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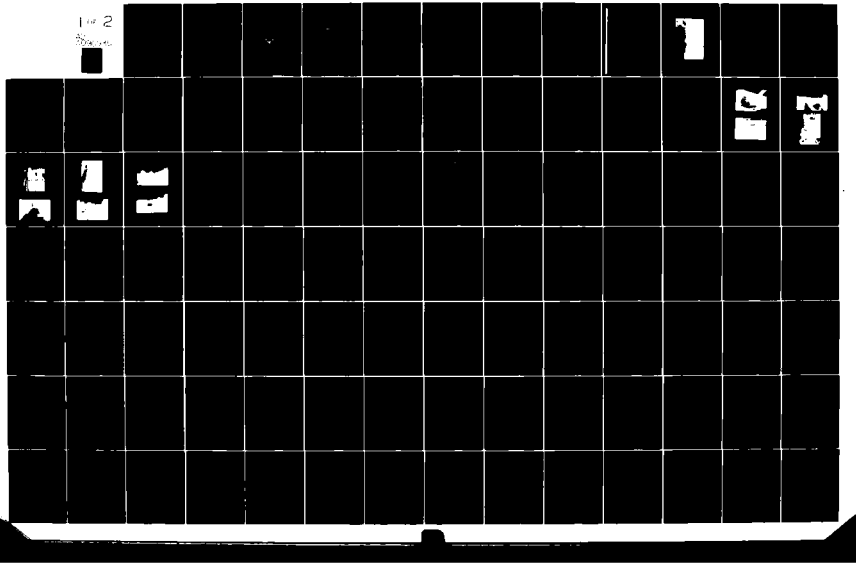

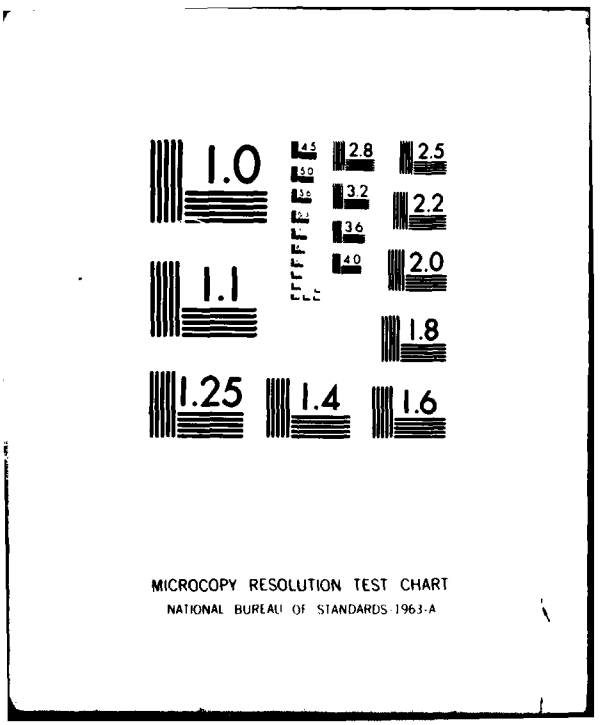
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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.

Examination of available documents and a visual inspection of the dam did not reveal conditions which constitute an immediate hazard to human life or property. However, the dam has some deficiencies which require further investigations and remedial work.

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Structural stability analyses of the gravity section of the dam indicate that the factors of safety against both overturning and sliding are unacceptable for all conditions analyzed. Further studies of the stability are required, including field investigations to determine the quality of the rock upon which the dam is founded. These studies should be commenced within 6 months of the date of notification of the owner. Modifications to the structure deemed necessary as a result of the stability analyses should be completed within 18 months of the date of notification.

The spillway does not have sufficient capacity to discharge the peak outflow from one-half the Probable Maximum Flood (PMF). For this storm event, high discharges will cause damage in the channel downstream of the dam. However, dam failure would not significantly increase the hazard to loss of life downstream from that which would exist just prior to an overtopping-induced failure. Therefore, the spillway is assessed as inadequate.

Several minor deficiencies were noted. These should be corrected within 12 months of the date of notification of the owner. Among the actions required are repairing deteriorated concrete on the counterweights and on the nose piers, replacing rusted steel on the three gates at the entrance to the power canal, and developing an emergency operation plan.

OSWEGO RIVER BASIN

WATERLOO DAM

SENECA COUNTY, NEW YORK
INVENTORY NO. N.Y. 709

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NEW YORK DISTRICT CORPS OF ENGINEERS

AUGUST 1980

CONTRACT NO. DACW-51-79-C0001

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PREFACE

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

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM,
WATERLOO DAM
(I.D. [redacted] NY 709)
OSWEGO RIVER BASIN,
SENECA COUNTY, NEW YORK.

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Waterloo Dam (I.D. No. NY 709)
State Located:	New York
County Located:	Seneca
Watershed:	Oswego River Basin
Date of Inspection:	May 9, 1980

ASSESSMENT

[From p. 1]

Examination of available documents and a visual inspection of the dam did not reveal conditions which constitute an immediate hazard to human life or property. However, the dam has some deficiencies which require further investigations and remedial work.

Structural stability analyses of the gravity section of the dam indicate that the factors of safety against both overturning and sliding are unacceptable for all conditions analyzed. Further studies of the stability are required, including field investigations to determine the quality of the rock upon which the dam is founded. These studies should be commenced within 6 months of the date of notification of the owner. Modifications to the structure deemed necessary as a result of the stability analyses should be completed within 18 months of the date of notification.

The spillway does not have sufficient capacity to discharge the peak outflow from one-half the Probable Maximum Flood (PMF). For this storm event, high discharges will cause damage in the channel downstream of the dam. However, dam failure would not significantly increase the hazard to loss of life downstream from that which would exist just prior to an overtopping-induced failure. Therefore, the spillway is assessed as inadequate.

Several minor deficiencies were noted. These should be corrected within 12 months of the date of notification of the owner. Among the actions required are repairing deteriorated concrete on the counterweights and on the nose piers, replacing rusted steel on the three gates at the entrance to the power canal, and developing an emergency operation plan.

George Koch

George Koch
Chief, Dam Safety Section
New York State Department
of Environmental Conservation
NY License No. 45937

Approved By:

Colonel W. M. Smith Jr.
New York District Engineer

Date: 30 Sep 80

OVERVIEW
WATERLOO DAM
I.D. No. NY-709

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
WATERLOO DAM
I.D. No. NY 709
#588-420
OSWEGO RIVER BASIN
SENECA COUNTY, NEW YORK

SECTION 1: PROJECT INFORMATION

1.1 GENERAL

a. Authority

The Phase I inspection reported herein was authorized by the Department of the Army, New York District, Corps of Engineers, to fulfill the requirements of the National Dam Inspection Act, Public Law 92-367.

b. Purpose of Inspection

This inspection was conducted to evaluate the existing conditions of the dam, to identify deficiencies and hazardous conditions, to determine if these deficiencies constitute hazards to life and property, and to recommend remedial measures where required.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam

The Waterloo Dam is a concrete dam with four tainter gates and two concrete overflow sections. Lock 4 of the Cayuga-Seneca Canal is at the eastern end of the dam. There is an abandoned canal at the western end of the dam which may function as an overflow channel.

The dam is a total of 241 feet long and is a maximum of 10 feet high. It is divided into 6 bays each of which has an opening of 36 feet. The first three bays beginning on the eastern end of the dam (which will be referred to as bays 1-3) are gated and form the entrance to the power canal for a New York State Electric and Gas (NYSE&G) hydroelectric generating station located about 1000 feet downstream of the dam. The next two bays (bays 4&5) are fixed concrete overflow sections. The last bay on the western end of the dam (bay 6) is another gated segment.

A concrete arch bridge which carries Locust Street over the outlet channel is located immediately downstream of the dam.

There are approach embankments at both ends of the bridge.

b. Location

The dam is located on the Cayuga and Seneca Canal in the Village of Waterloo. Lock 4 of the canal is adjacent to the dam. Locust Street bridges the outlet channel immediately downstream of the dam. The dam is approximately 1000 feet southwest of the intersection of New York State Routes 20 and 96.

c. Size Classification

This dam is 10 feet high and has an impoundment capacity of 585,700 acre-feet. Therefore, the dam is in the large size category as defined by the "Recommended Guidelines for Safety Inspection of Dams".

d. Hazard Classification

The dam is classified in the "high" hazard category due to the presence of New York State Route 96, a hydroelectric generating station, and several homes downstream of the dam.

e. Ownership

The dam is owned by the State of New York - Department of Transportation (NYS-DOT), Waterways Maintenance Subdivision. It is located in DOT Region 3, whose headquarters are in Syracuse. The addresses of the Main Office and the Regional Office are as follows:

NYS DOT
Main Office-State Campus
1220 Washington Avenue
Albany, New York 12232
Director-Mr. Joseph Stellato
(518)457-4420

NYS-DOT
Region 3 Office
Syracuse State Office Building
333 E. Washington Street
Syracuse, New York 13202
Mr. Leo Burns-Regional Waterways
Maintenance Engineer
(315)473-8194

f. Purpose of Dam

This dam is used to maintain the upper pool level for navigation on the Cayuga and Seneca Canal and to provide a pool for power generation in the hydroelectric station just downstream of the dam.

g. Design and Construction History

This dam was constructed in two stages as parts of Contracts E and G for Section 1 of the Cayuga and Seneca Canal. The plans for the structure, which were prepared by the State Engineer's Office were dated 1912 and 1914. Certain modifications have been made to the structure since it was constructed. The most substantial change was made in 1963 when gates on bays 4 and 5 were replaced with concrete bulkheads. This reconstruction was performed by DOT forces. The skin plate on the gate on bay number 6 (westernmost gate) was replaced in 1962.

h. Normal Operating Procedures

This dam is operated in a manner to provide a pool for navigation and to supply water for the hydroelectric station. The three gates which control flow into the power canal generally remain fully open. The other gate at the western end of the structure is usually closed. It is occasionally opened to flush out the downstream channel.

1.3 PERTINENT DATA

a. Drainage Area (sq. mi.)		753
b. Discharge at Dam	W.S. ELEV.(BCD)	(cfs)
Gate 6 (Fully Open)	448.5	3488
Flashboards removed (Bays 4&5)	448.5	69

c. Elevations (BCD-Barge Canal Datum)

Top-of-Dam		448.5
Flashboard Invert:	Bay 4	446.15
	Bay 5	446.05
Gate 6 (Bottom)		439.0
Gate 1-3 (Bottom)		435.0

d. Reservoir-Surface Area

	(sq. miles)
Seneca Lake (only)	67.6

e. Storage Capacity

	(acre-feet)
Top-of-Dam	585,700

f. Dam

Reinforced concrete dam and abutments between segments of the spillway.
Dam length (total) 241 ft.

g. Spillway

Principal Spillway
Type: 4 tainter gates each 36 feet wide on bays 1,2,3 and 6.

