLE BRANCH RESERVOIR
CENTRAL
HILLSIDE AVE
KELLEY RD
MAPLE ROAD
RESERVOIR ROAD
MERRICK RD
NELSON
BLVD
NEW YORK
Holly Stream
Holly Str
BM 410
BM 298
BM 326
PLACEABLE
TONET
SOUTHEAST
FIGURE 1
REGIONAL VICINITY MAP
SCALE 1·24000
N

CROTON SYSTEM — DATA PERTAININ

Name of Reservoir	Location: Town	Location: County	Drainage Area: Sq Mi.	Drainage Area: Includes Items	Date Put in Service	Kind of Dam
1 BOYDS CORNERS	KENT	PUTNAM	23.46	1	1879	MASONRY, EARTH & LOG
2x BARRETTS POND		"	0.5	2	1870	EARTH
3x LAKE GLENIDA	CARMEL	"	0.60	3	1870	EARTH
4 WEST BRANCH (CARMEL)	"	"	42.87	1 to 4	1895	EARTH, MASONRY CORE & SPILLWAY
5 WEST BRANCH	"	"				" " " "
6 MIDDLE BRANCH	SOUTHEAST	"	21.31	5	1878	EARTH, MASONRY CORE
7 BOG BROOK	"	"	5.67	6	1892	" " "
8 EAST BRANCH (SODOM)	"	"	80.20	6 & 7	1891	MASONRY, EARTH & LOG
9 CROTON FALLS (DIVERTING)	"	"	87.56	6 to 8	1911	EARTH, CONCRETE CORE & SPILLWAY
10x LAKE GILEAD	CARMEL	"	0.82	9	1870	EARTH
11 CROTON FALLS	"	"	188.64	4,5,8,9,10	1911	CYCLOPEAN MASONRY
12x LAKE KIRK	"	"	2.84	11	1870	EARTH
13 AMAWALK	SOMERS	WESTCHESTER	19.13	10 to 12	1897	EARTH, MASONRY CORE
14 TITICUS	NORTH SALEM	"	23.35	13	1893	MASONRY, EARTH & LOG & MASONRY
15 CROSS RIVER	BEDFORD	"	29.80	14	1906	CYCLOPEAN MASONRY, CONCRETE
16 MUSCOOT	SOMERS & BEDFORD	"	315.75	10 to 15	1905	MASONRY
17 NEW CROTON	CORTLAND	"	375.00	1 to 16	1905	MASONRY
x Controlled Lakes			CROTON TOTALS			

CATSKILL SYSTEM

1 ASHOKAN	OLIVE BRIDGE - ULSTER	29,000	1	1915	MASONRY
2 SCHOHARIE	GILBOA - GREENE	3,400	2	1926	MASONRY
CATSKILL TOTALS					

DELAWARE SYSTEM

1 NEVERSINK	NEVERSINK	SULLIVAN	930	1	1953	EARTH, CONCRETE CORE
2 PEPACTON	COLCHESTER & MIDDLETOWN	DELAWARE	3720	2	1954	" " "
3 CANNONSVILLE	DEPOSIT, TOMPKINS & WALTON	DELAWARE	4500	3	1967	ROLLED FILL
4 RONDOUT	WAWARSING, NEVERSINK	ULSTER, SULLIVAN	35,000	1 to 4	1951	" CONCRETE CORE
DELAWARE TOTALS						

KENSICO RESERVOIR & SAFETY DA

KENSICO	NEW CASTLE	WESTCHESTER	13.33		1915	MASONRY

	0.165		0.264	160.9	2 2	504.55		444.6	5.0		
SPILLWAY	10.070		1.692	1062.8	15.6	503.2		435.6	47.0		
LEFT DAM						514.55 Top		466.1			
	4.005		0.669	428.2	6 02	371.55		310.5	61.1		
	4.400		0 640	399.0	4.9	416.55		365.1	51.5		
	5.243		0.698	556.8	10.5	416.55		351.8	65.0		
SPILLWAY	0.806		0 240	153.6	4.2	309.55		279.6	29.0		
	0.380		0.191	122 2	2 ;	496.55		480 6	16.0		
	14.192		1.660	1082.4	18.0	309.4		214.6	95.0		
	0.565		0.158	101.1	3.1	502.55		384.6	18.0		
	6.692		0.947	606.1	8.5	399.55		334.6	65.0		
W/MASONRY CORE	7.167		1.046	669.4	8.1	324.5		249.6	75.0		
CONCRETE FACES	10.308		1.202	769.2	12.9	329.55		229.6	100.0		
	4.914		1.822	1166.1	35.0	190 55		169.6	30.0		
	23.782		3.530	2259.2	38.0	195.55		159.6	36.0		
	94.65	86.6	15.591	9911.0	177.52						

	127.650	122.9	12 99	6915.2	40.2	[illegible]	UNKNOWN	328.80	51.75	4.137	
	19.583	17.6	1 79	1145.0	16.5	1130 0	"	1030.0	80.00		
	147.44	140.5	14 78	9460.2	56.3						

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

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 Water Surface Feet	Width of Dam Feet: Top	Width of Dam Feet: Bott.	Length of Dam Feet: Total	Length of Dam Feet: Masonry Portion
UNKNOWN	135.0	UNKNOWN	78.0	57.0	6.60	53.60	6700.0	6700.0
	260.0		66.0	62.0	15.00	307.50	1794.5	260.0
	NO SPILLWAY		65.0	90.0	25.00	240.00	741.0	
	100.0		94.0		50.00	660.00	615.0	100.0
			No 1 60.0	47.0	25.00	238.50	1358.8	
			No 2 38.8	25.8	12.00	173.50	1358.8	
	500.0		96.0	70.0	12.00	93.00	1100.0	500.0
	1000.0		51.0	45.0	15.00	240.00	2190.0	1000.0
	700.0		173.0	113.0	23.00	116.00	1300.0	1100.0
	50.0			82.0	35.00	656.00	1270.0	50.0
	200.0		135.0	109.0	20.70	75.21	1319.0	320.0
	240.0		170.0	126.0	23.00	118.50	1060.0	640.0
	950.0		36.0		4.00	40.00	1150.0	1130.0
	1000.0		291.0	174.0	16.00	206.00	2168.0	2168.0

REMARKS

Most of the Croton carried by the Ne Aqueduct

4.137	950.0	[illegible]	252.0	210.0	26.33	200.00	4650.0	1000.0
	1324.0	150.0	182.0	155.0	15.00	138.00	2280.0	2000.0

Schoharie water is c Tunnel to A.[illegible] enter the Catskill Aq

1.600	600.0	175.00	345.0	195.0	60.00	1392.00	2620.0	NONE
6.000	600.0	180.00	304.0	204.0	60.00	1460.00	2450.0	"
1.092	D 240.0 D 560.0	176.00 S 57 W 2-00	196.0	179.0	45.00	1312.00	2600.0	"
2.367	600.0	175.00	375.0	195.0	60.00	1392.00	2400.0	"

Neversink, Pepacton are conveyed via th & W. Delaware Tunn Thence all Four su

ALSO SOME OF THE CROTON SUPPLY (SEE REMARKS).

UNKNOWN	50.0	155.50	307.0	160.0	28.00	235.00	1043.0	1043.0

Of the Croton Supply plus pumpage fro Falls flows into Ke

17.5 BIL. GAL. ABOVE MIN.
N A SAFETY STORAGE RES. KENSICO .

Comp J.J.O
Drawn J.R.D.

ngth of Dam Feet	
otal	Masonry Portion
700	670 0
94.5	260.0
41.0	
15.0	100.0
38.8	
00.0	500.0
90.0	1000.0
00.0	1100.0
70.0	50.0
19.0	3[illegible]1.0
60.0	8400
50.0	1130
88.0	2166.0

REMARKS

Most of the Croton Supply is carried by the New Croton Aqueduct

50.0	1000.0
80.0	2000.0

Schoharie water is conveyed by the Shandaken Tunnel to Ashokan Res. Thence both supplies enter the Catskill Aqueduct.

020.0	NONE
50.0	"
00 0	"
00.0	"

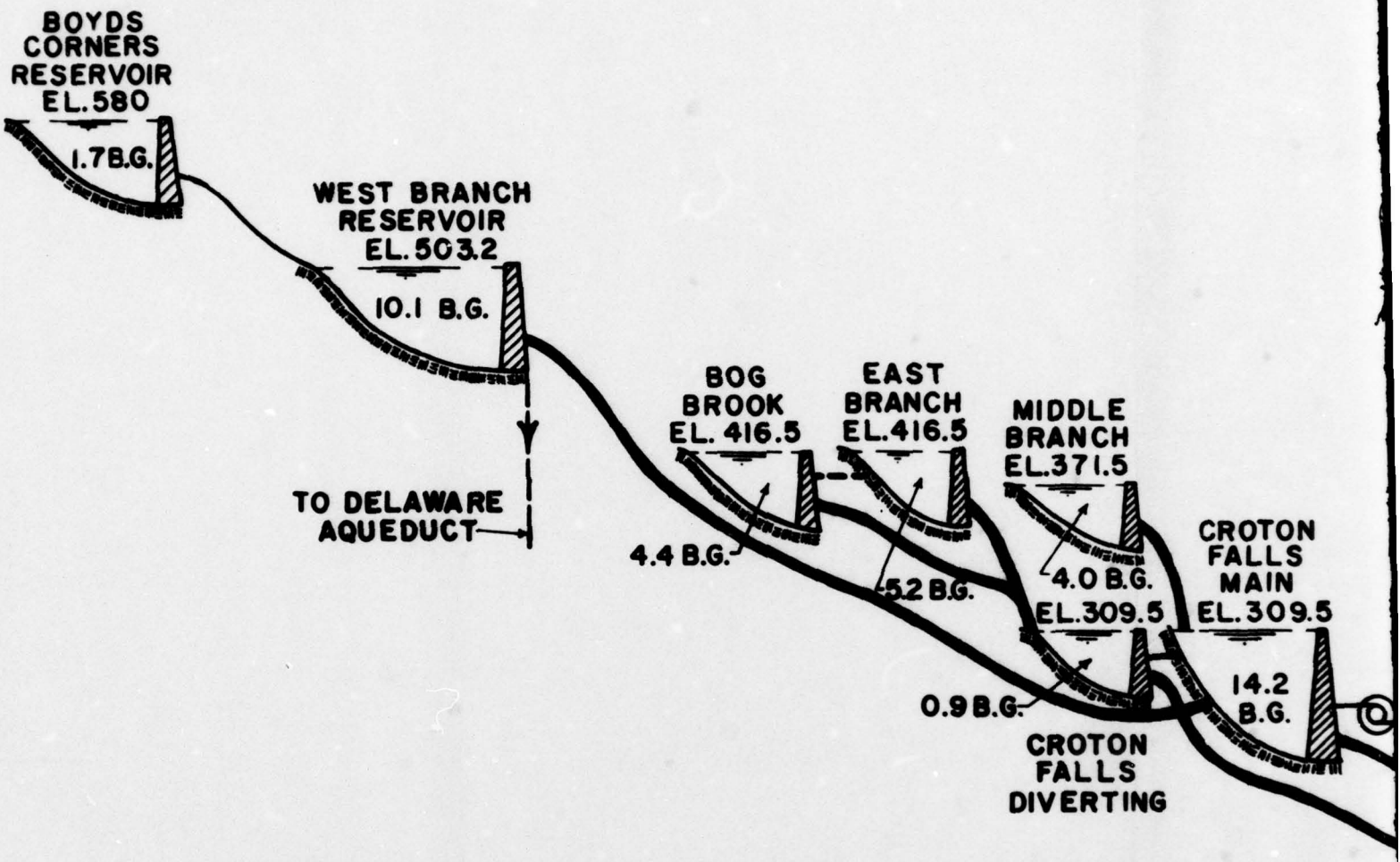
Neversink, Pepacton & Cannonsville supplies are conveyed via the Neversink, East Delaware & W. Delaware Tunnels to the Rondout Res. Thence all Four supplies enter the Del. Aqueduct.

