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Ulster County
Roundout Creek

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.

Merriman Dam was found to be in excellent condition.

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HUDSON RIVER VALLEY

ROUNDOUT CREEK, ULSTER COUNTY

NEW YORK

MERRIMAN DAM

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM.

Merriman Dam (NY 00121). Hudson River Valley, Roundout Creek, Ulster County, New York. Phase I Inspection Report.

NY 00121

(11) Aug 78

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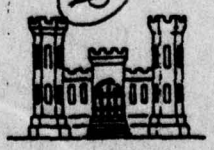

New York State Dept of Environmental Conser

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

Name of Dam: Merriman Dam
County and State: Ulster County, State of New York
Inventory Number: NY 00121

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: July 27, 1978

PHASE I REPORT

NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Merriman Dam

State Located: New York
County Located: Ulster County
Stream: Rondout Creek
Date of Inspection: June 27, 1978

CONT'D FROM PAGE 1

ASSESSMENT OF GENERAL CONDITIONS

Merriman Dam and its appurtenances appear to be in excellent condition. The reservoir area, dam, spillway, tunnel and outlet works are well maintained.

The spillway is adequate to pass flood flows equal to the Probable Maximum Flood with approximately 9.0 feet of freeboard still available below the top of the dam.

O'BRIEN & GERE ENGINEERS, INC.

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

UPSTREAM FACE OF DAM

UPSTREAM FACE OF DAM, SPILLWAY AND RIGHT BANK OF RESERVOIR

SIDE CHANNEL AND SPILLWAY

VIEW OF SPILLWAY

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM MERRIMAN DAM ID# NY 00121

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 State of New York, Department of Environmental Conservation.

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

1.2 PROJECT DESCRIPTION

a. Description of Dam, Reservoir and Appurtenances (From information provided by the New York State Department of Environmental Conservation)

1. Dam and Reservoir - Merriman Dam (also known as Rondout or Lackawack Dam) is located in Ulster County, New York, approximately five (5) miles northwest of the community of Ellenville. The dam and reservoir, owned by the City of New York, are part of the "Delaware System" supplying water to New York City through the Delaware Aqueduct. Rondout Reservoir, placed in service in 1951, has a total available capacity of approximately fifty (50) billion gallons and a surface area at spillway crest of 2,080 acres. Its associated drainage area is 95 square miles. Merriman Dam, completed in 1945, is a "rolled earth embankment" approximately 2,400 feet long with a maximum height 195 feet above original ground. At its maximum section, the width of the dam is 60 feet at the top and 1,392 feet at the base.

[CONT'D ON PAGE ii]

The upstream face of the Dam has slopes varying from 1 (vertical) on 2½ (horizontal) to 1 on 4. Three berms are provided at elevations 780, 725 and 712.5 respectively. The upstream face is protected by a "Rock Paving" on top of a graded layer of rock ("Rock embankment").

The downstream face of the dam is grass covered with slopes varying from 1 on 3 to 1 on 4. Three (3) berms are provided at elevations

712.5, 725 and 790 respectively. Longitudinal berm drains are provided with catch basins uniformly spaced.

A concrete cutoff wall is provided with a top elevation varying from approximately 850 to 710. The cutoff wall trench was excavated to "sound rock" and the cutoff wall was grouted in place.

2. Overflow Spillway and Channel - The overflow spillway and channel are constructed of large cut stones. The spillway (elevation 840) is 600 feet long. Water passes over the spillway onto a series of rock berms, then into a wide stone lined channel (see Photograph #A-11). This channel leads into a tunnel which discharges flow into Rondout Creek downstream of the dam. Flow in excess of the capacity of the tunnel is discharged by means of concrete lined channel (see Figure 6) located above the tunnel. This channel also discharges flow into Rondout Creek.

3. Outlet Works - Two (2) 54" steel pipes and four (4) 42" steel pipes are provided to allow water to pass from the reservoir into the Rondout West Branch Tunnel. The centerline of the pipe inlets is at elevation 697.5, 142.5 feet below spillway crest. Drawdown is also accomplished through these pipes. A weir is provided at elevation 720 just upstream of the inlets to the pipes

b. Size Classification - The normal storage volume of Rondout Reservoir is approximately 154,000 acre-feet. Since this exceeds 50,000 acre-feet, Merriman Dam is in the large size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

c. Hazard Classification - The Village of Lackawack, population 500, is about 3/4 miles downstream of Merriman Dam. Therefore, failure of Merriman Dam could result in the loss of many lives and extensive damage to personal property. 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 provided by the New York State Department of Environmental Conservation)

a. Drainage Area - The drainage area of Rondout Reservoir is 95 square miles as stated in "Data Pertaining to N.Y. City Reservoirs" (see Figure #2).

b. Discharges - Maximum discharge through the outlet works with the reservoir at elevation 840, spillway crest, is 890 million gallons per day (1,377 cfs). Maximum discharge over the spillway is approximately 180,000 cfs.

c. Reservoir Data (@ Spillway Crest. Elevation 840)

Length - 6.5 miles
Average Width - 0.75 miles
Volume - 154,000 acre-feet
Length of Shoreline - 17.0 miles

d. Dam Data

Type - Rolled Earth Embankment
Top Elevation - 860 feet
Streambed Elevation @ Centerline of Dam - 665 feet
Length - 2,400 feet
Top Width - 60 feet
Bottom Width - 1,392 feet (at maximum section)
Side Slopes - 1 on 2.5, 1 on 3.5 and 1 on 4 (upstream face) ; 1 on 3 and 1 on 4 (downstream face)
Cutoff - Concrete cutoff wall as shown in Figure #5

e. OutletWorks - See Section 1.2 a-3.

f. Engineering Data - The information available for review of Merriman Dam included:

1. Contract and Specifications (contract 340) from the Board of Water Supply of the City of New York, dated 1939).

2. Contract drawings (contract 340) from the Board of Water Supply of the City of New York, dated 1939 and 1946.

3. Articles from "The Delaware Water Supply News" dated November 1, 1939, March 1, 1940, September 15, 1940, January 15, 1941, August 15, 1941, November 1, 1941, November 15, 1941.

4. Geologic Map of New York, Lower Hudson Sheet, 1961.

5. Information sheet entitled "Data Pertaining to New York City Reservoirs".

1.4 OPERATION AND MAINTENANCE - (From Contract Drawings dated 1939 & 1946 (Contract #340) provided by the Board of Water Supply, City of New York and from conversations with on-duty operation personnel)

Rondout Reservoir serves as part of the "Delaware System" for Water Supply for the City of New York.

a. Operation - Water passes from the reservoir into the Rondout "Effluent Chamber" through four (4) waterways. Within the "Effluent Chamber", the flow passes through two (2) 54" and four (4) 42" pipes. These pipes discharge flow into the Rondout-West Branch Tunnel which leads to New York City. The water is treated before it enters the tunnel.

Each of the four (4) inlet waterways is provided with screens to remove debris before flow enters the "Effluent Chamber." These screens are mechanically removable and are stored and maintained in the superstructure above the "Effluent Chamber." This superstructure also houses all controls for electrical operation of valves, overhead cranes, elevators, air compressors, heaters, etc.

b. Maintenance - Maintenance of all equipment and machinery is acomplished on a regular basis by assigned maintenance personnel. The operation and maintenance program is administered through the NYC regional office in Grahmsville, New York.

c. Flood Warning System - No flood warning system is in effect. However, an operator is on duty at the damsite 24 hours per day, every day.

SECTION 2 - VISUAL INSPECTION

2.1 FINDINGS

a. General - The field inspection of Merriman Dam and the Rondout Reservoir outlet works was accomplished on June 27, 1978. The reservoir water surface elevation was at 837, three (3) feet below the spillway crest. No underwater areas were inspected.

b. Outlet Works - The two (2) valve chambers for the two (2) 54" pipes and four (4) 42" pipes were inspected. The shafts leading to the chambers, the valve exteriors and the spaces below the valves for sump pumps appear to be maintained in excellent condition. Valves are opeated electrically and are also equipped for manual operation. All equipment may be hoisted out of the valve chambers by means of an overhead crane. This crane and all other support equipment is housed in the outlet works building which also appears well maintained.

c. Downstream Face of Merriman Dam - The downstream face appears to be in excellent condition and is well maintained. A number of rodent holes, up to 2 feet in diameter, are evident on the downstream face of the embankment. Two sinkholes, one to three feet deep and approximately 10 feet in diameter, are evident approximately 100 yards downstream from the toe of the dam. The sinkholes were dry during the inspection.

d. Upstream Face - The "Rock Paving" on the upstream face is exposed and appears to be in excellent condition. Rectangular rocks, four (4) to five (5) feet on a side and approximately two (2) feet thick, make up most of the cover of the upstream face. Smaller rocks fill the voids between these larger rocks. An attempt was made to dislodge a few of these smaller rocks by hand. In all cases, this was impossible. Weathering was apparent on the surfaces of a few of the larger rocks.

e. Overflow Spillway and Channel - The overflow spillway, channel and entrance to the discharge tunnel were examined from the top of the dam. No water was flowing over the spillway; therefore, the entire overflow structure, up to and including the tunnel entrance, was visible. The spillway, downstream channel and tunnel entrance appear to be in excellent condition with virtually no deterioration visible. There is minor seepage through the spillway about six (6) feet below the crest of the weir at the eastern end. The channel was clear and free of sediment or debris.

f. Reservoir - The reservoir and its banks are owned by the City of New York and no construction is permitted within the property line. Therefore, the banks are heavily wooded to the shoreline and rise at approximately a 20% slope. There appears to be little erosion.

g. Downstream Channel - The overflow tunnel and channel lead into Rondout Creek which passes by the Village of Lackawack approximately 3/4 miles downstream of Merriman Dam.

SECTION 3 - HYDROLOGY/HYDRAULICS

The design flood used for Merriman Dam and Rondout Reservoir is the Probable Maximum Flood (PMF), according to the Recommended Guidelines for Safety Inspection of Dams. The PMF was derived from the adjusted 12 hour Probable Maximum Precipitation (PMP) and was routed through the reservoir using the U.S. Army Corps of Engineers computer program HEC-1. From this analysis, peak outflows and storages were determined for various percentages of the PMF. The routing analysis revealed that 23,645 acre-feet of water would be stored for the peak PMF outflow of 77,104 cfs. The storage input, as derived on sheet #A-16 in the appendix, shows that this storage corresponds to a reservoir elevation of 851.0, 11.0 feet above spillway crest and 9.0 feet below the top of the dam. Therefore, there is no danger of overtopping from a storm resulting in a flood equal to or less than the Probable Maximum Flood.

According to "The Delaware Water Supply News", March 1, 1940:

> "The maximum flood peak of record in the Rondout is that of August, 1928, reaching 26,715 cubic feet per second, with an indicated occurrence of once in 55 years; 14,000 cubic feet per second and over had been observed to occur three times in 25 years".

If inflow to the reservoir is assumed as 2 cfs per square mile of drainage area, drawdown from spillway crest to elevation 720 would take place in approximately 69 days.

SECTION 4 - STRUCTURAL STABILITY

4.1 VISUAL OBSERVATIONS AND DATA REVIEW

Plans, specifications and construction history were reviewed; the documents appeared thorough and in accordance with the state of the art of the year 1939. No design calculations were made available.

If the problems caused by the burrowing rodents, previously discussed, are not resolved, reduction in cross-sectional area and possible piping may result.

The dam is equipped with a considerable number of settlement measurement pipes on both its upstream and downstream face. According to verbal information provided by on-site operators in the Operation and Maintenance Office for Merriman dam in Grahmsville, New York, these pipes were monitored daily during construction to identify embankment settlement. After construction, the pipes were checked frequently for a period of approximately ten (10) years. Throughout this entire period, no appreciable settlement was observed. These pipes are presently not monitored for settlement.

Articles from "The Delaware Water Supply News" were provided by the New York State, Department of Environmental Conservation describing various design and construction procedures for Merriman Dam. Among the items discussed and reviewed for this report were: Model Tests of the Diversion Tunnel and Spillway System, Caisson Cutoff Construction, Soil Testing, Grouting and Compaction.

4.2 GEOLOGY AND SEISMIC STABILITY

Merriman Dam is located in the southeastern section of the Catskill Mountain area within the Appalachian Uplands physiographic province. The dam and Rondout reservoir lie in moderate to rugged topography formed by dissection of the underlying nearly horizontal non-marine Devonian shale and sandstone formations and modified by Pleistocene glaciation. Foundation materials at the dam consist of thick, granular, glacial deposits which were treated during construction by cutoff walls to preclude undue seepage losses from the impounded reservoir.

No major fault or fault zones are known to exist near the dam or reservoir. The dam is located within Seismic Zone 1 of the Seismic Zone Map of Contiguous States, and it appears that static stability conditions are satisfactory. No earthquakes of any significant magnitude have been recorded within 50 miles of the dam or reservoir. Therefore it appears that seismic stability conditions are satisfactory.