Auxiliary Spillway
Type: 2 reinforced concrete overflow sections each 36 feet wide with 2 ft. wide crest and sloped back.

h. Reservoir Drain

None.

i. Appurtenant Structures

1. Lock 4 - Cayuga-Seneca Canal; Rectangular concrete channel. 45 feet wide by 28 feet high; Vertical lift gate to control flow into back.

2. Abandoned Canal - Channel at western end of dam; 40 feet wide; Concrete weir controls flow.

3. Concrete arch bridge - located immediately downstream of dam; 6 arches each 36 feet wide with radii which varies from 33.5 to 45.5 feet

4. Power canal and power house - canal extends from three eastern gates on dam to NYSE&G Power House approximately 1000 feet downstream of dam; Canal walls are reinforced concrete with a slight batter.

SECTION 2: ENGINEERING DATA

2.1 GEOTECHNICAL DATA

a. Geology

The Waterloo Dam is located in the Erie-Ontario plains physiographic province of New York State. The rock in this area includes limestone, dolomite and shale from the Devonian era. A review of the "Brittle Structures Map of the State of New York" indicated that there are no faults in the immediate vicinity of the dam. However, the map does indicate that there is a major unconformity between Devonian and Silurian rock formations in the vicinity of the dam.

The surficial soils are the result of glaciations during the Cenozoic Era, the last of which was the Wisconsin glaciation. The most dominant land forms are the Ontario-Drumlins which are scattered over this portion of the physiographic province.

b. Subsurface Investigations

No record of any subsurface investigations performed for this structure could be located. The plans indicate that the structure is founded on rock. A note on the plans states that the engineer would determine the final elevation of the footings at the time of construction to assure a proper foundation.

2.2 DESIGN RECORDS

This dam was designed in 1912 by the State Engineer's office. Plans prepared in the design process were available from the Department of Transportation. Copies of selected sheets from the plans have been included in Appendix F.

2.3 CONSTRUCTION RECORDS

The plans available from DOT were the only records which could be located regarding the original construction. Plans for the modifications made to bays 4 and 5 by DOT in 1963 were also available and have been included in Appendix F.

2.4 OPERATION RECORDS

Reservoir level readings are taken on a regular basis. Records of these readings are kept in the Regional Waterways Maintenance Office in Syracuse.

2.5 EVALUATION OF DATA

The data presented in this report was obtained from the Department of Environmental Conservation files and from the Department of Transportation Regional Waterways Maintenance Office in Syracuse. While the subsurface information available concerning the structure was rather limited, it appears that the available data was reliable and adequate for Phase 1 inspection purposes.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspection of the Waterloo Dam was conducted on May 9, 1980. The weather was overcast and the temperature was in the forties. The water surface at the time of inspection was at elevation 445.57 (Barge Canal Datum).

b. Spillway Section

The spillway section is the dominant feature of this structure. There are operable tainter gates on four of the six spillway bays. These gates are all in satisfactory condition. Skin plates and some structural members on the gate on bay 6 have been replaced as part of maintenance operations. This gate was closed at the time of inspection, but there was some minor leakage under the gate. The other three gates are at the eastern end of the structure and form the entrance to the power canal. The concrete on the corners of the counterweights of all these gates was spalling and deteriorated. There was minor rusting of the steel skin plates on all these gates. The corner plate on the back corner of the gate on bay 1 was rusted completely through in several spots.

The remaining two bays were uncontrolled concrete weir structures with a notch in the center of each which can accomodate stop logs. At the time of inspection, there were no stop logs in place. The concrete on these sections was in generally good condition, although there was some minor deterioration on the nose piers and on the bridge support piers downstream of the spillway crest.

c. Abandoned Canal

The abandoned canal functions as an auxiliary spillway at the southern end of the dam. The concrete weir which forms the spillway was in good condition. The control mechanism for a slide gate was located on the top of the weir. The channel was partially filled in the area downstream of the weir.

d. Appurtenant Structures

Lock 4 on the Cayuga-Seneca Canal is to the east of this dam. The canal walls and lift gates appeared to be in satisfactory condition.

e. Downstream Channel

There were three distinct segments of the downstream channel. Downstream of the lock was the main canal channel. The three gates at bays 1,2 and 3 emptied into the power canal for the hydroelectric station. On the western side of the power canal was a concrete wall which showed some signs of deterioration. This canal was not inspected in great detail since it was downstream of the dam and was considered to be part of the hydro-electric station. The final segment of the channel was downstream of the three spillway bays on the western end of the dam and discharged into the old stream channel. This portion of the channel was partially bedrock lined and partially overgrown with trees and brush. The tainter gate on bay 6 is opened periodically to flush debris out of the old stream bed.

f. Reservoir

There were no signs of soil instability in the area upstream of the dam. The Cayuga-Seneca Canal formed a walled or riprapped channel up to Seneca Lake.

3.2 EVALUATION OF OBSERVATIONS

Visual inspection revealed several deficiencies on this structure. The following items were noted:

1. Minor leakage beneath the tainter gate on bay 6 when it was completely closed.

2. Deterioration of concrete on counterweights and rusting of steel of the three gates in front of the entrance to the power canal.

3. Concrete deterioration on the nose piers and on the bridge support piers of the two ungated bays.

SECTION 4: OPERATION AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

This dam is operated to provide a pool for navigation on the canal. Water is also provided for the NYSE&G power station located downstream of the dam. The normal procedures are to keep the three gates which control flow into the power canal completely opened. These gates are only closed on rare occasions to perform repair work on the power house. Gate 6 is generally closed at all times. This gate is sometimes opened for a short period of time to flush out the downstream channel.

4.2 MAINTENANCE OF DAM

The dam is maintained by DOT. Routine maintenance is performed on the structure on a regular basis.

4.3 WARNING SYSTEM IN EFFECT

No apparent warning system is present.

4.4 EVALUATION

The operation and maintenance procedures for this dam appear to be satisfactory.

SECTION 5: HYDROLOGIC/HYDRAULIC

5.1 DRAINAGE AREA CHARACTERISTICS

The delineation of the contributing watershed to this dam is shown on the map titled "Drainage Area Map - Waterloo Dam @ Lock C/S-4" (Appendix C). The relationship of this watershed to the entire Oswego River Basin is indicated on the map titled "Oswego River Basin - Basin Map" (Appendix C). The irregular but somewhat Y-shaped north-south oriented watershed of some 753 square miles is characterized by streams draining directly from the surrounding landscape into Seneca Lake and the 182 square mile subbasin controlled by the Keuka Lake Outlet dam. Inflows to Seneca Lake from Keuka Lake follow a natural channel called Keuka Lake Outlet. Some of the other large tributaries to Seneca Lake are Kashong Creek, Rock Stream, Van Zandt Hollow - Glen Creek-Townsend Creek, Shequaga Creek, Sixteen Falls Creek, and Catharine Creek. Direct tributaries to the Cayuga-Seneca Canal upstream of the dam are Black Creek and Kendig Creek.

The two large lakes, Keuka and Seneca, have surface areas of 18.3 and 67.6 square miles respectively and shoreline lengths of 55 and 77 miles respectively. The terrain surrounding the lakes rises steeply to the hilltops which are at elevations 400 to 1200 feet above the normal lake levels. Land use within the entire watershed is predominantly agricultural with large areas within the Keuka Lake subbasin devoted to vineyards

5.2 ANALYSIS CRITERIA

No hydrologic/hydraulic information was available regarding the original design for this dam. Watershed information was obtained from the Oswego River Basin (ORB) management study, 1960 and 1980 Corps of Engineers reports for Keuka Lake Outlet Dam, and USGS time-of-travel studies for selected ORB streams.

The analysis of the spillway capacity of the dam was performed using the Corps of Engineers HEC-1 computer program, Dam Safety version. The computer modeling parameters for the two drainage subbasins, Keuka Lake and Seneca Lake were selected from the ORB study. The spillway design flood selected was the Probable Maximum Flood (PMF) in accordance with the Recommended Guidelines of the Corps of Engineers. The PMF storm event is that hypothetical flow resulting from the most critical combination of rainfall, minimum soil infiltration loss, and concentration of runoff at a specific location that is considered reasonably possible for a specific watershed.

Storm event discharges for each subbasin were developed using the Snyder Synthetic Unit Hydrograph method. The inflow discharge for the Keuka Lake subbasin was reservoir routed over the Keuka Lake Outlet dam. The resulting outflow hydrograph was then combined with the Seneca Lake inflow hydrograph at the Waterloo Dam and then reservoir routed over the dam using the Modified Puls method.

5.3 SPILLWAY CAPACITY

The spillway is comprised of four radial tainter gates and two gravity section concrete weirs, each having a low-flow removable flashboard

section. Across and above the entire entrance of the spillway is a steel and timber walkway bridge which rises above the top-of-dam elevation by approximately one foot. This bridge was not regraded as causing orifice flow conditions at the weirs for water surface elevations rising above the top-of-dam. The three adjoining tainter gates located nearest the right abutment control inflows to the forebay of the hydroelectric station. These gates are normally fully open. However, for this analysis, these gates were considered fully closed because of possible damage and/or flooding of the power station during an extreme storm event. The fourth tainter gate adjacent the left abutment was considered to be closed until water surface elevations reached the top-of-dam; then a fully-open orifice flow condition was used for determining discharges. This tainter gate was analyzed for orifice flow using a discharge coefficient, C, of 0.6. The two gravity sections were analyzed as sharp-crested weirs with a C of 3.2. For water surface elevations rising above the top-of-dam elevation, a broad-crested weir C of 2.63 was used. Although there exists a small water-control structure at a bridge 200 feet left of the spillway's left abutment, the additional discharge capacity was not included in the analysis because of the discharge channel and bridge area being backfilled with earth and debris.

Computed discharges for the above conditions analyzed are as follows: (BCD - Barge Canal Datum)

Elev. (BCD)		Discharge
448.5	Total	3557
448.5	Gate 6-fully open	3488
448.5	Weirs @ Bays 4&5	69

The flood analyses performed for this dam considered an initial water surface level of 446 in Seneca Lake which is approximately mid-level between the ORB study maximum rule curve elevations of 445 (Winter) and 446.8 (Summer). For the conditions analyzed, the spillway does not have sufficient capacity for discharging the peak outflow from one-half the PMF. For this storm event, the peak inflow is 94,405 cfs and the peak outflow is 8,318 cfs. For the PMF event, the peak inflow and peak outflow are 189,765 cfs and 37,844 cfs respectively. The computed spillway discharge capacity is 3557 cfs.