43 0	1043.0

Of the Croton Supply, all of the West Branch plus pumpage from Cross River & Croton Falls flows into Kensico Reservoir.

Acc NS

FIGURE 2



LEGEND

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

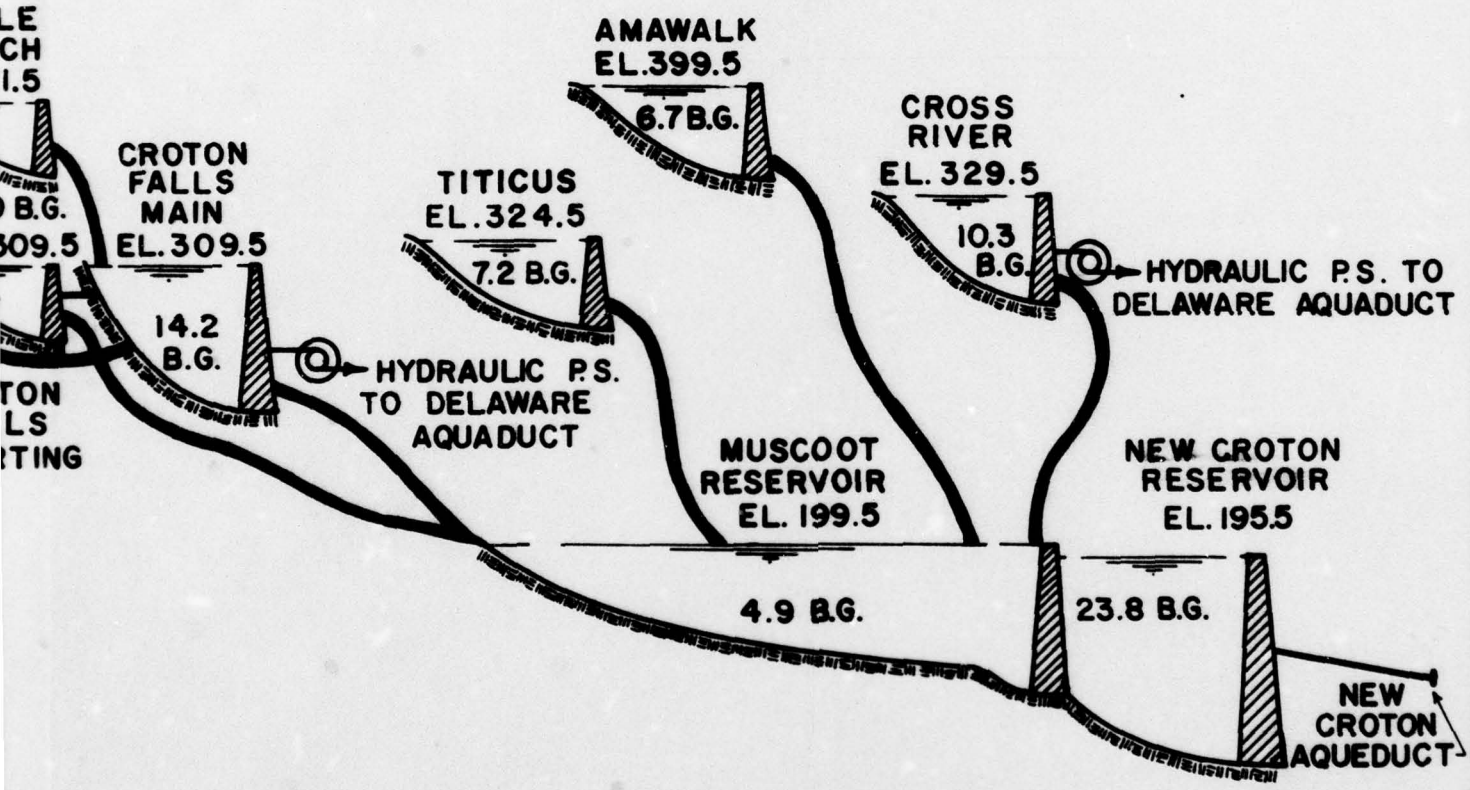
NOTE

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.