SECTION 5 - ASSESSMENT/REMEDIAL MEASURES

5.1 ASSESSMENT

Merriman Dam and its appurtenances appear to be in excellent condition. The visual inspection indicated that the outlet works, valve chambers, overhead crane and all support equipment are well maintained.

The spillway is adequate to pass flood flows equal to the Probable Maximum Flood with approximately 9.0 feet of freeboard still available below the top of the dam.

Minor seepage through the eastern end of the spillway was observed but should not affect the structural stability of the spillway section.

The significance of the sinkholes, located approximately 100 yards downstream from the toe of the dam, could not be determined from field observation.

The animal burrows on the downstream slope may penetrate into the embankment a considerable distance which may reduce the embankment cross-sectional area and increase the potential for fines migration.

5.2 REMEDIAL MEASURES

The following items are suggested as maintenance rather than emergency measures.

1. The sinkhole area, located approximately 100 yards downstream of the toe of the dam, should be monitored on at least a monthly basis to detect significant flow, fines migration, or the development of additional sinkholes.

2. Seepage through the eastern section of the spillway should be monitored; if the flow increases, remedial measures should be taken. A partial drawdown of the reservoir may be necessary to make the necessary repairs at the source of the flow.

3. Embankment settlement should be measured at least twice annually through the use of the settlement pipes and plates located on both the upstream and downstream faces of the dam.

FIGURES

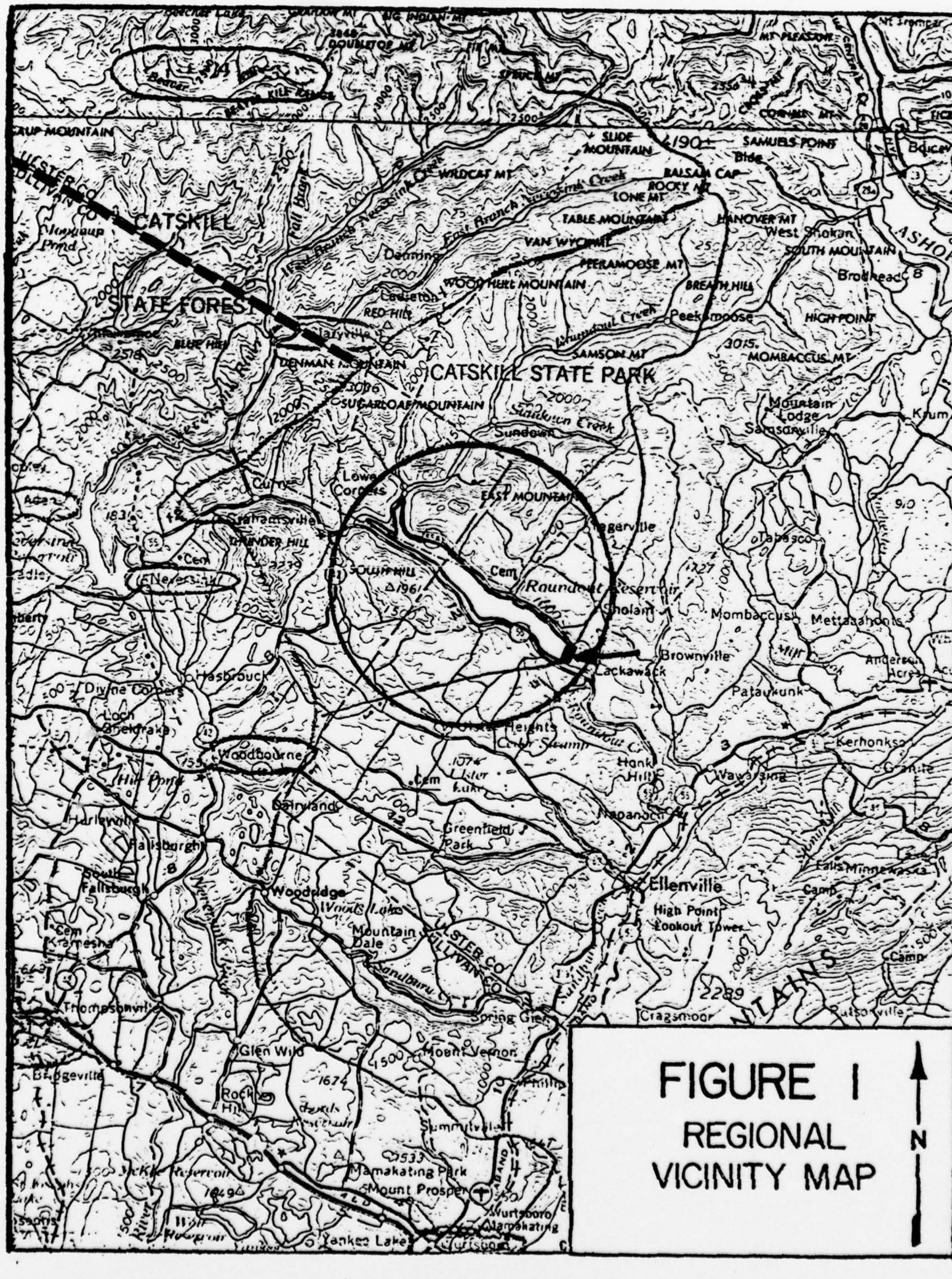


FIGURE 1
REGIONAL VICINITY MAP

CROTON SYSTEM — DATA PERTAINI

Name of Reservoir	Location: Town	Location: County	Drainage Area: Sq Mi.	Drainage Area: Includes Items	Date P.S. in Service	Kind of Dam
1 BOYDS CORNERS	KENT – PUTNAM		2846	1	1873	MASONRY, EARTH & LOS
2x BARRETTS POND			0.3*	2	1870	EARTH
3x LAKE GLENEIDA	CARMEL	"	0.80	3	1870	EARTH
4 MIDDLE BRANCH (Carmel)	"	"	42.87	1 to 4	1895	EARTH, MASONRY CORE & SP...WAY
5 WEST BRANCH	"	"				" " " " SPILLWAY
6 MIDDLE BRANCH	SOUTHEAST	"	21.81	5	1878	EARTH, MASONRY CORE
7 BOG BROOK	"	"	3.07	6	1892	" " "
8 EAST BRANCH (Boggy)	"	"	8.08	6 & 7	1891	MASONRY, EARTH & LOS
9 CROTON FALLS (Diverting)	"	"	67.28	6 to 8	1911	EARTH, CONCRETE CORE & SPILLW
10x LAKE GILEAD	CARMEL	"	0.88	9	1870	EARTH
11 CROTON FALLS	"	"	88.87	6,5,8,9,10	1911	CYCLOPEAN MASONRY
12x LAKE KIRK	"	"	2.87	11	1870	EARTH
13 AMAWALK	SOMERS – NORTHEAST		19.13	10 to 12	1897	EARTH, MASONRY CORE
14 TITICUS	NORTH SALEM	"	2.88	13	1893	MASONRY, EARTH & LOS & MASO
15 CROSS RIVER	LOWERED	"	3.98	14	1908	CYCLOPEAN MASONRY, CONCRE
16 MUSCOOT	SOMERS & LOWERED	"	26.73	10 to 15	1905	MASONRY
17 NEW CROTON	CORTLAND	"	37.89	1 to 15	1905	MASONRY
x Controlled Lakes			CROTON TOTALS			

CATSKILL SYSTEM

1 ASHOKAN	OLIVE & ROSE – ULSTER	77.00	1	1915	MASONRY
2 SCHOHARIE	GILBOA – GREENE	3.4.00	2	1926	MASONRY
CATSKILL TOTALS					

DELAWARE SYSTEM

1 NEVERSINK	NEVERSINK	SULLIVAN	43.0	1	1933	EARTH, CONCRETE CORE
2 PEPACTON	COLCHESTER & ROXBURY / MIDDLETOWN	DELAWARE	372.0	2	1954	" " "
3 CANNONSVILLE	DEPOSIT & TOMPKINS / HALCOTT	DELAWARE	4500	3	1967	" ROLLED FILL
4 RONDOUT	MARBLETOWN, NEVERSINK	ULSTER, SULLIVAN	93.00 / 10.0	1 to 4	1951	" CONCRETE CORE
DELAWARE TOTALS						

KENSICO RESERVOIR & SAFETY

KENSICO	MT. PLEASANT, NO CASTLE	WESTCHESTER	13.93	1915	MASONRY

NG TO N.Y. CITY RESERVOIRS

THE IMPOUNDING RESERVOIRS BELONG TO THE CROTON, C
OPERATING LEVEL & 568.0 BILL. GAL. (AVAILABLE ABOVE

	Capacity (Bil. Gal.)		Area of Water Surface at Spillway Elev.		Length of Shoreline Mi. (3)	Elev. of Spillway M.S.L. Datum Feet	Elev. of Ft. of Max. Depth (Min. Oper. Line) Feet	Elev. of Sill or Outlet Feet	Depth Spillway to Outlet Feet	Dead Storage Billion Gallons	Leng. Spi. Fee
	Total Avail. able (Above Sill or Outlet)	Cap. Dep. Ft. above Min. Op. Line	Sq. Mi.	Acres							
	1.696		0.464	296.9	6.2	560.05		520.7	49.4		135
	0.176		0.106	67.1	1.4	776.53		703.5	10.0		
	0.163		0.264	168.9	2.2	709.53		699.5	3.0		
	10.070		1.692	1082.6	13.6	568.2		488.6	47.0		260
						614.55 Sur.		466.1			MC 3
	4.005		0.669	428.2	6.62	571.63		510.3	61.1		100
	4.400		0.690	399.0	4.9	418.53		368.1	31.5		
	3.343		0.696	596.6	10.9	416.58		381.6	63.0		600
	0.808		0.340	153.6	4.2	309.53		279.0	30.0		1000
	0.380		0.191	122.2	2.1	196.53		180.6	16.0		
	14.142		1.680	1082.4	18.0	309.7		214.8	95.0		700
	0.586		0.156	101.1	3.1	282.53		266.0	16.0		
	6.692		0.991	606.1	8.5	344.53		306.0	38.8		50
	7.187		1.046	669.4	8.1	324.3		274.8	49.0		250
	10.306		1.302	784.2	12.9	324.53		224.8	100.0		240
	4.914		1.023	1186.1	35.0	170.53		150.8	20.0		950
	33.782		3.330	2291.2	30.0	193.53		134.8	59.0		1080
	94.637	66.6	15.531	9911.0	177.32						

	127.658	122.9	12.99	6315.2	40.2	1130.53	UNKNOWN	1081.53	35.75	4.137	930
	19.503	17.6	1.79	1145.0	16.3	1130.0	"	1090.0	40.00		1324
	147.161	140.5	14.78	9460.2	56.5						

W, CATSKILL & DELAWARE SYSTEMS TOTALLING 547.6 BIL. GAL. ABOVE MIN.
VE SILL. AN ADDITIONAL 30.6 BILL GAL. IS STORED IN A SAFETY STORAGE RES. KENSICO

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
135.0		78.0	57.0	6.00	53.60	670.0	670.0
240.0		66.0	63.0	18.00	107.60	1794.0	240.0
[illegible]		60.0	200	7.00	200.00	741.0	
100.0		94.0		20.00	180.00	873.0	100.0
		[illegible]	53.8	13.28	113.36	[illegible]	
500.0		96.0	70.0	12.00	93.00	1100.0	500.0
000.0		81.0	45.0	19.00	270.00	2140.0	1000.0
700.0		173.0	113.0	29.00	118.00	1300.0	1100.0
50.0			68.0	29.00	63.00	1270.0	50.0
2300.0		188.0	107.0	20.70	[illegible]	1319.0	[illegible]
2400		170.0	126.0	23.00	118.36	1000.0	2340.0
450.0		88.5		4.00	40.00	1150.0	1130.0
2000.0		241.0	174.0	18.00	208.00	2180.0	2180.0

UNKNOWN

950.0	[illegible]	252.0	210.0	26.33	200.00	4650.0	1000.0
324.0	180.0	182.0	155.0	15.00	138.00	2280.0	2000.0

600.0	175.00	345.0	195.0	60.00	1392.00	2670.0	NONE
900.0	180.00	304.0	204.0	60.00	1480.00	2450.0	"
240.0 360.0	175.00 [illegible]	196.0	179.0	45.00	1312.00	2000.0	"
600.0	175.00	375.0	195.0	60.00	1392.00	2400.0	"

OME OF THE CROTON SUPPLY (SEE REMARKS).