5.4 RESERVOIR CAPACITY

Normal water surface levels fluctuate throughout the year both in the Cayuga-Seneca Canal and Seneca Lake, ranging from approximately elevation 443 to elevation 446 (USGS) or from 444.6 to 447.6 (BCD). A storage-elevation curve (Appendix C) for Seneca Lake as given in the ORB report indicates a capacity of 585,700 acre-feet at the top-of-dam elevation. Since the dam is located approximately 5 miles downstream of the main body of Seneca Lake, stages recorded at the dam do not reflect corresponding lake levels.

5.5 FLOODS OF RECORD

The maximum known flood in the watershed occurred on June 25, 1972 when a gage reading of 450.47 BCD (448.88 USGS) was recorded at Watkins Glen. The operation of the gates during this event was not determined; hence, the actual spillway discharges into the downstream channel is unknown.

5.6 OVERTOPPING POTENTIAL

Records indicate that the existing dam has been overtopped by approximately 2 feet during the maximum known flood. No dam failure was recorded. The analysis indicates the spillway does not have sufficient discharge capacity for one-half the PMF. The computed depth of overtopping is 2.39 feet for this event. Overtopping would occur for all storm events exceeding 23% of the PMF.

5.7 EVALUATION

The spillway does not have sufficient capacity for discharging the peak outflow from one-half the PMF. Since the downstream channel is the Cayuga-Seneca Canal, large spillway overtopping discharge would result in flooding of the downstream areas. However, dam failure would not significantly increase the hazard to loss of life downstream from that which would exist just prior to an overtopping-induced failure. Therefore, the spillway is assessed as inadequate.

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Visual inspection of the structure did not reveal any signs of major distress. There was some deterioration of concrete on the nose piers between the bays and on several of the counterweights. In addition, there was minor rusting of steel on the three tainter gates in front of the entrance to the power canal.

b. Data Review and Stability Evaluation

The structural information needed to perform a stability analysis was taken from the DOT plans. The section analyzed was the auxiliary spillway overflow weir, bays 4 and 5. Cross-sectional information used for the analysis was taken from the plans prepared by DOT in August, 1963.

The following conditions were analyzed:

a. Normal conditions with water level one foot below the crest of the spillway

b. Water level one foot below spillway crest with an ice load of 5,000 lb/ft.

c. One half PMF, water flowing over the masonry crest at a depth of 2.39 feet.

The analyses performed (See Appendix D) indicate that the factors of safety against overturning and sliding are as follows:

Case	Factors of Safety		
	Overturning	Resultant Within Middle Third	Sliding
a. Reservoir one foot below spillway crest, no ice	1.33	No	5.9
b. Reservoir one foot below spillway crest; ice load of 5,000 lb/ft.	.30	No	2.0
c. One-half PMF, water flowing over masonry at depth of 2.39 feet	.91	No	3.89

The analyses performed indicate that the safety factors against overturing are seriously deficient. The resultant force falls outside of the middle third of the base for all conditions analyzed. The safety factors against sliding are generally adequate.

The analysis was performed for the spillway section only. Since the plans state that no vertical keyway between the overflow section and the piers on either end was required, no benefit from the piers was assumed. The effects of the anchors were also ignored. A more complete stability analysis is required which includes field investigations to determine the quality of the

rock upon which the dam is founded. Based on the results of this evaluation, it should be determined whether modifications to the structure are required.

d. Seismic Stability

A seismic stability analysis was performed for this structure assuming a seismic coefficient of 0.1. The seismic analysis was performed for normal conditions with the water level one foot below the spillway crest. The safety factor against overturning with seismic considerations included is 1.10 but the resultant force does fall within the limits of the base. The safety factor against sliding is 4.54.

SECTION 7: ASSESSMENT/RECOMMENDATIONS

7.1 ASSESSMENT

a. Safety

The Phase 1 inspection of the Waterloo Dam did not reveal conditions which constitute an immediate hazard to human life or property. Several deficiencies were noted such as deteriorated concrete on the counterweights as well as the nose piers, and rusted steel on some of the gates. In addition, analyses performed indicate that the stability of the overflow weir sections is questionable.

The spillway while not having sufficient discharge capacity for passing one-half the PMF, is considered to be inadequate. An emergency action plan and warning system should be developed to warn residents of high floodwater conditions.

b. Adequacy of Information

The information available for the preparation of this report was generally adequate. There was, however, very little information available about the subsurface conditions or the foundation of the structure.

c. Need for Additional Investigations

Further analysis of the structural stability is required. This analysis should be a more detailed study than was made for this report. Included should be a series of subsurface investigations to obtain more information about the rock foundation and a determination as to whether modifications to the structure are required to increase the stability.

d. Urgency

The additional investigations which are required should be commenced within 6 months of the date of notification of the owner. Within 18 months of the date of notification, modifications to the structure deemed necessary as a result of the stability analysis should be made. Other deficiencies outlined should be corrected within 1 year of the date of notification.

7.2 RECOMMENDED MEASURES

a. After the structural stability analysis has been completed, appropriate remedial work should be performed.

b. The deteriorated concrete on the counterweights and rusting of steel of the three gates at the entrance to the power canal should be repaired.

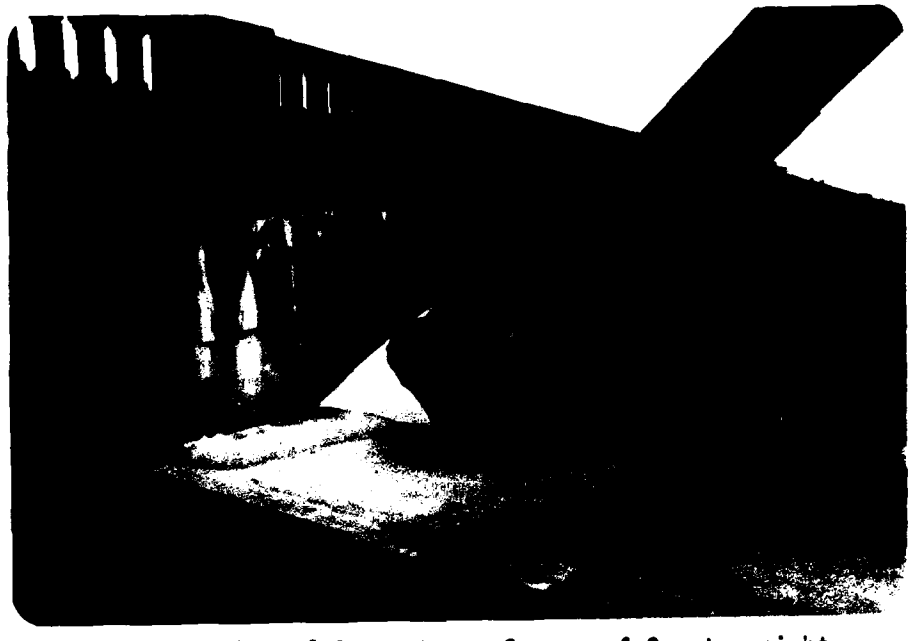
c. The deteriorated concrete on the nose piers and on the bridge support piers of the two ungated bays should be repaired.

d. The tainter gate on bay 6 should be made so it will close completely.

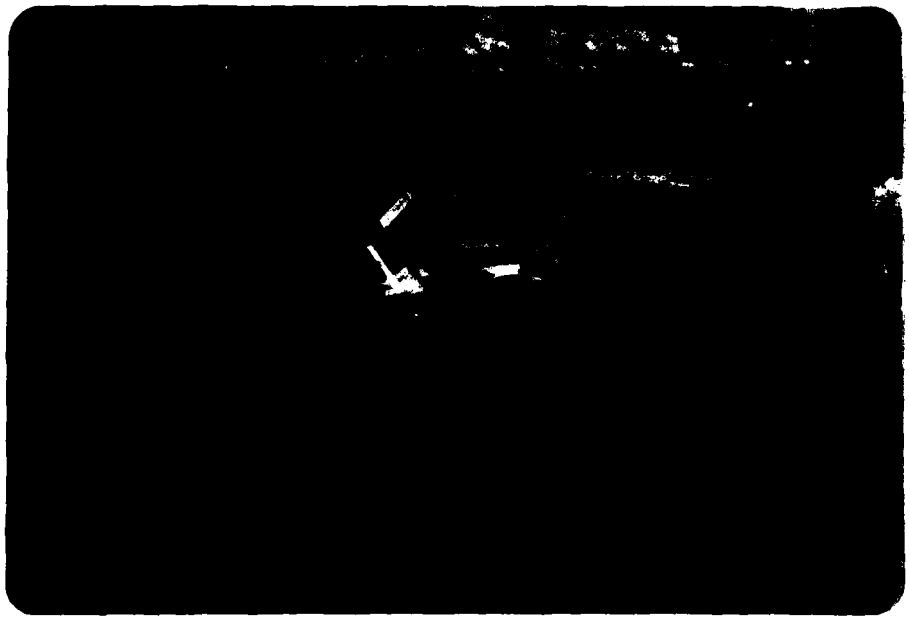
e. A detailed emergency-operation action plan and warning system should be developed and implemented.