PR

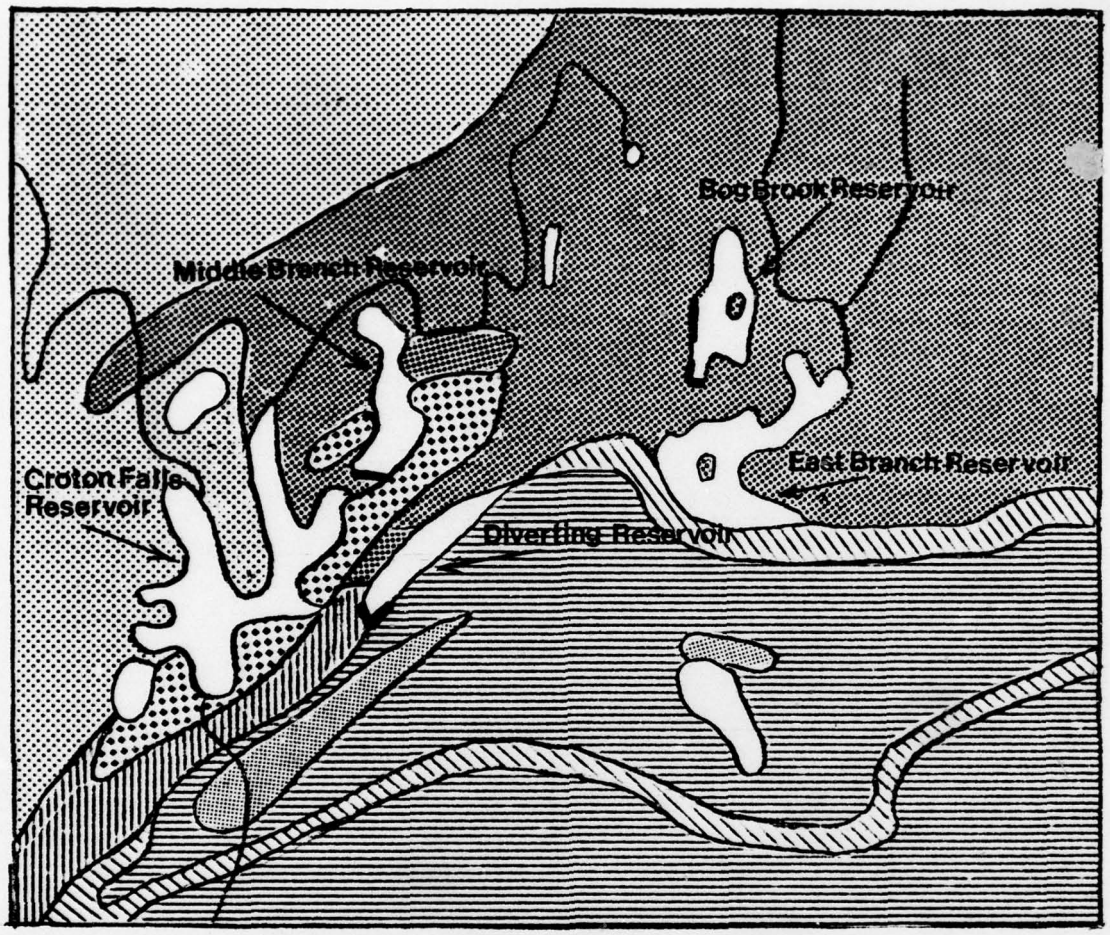
1



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

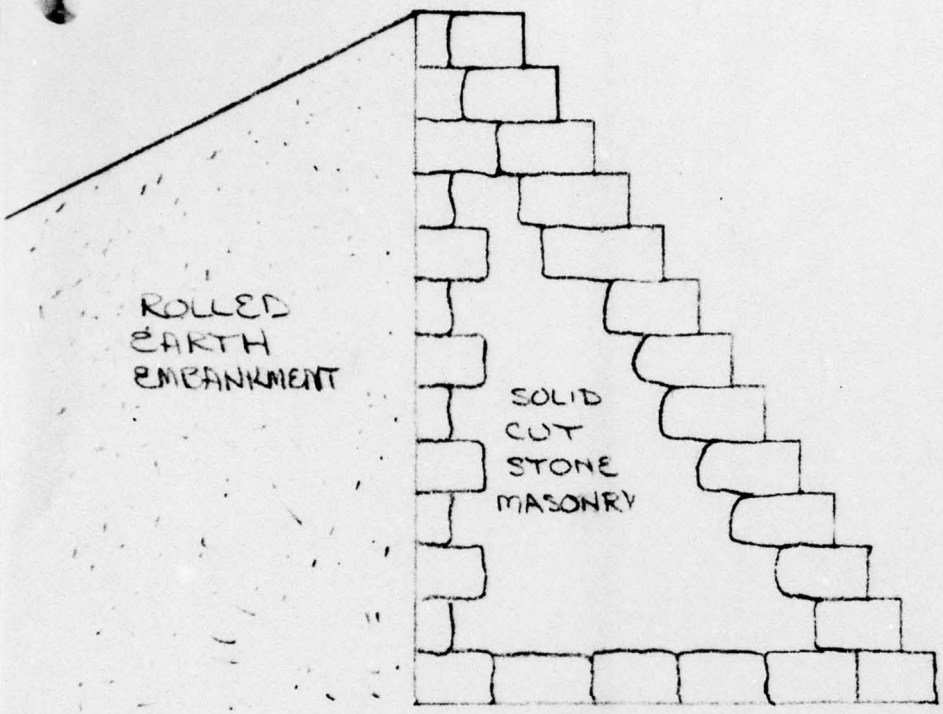
bg - biotite, granitic gneiss

qtcs - quartz, feldspar, gneiss

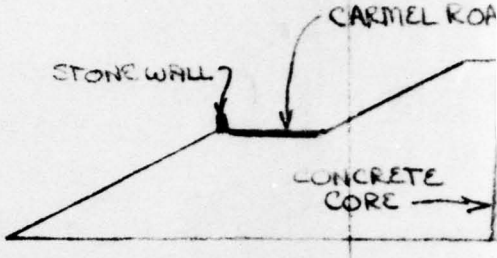
Xm - schistose gneiss

Xgb - gabbro, hornblende, gneiss

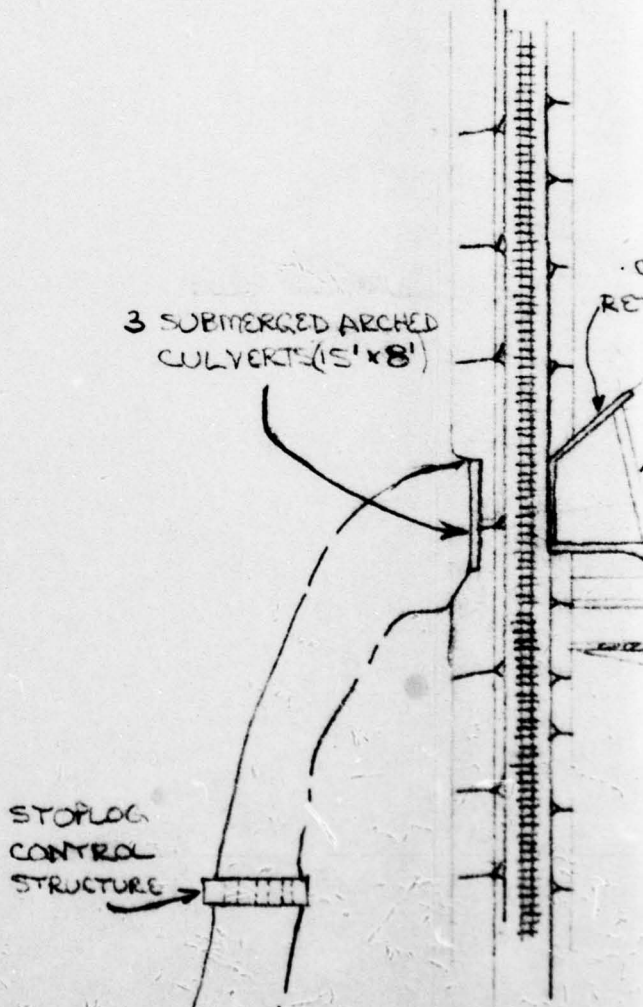
Figure 4
Geologic Map



SECTION A-A *
(SPILLWAY)