60.0	155.50	307.0	166.0	28.00	235.00	1643.0	1643.0

REMARKS

Most of the Croton Supp
carried by the New Cro
Aqueduct

Schoharie water is conveye
Tunnel to Ashokan Res. Th
enter the Catskill Aqueduc

Neversink, Pepacton & Ca
are conveyed via the New
& W. Delaware Tunnels to
thence all four supplies

of the Croton Supply, all
plus pumpage from Cr
Falls flows into Kensico

S BIL. GAL. ABOVE MIN.
A SAFETY STORAGE RES. KENSICO

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

gth of Dam Feet	
al	Masonry Portion
0.0	650.0
4.8	260.0
1.0	
.0	100.0
.8	
.0	500.0
.0	1000.0
.0	1100.0
.0	30.0
.0	3145
.0	3440.0
.0	1130.0
.0	2160.0

REMARKS

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

2.0	1000.0
0.0	2000.0

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

0.0	NONE
.0	"
0.0	"
.0	"

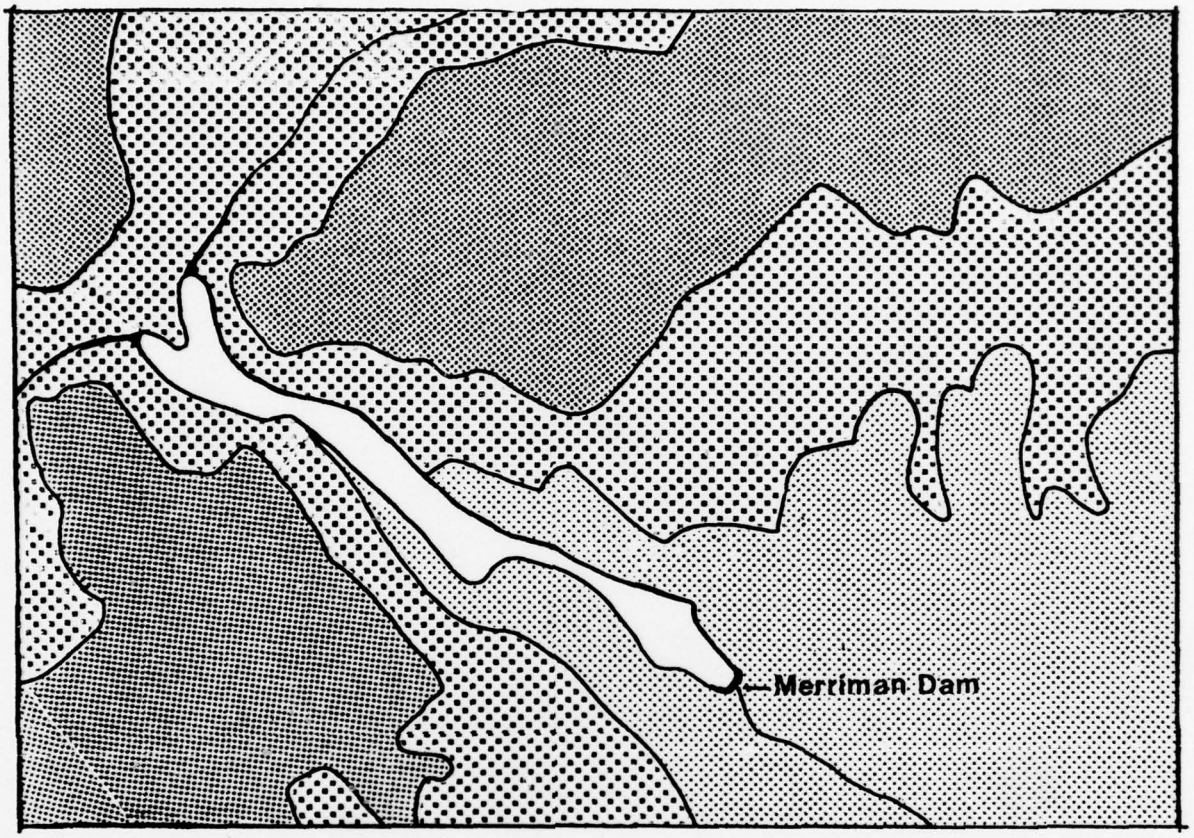
Neversink, Pepacton & Cannonsville supplies are conveyed via the Neversink, East Delaware & W. Delaware Tunnels to the Rondout Res. Thence all Four supplies enter the Del. Aqueduct.

FIGURE 2

0	1643.0

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

Acc No



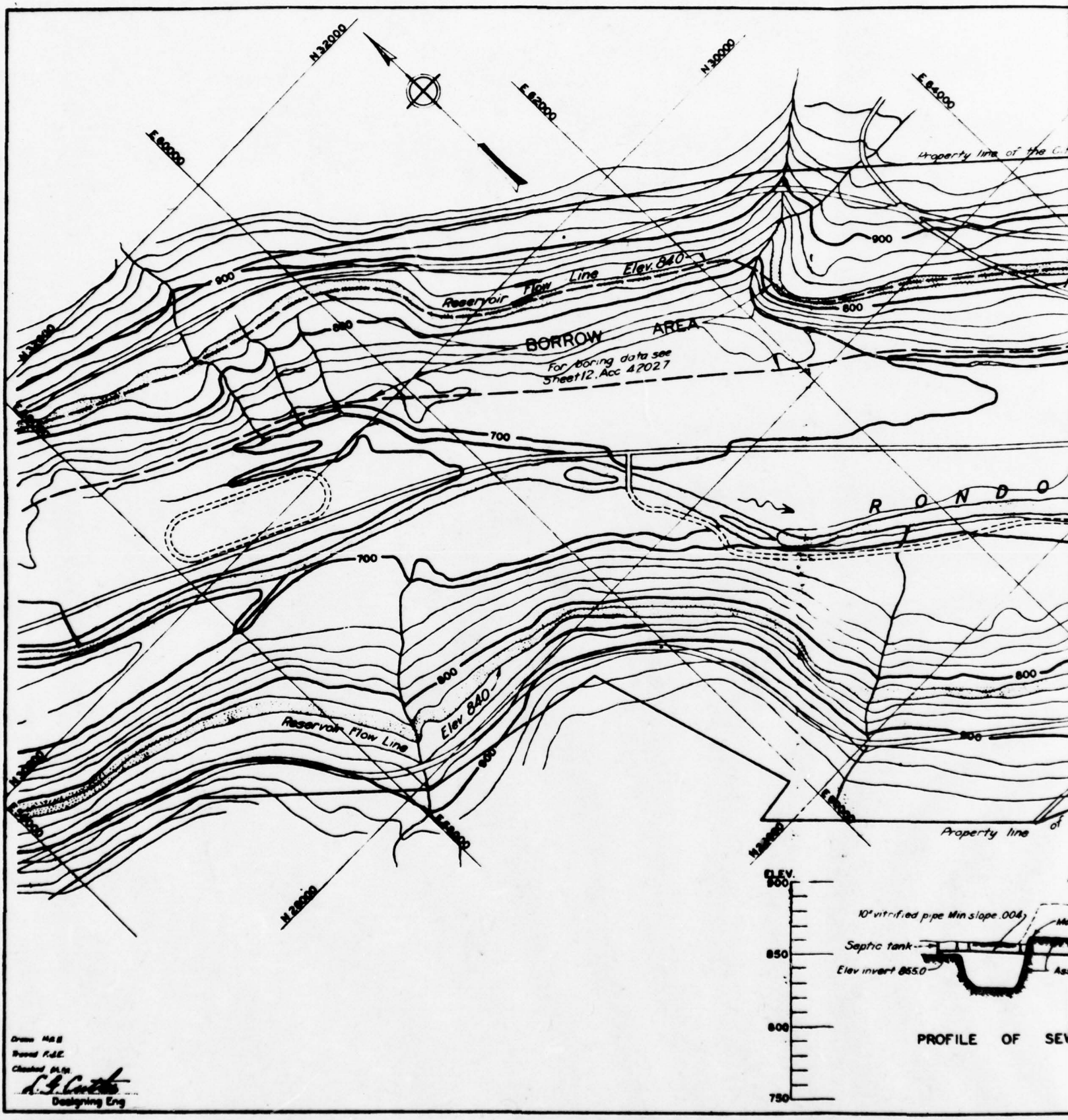
Dsd- sandstone, red shale and siltstone

Dss- sandstone, conglomerate and shale

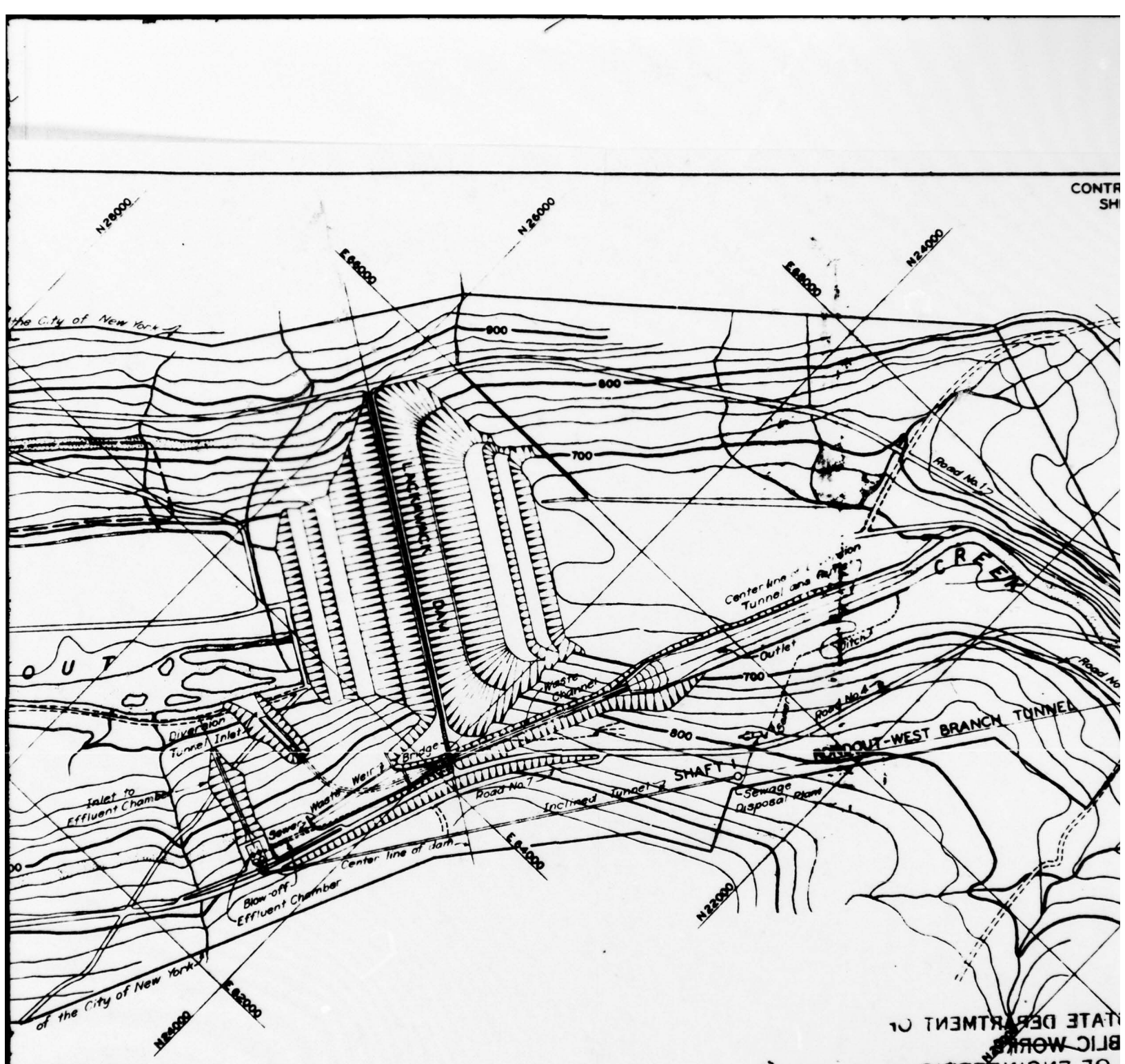
Dgk- sandstone and red shale

FIGURE 3

GEOLOGIC MAP


N 32000
N 30000
N 28000
E 80000
E 82000
E 84000
Property line of the C
900
800
700
Reservoir Flow Line Elev. 840
BORROW AREA
For boring data see Sheet 12, Acc 47027
R O N D O
Reservoir Flow Line
Elev 840
Property line of
ELEV.
900
850
800
750
10" vitrified pipe Min slope .004
Septic tank
Elev invert 855.0
PROFILE OF SEV
Drawn MAB
Traced F.A.E.
Checked W.H.
Designing Eng

1



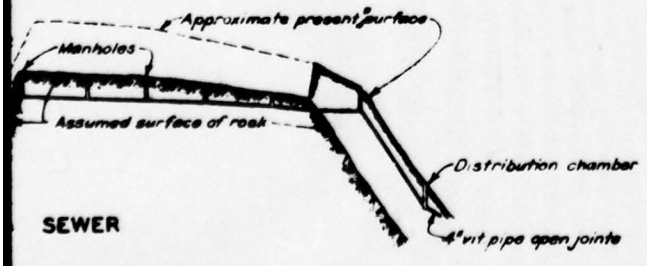


FIGURE 4

Roger St. Armstrong
Dept. Eng. Hdqrs.