APPENDIX A

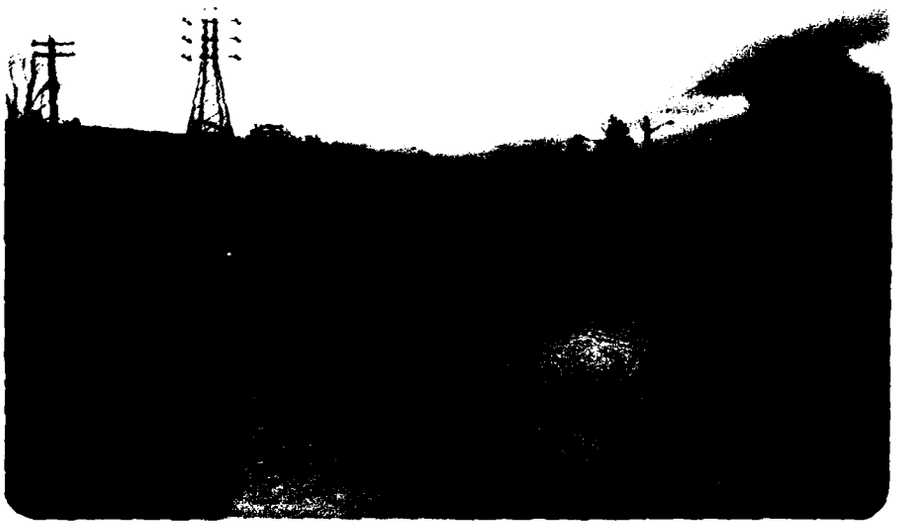
PHOTOGRAPHS



Deterioration of Concrete on Corner of Counterweight
of Gate on Bay No. 3



Perforations in Steel Plates on Gate at Bay No. 1

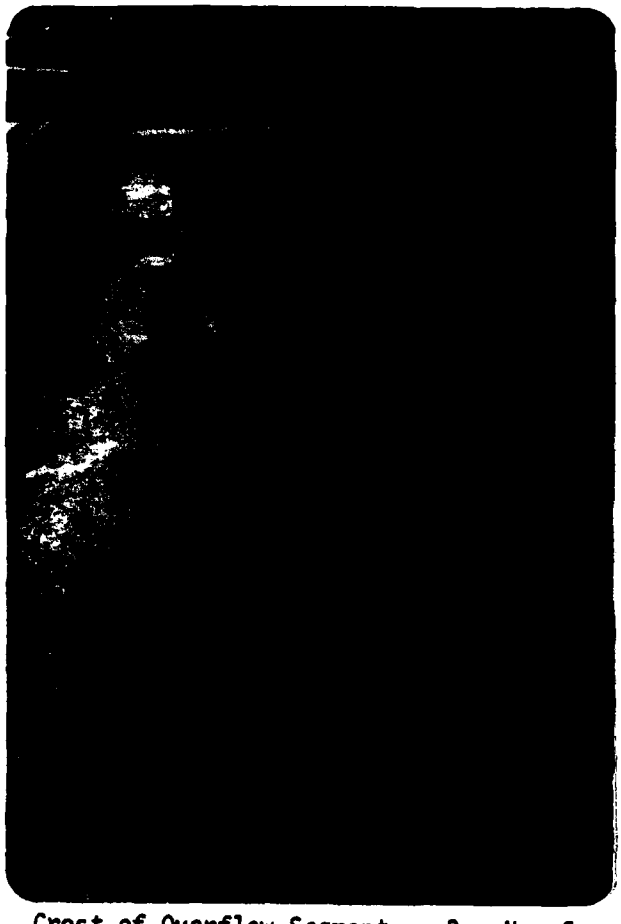


View from Western End of Dam - Note Closed Gate on Bay No. 6

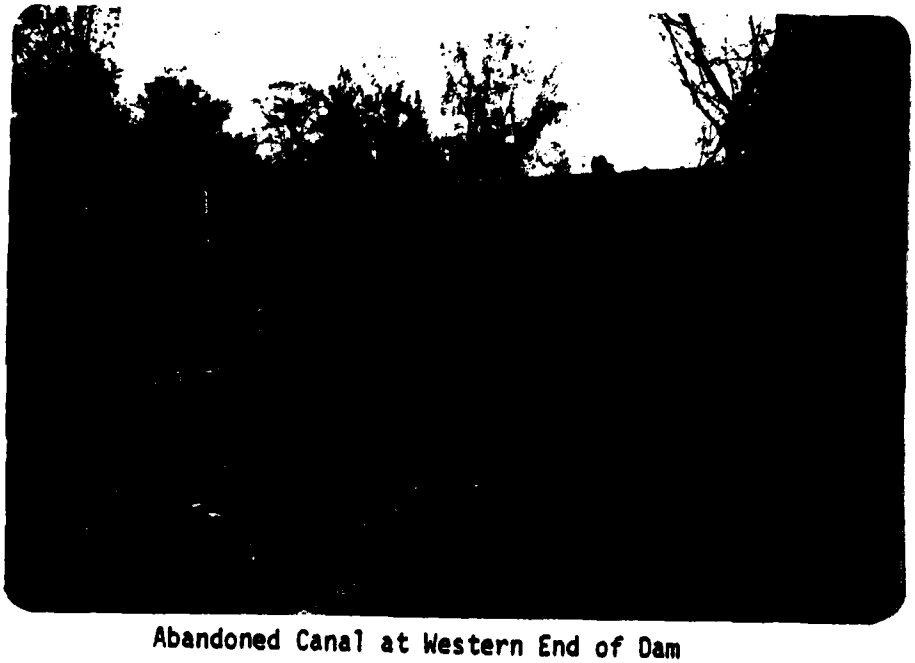
Gate on Bay No. 6 - Note Leakage Beneath Gate

View of Gated Bay No. 6 at Right and
Overview Sections on Bays No. 4 and 5

Deterioration of Concrete on Bridge Support
Piers between Bays No. 4 and 5

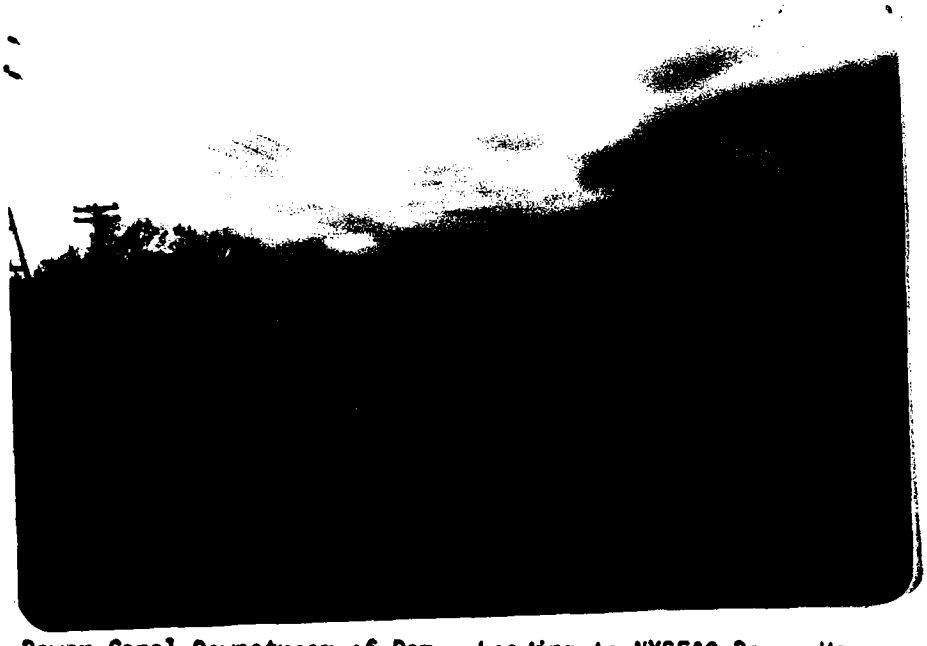


Crest of Overflow Segment on Bay No. 5



Abandoned Canal at Western End of Dam

Lock Number 4 Lift Gate at Eastern End of Dam



Power Canal Downstream of Dam - Leading to NYSE&G Power House

APPENDIX B

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam WATERLOO DAM

Fed. I.D. # 709 DEC Dam No. 58B-420

River Basin OSWEGO

Location: Town WATERLOO County SENECA

Stream Name CAYUGA & SENECA CANAL

Tributary of

Latitude (N) 45° 24.0′ Longitude (W) 76° 52.0′

Type of Dam CONCRETE

Hazard Category C

Date(s) of Inspection 5/9/80

Weather Conditions 45°F OVERCAST

Reservoir Level at Time of Inspection 445.57 BARGE CANAL DATUM

b. Inspection Personnel W. LYNICK R. WARRENDER

c. Persons Contacted (Including Address & Phone No.)

RICHARD ALDRICH - REGION 3 WATERWAYS 315-473-8194

DAVE CONROY - CANAL SECTION SUPERINTENDENT

d. History:

Date Constructed 1912-14 Date(s) Reconstructed 1963

Designer

Constructed By GATES - LUPPER & REMICK OF BUFFALO - STEEL FABRICATORS J.B. McHOLLAND & Co. PITTSBURG, PA.

Owner DOT-WATERWAYS

SECTION 2. EMBANKMENT – NOT COMPLETED BECAUSE THERE WAS NO EMBANKMENT

(1) Erosion at Contact _____

(2) Seepage Along Contact _____

3) Drainage System

a. Description of System NONE

b. Condition of System _____

c. Discharge from Drainage System _____

4) Instrumentation (Momumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.) STAFF GAGE ON LOCK WALL FOR MEASURING WATER LEVELS

5) Reservoir

a. Slopes SENECA CANAL Upstream to SENECA LAKE, - WALLED, RIPRAPED OR NATURAL GROUND CHANNEL

b. Sedimentation NONE APPARENT

c. Unusual Conditions Which Affect Dam POSSIBLE AUX. SPILLWAY ON NORTH END OF DAM THRU ABANDONED CANAL BRIDGE CROSSING

6) Area Downstream of Dam

a. Downstream Hazard (No. of Homes, Highways, etc.) RTE 96 - NYS GAS & ELECTRIC POWERHOUSE - HOUSES NEAR CANAL CHANNEL

b. Seepage, Unusual Growth NONE

c. Evidence of Movement Beyond Toe of Dam NONE

d. Condition of Downstream Channel POWER STATION SLUICEWAY - SATISFACTORY TREES & BRUSH LINED BANKS ALONG DEWATERED SIDE OF WALL

7) Spillway(s) (Including Discharge Conveyance Channel)

6 GATED BAYS No.1 - NORTH No.2 & 3 CONC. STRUCTURE No.4,5 & 6 - SLUICEWAY 1 GATE ON OLD CANAL WHICH CAN BE OPERATED AS WELL

a. General No.1 - USED FOR FLUSHING DOWNSTREAM CHANNEL
No.2 & 3 - NO OPERATING MECHANISM - OPERATES AS AUXILIARY
No.4,5 & 6 - ORIGINAL EQUIPMENT FROM 1915 - THESE GATES ARE OPERATED TO PROVIDE WATER FOR POWER HOUSE

b. Condition of Service Spillway - GATED BAYS No.1, 4, 5 & 6. - THESE CAN BE OPERATED AS SERVICE - OVERALL CONDITION IS SATISFACTORY - MINOR RUSTING OF STEEL - CORNER BRACE PLATE ON No.6 HAS HOLE RUSTED IN IT. CONCRETE SPALLING ON CORNERS OF COUNTERWEIGHT ON SEVERAL
GATE No.1 - CLOSED @ DURING INSPECTION OTHERS OPEN
SKIN PLATES & SOME STRUCTURAL MEMBERS ON GATE No.1 HAVE BEEN REPLACED AS PART OF MAINTENANCE OPERATIONS

c. Condition of Auxiliary Spillway BAYS No, 2 & 3 FUNCTION AS AUXILIARY GATES REMOVED & CONCRETE PLACED IN 1963 - CONCRETE IN GOOD CONDITION - CONCRETE WEIR ACROSS ABANDONED CANAL AT NORTH END CAN ALSO FUNCTION AS AUXILIARY - CLEAR OPENING IS 19 FT WIDE

d. Condition of Discharge Conveyance Channel CHANNEL FROM GATES 4, 5 & 6 TO POWER HOUSE - APPEARED TO BE IN SATISFACTORY CONDITION NOT INSPECTED IN GREAT DETAIL BECAUSE IT IS RELATED TO POWER HOUSE