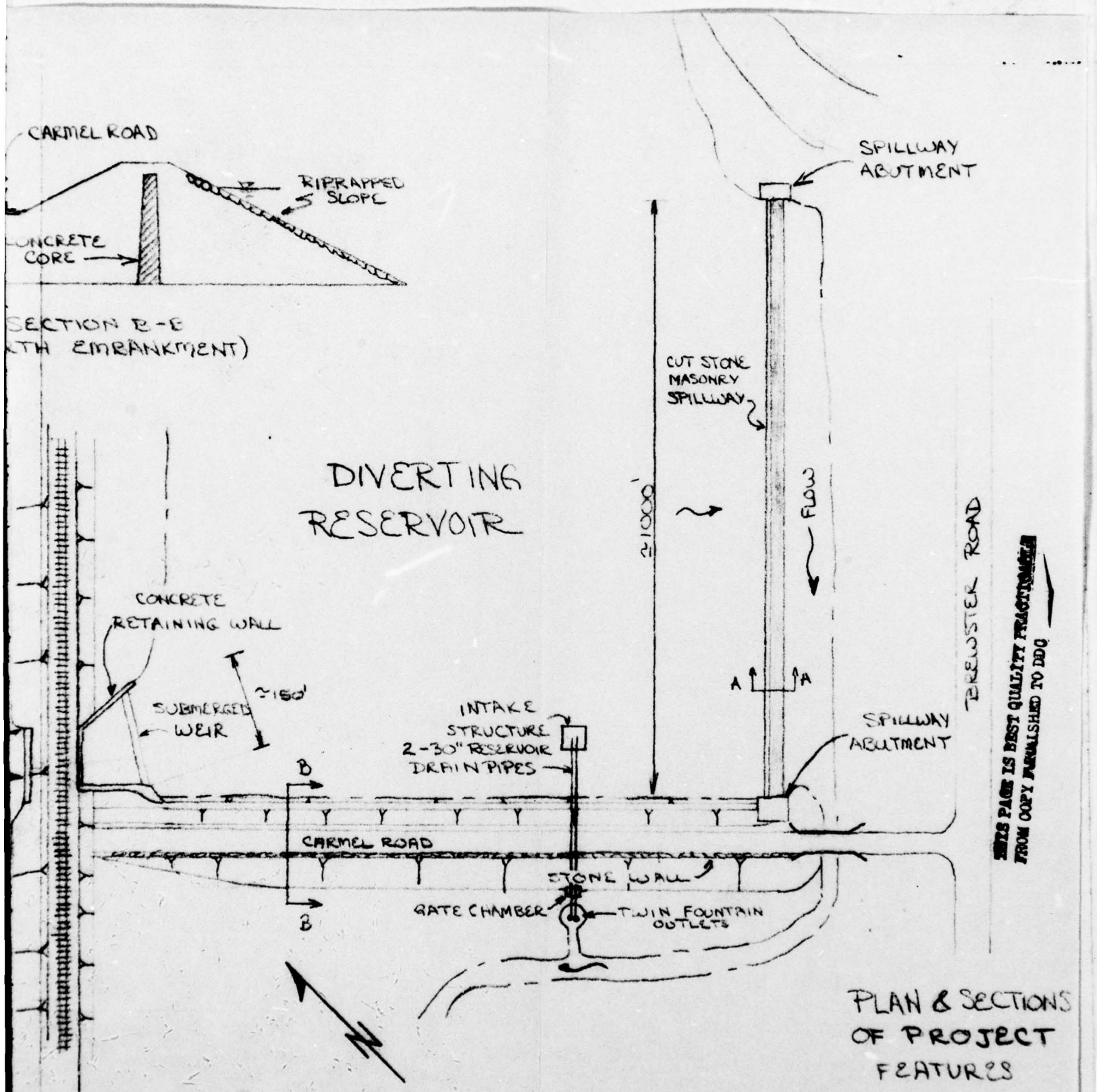


SECTION
(EARTH EMBA



* ACCORDING TO AN INSPECTION REPORT PREPARED BY THE STATE OF NEW YORK, DEPARTMENT OF STATE ENGINEER AND SURVEYOR

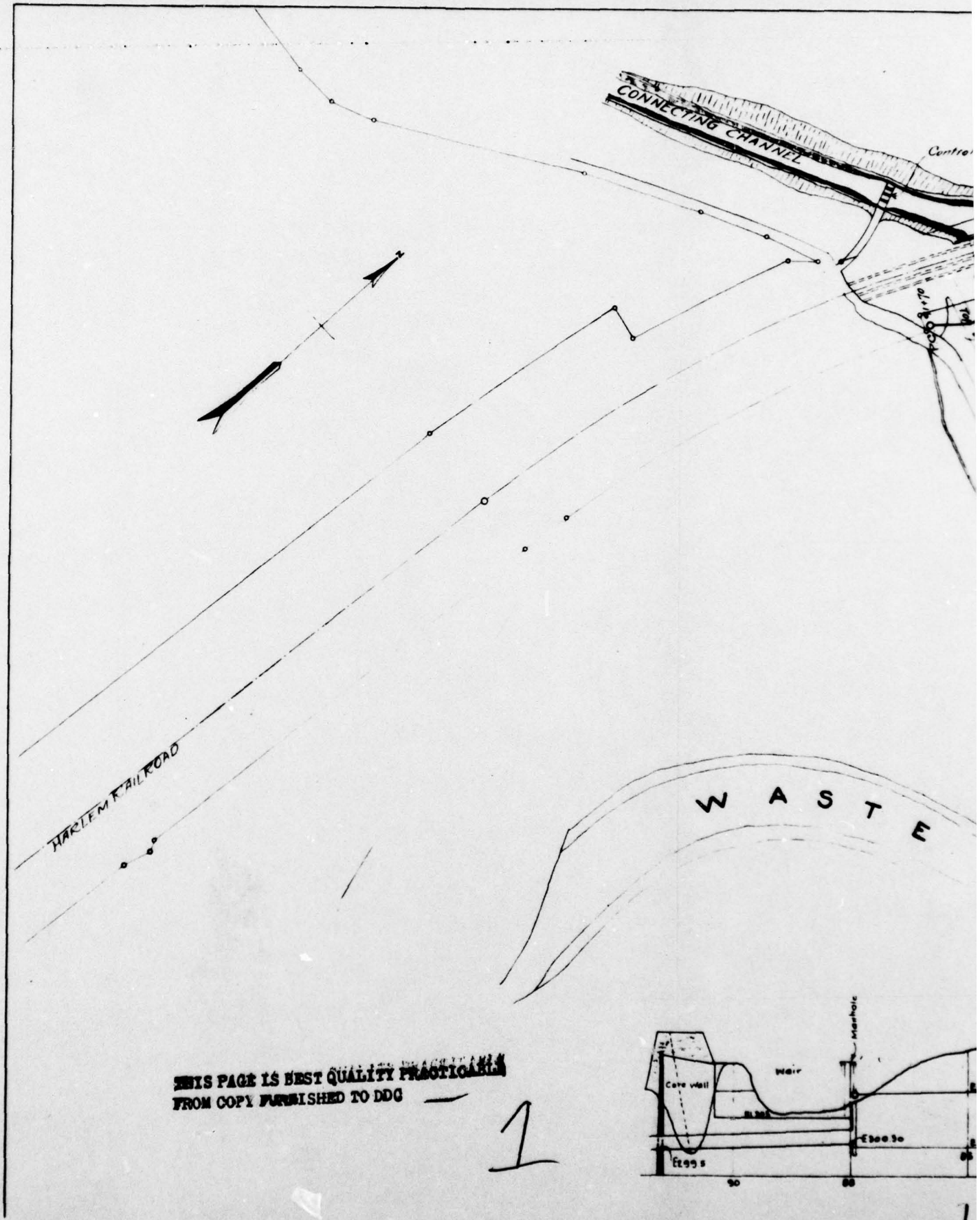
1



PLAN & SECTIONS OF PROJECT FEATURES

NOT TO SCALE

FIGURE 5



1

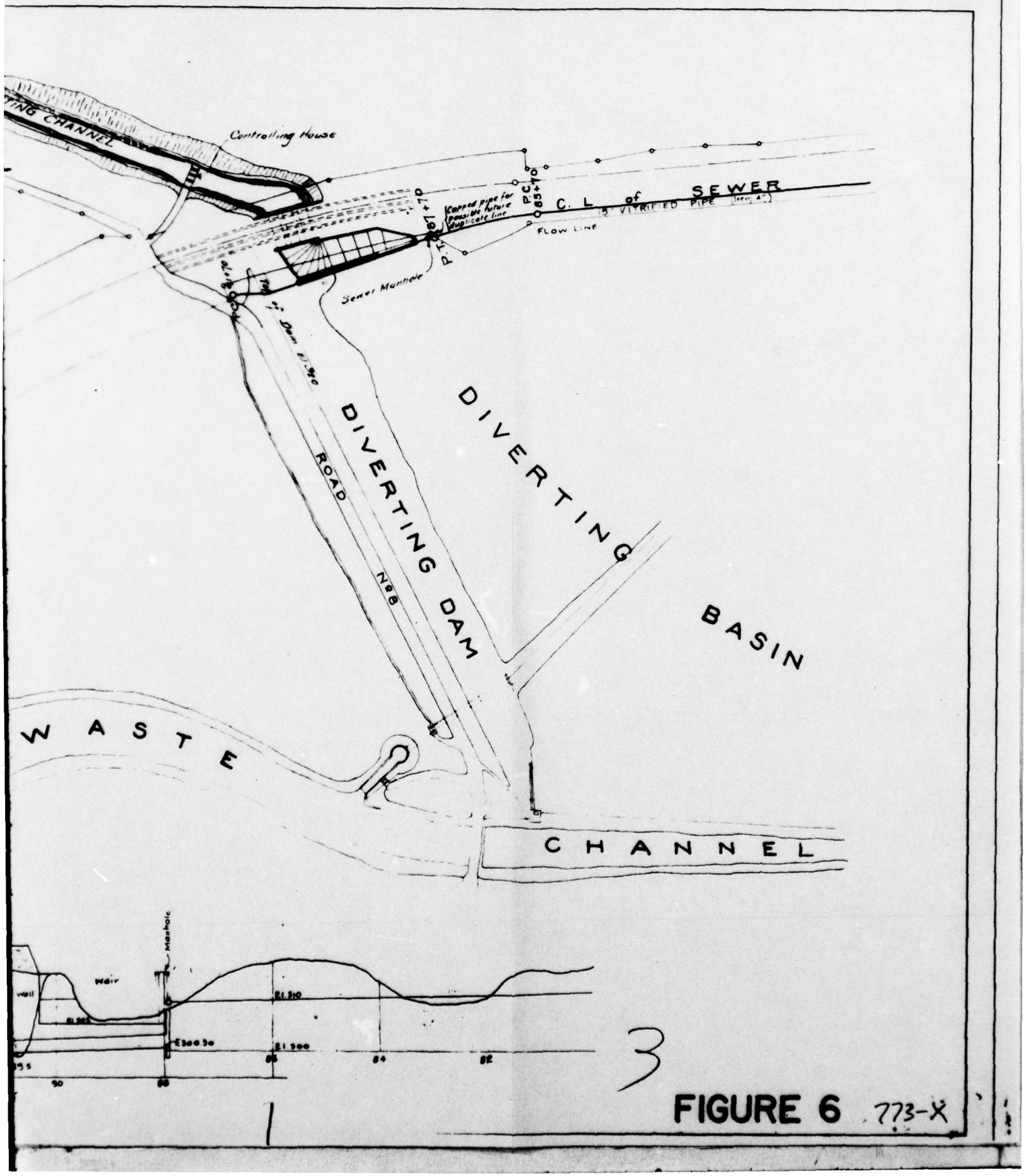
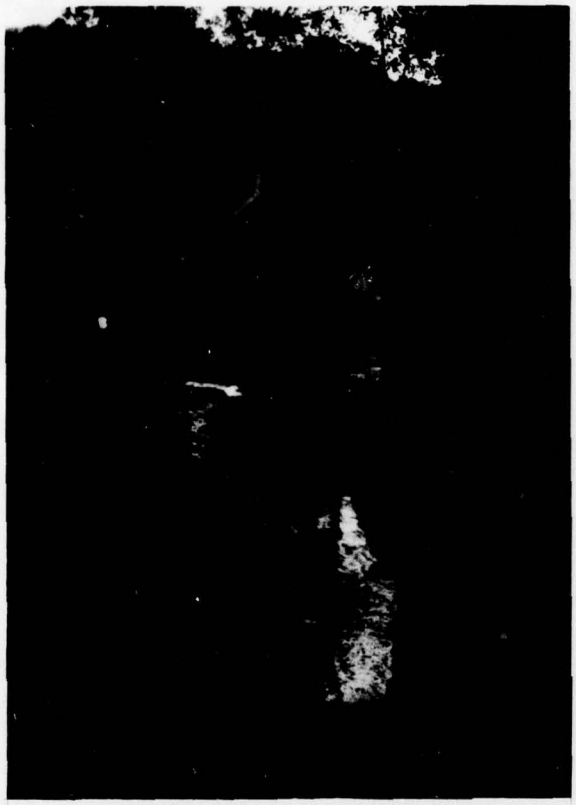


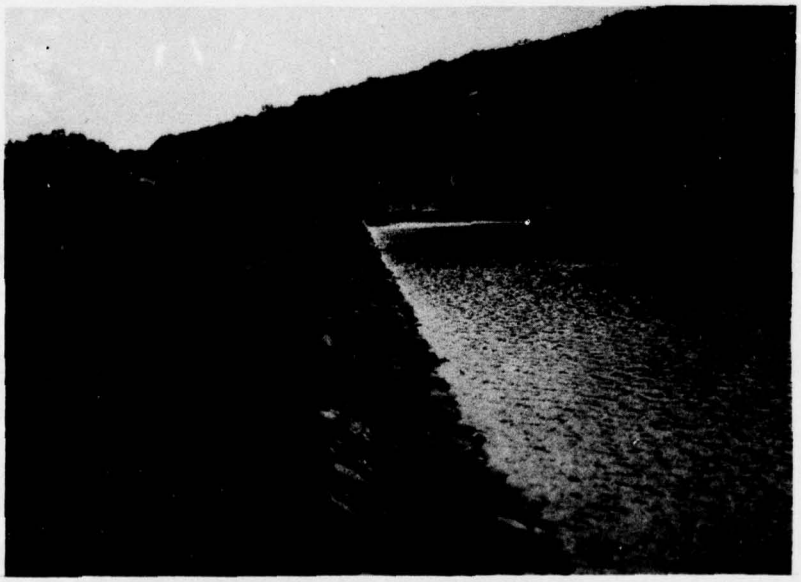
FIGURE 6 773-X

APPENDIX

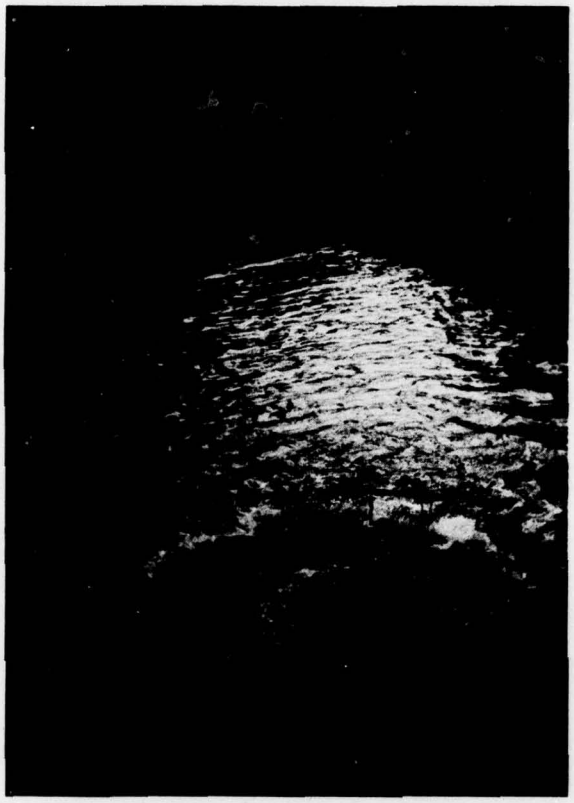
PHOTOGRAPHS



DOWNSTREAM CHANNEL FROM
CARMEL ROAD BRIDGE



UPSTREAM SLOPE OF EARTH EMBANKMENT



DISCHARGE CHANNEL
FROM OUTLET WORKS

SOUTHWEST ABUTMENT AT JUNCTION OF
SPILLWAY AND EMBANKMENT

FIELD INSPECTION REPORT

Check List
Visual Inspection
Phase 1

Name Dam Diverting Reservoir Dam County Putnam State New York Coordinators _____

Date(s) Inspection 7/17/78 Weather Clear Temperature 75°

Pool Elevation at Time of Inspection 306 M.S.L. Tailwater at Time of Inspection _____ M.S.L.