1

2

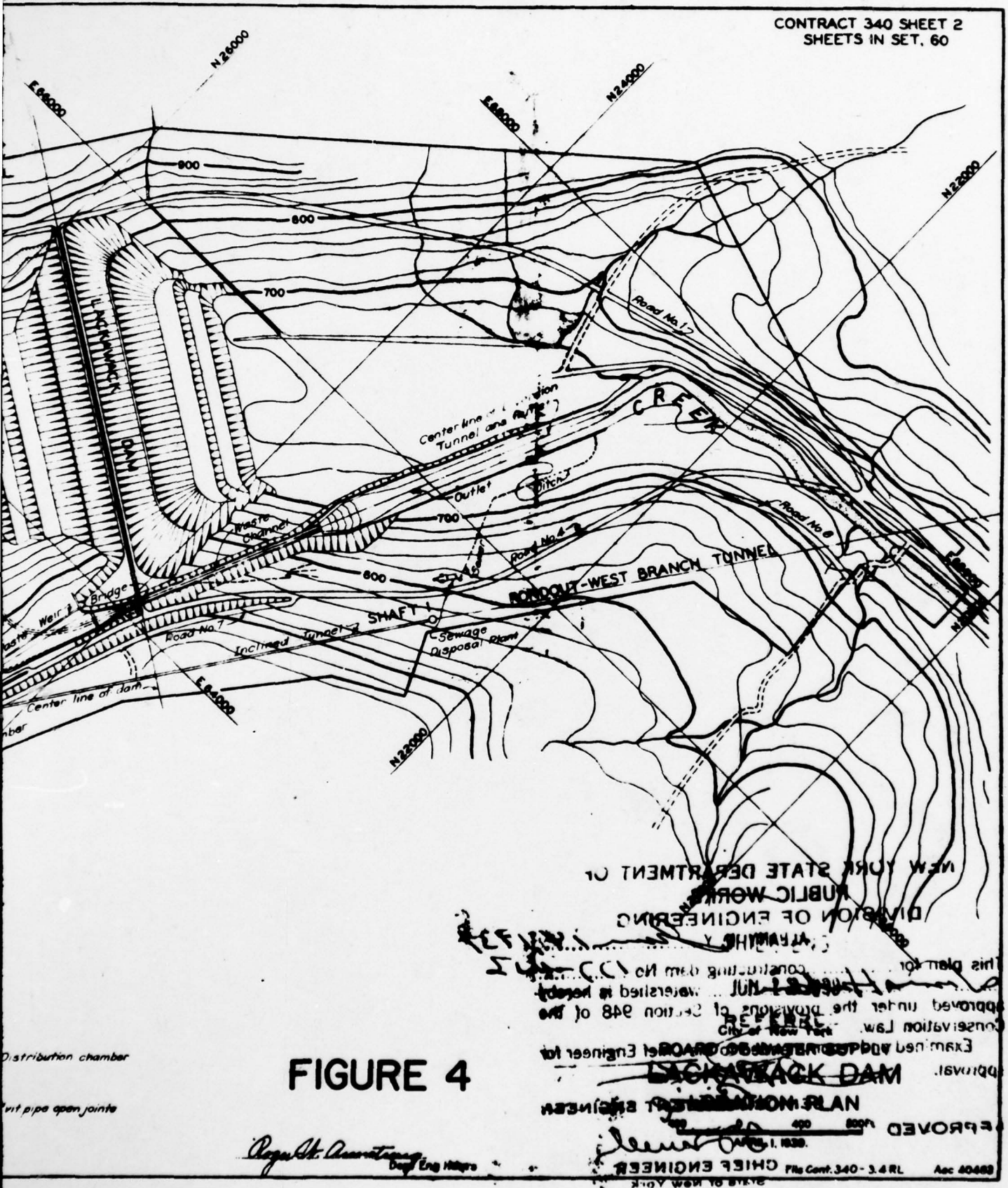
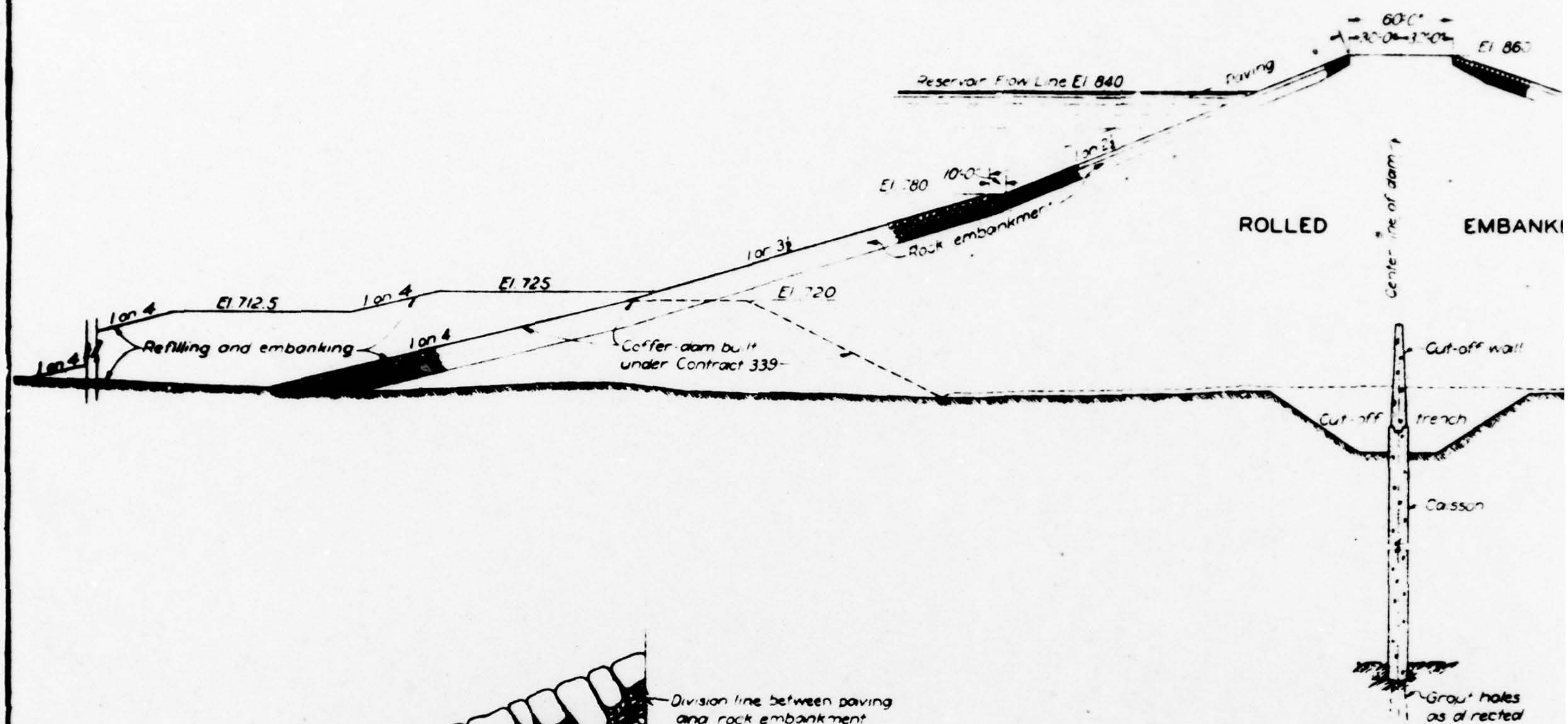