8) Reservoir Drain/Outlet - GATE ON ABANDONED CANAL COULD POSSIBLY BE USED AS RESERVOIR DRAIN - ESSENTIALLY UNOBSERVABLE

Type: Pipe _____ Conduit _____ Other _____

Material: Concrete _____ Metal _____ Other _____

Size: _____ Length _____

Invert Elevations: Entrance _____ Exit _____

Physical Condition (Describe): Unobservable _____

Material: _____

Joints: _____ Alignment _____

Structural Integrity: _____

_____

Hydraulic Capability: _____

_____

Means of Control: Gate ✓ Valve _____ Uncontrolled _____

Operation: Operable ✓ Inoperable _____ Other _____

Present Condition (Describe): REPORTED THAT THE GATE IS OPENED OCCASIONALLY TO FLUSH OUT THE CANAL

9) Structural

a. Concrete Surfaces GATES 4,5 & 6 CONCRETE COUNTER WEIGHTS CRACKING AND CORNER DETERIORATION

SOME SURFACE DETERIORATION ON WALLS NEAR BRIDGE

b. Structural Cracking NOSE PIER (BETWEEN GATES 2 & 3) AT WALKWAY BRIDGE ANCHORAGE (FROM TOP TO BELOW WATERLINE)

c. Movement - Horizontal & Vertical Alignment (Settlement) NONE

d. Junctions with Abutments ~~or Embankments~~ SATISFACTORY

e. Drains - Foundation, Joint, Face NONE

f. Water Passages, Conduits, Sluices SLUICEWAY TO POWERHOUSE

NOT INSPECTED IN GREAT DETAIL - APPEARED SATISFACTORY

g. Seepage or Leakage MINOR LEAKAGE BENEATH GATE NO. 1 SILL

h. Joints - Construction, etc. SATISFACTORY

i. Foundation BEDROCK IN DOWNSTREAM CHANNEL

j. Abutments SATISFACTORY

k. Control Gates STEEL PERFORATION THRU BRACE PLATES NEAR COUNTER WEIGHTS ON GATES 5&6 RUSTING STEEL ~~MARK~~ ON SKIN PLATES OF GATES 4 5,&6

l. Approach & Outlet Channels NO PROBLEMS EVIDENT

m. Energy Dissipators (Plunge Pool, etc.) BEDROCK CHANNEL AND APRON

n. Intake Structures

o. Stability

p. Miscellaneous

10) Appurtenant Structures (Power House, Lock, Gatehouse, Other)

a. Description and Condition

LOCK - CAYUGA-SENECA CANAL LOCK 4 - SEPERATED FROM DAM BY ORIGINAL GROUND - LOCK APPEARED TO BE SATISFACTORY BUT WASN'T INSPECTED IN GREAT DETAIL.

CONCRETE BRIDGE - IMMEDIATELY DOWNSTREAM OF DAM SATISFACTORY CONDITION

SLUICEWAY & POWER HOUSE - NOT INSPECTED CLOSELY

APPENDIX C

HYDROLOGIC/HYDRAULIC ENGINEERING DATA AND COMPUTATIONS

WATERLOO DAM @ LOCK C/S - 4

1

CHECK LIST FOR DAMS
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

AREA-CAPACITY DATA:

		(BCD) Elevation (ft.)	Surface Area (acres)	Storage Capacity (acre-ft.)
1)	Top of Dam	448.5		585,700
2)	Design High Water (Max. Design Pool)	N/A		
3)	Auxiliary Spillway Crest	N/A		
4)	Pool Level [redacted] @ Flashboards CREST	446.05		
5)	Service Spillway Crest - GATE INVERTS	439 - G6 435 - (G1-G3)		

DISCHARGES

		Volume (cfs)
1)	Average Daily	N/A
2)	GATE 6 Spillway @ Maximum High Water (GATE FULLY OPEN)	3488
3)	Spillway @ Design High Water	N/A
4)	Spillway @ Auxiliary Spillway Crest Elevation	N/A
5)	Low Level Outlet	NONE
6)	Total (of all facilities) @ Maximum High Water (NOT INCLUDE POWER STATION)	3557
7)	Maximum Known Flood	OVERTOPPED - 1.97'
8)	At Time of Inspection - ELEV. 445.57	N/A

NAVIGATION SIGN @ LOCK C/S - 4:
UPPER POOL = 445
LOWER POOL = 430.5

USGS (DATUM) + 1.59 = BCD

CREST: ELEVATION: 448.5 BCD

Type: 2 CONCRETE WEIRS + 4 TAINTER GATES + SEPARATING PIERS

Width: 2' (GRAVITY SECTION) Length: 241'

Spillover ENTIRE CREST

Location ENTIRE CREST

SPILLWAY:

[redacted]		[redacted]
446.05 446.15 (BCD)	Elevation (BCD)	439
FLASHBOARDS (2)	Type	TAINTER GATE - G6
3.85' 3.87' (BAY 5) (BAY 4)	Width	36'
	Type of Control	
N/A	Uncontrolled	N/A
✓	Controlled:	✓
FLASHBOARDS	Type (Flashboards; gate)	GATE
2	Number	1
(SEE WIDTH)	Size/Length	(SEE WIDTH)
	Invert Material	CONCRETE
	Anticipated Length of operating service	N/A
N/A	Chute Length	N/A
7' ±	Height Between Spillway Crest & Approach Channel Invert (Weir Flow)	N/A

3 SIMILAR GATES @ BAYS 1-3 CONTROLLING INFLOW TO HYDRO-POWER STATION — NORMAL POSITION IS FULL OPEN.

HYDROMETEROLOGICAL GAGES:

Type : USGS WATER-STAGE RECORDER — LAKE STAFF GAGE @ LOCK 4

Location: WATKINS GLEN ON UPSTREAM ABUT. WALL

Records:

Date - 6/25/72

Max. Reading - 448.88 USGS
450.47 BCD

FLOOD WATER CONTROL SYSTEM:

Warning System: NONE LOCK OPERATOR ON DUTY (7AM - 11 PM)

Method of Controlled Releases (mechanisms):

4 TAINTER GATES

DRAINAGE AREA: 753 SQ MILES

DRAINAGE BASIN RUNOFF CHARACTERISTICS:

Land Use - Type: PRIMARILY AGRICULTURAL

Terrain - Relief: MODERATE TO STEEP

Surface - Soil: TILLABLE - SLOW INFILTRATION

Runoff Potential (existing or planned extensive alterations to existing (surface or subsurface conditions)

N/A

Potential Sedimentation problem areas (natural or man-made; present or future)

N/A

Potential Backwater problem areas for levels at maximum storage capacity including surcharge storage:

LOW AREAS IMMEDIATELY ADJACENT TO C/S CANAL

Dikes - Floodwalls (overflow & non-overflow) - Low reaches along the Reservoir perimeter:

Location: N/A

Elevation: _____

Reservoir: SENECA LAKE (ONLY)

Length @ Maximum Pool 35 ± (Miles)

Length of Shoreline (@ Spillway Crest) 77 ± (Miles)

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NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
LOCK C/S-4 DAM @ WATERLOO	1/		
SUBJECT		**COMPUTED BY**	**DATE**
WATERSHED PARAMETERS		WCL	8/19/80

DRAINAGE AREA TO LOCK C/S-4 DA = 753 SQ MI ← USE

DRAINAGE AREA:

	SUBBASIN	DA			
KEUKA LAKE		182 SQ MI	USE DATA FOR PHASE 1 RPT KEUKA LAKE OUTLET DAM NY-390		
KEUKA LAKE OUTLET TO USGS GAGE @ DRESDEN (#04232482)		207 SQ MI (INCREMENTAL DA = 25 SQ MI)			LOCK C/S-4
SENECA LAKE:					TOTAL DA ↓
REF: OSWEGO RIVER BASIN STUDY (CORPS ENGRS):					
PAGE	SENECA LAKE DA (SQ MI)				
B-163	524		+182	+39 =	745
→ C-10	714 (507)	(INCL. KEUKA LAKE OUTLET)		+39 =	753 ↖
USGS GAGE @ WATKINS GLEN (#04232400)	704 (497)	(INCL. KEUKA LAKE OUTLET)		+39 =	743
SENECA LAKE OUTLET TO LOCK C/S-4 DAM (PAGE B-163)	39 SQ MI.				
SENECA LAKE + SENECA LAKE OUTLET TO LOCK C/S-4 (NO KEUKA LAKE) PLANIMETERED @	567 SQ MI		+182	=	749

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PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
LOCK C/S-4 @ WATERLOO	2/		
SUBJECT		**COMPUTED BY**	**DATE**
WATERSHED PARAMETERS - SUBBASINS		WCL	8/19/80

SNYDER UNIT HYDROGRAPH:

SUBBASIN ⟶	KEUKA LAKE	SENECA LAKE (TO LOCK C/S-4)
AREA (SQ MI)	182	571
T_P	12.26 HRS	17.86 HRS (SHT 3/)
LAG TO SENECA LAKE (GAGE @ DRESDEN) {TO PENN YAN} (6.5 MI)	4.7 HRS	—
C_P	0.625 ←(USE)→	0.625

FOR SENECA LAKE SUBBASIN:

LONGEST DRAINAGE PATH = L = 22.65 MILES + 33.28 MILES + 4.85 MI.
L = 60.78 MILES (CATHARINE CREEK) (SENECA LAKE) (C/S CANAL)

[FROM 7.5' USGS QUAD = 59.8" = 119,600'] + 175,680' + 25620'

DIST TO CENTROID OF DA = L_{CA} = + 19.73 MI. + 4.85

L_{CA} = 24.58 MILES 104,170' + 25600'

(USE) C_t = 2.0 SLOPES (MODERATE TO STEEP)

$$LAG = t_p = C_t (L \times L_{CA})^{0.3}$$

$$= 2(60.78 \times 24.58)^{0.3}$$

t_p = 17.92 HRS

UNIT RAINFALL DURATION $= t_r = \frac{t_p}{5.5} = \frac{17.92}{6.5} = 3.25$ HRS

[USE 3.0 HRS = t_R]

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PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
LOCK C/S-4 @ WATERLOO	3/		
SUBJECT		**COMPUTED BY**	**DATE**
WATERSHED PARAMETERS - SUBBASINS		WCL	8/20/80

FOR SENECA LAKE SUBBASIN:

ADJUSTED LAG = TP = $t_p + 0.25(t_R - t_r)$

$= 17.92 + 0.25(3 - 3.25)$

TP = 17.86 HRS

IMPERVIOUS AREA (PRIMARILY SENECA LAKE)

SURFACE AREA = 67.10 SQ MI.
SUBBASIN AREA = 571 SQ MI

} RIMP = 0.118 (11.8%)

REF: OSWEGO RIVER BASIN STUDY:

LOSS RATES:
- INITIAL = 1.50 INS/HR
- CONSTANT = 0.03

} BASIS: MODEL CALIBRATED TO JUNE 1972 EVENT (AGNES)

BASE FLOW:
- STARTQ = 500 cfs
- QRCSN = 2800 cfs
- RTIOR = 1.6

} SAME

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PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
LOCK C/S-4 @ WATERLOO	4/		
SUBJECT		COMPUTED BY	DATE
		WCL	8/20/80

PMP RAINFALL :

DA = 753 SQ MI HMR # 33 ON ZONE BOUNDARY

FOR 200 SQ MI - 24 HR P = 21.2" (INDEX)

HRS	ZONE 1	AVE.	ZONE 2
6	55.5	60.5	65.5
12	71	73	75
24	82	82.5	83
48	89	90.5	92

STAGE - STORAGE DATA : SENECA LAKE (REF: OSWEGO RIVER BASIN STUDY)

ELEV. (BCD)	ELEV (USGS)	AC-FT (x 1000)	
443.6	442	369.8	
444.6	443	412.5	
445.6	444	457.1	
446.6	445	500.0	
447.6	446	542.9	
	TOP DAM		
448.6	447	585.7	
449.6	448	628.6	
450.6	449	671.4	ΔV = 21500 AC-FT
451.1	449.5	692.9	
	(4.9' x ΔV)		
456	454.4	798.25	

WATERLOO
DAM

NY - 709

4A/

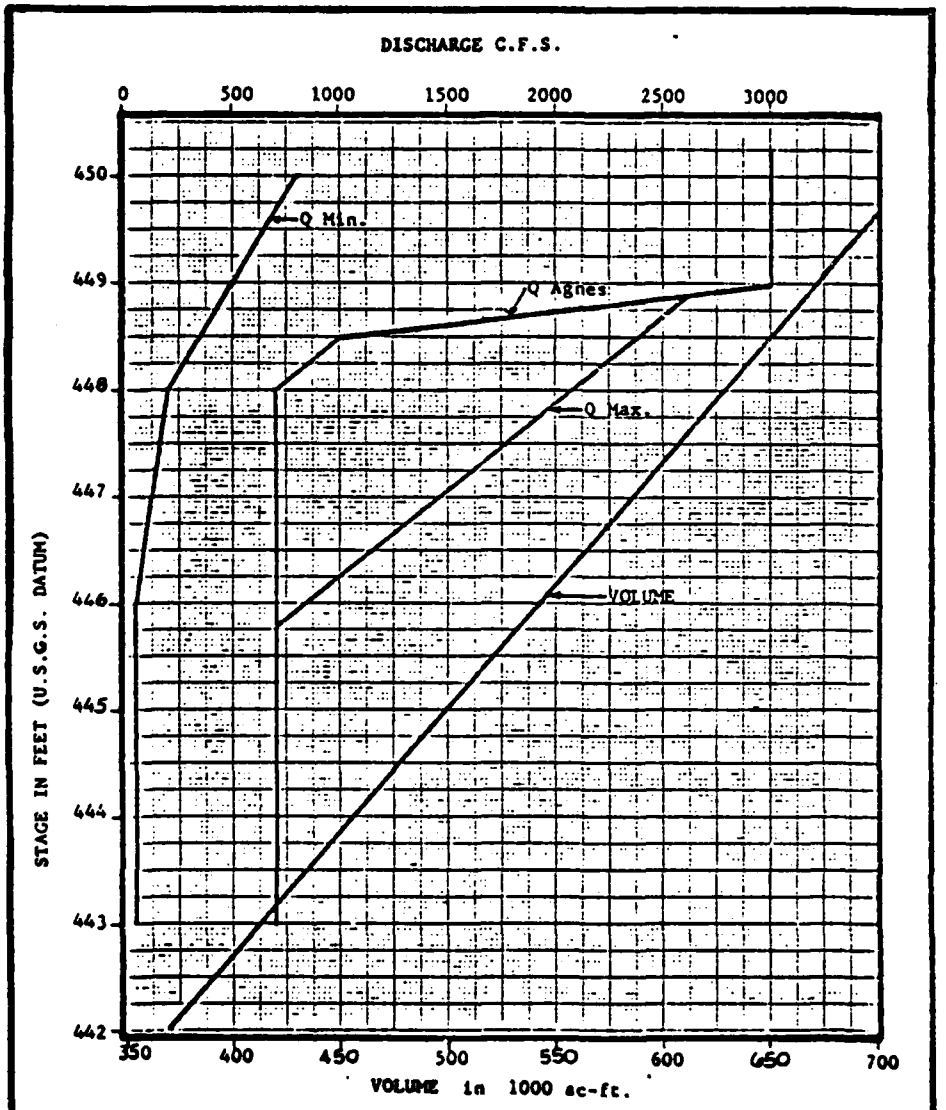

FIGURE A-26

OSWEGO RIVER BASIN

SENECA LAKE

STAGE vs VOLUME & DISCHARGE CURVES

U.S. ARMY ENGINEER DISTRICT, BUFFALO

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PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
LOCK C/S-4 @ WATERLOO	5/		
SUBJECT		**COMPUTED BY**	**DATE**
		WCL	9/4/80

DISCHARGE CAPACITY: BAY 4 & 5

GEOMETRY - PLANS DATED 8/63 & AS-BUILT PLAN (1964)

DATUM: USGS + 1.59 = BCD

$Q = CLH^{3/2}$ NO FLASHBOARDS

SHARP-CRESTED WEIR W/ END CONTRACTIONS

$C = 3.2$

$L = L' - 0.4H$ $= L' - 2(NK_p + K_a)H$

$N = 0$ $K_a = 0.2$

BAY 4: $L' = 3.87'$ BAY 5: $L' = 3.85'$

USGS	BCD	H	L	Q	H	L	Q	TOTAL Q
	446.05	—		—	—	3.85	—	—
	446.15	—	3.87	—	0.1	3.81	0.4	0.4
	446.25	0.1	3.83	0.4	0.2	3.77	1.1	1.5
	446.5	0.35	3.73	2.5	0.45	3.67	3.5	6
	447	0.85	3.53	8.8	0.95	3.47	10.3	19
	447.5	1.35	3.33	16.7	1.45	3.27	18.3	35
	448	1.85	3.13	25.2	1.95	3.07	26.8	52
TOP DAM	448.5	2.35	2.93	33.8	2.45	2.87	35.2	69

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PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
LOCK C/S-4 @ WATERLOO	6/		
SUBJECT		COMPUTED BY	DATE
		WCL	9/4/80

DISCHARGE CAPACITY: BAY 6 FULLY OPEN
GEOMETRY - PLANS DATED 7/27/14
CONTRACT 6 - SHT 17

$Q = CA\sqrt{2gH} = 1560\sqrt{H}$

C = 0.6

A = 324 FT^2 = 36 x 9 (448-439)

H - MEASURED TO ℄ OF ORIFICE @ 443.5 ELEV.

	USGS	BCD	H	Q
TOP DAM		448.5	5	3488
		449	5.5	3658
		450	6.5	3977
		451	7.5	4272
		452	8.5	4548
		453	9.5	4808
		454	10.5	5055
		455	11.5	5290
		456	12.5	5515

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PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
LOCK C/S-4 @ WATERLOO	7/		
SUBJECT		COMPUTED BY	DATE
		WCL	9/4/80

DISCHARGE CAPACITY: BAYS 1-5 ABOVE ELEV 448.5
(OVERTOPPING) (OVER THE GATES)
(WEIR FLOW)

$Q = CLH^{3/2}$

$C = 3.1$
$L = 205'$

$Q = 635.5H^{3/2}$

	USGS	BCD	H	Q
TOP DAM		448.5	—	—
		449	0.5	224
		450	1.5	1167
		451	2.5	2512
		452	3.5	4161
		453	4.5	6066
		454	5.5	8197
		455	6.5	10531
		456	7.5	13053

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PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
LOCK C/S-4 @ WATERLOO	8/		
SUBJECT		**COMPUTED BY**	**DATE**
		WCL	9/4/80

DISCHARGE CAPACITY: RIGHT ABUTMENT TO LOCK 4
(ONE BTOPPING WEIR FLOW)

$Q = CL H^{3/2}$ BROAD-CRESTED WEIR

C = 2.63
L = 170'

$Q = 447.1 H^{3/2}$

	USGS	BCD	H	Q
TOP DAM		448.5	—	—
		449	0.5	158
		450	1.5	821
		451	2.5	1767
		452	3.5	2927
		453	4.5	4268
		454	5.5	5767
		455	6.5	7409
		456	7.5	9183

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PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
LOCK C/S-4 @ WATERLOO	9/		
SUBJECT		**COMPUTED BY**	**DATE**
		WCL	9/5/80

(ELEV) PCD	LOW LEVEL FULLY OPEN Q BAYS 4&5	SALIE (6 BAYS 1-5	OVERTOP Q	OVERTOP Q RT. ABUT TO LOCK 4	(cfs) TOTAL Q			
446	—		—	—	—			
446.5	6				6			
447	19				19			
448	52				52			
TOP BANK 448.5	69	(@ 448.49 = 0)	—	—	3557	3951	6853	10943
449	3488		3658	224	4109	5213	8778	13321
450	3977		11647	801	6034		11705	15890
451	4272		25112	1767	8630		15211	18437
452	4548		41611	2927	11705		19088	23299
453	4908		60666	4268	15211		23990	27830
454	5015		81997	5747	19088		27830	31837
455	5090		105311	7409	23299		31837	35515
TOP ROAD 456	69		130553	9183	27830		35515	39223