Inspection Personnel:

Mr. George Elias

Mr. David Campbell

Mr. Stephen Snider

Mr. David Campbell Recorder

Accompanied by:

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

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBERSVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	A horizontal crack was noted in the spillway's southwest abutment.	The crack does not appear to affect the stability of the structure.
STRUCTURAL CRACKING	None noted.	None.
VERTICAL AND HORIZONTAL ALIGNMENT	Vertical and horizontal alinement is excellent.	None.
MONOLITH JOINTS	- - -	- - -
CONSTRUCTION JOINTS	All joints appeared to be tight.	None.

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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	Vertical and horizontal alinement is good.	None.
RIPRAP FAILURES	Riprap is in excellent condition.	None.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No problem areas were observed.	None.
ANY NOTICEABLE SEEPAGE	A small amount of standing water was noted along the embankment bench. It appeared to be due to heavy rainfall from the previous night.	None.
STAFF GAGE AND RECORDER	No gages were observed, but reservoir water surface readings are taken daily.	None.
DRAINS	No drains were noted.	None.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CUT STONE WEIR	The solid cut stone masonry weir is in excellent condition. Both the horizontal and vertical alinement are excellent. No undermining or wear were observed.	The spillway appeared to be silted in, but an inspection report (undated) shows a rolled earth embankment abutting the spillway's upstream face.
APPROACH CHANNEL	None.	None.
DISCHARGE CHANNEL	The spillway discharges into a side channel. The channel is clear of debris and the overbanks are heavily covered with trees and brush.	None.
BRIDGE AND PIERS	A clear span bridge is located just downstream of the spillway. The arched opening is about 400 square feet.	High flows could cause overtopping of the bridge and resultant damage to areas of the lower portion of the embankment.

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OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The gate chamber downstream of the embankment is in excellent condition. No cracking or spalling of concrete surfaces was noted.	None.
INTAKE STRUCTURE	The intake is a cut stone masonry structure located offshore. No access was available for a thorough inspection, but the structure appeared to be in good condition.	None.
OUTLET STRUCTURE	A small circular stilling basin is constructed about 100 feet downstream of the embankment. The basin is used for dissipating the excess energy of discharge through the outlet works.	The discharge pipes terminate in a vertical orientation, creating a fountain outlet.
OUTLET CHANNEL	The outlet channel from the stilling basin is about 150 feet long. The channel joins the spillway discharge channel (East Branch Croton River).	None.
EMERGENCY GATE	The pipes of the outlet works are controlled by gate valves located in a concrete gate chamber downstream of the embankment. The valves appear to be in good condition but were not operated.	The Section Engineer stated that the valves are exercised periodically and are in good working order.

ITEM	REMARKS
MONITORING SYSTEMS	Reservoir is visited daily. Reservoir water surface elevation is measured daily.
MODIFICATIONS	Unknown.
HIGH POOL RECORDS	According to Mr. Birrell, the highest pool of record was 1.25 feet above the spillway crest on October 16, 1955.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None made available.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	No information made available.
MAINTENANCE OPERATION RECORDS	None made available.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Reservoir slopes are mild and well covered with trees and brush.	None.
SEDIMENTATION	During the inspection visit, the spillway appeared to be silted in. A review of a previous inspection report (undated) revealed that a rolled earth embankment is constructed against the upstream face of the spillway.	No information could be found to explain the reason the earth embankment was constructed.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel is clear of debris.	None.
SLOPES	Downstream slopes are mild to moderate, and are well covered with trees and brush.	None.
APPROXIMATE NO. OF HOMES AND POPULATION All	The town of Croton Falls, New York is located about 2 miles downstream from the dam. About 50 dwellings are located low enough to be affected by flood waters.	The Section Engineer stated that local police and Civil Defense personnel would be alerted in the event of impending overtopping or failure.

ITEM	REMARKS
DESIGN REPORTS	None made available.
GEOLOGY REPORTS	None made available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None made available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None made available.
POST-CONSTRUCTION SURVEYS OF DAM	None made available.
BORROW SOURCES.	Unknown.

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

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

SHEET NO. 1 OF
DATE 8/3/78
COMP. BY DBC
CHECKED BY RCH

NAME OF CLIENT NYSDEC
PROJECT Croton Falls Diverting Reservoir

Drainage Area = 87.58 sq. miles

L = 24 miles L_{CA} = 11 miles

Use average Snyder coefficients

$C_t = 2.0$ $C_p = .625$

$t_p = C_t(L \times L_{CA})^{.3} = 10.65$ hrs.

$t_R = t_p/5.5 = 1.94$ hrs. Use $t_R = 20$ hrs

6 hr. PMP = 24"

- less "probable misfit" of basin to storm isohyetals = 13.5%

6 hr. PMP = 20.3"

× area factor (.75)

6 hr. PMP = 15.2" (MGT)

12 hr. PMP = 20.3" × .87 = 17.7"

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

SHEET NO. 2 OF _____
DATE 8/3/78
COMP. BY DRBC
CHECKED BY RMN

NAME OF CLIENT NYSDEC
PROJECT Croton Falls Diverting Reservoir

Time (hrs)	PMP(in.) Σ	PMP(in.) Δ	
0-2	9.9	9.9	65% 6HR PMP
2-4	12.9	3.0	85% 6HR PMP
4-6	15.2	2.3	100% 6HR PMP
6-8	16.2	1.0	12 HR. PMP − 6HR. PMP
8-10	17.0	.8	17.7 − 16.2 = 2.5
10-12	17.7	.7	

Third Quartile Distribution

Time (hrs)	PMP(in.) Σ	PMP(in.) Δ
0-2	.7	.7
2-4	1.7	1.0
4-6	4.0	2.3
6-8	13.9	9.9
8-10	16.9	3.0
10-12	17.7	.8

* Minimum Loss Rate = .2 inches/hour

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

SHEET NO. 3 OF
DATE 8/3/78
COMP. BY DBC
CHECKED BY

NAME OF CLIENT NYSDEC
PROJECT Croton Falls Diverting Reservoir

Stage-Discharge Relation

Spillway Length = 1000ft.
Spillway crest elevation = 309.55 ft MSL
Top of Dam elevation = 320.0 ft MSL

$Q_{Spill} = 3.1 \times 1000 \times H^{3/2}$

Reservoir Elevation	H	Q_s
309.55	0	0
311.0	1.45'	5413
313.0	3.45'	19865
315.0	5.45'	39442
317.0	7.45'	63037
319.0	9.45'	90055
320.0	10.45'	104722

Surface area of reservoir @ spillway crest
147 acres (Elevation 309.55)

Surface area @ Elevation 315.55
155 acres

NAME OF CLIENT NYSDEC

PROJECT Croton Falls Diverting Reservoir

Assume surface area to vary linearly with height above spillway crest

$A = 4/3H + 147$, ¢

Surcharge Storage(S) $= \int A\,dH$

$\therefore S = 2/3H^2 + 147H + ¢^{0}$

Reservoir Elevation	H(ft)	S(acre-ft.)
309.55	0	0
311.0	1.45	215
313.0	3.45	515
315.0	5.45	821
317.0	7.45	1132
319.0	9.45	1449
320.0	10.45	1609

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

SHEET NO. 4 OF
DATE 8/3/78
COMP. BY DBC
CHECKED BY RCD

NAME OF CLIENT NYSDEC
PROJECT Croton Falls Diverting Reservoir

Assume surface area to vary linearly with height above spillway crest

$A = 4/3 H + 147$, ¢

Surcharge Storage (S) = $\int A \, dH$

$\therefore S = 2/3 H^2 + 147 H + ¢^{0}$

Reservoir Elevation	H(ft)	S(acre-ft.)
309.55	0	0
311.0	1.45	215
313.0	3.45	515
315.0	5.45	821
317.0	7.45	1132
319.0	9.45	1449
320.0	10.45	1609

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

SHEET NO. 5 OF _____
DATE 8/3/78
COMP. BY DBC
CHECKED BY [illegible]

NAME OF CLIENT NYSDEC
PROJECT Diverting Reservoir

Drawdown Analysis

Discharge from 3x" pipes

$$H = \left(1 + K_e + K_v + \frac{29n^2L}{R_h^{4/3}}\right)\frac{V^2}{2g}$$

$n = .015$
K_e = entrance and exit losses = 1.5
K_v = valve loss = .5
& $V^2/2g = Q^2/2gA^2$

$$H = \left(1 + 1.5 + .5 + \frac{29(.015)^2 230}{.625^{4/3}}\right)\frac{Q^2}{2g \times (\pi\, 1.25^2)^2}$$

$$H = .00374\, Q^2$$

$\therefore Q = 16.3\, H^{1/2}$ per pipe

For both pipes $Q_T = 32.6 H^{1/2}$

Inflow = 2 cfs/sq.mi × 87.6 sq. mi ≈ 175cfs

NET OUTFLOW (Q_n) = $32.6 H^{1/2} - 175$

H = 40' at spillway crest

H	40	35	30	29
Q_n	31	18	4	0

Reservoir outlet works cannot drawdown the pool below H = 29 (≈ Elevation 299.0)

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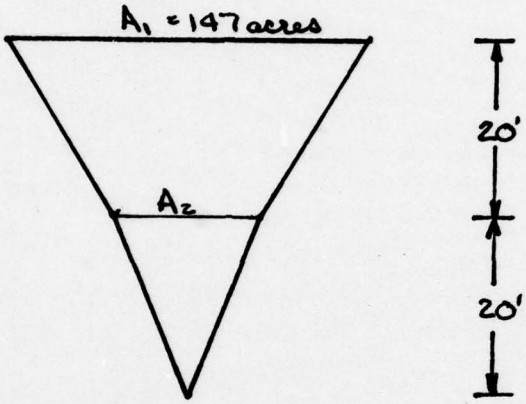
PHILADELPHIA, PA

SHEET NO. 6 OF
DATE 8/3/78
COMP. BY DBC
CHECKED BY REH

NAME OF CLIENT NYSDEC
PROJECT Diverting Reservoir

Normal pool volume = 2700 acre-feet
Depth = 40 feet



$2700 = 20 \times (147 + A_2)/2 + \frac{1}{2} \times 20 \times A_2$

$A_2 = 61.5$ acres

ΔH	H_{AVE}	A_{AVE}	ΔS	$Q_{n\,AVE}$	ΔT (hrs)	ΣT (days)
40 to 35	37.5	136.3	682	24.6	335	14
35 to 30	32.5	114.9	575	10.8	644	41
30 to 29	29.5	102.1	102.1	2.1	588	65

For the assumed inflow of 2 cfs/sq. mi., the reservoir cannot be drained below Elevation 299.0.