FIGURE 4

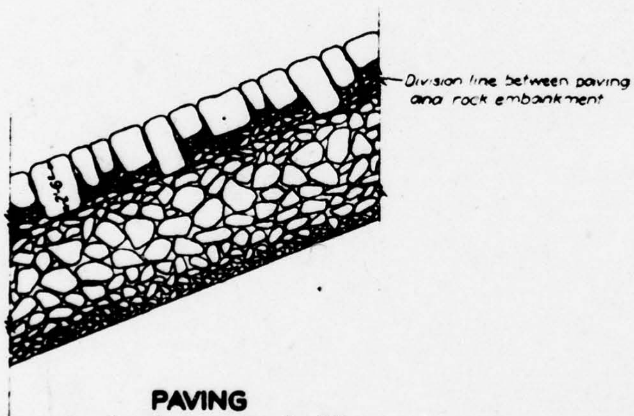
Roger St. Armstrong
Dep. Eng Hdqrs

2

3

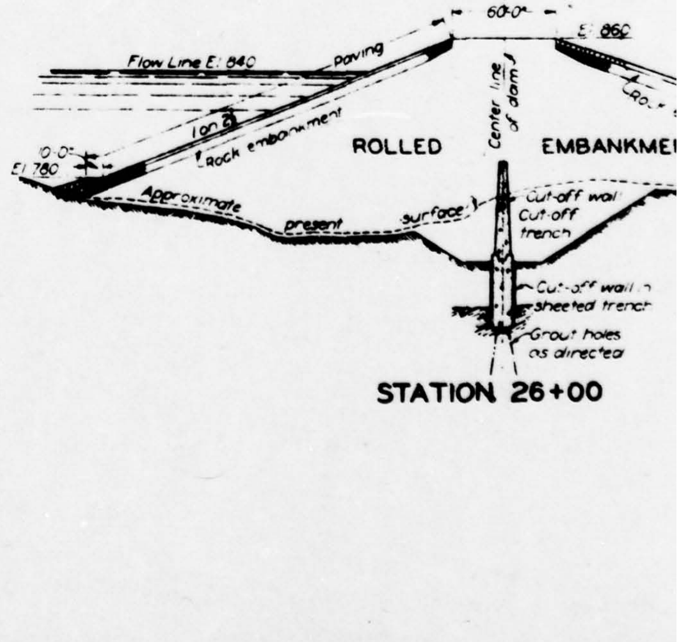


TYPICAL SECTION

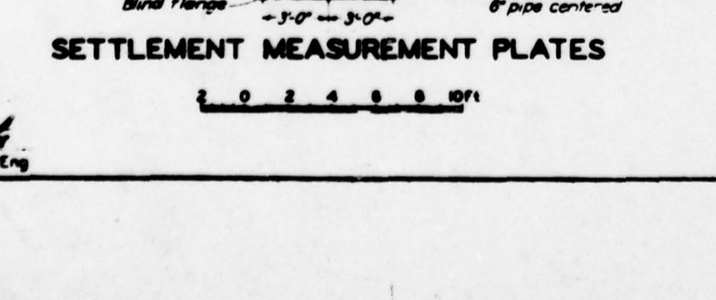


PAVING

2 0 2 4 6 8 10 Ft



STATION 26+00



SETTLEMENT MEASUREMENT PLATES

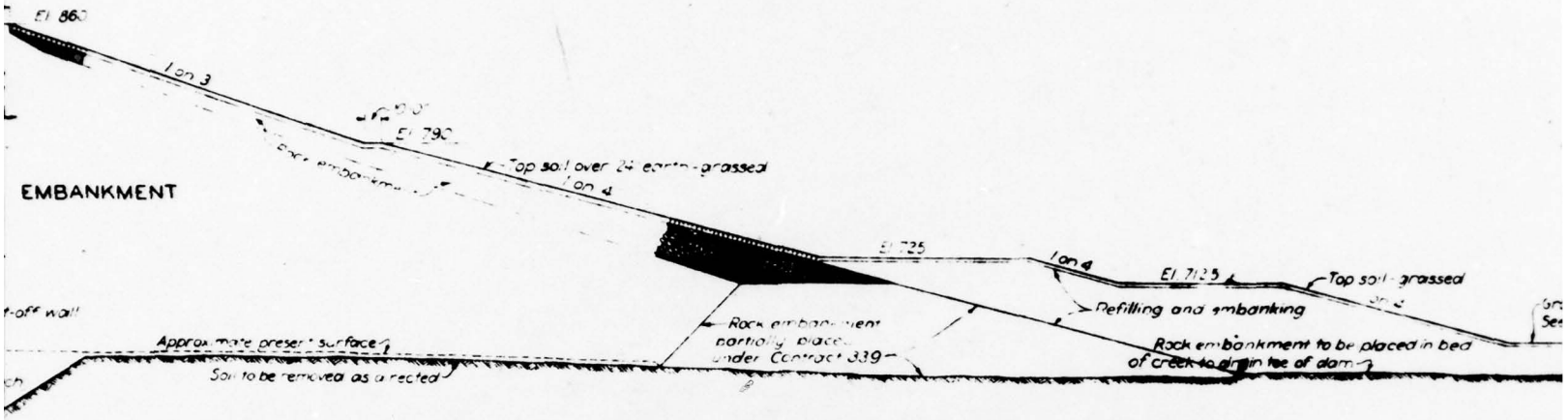
2 0 2 4 6 8 10 Ft

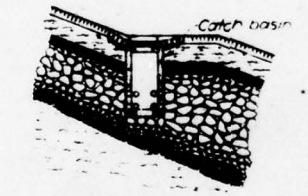
Drawn
Traced
Checked

L. G. Carter
Designing Eng

Ref - Acc. 40840

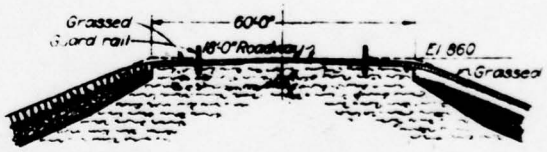
1





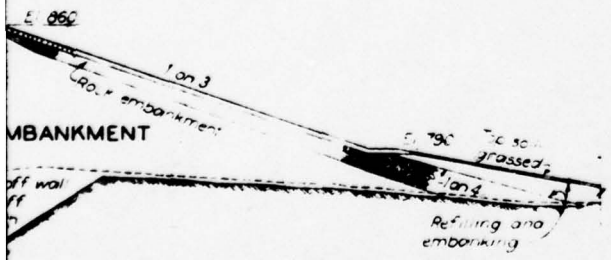
BERM DRAIN

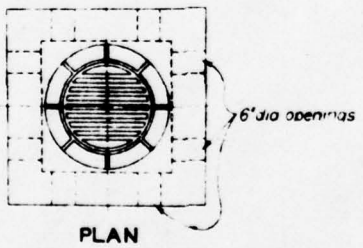
10 0 10 20Ft



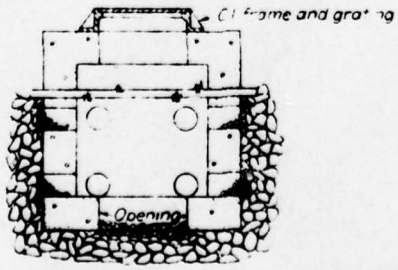
TOP OF DAM

20 0 20 40Ft





PLAN



SECTION

CATCH BASIN

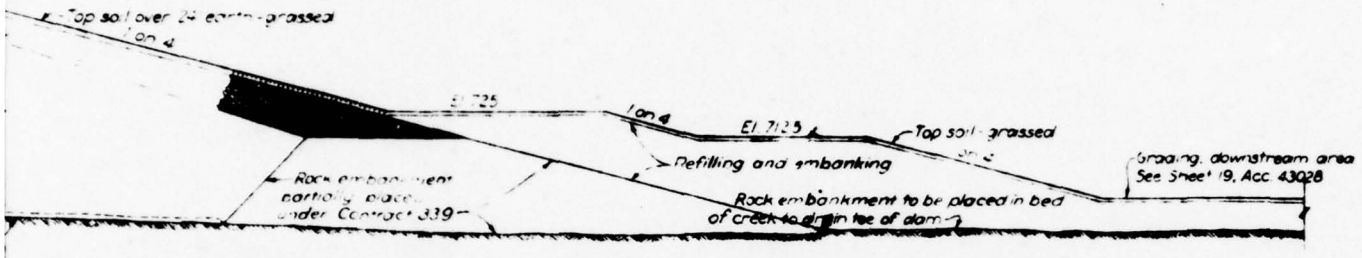
2 0 2 4Ft

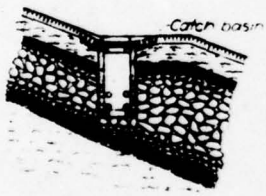
FIGURE 5

Deputy Engineer

1 2 1

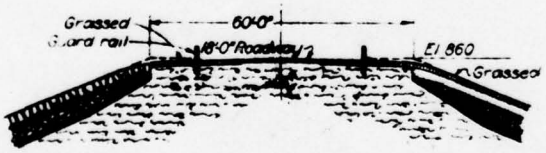
CONTRACT 340 SHEET 7
SHEETS IN SET, 60





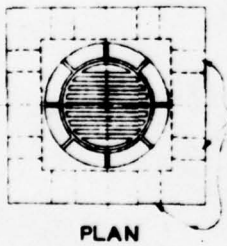
BERM DRAIN

10 0 10 20Ft

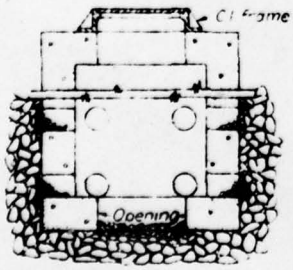


TOP OF DAM

20 0 20 40Ft



PLAN



SECTION
CATCH BASIN

2 0 2 4Ft

For plan see Sheet 5, Acc 42252
For profile see Sheet 6, Acc 42037
For details of cut-off wall, trench and caissons see Sheet 8, Acc 42036, Sheet 9, Acc 42254, Sheet 10, Acc 42256 and Sheet 11, Acc 43064