DEDUCT FROM FOR ANALYSIS

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**********                                                    **********
FLOOD HYDROGRAPH PACKAGE (HEC-1)                              NEW YORK STATE
DAM SAFETY VERSION     JULY 1978                              DEPT OF ENVIRONMENTAL CONSERVATION
  LAST MODIFICATION  26 FEB 79                                FLOOD PROTECTION BUREAU
  MODIFIED FOR HOFFMAN-ENGINEERING APR 79
**********                                                    **********
    1          A WATERLOO DAM AT LOCK C/S = 4  NY-709                 OSWEGO RIVER BASIN
    2          A                NYS WATERWAYS MAINT SUBDIV            SENECA COUNTY
    3          A                                                      PMF - SNYDER UH
    4          B   200      2       0       0       0       0       0       0       0       0
    5          B1    5
    6          J     1      2       1
    7          J1  0.5      1
    8          K     C   KEUKA                                                  1
    9          K1                   INFLOW HYDROGRAPH - KEUKA LAKE SUBBASIN
   10          H     1      1     182             753                                       1
   11          P           21.2    60.5      73    82.5    90.5
   12          T                                                    3.5    0.03             0.1
   13          W 12.26   0.625
   14          X   100      800     1.6
   15          K     1   KLDAM                       2                 1
   16          K1                   ROUTED HYDROGRAPH - KEUKA LAKE DAM - CENTER SPWAY & GATES
   17          Y                                1      1
   18          Y1    1                                                -713.99      -1
   19          Y4706.43  713.99     714     715   715.6     716   716.5     717   717.5     718
   20          Y4 718.5  718.75     719
   21          Y5    0       0     452     583     666     717     802     933    1091    1277
   22          Y5 1460    1588    1701
   23          $S 76000  97000  119000  142000  166000  191000  217000  230000  240000
   24          $E  708     710     712     714     716     718     720     721   721.7
   25          $$  714
   26          $D718.75     3.1     1.5    60.2
   27          K     C  SENECA                                              1
   28          K1                   INFLOW HYDROGRAPH - SENECA LAKE SUBBASIN TO DAM
   29          M     1      1     571             753                                       1
   30          P           21.2    60.5      73    82.5    90.5
   31          T                                                    1.5    0.03            0.118
```

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32   N  17,nn   0,025
33   X    500    2800     1,6
34   K      2     LAM                          2              1
35   K1              COMBINED HYDROGRAPH = KL OUTFLOW WITH SENECA LAKE INFLOW
36   K      1     DAM                          2              1
37   K1              ROUTED HYDROGRAPH AT DAM  (G1-G3 CLOSED  G6 OPEN)
38   Y                                    1      1
39   Y1     1                                                -446      -1
40   Y4   446     447      448   448,49   448,5     449      450      451      452      453
41   Y4   454     455      456
42   Y5     0      19       32       69     3557     3951     8213     8883     8778    10943
43   Y5 13321   15890    18637
44   $S412500  457100   500000   542900   585700   628600   671400   692900   798250
45   $E 444,6   445,6    446,6    447,6    448,6    449,6    450,6    451,1      456
46   $$   446
47   $D 448,5    2,63      1,5      170
48   K     99
49   A
50   A
51   A
52   A
53   A
```

```
PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS
        RUNOFF HYDROGRAPH AT        KEUKA
        ROUTE HYDROGRAPH TO         KLDAM
        RUNOFF HYDROGRAPH AT        SENECA
        COMBINE  2 HYDROGRAPHS AT     DAM
        ROUTE HYDROGRAPH TO           DAM
        END OF NETWORK
```

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**********                                          **********
FLOOD HYDROGRAPH PACKAGE (HEC-1)                    NEW YORK STATE
DAM SAFETY VERSION    JULY 1978                     DEPT OF ENVIRONMENTAL CONSERVATION
  LAST MODIFICATION  26 FEB 79                      FLOOD PROTECTION BUREAU
  MODIFIED FOR HONEYWELL APR 79
**********                                          **********

FOR  DATE 09/05/80
                    WATERLOO DAM AT LOCK C/S - 4  NY-709                 SENECA RIVER BASIN
                                  NYS WATERWAYS MAINT SUBDIV             SENECA COUNTY
                                                                         PMF - SNYDER UH

                                        JOB SPECIFICATION
                    NO      NHR     NMIN     IDAY     IHR     IMIN    METRC     IPLT     IPRT    NSTAN
                   200        2        0        0       0        0        0        0        0        0
                                     JOPER      NW1    LROPT    TRACE
                                         5        0        0        0

                                  MULTI-PLAN ANALYSES TO BE PERFORMED
                                      NPLAN= 1 NRTIO= 2 LRTIO= 1
                          RTIOS=   0.50   1.00

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

                                  SUB-AREA RUNOFF COMPUTATION

                                  INFLOW HYDROGRAPH - KEUKA LAKE SUBBASIN
                                ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                KEUKA       0       0       0       0       0       1       0       0

                                        HYDROGRAPH DATA
                          IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                              1       1  182.00      0.  753.00      0.      0.       0       1       0

                                        PRECIP DATA
                                    SPFE     PMS      R6     R12     R24     R48     R72     R96
                                      0.   21.20   60.50   73.00   82.50   90.50      0.      0.
TRSPC COMPUTED BY THE PROGRAM IS 0.907

                                        LOSS DATA
                          LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
                              0      0.      0.    1.00      0.      0.    1.00    1.50    0.03      0.    0.10

                                    UNIT HYDROGRAPH DATA
                                TP= 12.26    CP=0.63    NTA=  0

                                    RECESSION DATA
                                STRTQ=  100.00    QRCSN=  800.00    RTIOR= 1.60
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 7.00 AND R= 5.50 INTERVALS

                UNIT HYDROGRAPH 33 END-OF-PERIOD ORDINATES, LAG=  12.14 HOURS, CP= 0.63  VOL= 1.00
                  373.    1367.    2706.    4149.    5352.    6028.    6082.    5443.    4535.    3779.
                 3149.    2624.    2186.    1822.    1518.    1265.    1054.     878.     732.     610.
                  508.     423.     353.     294.     245.     204.     170.     142.     118.      98.
                   82.      68.      57.