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

NATIONAL DAM INSPECTION PROGRAM
DIVERTING RESERVOIR DAM
PMF HYDROGRAPH

JOB SPECIFICATION

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

JOPER	NHI
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	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	1	87.58	0.00	0.00	0.00	0.000	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
6	0.00	0.00	0.00

PRECIP PATTERN

.70 1.00 2.30 9.90 3.00 .80

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= 10.65 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= 6.29 AND R= 4.87 INTERVALS

UNIT HYDROGRAPH 30 END-OF-PERIOD ORDINATES, LAG= 10.74 HOURS, CP= .63 VOL= 1.00

235.	857.	1686.	2517.	3107.	3309.	3039.	2511.	2044.	1663.
1354.	1102.	897.	730.	594.	484.	394.	320.	261.	212.
173.	141.	114.	93.	76.	62.	50.	41.	33.	27.

END-OF-PERIOD FLOW

	TIME	RAIN	EXCS	COMP Q
1	2 0	.70	.50	118.
1	4 0	1.00	.80	617.
1	6 0	2.30	2.10	2023.
1	8 0	9.90	9.70	6691.

A19

1	12	0	.80	.60	28320.
1	14	0	0.00	0.00	40338.
1	16	0	0.00	0.00	48831.
1	18	0	0.00	0.00	51719.
1	20	0	0.00	0.00	49350.
1	22	0	0.00	0.00	41152.
2	0	0	0.00	0.00	33806.
2	2	0	0.00	0.00	27538.
2	4	0	0.00	0.00	22414.
2	6	0	0.00	0.00	18243.
2	8	0	0.00	0.00	14848.
2	10	0	0.00	0.00	12085.
2	12	0	0.00	0.00	9836.
2	14	0	0.00	0.00	8006.
2	16	0	0.00	0.00	6516.
2	18	0	0.00	0.00	5304.
2	20	0	0.00	0.00	4317.
2	22	0	0.00	0.00	3513.
3	0	0	0.00	0.00	2860.
3	2	0	0.00	0.00	2327.
3	4	0	0.00	0.00	1894.
3	6	0	0.00	0.00	1542.
3	8	0	0.00	0.00	1255.
3	10	0	0.00	0.00	1021.
3	12	0	0.00	0.00	831.
3	14	0	0.00	0.00	666.
3	16	0	0.00	0.00	524.
3	18	0	0.00	0.00	380.
3	20	0	0.00	0.00	96.
3	22	0	0.00	0.00	16.
4	0	0	0.00	0.00	0.
4	2	0	0.00	0.00	0.
4	4	0	0.00	0.00	0.
4	6	0	0.00	0.00	0.
4	8	0	0.00	0.00	0.
4	10	0	0.00	0.00	0.
4	12	0	0.00	0.00	0.
4	14	0	0.00	0.00	0.
4	16	0	0.00	0.00	0.
4	18	0	0.00	0.00	0.
4	20	0	0.00	0.00	0.
4	22	0	0.00	0.00	0.
5	0	0	0.00	0.00	0.
5	2	0	0.00	0.00	0.
5	4	0	0.00	0.00	0.
		SUM	17.70	16.50	464081.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	51719.	49633.	32637.	12891.	464081.
INCHES		5.27	13.87	16.43	16.43
AC-FT		24624.	64768.	76747.	76747.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

24.	123.	405.	1338.	3217.	5664.	8068.	9766.	10344.	9670.
8230.	6761.	5508.	4483.	3649.	2970.	2417.	1967.	1601.	1303.
1061.	863.	703.	572.	465.	379.	308.	251.	204.	166.
133.	105.	76.	19.	3.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10344.	9927.	6527.	2578.	92816.
INCHES		1.05	2.77	3.29	3.29
AC-FT		4925.	12954.	15349.	15349.

A20

47.	247.	809.	2677.	6434.	11328.	16135.	19532.	20687.	19340.
16461.	13523.	11015.	8965.	7297.	5939.	4834.	3934.	3202.	2606.
2121.	1727.	1405.	1144.	931.	758.	617.	502.	409.	333.
266.	210.	152.	38.	6.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	20687.	19853.	13055.	5156.	185632.
INCHES		2.11	5.55	6.57	6.57
AC-FT		9850.	25907.	30699.	30699.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

71.	370.	1214.	4015.	9650.	16992.	24203.	29299.	31031.	29010.
24691.	20284.	16523.	13448.	10946.	8909.	7251.	5902.	4804.	3910.
3182.	2590.	2108.	1716.	1396.	1137.	925.	753.	613.	499.
399.	314.	228.	57.	10.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	31031.	29780.	19582.	7735.	278449.
INCHES		3.16	8.32	9.86	9.86
AC-FT		14775.	38861.	46048.	46048.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

94.	494.	1619.	5353.	12867.	22656.	32271.	39065.	41375.	38680.
32921.	27045.	22030.	17931.	14594.	11878.	9668.	7869.	6405.	5213.
4243.	3453.	2811.	2288.	1862.	1515.	1233.	1004.	817.	665.
533.	419.	304.	77.	13.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	41375.	39707.	26109.	10313.	371265.
INCHES		4.22	11.09	13.14	13.14
AC-FT		19699.	51814.	61398.	61398.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

118.	617.	2023.	6691.	16084.	28320.	40338.	48831.	51719.	48350.
41152.	33806.	27538.	22414.	18243.	14848.	12085.	9836.	8006.	6516.
5304.	4317.	3513.	2860.	2327.	1894.	1542.	1255.	1021.	831.
666.	524.	380.	96.	16.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	51719.	49633.	32637.	12891.	464081.
INCHES		5.27	13.87	16.43	16.43
AC-FT		24624.	64768.	76747.	76747.

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

HYDROGRAPH ROUTING

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

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	1

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

8447.	6927.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
1116.	908.	739.	602.	490.	399.	324.	264.	215.	175.
141.	111.	83.	35.	3.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

1.	4.	13.	42.	107.	201.	266.	301.	318.	306.
278.	246.	220.	188.	152.	124.	101.	82.	67.	54.
44.	36.	29.	24.	19.	16.	13.	10.	9.	7.
6.	4.	3.	1.	0.	0.	-0.	-0.	-0.	-0.
-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10367.	9897.	6504.	2578.	92822.
INCHES		1.05	2.76	3.29	3.29
AC-FT		4910.	12907.	15350.	15350.

STATION 2, PLAN 1, RTIO 2

47.	182.	649.	2127.	5407.	10959.	15391.	19296.	20635.	19603.
16881.	13861.	11316.	9197.	7494.	6094.	5033.	4157.	3362.	2744.
2231.	1816.	1478.	1203.	979.	797.	649.	528.	430.	350.
282.	223.	166.	70.	6.	2.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

2.	7.	26.	84.	215.	330.	422.	503.	527.	518.
453.	390.	338.	294.	258.	229.	200.	165.	134.	109.
89.	72.	59.	48.	39.	32.	26.	21.	17.	14.
11.	9.	7.	3.	0.	0.	-0.	-0.	-0.	-0.
-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	20635.	19845.	13011.	5157.	185644.
INCHES		2.11	5.53	6.57	6.57
AC-FT		9846.	25821.	30701.	30701.

STATION 2, PLAN 1, RTIO 3

71.	273.	974.	3190.	8605.	16143.	23440.	29008.	30954.	29384.
25123.	20690.	16993.	13784.	11247.	9137.	7447.	6055.	5007.	4129.
3341.	2726.	2217.	1805.	1469.	1196.	973.	792.	645.	525.
423.	334.	249.	105.	6.	4.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

3.	11.	39.	127.	281.	438.	571.	658.	688.	664.
537.	528.	455.	389.	336.	292.	257.	228.	199.	164.
133.	108.	88.	72.	58.	47.	39.	31.	26.	21.
17.	13.	10.	4.	0.	0.	-0.	-0.	-0.	-0.
-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	30954.	29782.	19542.	7735.	278466.
INCHES		3.16	8.30	9.86	9.86
AC-FT		14776.	38782.	46051.	46051.

STATION 2, PLAN 1, RTIO 4

94.	364.	1299.	4253.	11804.	21403.	31596.	38445.	41481.	38985.
33629.	27497.	22520.	18329.	15026.	12165.	9940.	8067.	6580.	5357.
4507.	3617.	2962.	2404.	1959.	1594.	1298.	1056.	860.	700.
563.	445.	333.	141.	11.	5.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

4.	14.	52.	169.	348.	539.	698.	805.	848.	814.
[illegible]	[illegible]	666.	483.	415.	355.	309.	270.	239.	213.

22.	18.	13.	6.	0.	0.	-0.	-0.	-0.	-0.
-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	41481.	39637.	26073.	10314.	371289.
INCHES		4.21	11.08	13.15	13.15
AC-FT		19665.	51742.	61402.	61402.