City of New York BOARD OF WATER SUPPLY

LACKAWACK DAM

SECTIONS

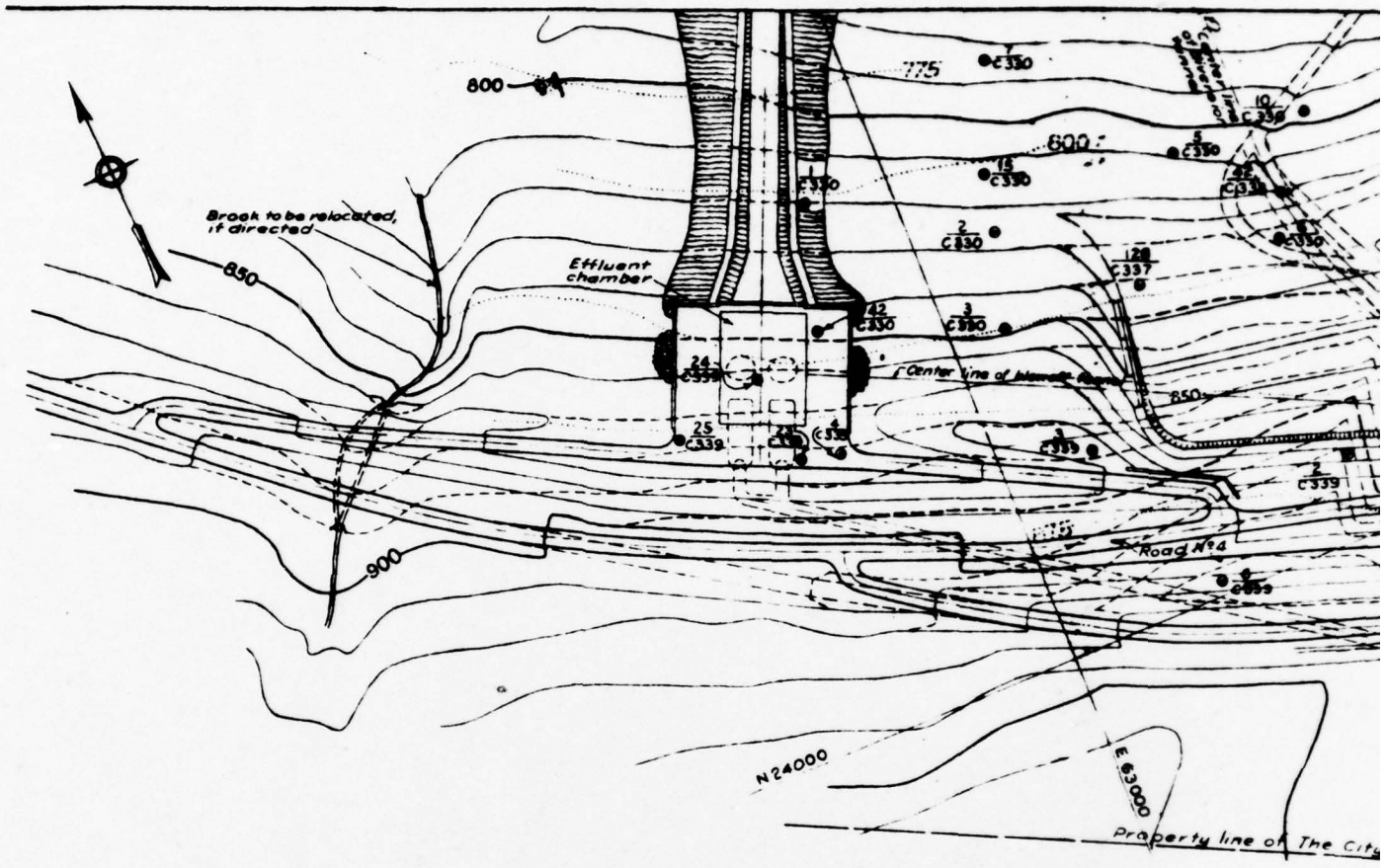
10 0 50 100Ft

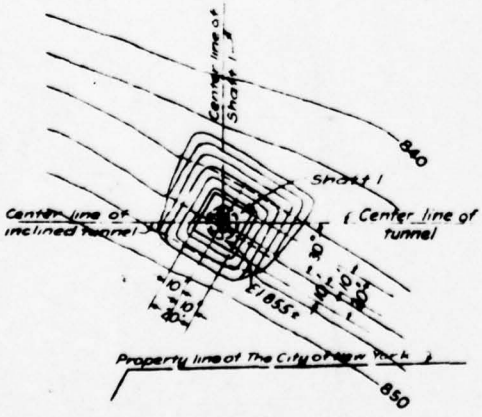
APRIL 1, 1939

Deputy Eng Hdqrs CHIEF ENGINEER File Cont 340-3.4 RL Acc 42118

FIGURE 5

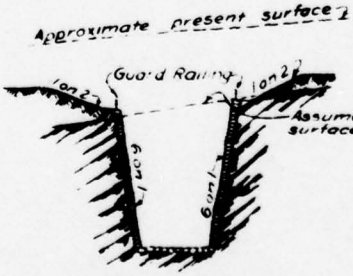
2 1 3





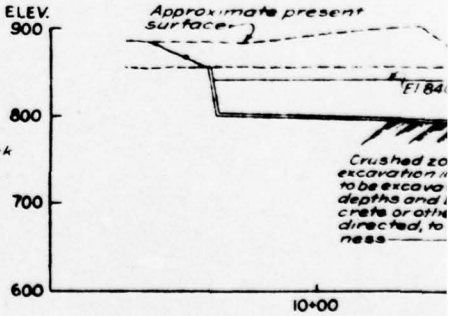
GRADING PLAN - SHAFT 1

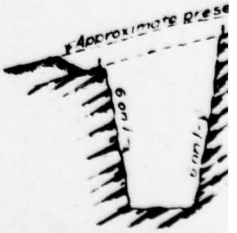
40 0 40 80Ft



SECTION X-X

40 0 40 80Ft





SECTION Y-

40 0 40

Designing Eng

1

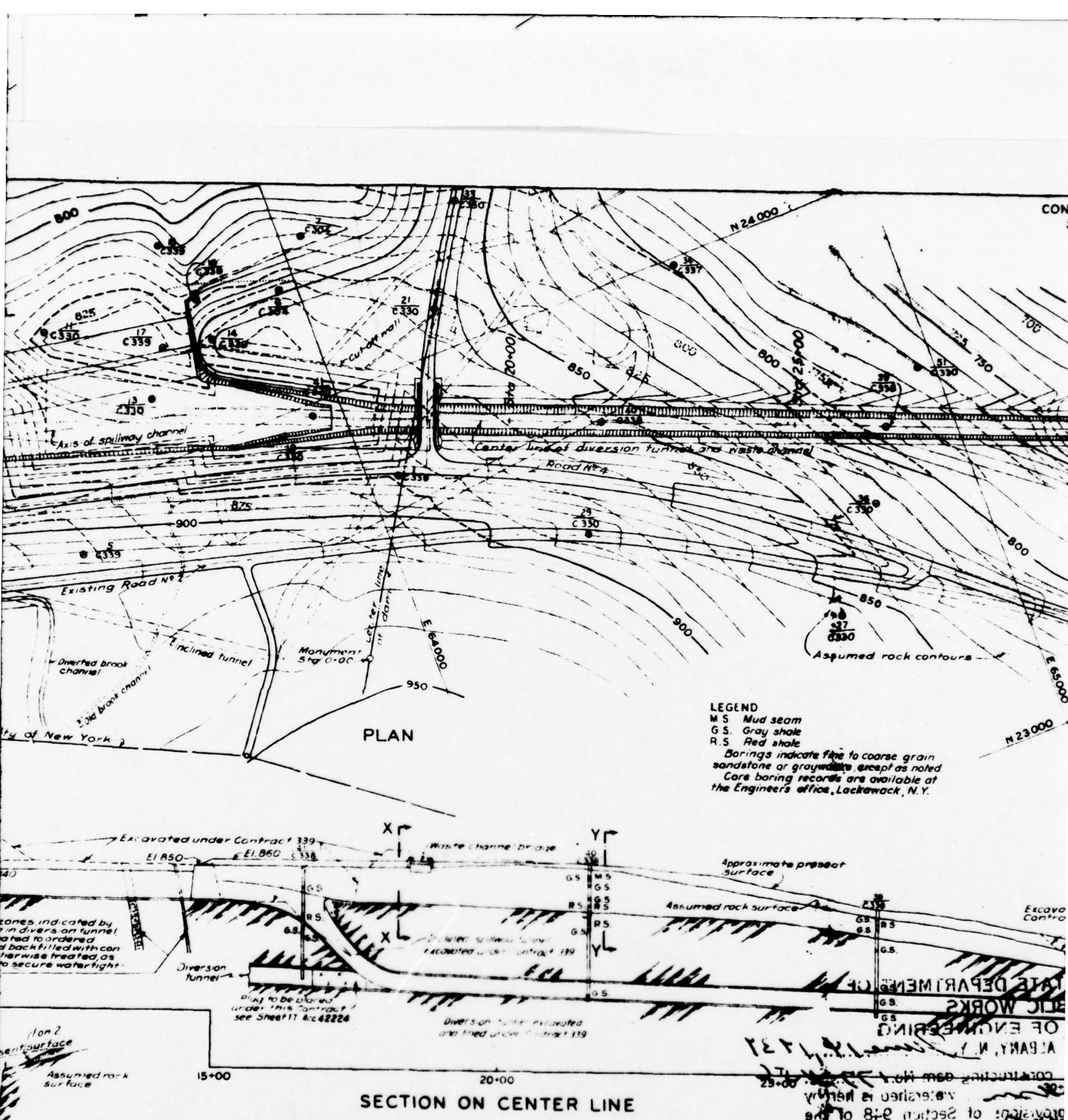

PLAN
Axis of spillway channel
Center line of dam
Center line of diversion tunnel and waste channel
Road No. 4
Existing Road No. 2
Inclined tunnel
Diverted brook channel
Old brook channel
Monument Sta 0+00
Assumed rock contours
N 24000
N 23000
E 64000
E 65000
LEGEND
M S Mud seam
G S. Gray shale
R S Red shale
Borings indicate fine to coarse grain sandstone or graywacke, except as noted
Core boring records are available at the Engineer's office, Lackawack, N.Y.
SECTION ON CENTER LINE
Excavated under Contract 339
El 850
El 860
Waste channel bridge
Approximate present surface
Assumed rock surface
Diversion tunnel
Plug to be placed under this contract see Sheet 17 Acc 42224
Assumed rock surface
15+00
20+00
25+00
For plan and sections of Waste Weir and Channel see Sheet 14, Acc 42301 and Sheet 15, Acc 42279
For Highways, Plan and Profiles, see Sheet 18, Acc 43201
BOARD OF WA
LACKAWA
WASTE WEIR A
GENERAL PLAN

FIGURE 6

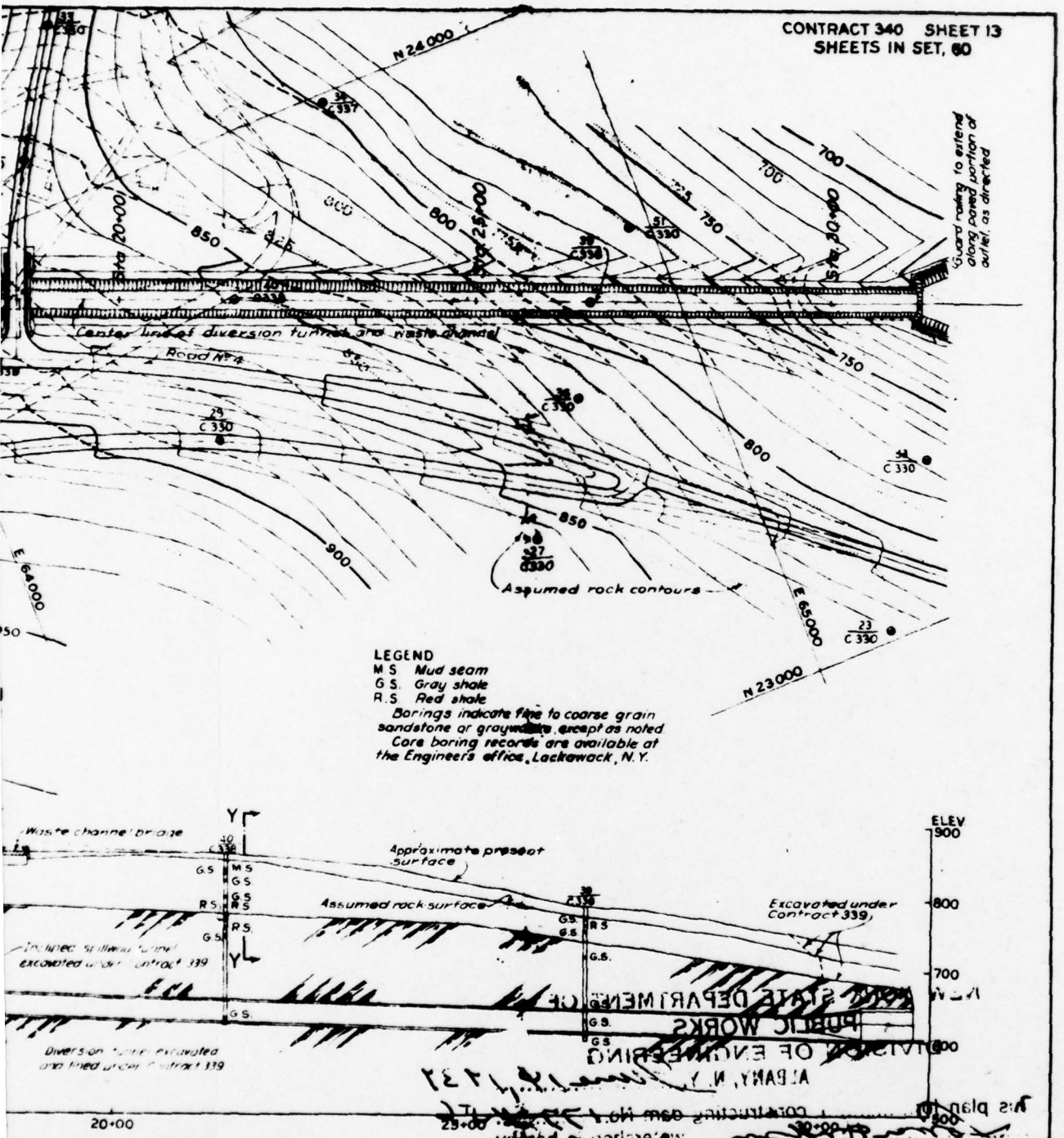

CONTRACT 340 SHEET 13
SHEETS IN SET, 60
N 24000
N 23000
E 64000
E 65000
Center line of diversion tunnel and waste channel
Road No. 4
Assumed rock contours
LEGEND
M S Mud seam
G S. Gray shale
R.S Red shale
Borings indicate fine to coarse grain sandstone or graywacke, except as noted
Core boring records are available at the Engineer's office, Lackawack, N.Y.
Waste channel bridge
Approximate present surface
Assumed rock surface
Excavated under Contract 339
Diversion tunnel excavated and lined under Contract 339
ELEV
900
800
700
20+00
25+00
30+00
ION ON CENTER LINE
City of New York
BOARD OF WATER SUPPLY
LACKAWACK DAM
WASTE WEIR AND CHANNEL
GENERAL PLAN AND SECTIONS
APRIL 1, 1939
CHIEF ENGINEER
Dept Eng Hdqtrs, N.Y. City
File Cont 340-344 RL
Acc 42262

FIGURE 6

15

APPENDIX

FIELD INSPECTION REPORT

Check List
Visual Inspection
Phase 1

Name Dam Merriman Dam County Ulster County State New York Coordinators _____

Date(s) Inspection 6/27/78 Weather Sunny Temperature 90°

Pool Elevation at Time of Inspection 837 M.S.L. Tailwater at Time of Inspection 697.5 M.S.L.

Inspection Personnel:

P-1 George C. Elias, P.E. James V. Ryan _____

Charles A. Richardson, P.E. _____ _____

Frank E. Falcone, P.E.

Frank E. Falcone, P.E. Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No cracks observed but downstream face shows a number of rodent holes.	Program should be implemented to remove the rodents and backfill the holes.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Approximately 100 yards downstream of the toe, two (2) sinkholes were observed. They were approximately 10' in diameter and 3' deep. At the time of inspection they were dry.	Steps should be taken to identify the reason for the sinkholes. Settlement pipes and plates should be monitored at least twice annually.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed.	None.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	In excellent condition.	None.
RIPRAP FAILURES	None.	None.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Excellent condition.	None.
ANY NOTICEABLE SEEPAGE	None observed.	None.
STAFF GAGE AND RECORDER	Not observed.	None.
DRAINS	Longitudinal drains exist on the downstream face at the berms. Many catch basins were blocked by mowed grass.	Insure that catch basins are free of debris.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None, excellent condition.	None.
INTAKE STRUCTURE	Effluent chamber was inspected, excellent condition.	None.
OUTLET STRUCTURE	Inspected areas were in excellent condition.	None.
OUTLET CHANNEL	Flow passes into Rondout-West Branch Tunnel, not inspected.	None.
EMERGENCY GATE	Not observed.	None.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS		
OBSERVATION WELLS		
WEIRS	Weir at elevation 720 just upstream of pipe inlets, not observed. (No underwater areas were inspected).	None.
PIEZOMETERS		
OTHER Settlement Pipes and Plates	Settlement pipes and plates are provided on both upstream and downstream faces, currently not used.	A program should be implemented whereby settlement is monitored on each settlement pipe at least twice annually.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Heavily wooded, stable and clear of debris.	None.
SEDIMENTATION	None observed.	None.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Well-defined and stable, only minimal debris.	None.
SLOPES	Well-defined.	None.
APPROXIMATE NO. OF HOMES AND POPULATION	Village of Lackawack is approximately 1.5 miles downstream of Merriman Dam; approximately 20 structures and a population of 300 to 500.	

UNGATED SPILLWAY

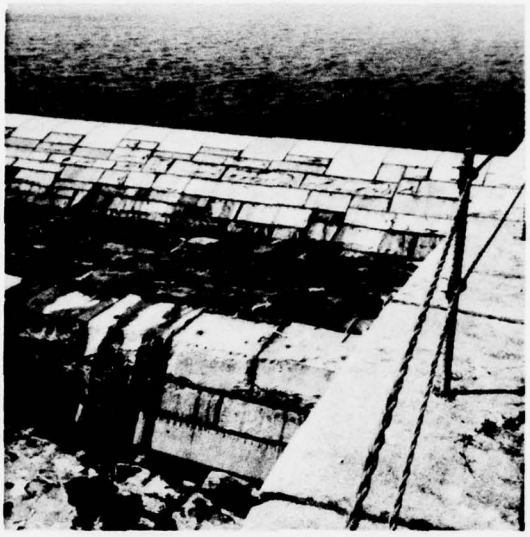
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CUT STONE WEIR	Generally in excellent condition, minor seepage through the spillway approximately 6' below the crest near the eastern end.	Monitor seepage, insure that it does not increase. If increase occurs, make structural repairs.
APPROACH CHANNEL	Excellent condition.	None.
DISCHARGE CHANNEL	Excellent condition. Well-maintained, free of debris, adequate to pass probable maximum flow.	None.
BRIDGE AND PIERS	None.	None.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

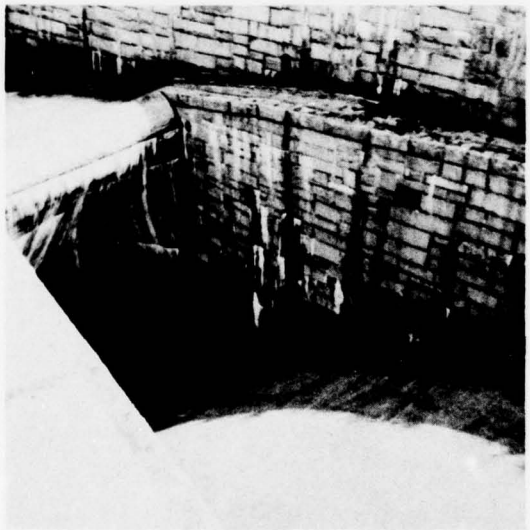
ITEM	REMARKS
PLAN OF DAM	* Provided in contract drawings, Contract #340, Board of Water Supply of the City of New York, dated 1939 and 1946.
REGIONAL VICINITY MAP	U. S. Geological Survey Quadrangles: 7.5 minute series, Rondout Reservoir; 15 minute series, Scranton, Pennsylvania, New York, New Jersey.
CONSTRUCTION HISTORY	Various articles from "The Delaware Water Supply News"
TYPICAL SECTIONS OF DAM	* Same.
HYDROLOGIC/HYDRAULIC DATA	None provided.
OUTLETS - PLAN	
- DETAILS	* Same.
-CONSTRAINTS -DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	None provided.

ITEM	REMARKS
SPILLWAY PLAN	
SECTIONS	* Same.
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	* Same.

PHOTOGRAPHS



SPILLWAY SHOWING SEEPAGE



ENTRANCE TO TUNNEL AT DOWNSTREAM END OF CHANNEL

HYDROLOGIC AND HYDRAULIC CALCULATIONS

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

SHEET NO. 1 OF _____

DATE 7/6/78

NAME OF CLIENT _____

COMP. BY FEF

PROJECT MERRIMAN DAM

CHECKED BY DBC

STAGE - DISCHARGE RELATIONSHIP

$Q = CLH^{3/2}$ (SPILLWAY CREST). $C = 3.4$, $L = 600'$ } $CL = 2040$

1. ELEVATION HEAD $H^{3/2}$ DISCHARGE

840.0	0	0	0
840.5	0.5	0.35	714
841.0	1.0	1.00	2040
842.0	2.0	2.83	5773
843.0	3.0	5.20	10608
844.0	4.0	8.00	16320
845.0	5.0	11.18	22807
848.0	8.0	22.63	46165
850.0	10.0	31.62	64505
855.0	15.0	58.09	117109
860.0	20.0	89.44	180311

→ $C = 3.2$, $L = 630$, $CL = 2016$

2. DETERMINE DISCHARGE THROUGH OUTLET WORKS.

MAXIMUM DISCHARGE @ EL. 840 = 890 MILLION GALLONS/DAY
= 1377 cfs.

DISCHARGE @ EL. 720 (OVERFLOW WEIR) = 700 MILLION GALLONS/DAY
= 1083 cfs.

STRAIGHT LINE RELATIONSHIP FROM EL. 840 TO EL. 720

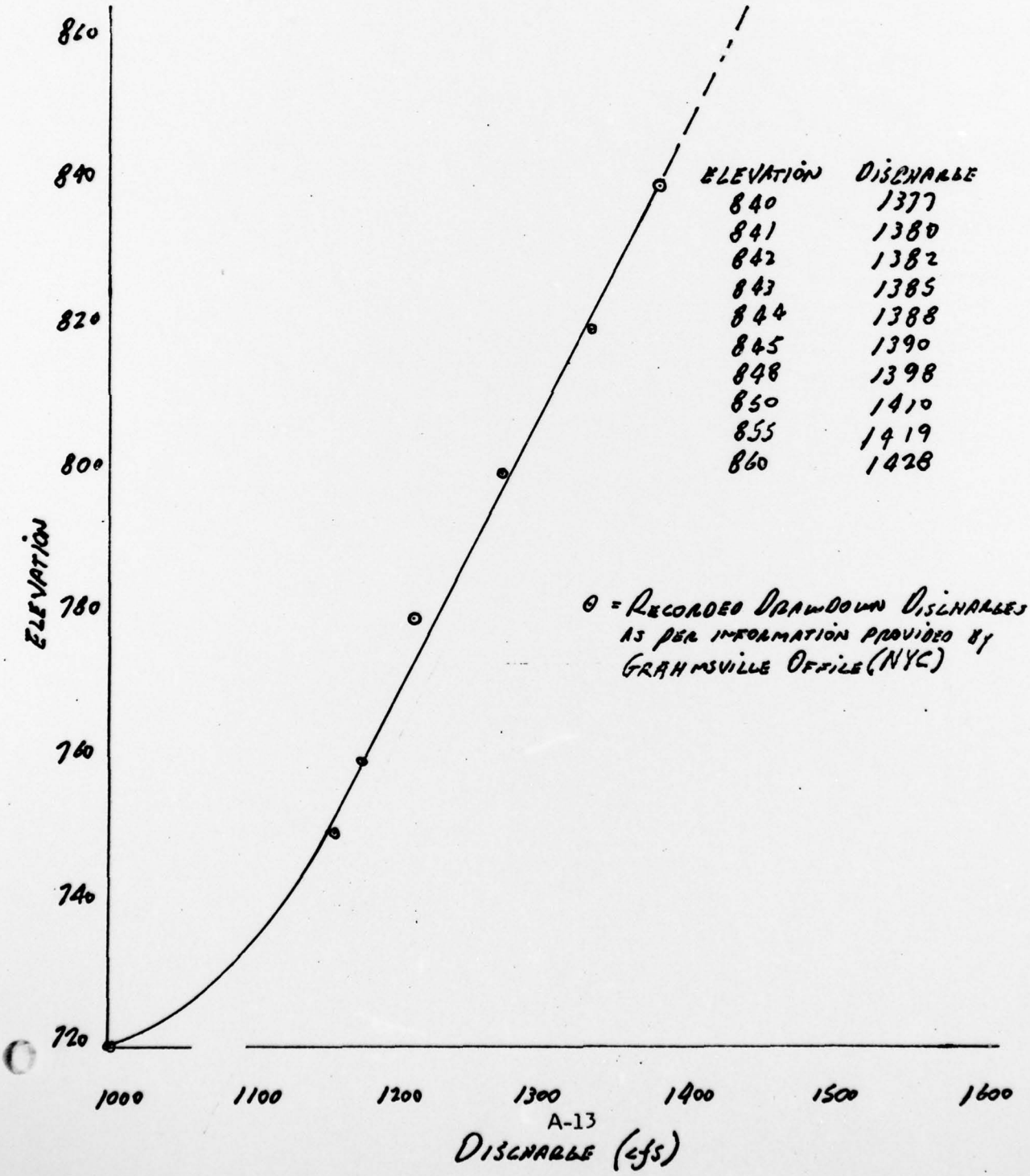
→ THIS INFORMATION PROVIDED BY MR. KEVIN CLOONAN
GRAHAMSVILLE, N.Y., 12740
POB 94

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

SHEET NO. 2 OF _____
DATE 7/25/78
COMP. BY FEH
CHECKED BY DBC

NAME OF CLIENT _____
PROJECT MERRIMAN DAM

DISCHARGE THROUGH OUTLET WORKS



ELEVATION	DISCHARGE
840	1377
841	1380
842	1382
843	1385
844	1388
845	1390
848	1398
850	1410
855	1419
860	1428

⊙ = RECORDED DRAWDOWN DISCHARGES AS PER INFORMATION PROVIDED BY GRAHAMSVILLE OFFICE (NYC)

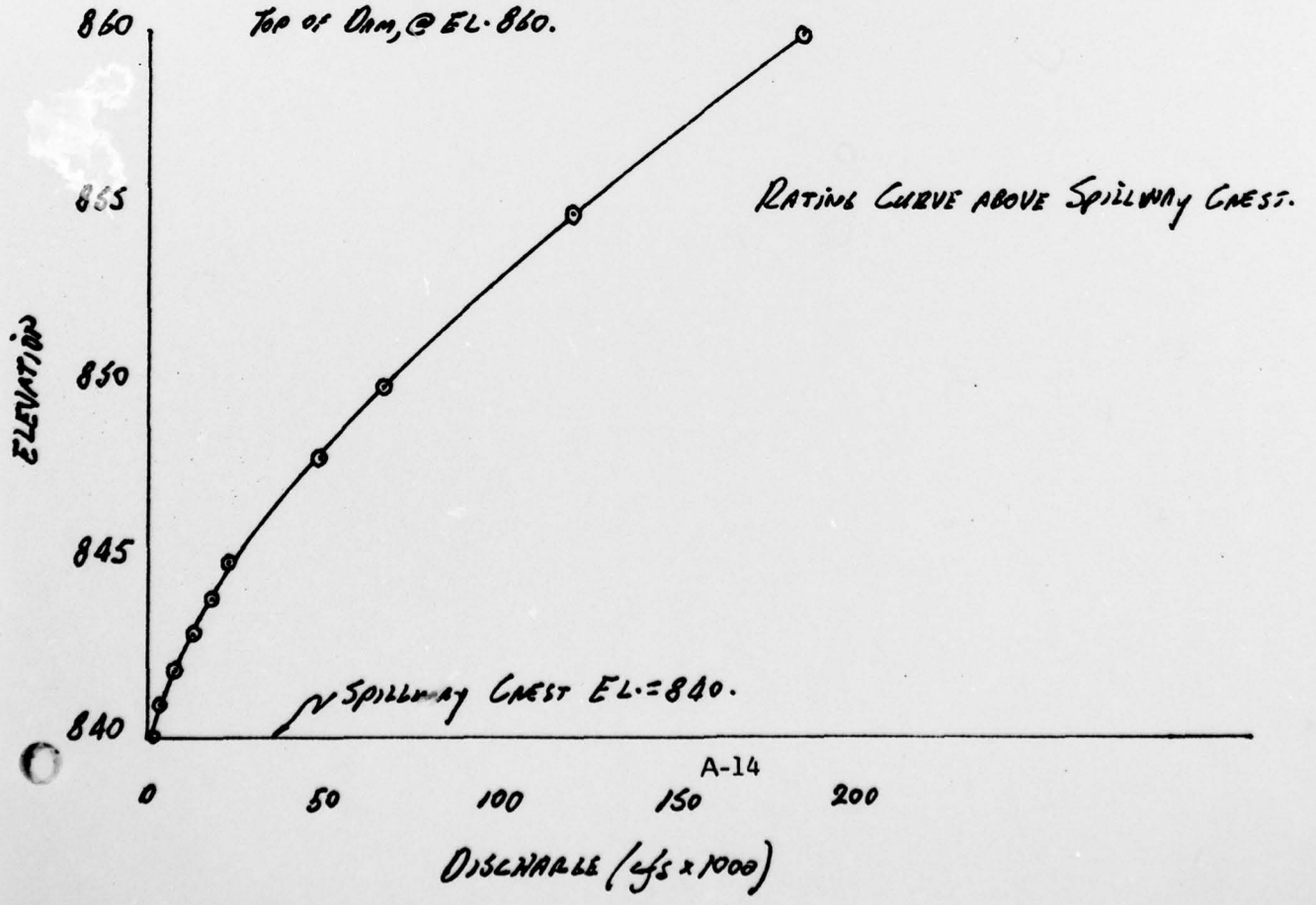
JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 3 OF _____
DATE 7/25/78
COMP. BY FEK
CHECKED BY DBC

NAME OF CLIENT _____
PROJECT Merriman Dam

TOTAL DISCHARGE DETERMINATION

ELEVATION	OUTLET WORKS	SPILLWAY	TOTAL DISCHARGE
840	1377	0	1377
841	1380	2040	3420
842	1382	5773	7155
843	1385	10608	11993
844	1388	16320	17708
845	1390	22807	24197
848	1398	46165	47563
850	1410	64505	65915
855	1419	117109	118528
860	1428	180311	181739



STAGE - STORAGE RELATIONSHIP

AREA @ 840, SPILLWAY CREST = 3.25 SQ. MI. = 2080 ACRES.

AREA @ 860, TOP OF DAM = 3.57 SQ. MI = 2285 ACRES.

$(2285-2080)/20' = 205/20 = 10.25 \approx 10$ ACRES/FT.