STATION 2. PLAN 1. RTIO 5

118.	455.	1624.	5316.	15004.	26856.	39424.	48325.	51688.	48835.
41790.	34481.	28075.	22862.	18663.	15278.	12382.	10110.	8210.	6693.
5441.	4584.	3690.	3013.	2446.	1993.	1622.	1320.	1074.	874.
704.	556.	416.	176.	14.	6.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

5.	18.	64.	211.	414.	624.	821.	938.	982.	945.
852.	743.	643.	562.	490.	420.	360.	312.	273.	242.
216.	182.	146.	120.	97.	79.	64.	52.	43.	35.
28.	22.	17.	7.	1.	0.	-0.	-0.	-0.	-0.
-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	51688.	49616.	32507.	12892.	464111.
INCHES		5.27	13.85	16.43	16.43
AC-FT		24616.	64708.	76752.	76752.

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

PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

PERATION	STATION	PLAN	RATIOS APPLIED TO FLOWS .20	.40	.60	.80	1.00
YDROGRAPH AT	1	1	10344.	20687.	31031.	41375.	51719.
		2	0.	0.	0.	0.	0.
OUTED TO	2	1	10367.	20635.	30954.	41481.	51688.
		2	0.	0.	0.	0.	0.

STABILITY ANALYSES

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

SHEET NO. ____ OF ____

DATE 8/3/78

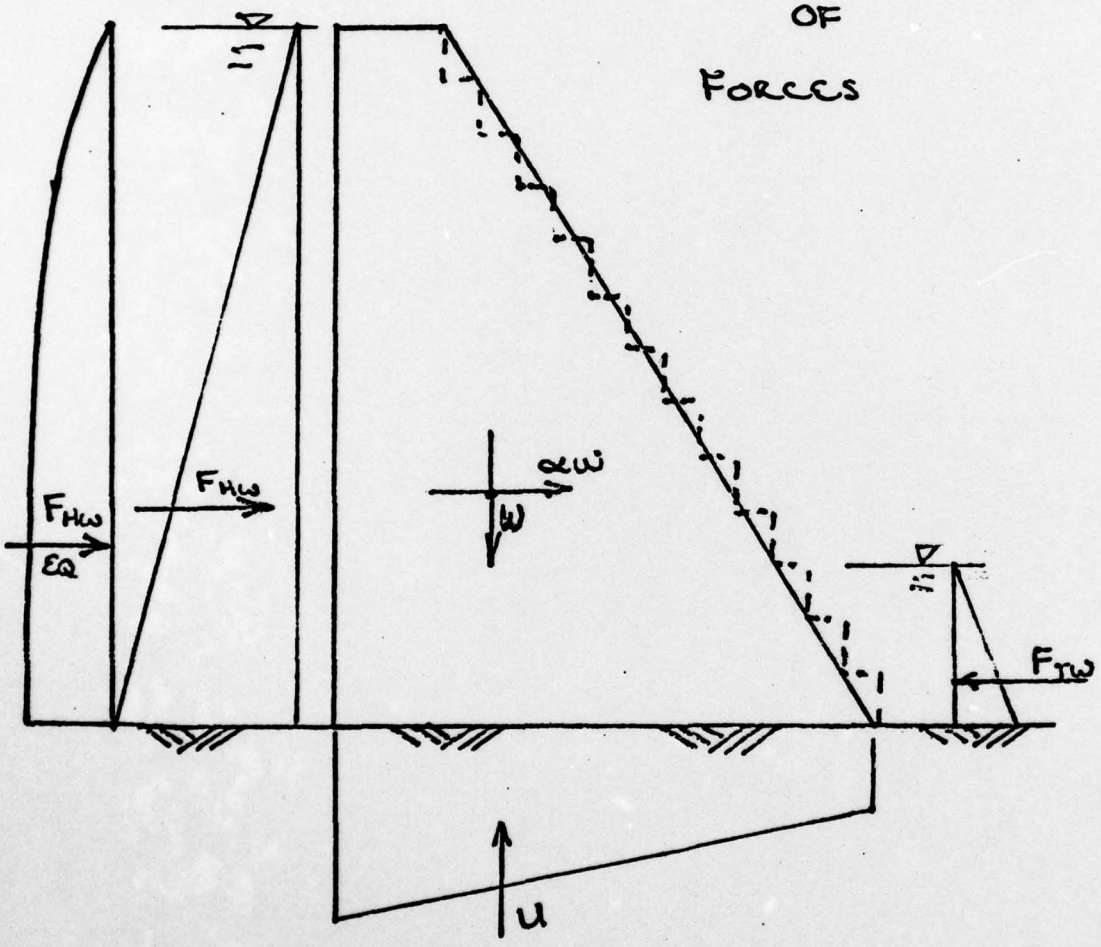
NAME OF CLIENT NYSDEC

COMP. BY DBC

PROJECT Diverting Reservoir

CHECKED BY ____

EXPLANATION OF FORCES



W - Weight of dam

αW - Inertial force of dam during earthquake

F_{HW} - Headwater force

F_{TW} - Tailwater force

F_{HW}_{EQ} - Inertial force of headwater during earthquake

U - Uplift force

****

NATIONAL DAM INSPECTION PROGRAM-DIVERTING RESERVOIR DAM
NORMAL POOL

****

BASE ELEVATION= 270.00FT. TOP ELEVATION= 309.55FT. BASE WIDTH= 30.00FT. DENSITY= 165.00PCF
HEADWATER ELEVATION= 309.55FT. TAILWATER ELEVATION= 0.00FT. EARTHQUAKE ACCELERATION***.000G (HORIZ),.000G (VERT)
SILT ELEVATION= 309.55FT. SILT DENSITY(SUBMERGED)= 75.00PCF SILT PRESSURE COEFFICIENT(K)= .33
SHEAR STRESS= 100.00PSI SHEAR WIDTH= 30.00FT. FRICTION FACTOR= .65

****

LOADING	FORCE(KIPS)	ARM(FEET)	STABILIZING MOMENT	OVERTURNING MOMENT
WEIGHT OF DAM	117.46	19.67	2310.12	
HEADWATER	48.80	13.17		642.74
UPLIFT	37.02	20.00		740.38
SILT	19.53	13.18		257.51
			**********	**********
			2310.12	1640.63

****

A26

NET HORIZONTAL FORCE= 69.34 KIPS
NET VERTICAL FORCE= 80.44 KIPS
NET MOMENT= 669.99KIP-FEET
X-BAR OF FOUNDATION REACTION= 8.32 FEET
ECCENTRICITY OF FOUNDATION REACTION FROM CENTER= 6.68 FEET
**********FOUNDATION REACTION NOT IN CENTRAL THIRD OF BASE*****TENSION AT HEEL OF DAM*****
FOUNDATION REACTION PRESSURES*******TOE= 43.49 PSI*******HEEL= -6.25 PSI*******
OVERTURNING FACTOR OF SAFETY= 1.41
SLIDING FACTOR OF SAFETY= .77
DEVELOPED FRICTION FACTOR (NO SHEAR)= .85
SLIDING WITH SHEAR FACTOR OF SAFETY= 7.09(SHEAR ACROSS FULL BASE WIDTH)

NATIONAL DAM INSPECTION PROGRAM-DIVERTING RESERVOIR DAM
NORMAL POOL + EARTHQUAKE

BASE ELEVATION= 270.00FT. TOP ELEVATION= 309.55FT. BASE WIDTH= 30.00FT. DENSITY= 165.00PCF
HEADWATER ELEVATION= 309.55FT. TAILWATER ELEVATION= 0.00FT. EARTHQUAKE ACCELERATION***.025G (HORIZ),.000G (VERT)
SILT ELEVATION= 309.55FT. SILT DENSITY(SUBMERGED)= 75.00PCF SILT PRESSURE COEFFICIENT(K)= .33
SHEAR STRESS= 100.00PSI SHEAR WIDTH= 30.00FT. FRICTION FACTOR= .65

LOADING	FORCE(KIPS)	ARM(FEET)	STABILIZING MOMENT	OVERTURNING MOMENT
WEIGHT OF DAM	117.46	19.67	2310.12	
HEADWATER	48.80	13.17		642.74
UPLIFT	37.02	20.00		740.38
EARTHQUAKE INDUCED LOADINGS				
INERTIA-WATER	1.33	15.82		21.03
HORIZONTAL INERTIA-DAM	2.94	15.38		45.17
SILT	19.53	13.18		257.51
			**********	**********
			2310.12	1706.83

NET HORIZONTAL FORCE= 72.60 KIPS
NET VERTICAL FORCE= 80.44 KIPS
NET MOMENT= 603.29KIP-FEET
X-BAR OF FOUNDATION REACTION= 7.50 FEET
ECCENTRICITY OF FOUNDATION REACTION FROM CENTER= 7.50 FEET
**********FOUNDATION REACTION NOT IN CENTRAL THIRD OF BASE*****TENSION AT HEEL OF DAM*****
FOUNDATION REACTION PRESSURES********TOE= 46.56 PSI********HEEL= -9.31 PSI********
OVERTURNING FACTOR OF SAFETY= 1.35
SLIDING FACTOR OF SAFETY= .72
DEVELOPED FRICTION FACTOR (NO SHEAR)= .90
SLIDING WITH SHEAR FACTOR OF SAFETY= 6.67(SHEAR ACROSS FULL BASE WIDTH)

NATIONAL DAM INSPECTION PROGRAM-DIVERTING RESERVOIR DAM
PROBABLE MAXIMUM FLOOD

BASE ELEVATION= 270.00FT. TOP ELEVATION= 309.55FT. BASE WIDTH= 30.00FT. DENSITY= 165.00PCF
HEADWATER ELEVATION= 315.00FT. TAILWATER ELEVATION= 290.00FT. EARTHQUAKE ACCELERATION=.000G (HORIZ),.000G (VERT)
SILT ELEVATION= 303.55FT. SILT DENSITY(SUBMERGED)= 75.00PCF SILT PRESSURE COEFFICIENT(K)= .33
SHEAR STRESS= 100.00PSI SHEAR WIDTH= 30.00FT. FRICTION FACTOR= .65

LOADING	FORCE(KIPS)	ARM(FEET)	STABILIZING MOMENT	OVERTURNING MOMENT
WEIGHT OF DAM	117.46	19.67	2310.12	
HEADWATER	62.25	14.61		909.36
TAILWATER	12.48	6.66	83.12	
UPLIFT	60.84	16.92		1029.60
SILT	19.53	13.18		257.51
			*********	*********
			2393.23	2196.47

NET HORIZONTAL FORCE= 69.31 KIPS
NET VERTICAL FORCE= 56.62 KIPS
NET MOMENT= 196.76KIP-FEET
X-BAR OF FOUNDATION REACTION= 3.47 FEET
ECCENTRICITY OF FOUNDATION REACTION FROM CENTER= 11.53 FEET
**********FOUNDATION REACTION NOT IN CENTRAL THIRD OF BASE*****TENSION AT HEEL OF DAM*****
FOUNDATION REACTION PRESSURES********TOE= 43.32 PSI********HEEL= -17.11 PSI********
OVERTURNING FACTOR OF SAFETY= 1.09
SLIDING FACTOR OF SAFETY= .53
DEVELOPED FRICTION FACTOR (NO SHEAR)= 1.22
SLIDING WITH SHEAR FACTOR OF SAFETY= 6.76(SHEAR ACROSS FULL BASE WIDTH)

PREVIOUS INSPECTION REPORT

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.