AREA = 10 DEPTH + 2080

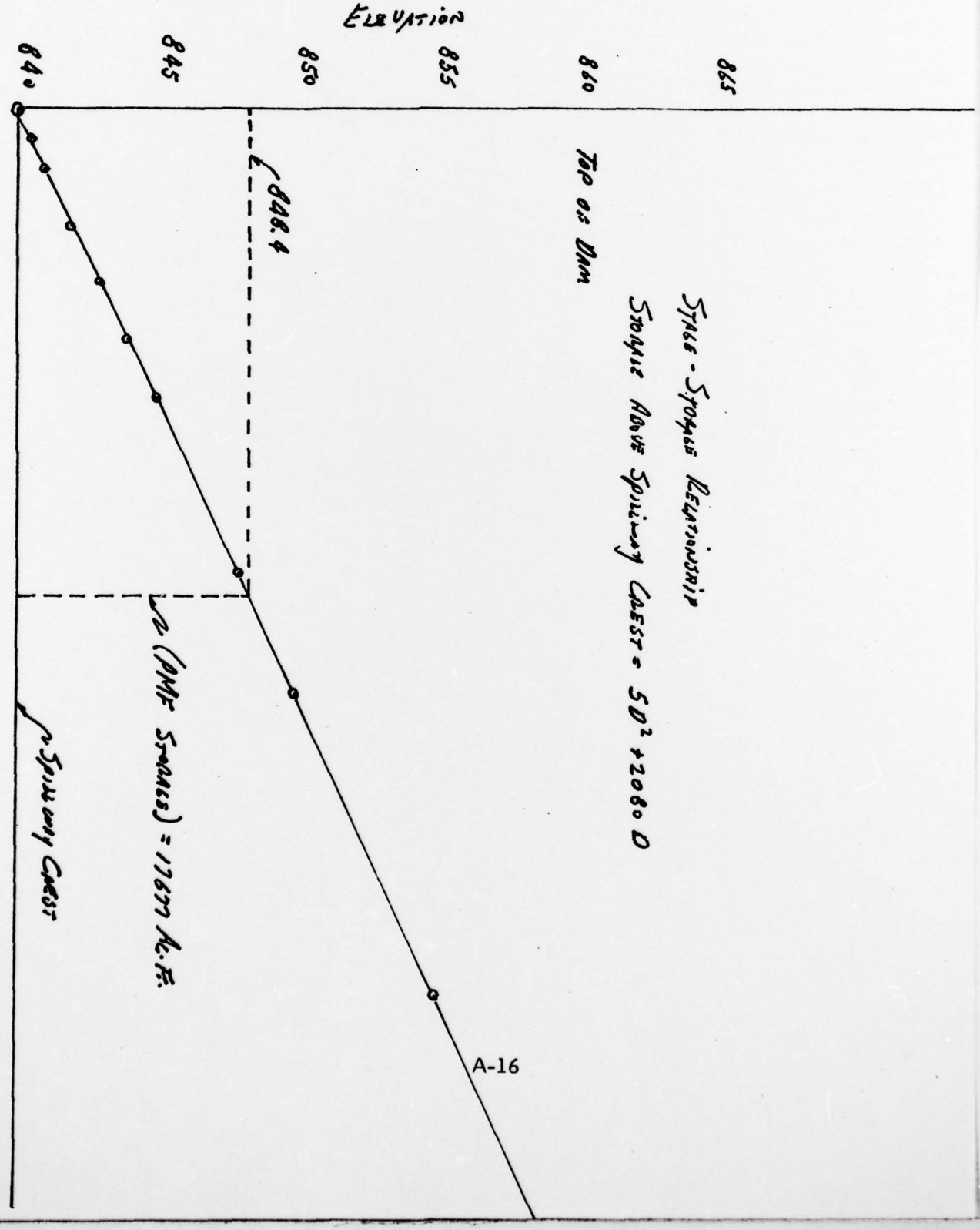
STORAGE = $\int 10D + 2080 = 5D^2 + 2080D$

ELEVATION	DEPTH	$5D^2$	$2080D$	STORAGE
840.0	0	0	0	0 .
840.5	0.5	1.25	1040.0	1041
841.0	1.0	5.0	2080.0	2085 .
842.0	2.0	20.0	4160.0	4180 .
843.0	3.0	45.0	6240.0	6285 .
844.0	4.0	80.0	8320.0	8400 .
845.0	5.0	125.0	10400.0	10525 .
848.0	8.0	320.0	16640.0	16960 .
850.0	10.0	500.0	20800.0	21300 .
855.0	15.0	1125.0	31200.0	32325 .
860.0	20.0	2000.0	41600.0	43600 .

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

SHEET NO. 5 OF
DATE 7/6/78
COMP. BY FBF
CHECKED BY DBC

NAME OF CLIENT
PROJECT MERRIMAN DAM



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

SHEET NO. 6 OF _____
DATE 7/7/78
COMP. BY FEF
CHECKED BY DBC

NAME OF CLIENT _____
PROJECT MERRIMAN DAM

PROBABLE MAXIMUM FLOOD COMPUTATIONS

DRAINAGE AREA = 95 SQ. MI. PMP = 23"

PMP IN ZONE #1 - 75% OF 10 SQ MILES, 6 HOUR VALUES

ISOHYETAL FIT REDUCTION FACTOR = 13.0%

CAR. ADJUSTED PMP = 23" x .13 = 2.99

REDUCTION = 23 - 2.99 = 20.01

20.01 x .75 = 15.01, USE 15 INCHES.

12 HR PMP = 20.01 x .84 = 16.8 INCHES.

$C_T = 2.0$
$C_p = .625$

$L = 11.80$ MILES
$L_{CA} = 2.0$ MILES

$T_p = C_T (L \times L_{CA})^{.3}$
$= 2.0 (11.8 \times 2.0)^{.3} = 5.16$

$T_R = T_P/5.5 = .94 \simeq 1.0$

Use 12 Hour Storm

Time (hours)	Rainfall Σ	Incr
0-1	.20	.20
1-2	.40	.20
2-3	.80	.40
3-4	1.20	.40
4-5	2.25	1.05
5-6	3.45	1.20
6-7	10.80	7.35
7-8	13.20	2.40
8-9	14.70	1.50
9-10	16.20	1.50
10-11	16.50	.30
11-12	16.80	.30

Use minimum loss rate of .1 inch/hour

JUSTIN & COURTNEY, INC.
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PHILADELPHIA, PA

SHEET NO. 8 OF _____
DATE 7/25/78
COMP. BY FEF
CHECKED BY DBC

NAME OF CLIENT _____
PROJECT MERRIMAN DAM

DRAWDOWN COMPUTATIONS — DRAWDOWN TIME = 69 DAYS

A_1 = AREA AT EL. 840 — S_1 = STORAGE AT EL. 840 = 154000 ACRE FT.

A_2 = AREA AT EL. 720 — S_2 = STORAGE AT EL. 720 = 7300 ACRE FT.

D = DEPTH.

$(A_1 + A_2)/2 \times D = S_1 - S_2$

$(2080 + A_2)/2 = (154000 - 7300)/D$

$2080 + A_2 = 2(154000 - 7300)/120$

$A_2 = 2445 - 2080$

$A_2 = 365$ ACRE

RISE = $(2080 - 365)/120' = 14.3$ ACRES/FT.

AREA = $14.30 + A_2$

AREA = $1430 + 365$

STORAGE = $7.15D^2 + 365D$

SEE SHEET #9

ELEVATION	DISCHARGE* (CFS)	FROM/TO (ELEVATION)	INCREMENT (STORAGE)	TIME (HRS.)	TIME (DAYS)
840	1187	840/830	20095	205	8.54
820	1140	830/810	35900	381	15.88
800	1077	810/790	30180	339	14.13
780	1020	790/770	24420	290	12.08
760	987	770/760	10085	124	5.17
750	967	760/720	26040	326	13.58
720	0				

TOTAL TIME = 69 DAYS.

*ACCOUNTS FOR 2 CFS/SQ MI DRAINAGE AREA AS INFLOW

INFLOW = 2 × 95 = 190 CFS.

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

SHEET NO. 9 OF _____

NAME OF CLIENT _____

DATE 7/25/78

PROJECT Merriman Dam

COMP. BY FBF

CHECKED BY DBC

$STORAGE = 7.15D^2 + 365D$

ELEVATION	DEPTH (FT.)	$7.15D^2$	365D	STORAGE (AC.-FT.)	INCREMENT STORAGE
840	120	102960	43800	146760	
					20095
830	110	86515	40150	126665	
					35900
810	90	57915	32850	90765	
					30180
790	70	35035	25550	60585	
					24460
770	50	17875	18250	36125	
					10085
760	40	11440	14600	26040	
					26040
720	0	0	0		

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

MERRIMAN DAM
PMF HYDROLOGY
NATIONAL DAM INSPECTION PROGRAM

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
48	1	0	1	0	0	0	0	0	0

JOPER	NWT
3	0

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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	95.00	0.00	0.00	0.00	0.000	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
12	0.00	0.00	0.00

PRECIP PATTERN

.20	.20	.40	.40	1.05	1.20	7.35	2.40	1.50	1.50
.30	.30								

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= 5.16 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= 6.06 AND R= 4.61 INTERVALS

UNIT HYDROGRAPH 28 END-OF-PERIOD ORDINATES, LAG= 5.14 HOURS, CP= .63 VOL= 1.00

568.	2062.	4040.	5954.	7210.	7474.	6635.	5346.	4301.	3459.
2783.	2238.	1801.	1448.	1165.	937.	754.	606.	488.	392.
315.	254.	204.	164.	132.	105.	96.	69.		

END-OF-PERIOD FLOW

	TIME	RAIN	EXCS	COMP Q
1	1 0	.20	.10	57.
1	2 0	.20	.10	263.
1	3 0	.40	.30	780.
1	4 0	.40	.30	1788.
1	5 0	1.05	.95	3686.
1	6 0	1.20	1.10	7049.

1	11	0	.30	.20	92667.
1	12	0	.30	.20	100494.
1	13	0	0.00	0.00	97188.
1	14	0	0.00	0.00	86427.
1	15	0	0.00	0.00	73784.
1	16	0	0.00	0.00	61056.
1	17	0	0.00	0.00	49585.
1	18	0	0.00	0.00	40013.
1	19	0	0.00	0.00	32188.
1	20	0	0.00	0.00	25892.
1	21	0	0.00	0.00	20827.
1	22	0	0.00	0.00	16753.
1	23	0	0.00	0.00	13476.
2	0	0	0.00	0.00	10840.
2	1	0	0.00	0.00	8720.
2	2	0	0.00	0.00	7014.
2	3	0	0.00	0.00	5642.
2	4	0	0.00	0.00	4538.
2	5	0	0.00	0.00	3645.
2	6	0	0.00	0.00	2927.
2	7	0	0.00	0.00	2338.
2	8	0	0.00	0.00	1864.
2	9	0	0.00	0.00	1447.
2	10	0	0.00	0.00	1103.
2	11	0	0.00	0.00	486.
2	12	0	0.00	0.00	264.
2	13	0	0.00	0.00	135.
2	14	0	0.00	0.00	31.
2	15	0	0.00	0.00	14.
2	16	0	0.00	0.00	0.
2	17	0	0.00	0.00	0.
2	18	0	0.00	0.00	0.
2	19	0	0.00	0.00	0.
2	20	0	0.00	0.00	0.
2	21	0	0.00	0.00	0.
2	22	0	0.00	0.00	0.
2	23	0	0.00	0.00	0.
3	0	0	0.00	0.00	0.
		SUM	16.80	15.60	951479.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	100494.	87684.	38931.	19822.	951478.
INCHES		8.59	15.25	15.53	15.53
AC-FT		43502.	77258.	78675.	78675.

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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	0

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

STORAGE=	0.	2085.	4180.	6285.	8400.	10525.	16960.	21300.	32325.	43609.
OUTFLOW=	0.	3420.	7155.	11993.	17708.	24197.	47563.	65915.	118528.	181739.

1	3	0	78.	522.	127.
1	4	0	167.	1284.	274.
1	5	0	358.	2737.	587.
1	6	0	728.	5368.	1194.
1	7	0	1511.	11315.	2479.
1	8	0	3153.	23768.	5324.
1	9	0	5993.	42689.	11322.
1	10	0	9930.	64481.	17379.
1	11	0	14378.	84104.	33186.
1	12	0	18540.	96580.	54244.
1	13	0	21670.	98841.	67583.
1	14	0	23336.	91808.	75630.
1	15	0	23645.	80106.	77104.
1	16	0	22976.	67420.	73914.
1	17	0	21693.	55321.	67789.
1	18	0	20083.	44793.	60768.
1	19	0	18347.	36100.	53430.
1	20	0	16624.	29040.	46345.
1	21	0	14973.	23359.	40347.
1	22	0	13424.	18790.	34722.
1	23	0	12015.	15115.	29606.
2	0	0	10761.	12159.	25053.
2	1	0	9645.	9780.	21510.
2	2	0	8644.	7867.	18452.
2	3	0	7746.	6328.	15940.
2	4	0	6939.	5090.	13760.
2	5	0	6219.	4092.	11842.
2	6	0	5573.	3286.	10358.
2	7	0	4990.	2632.	9018.
2	8	0	4468.	2101.	7918.
2	9	0	4000.	1655.	6934.
2	10	0	3572.	1275.	6071.
2	11	0	3166.	794.	5347.
2	12	0	2783.	375.	4664.
2	13	0	2439.	199.	4052.
2	14	0	2134.	83.	3507.
2	15	0	1864.	22.	3058.
2	16	0	1628.	7.	2671.
2	17	0	1421.	0.	2332.
2	18	0	1241.	0.	2036.
2	19	0	1083.	0.	1777.
2	20	0	946.	0.	1552.
2	21	0	826.	0.	1355.
2	22	0	721.	0.	1183.
2	23	0	629.	0.	1032.
3	0	0	550.	0.	901.
		SUM			945698.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	77104.	70481.	36967.	19702.	945698.
INCHES		6.90	14.48	15.43	15.43
AC-FT		34967.	73362.	78197.	78197.

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RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	100494.	87684.	38931.	19822.	95.00
ROUTED TO	2	77104.	70481.	36967.	19702.	95.00