1. The structure is on Croton Falls Diverting Weir The east branch of the Croton River in the Town of Southeast County of Putnam xxx New York about 2-1/4 miles northeast from the Village of Croton Falls, Westchester N.Y.
(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 the direction of the horizontal outcropping relative to the axis of the main structure and the inclination and direction 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.....square miles.

13. The pond area at the spillway crest elevation is 154 acres and the pond impounds 118.7 m: cubic feet of water.

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

..... (Date)

15. Has the spillway capacity ever been exceeded by a high flow?.....

Can any possible flood flow from the pond otherwise than through the wastes noted under 17 and 18 of this report?..... If so, give the location, the length and the elevation relative to the spillway crest and the 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 possible failure of the above structure. Describe the location, the character and the use of buildings below the structure which might be damaged by any failure of the structure; of roads adjacent to or crossing the stream below the structure, giving the lowest elevation of the roadway above the stream bed and giving the shape, the height and the width of stream openings; and of any embankments or steep slopes that any flood could pass over. Also indicate the character and use made of the ground below the structure.....

In case the dam should fail, the released water would flow down the East Branch of the Croton River into the New Croton Reservoir, a distance of about 2-1/2 miles(No great damage or loss of life would occur.

17. WASTES. The spillway of the above structure is 1000 feet long in the clear; the waters are held at the right end by an earth dam..... the top of which is 10 feet above the spillway crest, and has a top width of 15 feet; and at the left end by a hillside, the top of which is 10 feet above the spillway crest, and has a top width of.....feet.

18. There is also for flood discharge a 2 pipe 30 inches in its diameter and the bottom is 31 feet below the spillway crest; and a (sluice, gate outlet)..... feet wide in the clear by..... feet high, and the bottom is..... feet below the spillway crest.

19. APRON. Below the spillway there is no apron but a heavily paved waste channel (Material)
feet wide and ..... feet thick. The downstream side of the apron has a thickness of ..... feet
for a width of ..... feet.

20. Has the structure any weaknesses which are liable to cause its failure in high flows? .....
No.

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 1911 by the City of New York

The total length of this dam is 2000 feet. The spillway or waste weir portion, is about 1000 feet long, and the crest of the spillway about 8 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 under gate house

At the time of this inspection the water level above the dam was 0 ft. 1/8 in 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.)

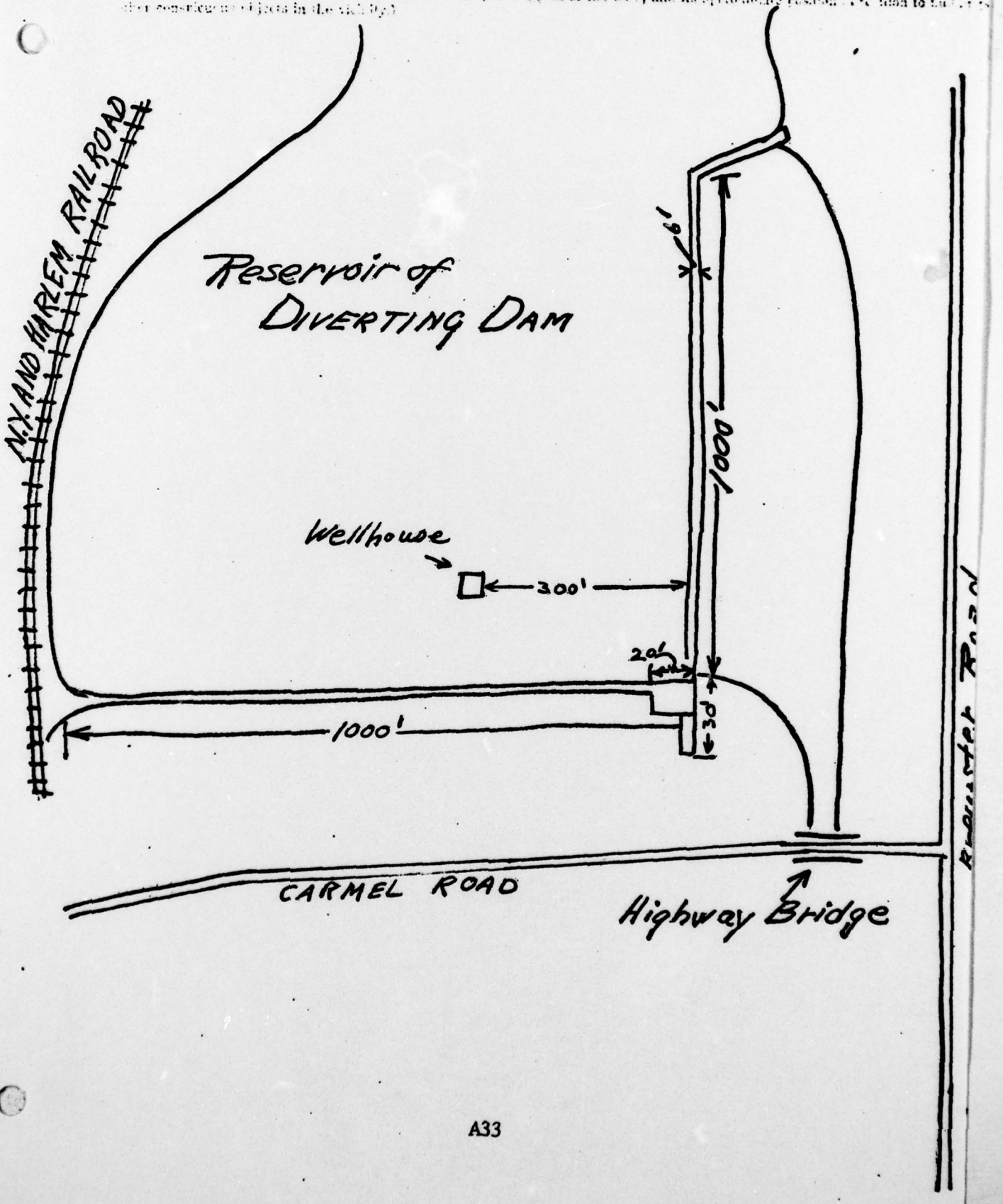
This dam is in good condition throughout and in case of rupture water would probably be caught by the lower dam or swamp valley below where it would probably carry away several houses and an electric light plant and factory located below on the same stream

A32

Reported by L D Leymour

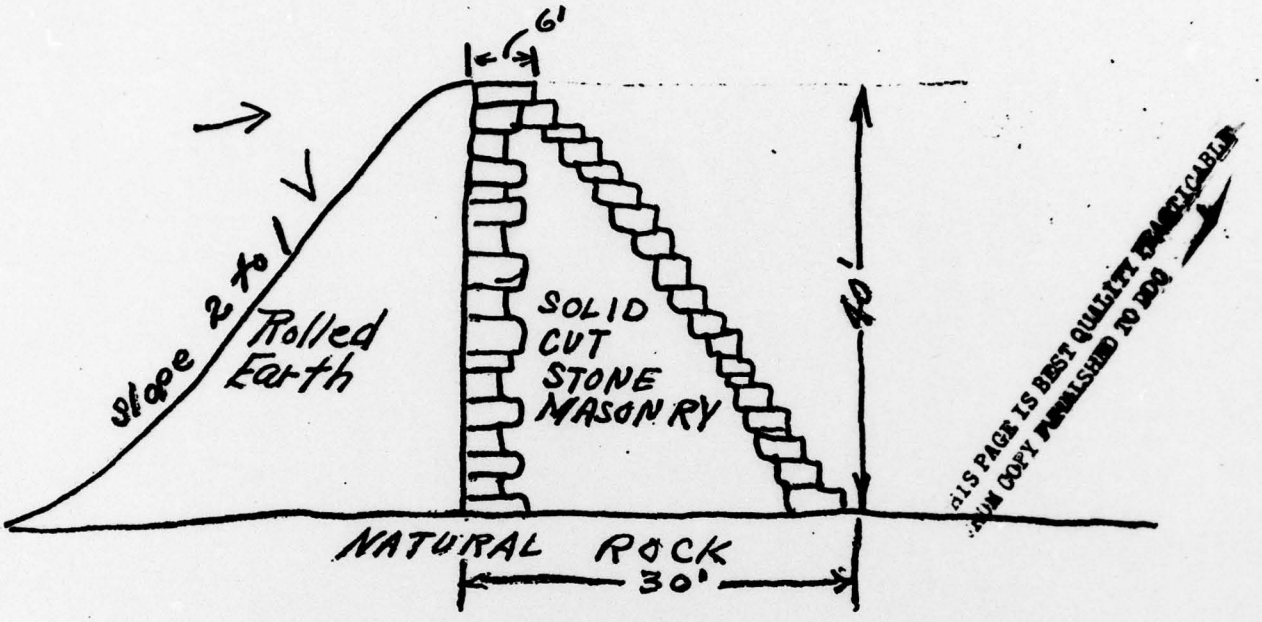
Walcott N.Y.

(In the space below, or on a third sheet, sketch showing the general plan of the dam, and its approximate position with reference to [illegible] other conspicuous objects in the vicinity.)



In the space below, make a careful sketch showing the form and dimensions of a cross section through the spillway or waste-weir of this dam, and in 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