                0                       END-OF-PERIOD FLOW
              MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS     COMP Q       MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS     COMP Q
               1.01   2.00       1   0.02   0.00   0.02         96.        1.09  10.00     101     0.     0.     0.         78.
               1.01   4.00       2   0.02   0.00   0.02         95.        1.09  12.00     102     0.     0.     0.         74.
```

1.01	8.00	4	0.04	0.01	0.07	105.	1.09	16.00	104	0.	0.	0.	67.
1.01	10.00	5	0.08	0.01	0.07	121.	1.09	18.00	105	0.	0.	0.	64.
1.01	12.00	6	0.08	0.01	0.07	147.	1.09	20.00	106	0.	0.	0.	61.
1.01	14.00	7	0.29	0.03	0.26	188.	1.09	22.00	107	0.	0.	0.	59.
1.01	16.00	8	0.60	0.06	0.54	267.	1.10	0.	108	0.	0.	0.	56.
1.01	18.00	9	0.24	0.02	0.21	394.	1.10	2.00	109	0.	0.	0.	53.
1.01	20.00	10	0.04	0.00	0.03	548.	1.10	4.00	110	0.	0.	0.	51.
1.01	22.00	11	0.04	0.00	0.03	698.	1.10	6.00	111	0.	0.	0.	48.
1.02	0.	12	0.04	0.00	0.03	815.	1.10	8.00	112	0.	0.	0.	46.
1.02	2.00	13	0.24	0.19	0.05	945.	1.10	10.00	113	0.	0.	0.	44.
1.02	4.00	14	0.24	0.19	0.05	1196.	1.10	12.00	114	0.	0.	0.	42.
1.02	6.00	15	0.24	0.19	0.05	1637.	1.10	14.00	115	0.	0.	0.	40.
1.02	8.00	16	0.80	0.75	0.05	2530.	1.10	16.00	116	0.	0.	0.	38.
1.02	10.00	17	0.80	0.75	0.05	4206.	1.10	18.00	117	0.	0.	0.	37.
1.02	12.00	18	0.80	0.75	0.05	6771.	1.10	20.00	118	0.	0.	0.	35.
1.02	14.00	19	3.02	2.97	0.05	10990.	1.10	22.00	119	0.	0.	0.	33.
1.02	16.00	20	6.17	6.11	0.05	19152.	1.11	0.	120	0.	0.	0.	32.
1.02	18.00	21	2.44	2.39	0.05	32239.	1.11	2.00	121	0.	0.	0.	30.
1.02	20.00	22	0.37	0.31	0.05	48158.	1.11	4.00	122	0.	0.	0.	29.
1.02	22.00	23	0.37	0.31	0.05	63767.	1.11	6.00	123	0.	0.	0.	28.
1.03	0.	24	0.37	0.31	0.05	75905.	1.11	8.00	124	0.	0.	0.	26.
1.03	2.00	25	0.	0.	0.	82196.	1.11	10.00	125	0.	0.	0.	25.
1.03	4.00	26	0.	0.	0.	81497.	1.11	12.00	126	0.	0.	0.	24.
1.03	6.00	27	0.	0.	0.	74404.	1.11	14.00	127	0.	0.	0.	23.
1.03	8.00	28	0.	0.	0.	64305.	1.11	16.00	128	0.	0.	0.	22.
1.03	10.00	29	0.	0.	0.	54519.	1.11	18.00	129	0.	0.	0.	21.
1.03	12.00	30	0.	0.	0.	45876.	1.11	20.00	130	0.	0.	0.	20.
1.03	14.00	31	0.	0.	0.	38345.	1.11	22.00	131	0.	0.	0.	19.
1.03	16.00	32	0.	0.	0.	31953.	1.12	0.	132	0.	0.	0.	18.
1.03	18.00	33	0.	0.	0.	26627.	1.12	2.00	133	0.	0.	0.	17.
1.03	20.00	34	0.	0.	0.	22189.	1.12	4.00	134	0.	0.	0.	16.
1.03	22.00	35	0.	0.	0.	18491.	1.12	6.00	135	0.	0.	0.	16.
1.04	0.	36	0.	0.	0.	15409.	1.12	8.00	136	0.	0.	0.	15.
1.04	2.00	37	0.	0.	0.	12841.	1.12	10.00	137	0.	0.	0.	14.
1.04	4.00	38	0.	0.	0.	10701.	1.12	12.00	138	0.	0.	0.	14.
1.04	6.00	39	0.	0.	0.	8918.	1.12	14.00	139	0.	0.	0.	13.
1.04	8.00	40	0.	0.	0.	7431.	1.12	16.00	140	0.	0.	0.	12.
1.04	10.00	41	0.	0.	0.	6191.	1.12	18.00	141	0.	0.	0.	12.
1.04	12.00	42	0.	0.	0.	5159.	1.12	20.00	142	0.	0.	0.	11.
1.04	14.00	43	0.	0.	0.	4300.	1.12	22.00	143	0.	0.	0.	11.
1.04	16.00	44	0.	0.	0.	3585.	1.13	0.	144	0.	0.	0.	10.
1.04	18.00	45	0.	0.	0.	2988.	1.13	2.00	145	0.	0.	0.	10.
1.04	20.00	46	0.	0.	0.	2482.	1.13	4.00	146	0.	0.	0.	9.
1.04	22.00	47	0.	0.	0.	2061.	1.13	6.00	147	0.	0.	0.	9.
1.05	0.	48	0.	0.	0.	1709.	1.13	8.00	148	0.	0.	0.	9.
1.05	2.00	49	0.	0.	0.	1390.	1.13	10.00	149	0.	0.	0.	8.
1.05	4.00	50	0.	0.	0.	1124.	1.13	12.00	150	0.	0.	0.	8.
1.05	6.00	51	0.	0.	0.	902.	1.13	14.00	151	0.	0.	0.	7.
1.05	8.00	52	0.	0.	0.	776.	1.13	16.00	152	0.	0.	0.	7.
1.05	10.00	53	0.	0.	0.	741.	1.13	18.00	153	0.	0.	0.	7.
1.05	12.00	54	0.	0.	0.	707.	1.13	20.00	154	0.	0.	0.	6.
1.05	14.00	55	0.	0.	0.	674.	1.13	22.00	155	0.	0.	0.	6.
1.05	16.00	56	0.	0.	0.	643.	1.14	0.	156	0.	0.	0.	6.
1.05	18.00	57	0.	0.	0.	614.	1.14	2.00	157	0.	0.	0.	6.
1.05	20.00	58	0.	0.	0.	585.	1.14	4.00	158	0.	0.	0.	5.
1.05	22.00	59	0.	0.	0.	559.	1.14	6.00	159	0.	0.	0.	5.
1.06	0.	60	0.	0.	0.	533.	1.14	8.00	160	0.	0.	0.	5.
1.06	2.00	61	0.	0.	0.	508.	1.14	10.00	161	0.	0.	0.	5.
1.06	4.00	62	0.	0.	0.	485.	1.14	12.00	162	0.	0.	0.	4.
1.06	6.00	63	0.	0.	0.	463.	1.14	14.00	163	0.	0.	0.	4.
1.06	8.00	64	0.	0.	0.	442.	1.14	16.00	164	0.	0.	0.	4.
1.06	10.00	65	0.	0.	0.	421.	1.14	18.00	165	0.	0.	0.	4.
1.06	12.00	66	0.	0.	0.	402.	1.14	20.00	166	0.	0.	0.	4.
1.06	14.00	67	0.	0.	0.	384.	1.14	22.00	167	0.	0.	0.	3.
1.06	16.00	68	0.	0.	0.	366.	1.15	0.	168	0.	0.	0.	3.

1.06	20.00	70	0.	0.	0.	333.	1.15	4.00	170	0.	0.	0.	3.
1.06	22.00	71	0.	0.	0.	318.	1.15	6.00	171	0.	0.	0.	3.
1.07	0.	72	0.	0.	0.	303.	1.15	8.00	172	0.	0.	0.	3.
1.07	2.00	73	0.	0.	0.	289.	1.15	10.00	173	0.	0.	0.	3.
1.07	4.00	74	0.	0.	0.	276.	1.15	12.00	174	0.	0.	0.	3.
1.07	6.00	75	0.	0.	0.	263.	1.15	14.00	175	0.	0.	0.	2.
1.07	8.00	76	0.	0.	0.	251.	1.15	16.00	176	0.	0.	0.	2.
1.07	10.00	77	0.	0.	0.	240.	1.15	18.00	177	0.	0.	0.	2.
1.07	12.00	78	0.	0.	0.	229.	1.15	20.00	178	0.	0.	0.	2.
1.07	14.00	79	0.	0.	0.	218.	1.15	22.00	179	0.	0.	0.	2.
1.07	16.00	80	0.	0.	0.	208.	1.16	0.	180	0.	0.	0.	2.
1.07	18.00	81	0.	0.	0.	199.	1.16	2.00	181	0.	0.	0.	2.
1.07	20.00	82	0.	0.	0.	190.	1.16	4.00	182	0.	0.	0.	2.
1.07	22.00	83	0.	0.	0.	181.	1.16	6.00	183	0.	0.	0.	2.
1.08	0.	84	0.	0.	0.	173.	1.16	8.00	184	0.	0.	0.	2.
1.08	2.00	85	0.	0.	0.	165.	1.16	10.00	185	0.	0.	0.	1.
1.08	4.00	86	0.	0.	0.	157.	1.16	12.00	186	0.	0.	0.	1.
1.08	6.00	87	0.	0.	0.	150.	1.16	14.00	187	0.	0.	0.	1.
1.08	8.00	88	0.	0.	0.	143.	1.16	16.00	188	0.	0.	0.	1.
1.08	10.00	89	0.	0.	0.	136.	1.16	18.00	189	0.	0.	0.	1.
1.08	12.00	90	0.	0.	0.	130.	1.16	20.00	190	0.	0.	0.	1.
1.08	14.00	91	0.	0.	0.	124.	1.16	22.00	191	0.	0.	0.	1.
1.08	16.00	92	0.	0.	0.	118.	1.17	0.	192	0.	0.	0.	1.
1.08	18.00	93	0.	0.	0.	113.	1.17	2.00	193	0.	0.	0.	1.
1.08	20.00	94	0.	0.	0.	108.	1.17	4.00	194	0.	0.	0.	1.
1.08	22.00	95	0.	0.	0.	103.	1.17	6.00	195	0.	0.	0.	1.
1.09	0.	96	0.	0.	0.	98.	1.17	8.00	196	0.	0.	0.	1.
1.09	2.00	97	0.	0.	0.	94.	1.17	10.00	197	0.	0.	0.	1.
1.09	4.00	98	0.	0.	0.	89.	1.17	12.00	198	0.	0.	0.	1.
1.09	6.00	99	0.	0.	0.	85.	1.17	14.00	199	0.	0.	0.	1.
1.09	8.00	100	0.	0.	0.	81.	1.17	16.00	200	0.	0.	0.	1.
									SUM	17.40	15.37	2.03	915552.
										(442.)	(390.)	(52.)	(25925.55)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	82196.	79616.	57530.	24780.	915506.
CMS	2328.	2254.	1629.	702.	25924.
INCHES		4.07	11.76	15.20	15.60
MM		103.36	298.75	386.05	396.18
AC-FT		39479.	114109.	147452.	151323.
THOLS CU M		48696.	140751.	181879.	186655.

HYDROGRAPH AT STA KEUKA FOR PLAN 1, RTIO 1

48.	48.	49.	53.	61.	73.	94.	134.	197.	274.
349.	407.	473.	598.	819.	1265.	2104.	3385.	5495.	9576.
16119.	24079.	31883.	37952.	41098.	40748.	37202.	32152.	27259.	22938.
19173.	15977.	13313.	11094.	9245.	7704.	6421.	5351.	4459.	3716.
3096.	2580.	2150.	1792.	1494.	1241.	1030.	855.	695.	562.
451.	368.	370.	353.	337.	322.	307.	293.	279.	266.
254.	243.	231.	221.	211.	201.	192.	183.	175.	167.
159.	152.	145.	138.	132.	126.	120.	114.	109.	104.
99.	95.	90.	86.	82.	79.	75.	71.	68.	65.
62.	59.	57.	54.	51.	49.	47.	45.	43.	41.
39.	37.	35.	34.	32.	31.	29.	28.	27.	25.
24.	23.	22.	21.	20.	19.	18.	17.	17.	16.
15.	14.	14.	13.	13.	12.	11.	11.	10.	10.
9.	9.	9.	8.	8.	7.	7.	7.	7.	6.
6.	6.	5.	5.	5.	5.	4.	4.	4.	4.
4.	4.	3.	3.	3.	3.	3.	3.	3.	2.
2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	41098.	39808.	28765.	12390.	457753.
CMS	1164.	1127.	815.	351.	12962.
INCHES		2.03	5.88	7.60	7.80
MM		51.68	149.37	193.02	198.09
AC-FT		19739.	57054.	73726.	75662.
THOLS CU M		24340.	70375.	90940.	93327.

HYDROGRAPH AT STA KEUKA FOR PLAN 1, RTIO 2

96.	95.	97.	105.	121.	147.	188.	267.	394.	548.
698.	815.	945.	1196.	1637.	2530.	4208.	6771.	10990.	19152.
32239.	48158.	63767.	75965.	82196.	81497.	74404.	64305.	54519.	45876.
38345.	31553.	26627.	22189.	18491.	15409.	12841.	10701.	8918.	7431.
6191.	5159.	4300.	3585.	2988.	2482.	2061.	1709.	1390.	1124.
902.	776.	741.	707.	674.	643.	614.	585.	559.	533.
508.	485.	463.	442.	421.	402.	384.	366.	349.	333.
318.	303.	289.	276.	263.	251.	240.	229.	218.	208.
199.	190.	181.	173.	165.	157.	150.	143.	136.	130.
124.	118.	113.	108.	103.	98.	94.	89.	85.	81.
78.	74.	71.	67.	64.	61.	59.	56.	53.	51.
48.	46.	44.	42.	40.	38.	37.	35.	33.	32.
30.	29.	28.	26.	25.	24.	23.	22.	21.	20.
19.	18.	17.	16.	16.	15.	14.	14.	13.	12.
12.	11.	11.	10.	10.	9.	9.	9.	8.	8.
7.	7.	7.	6.	6.	6.	6.	5.	5.	5.
5.	4.	4.	4.	4.	4.	3.	3.	3.	3.
3.	3.	3.	3.	2.	2.	2.	2.	2.	2.
2.	2.	2.	2.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	82196.	79616.	57530.	24780.	915506.
CMS	2328.	2254.	1629.	702.	25924.
INCHES		4.07	11.76	15.20	15.60
MM		103.36	298.75	386.05	396.18
AC-FT		39479.	114109.	147452.	151323.
THOLS CU M		48696.	140751.	181879.	186655.

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HYDROGRAPH ROUTING

ROUTED HYDROGRAPH - KEUKA LAKE DAM - CENTER SPRAY < GATES

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

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPRP	LSTR
0.	0.	0.	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.	0.	0.	-714.	-1

STAGE	708.43	713.99	714.00	715.00	715.60	716.00	716.50	717.00	717.50	718.00
	718.50	718.75	719.00							
FLOW	0.	0.	452.00	583.00	666.00	717.00	802.00	933.00	1091.00	1277.00
	1480.00	1588.00	1701.00							
CAPACITY=	76000.	97000.	119000.	142000.	166000.	191000.	217000.	230000.	240000.	
ELEVATION=	708.	710.	712	714	716	718	720	722	724	

CRIT	SPWID	COOL	EXPW	ELEVL	COOL	CAREA	EXPL
714.0	0.	0.	0.	0.	0.	0.	0.

DAM DATA

TOPEL	COQD	EXPD	DAMWID
718.8	3.1	1.5	0C.

STATION KLOAM, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

22.	34.	40.	45.	50.	58.	7C.	90.	124.	175.
237.	301.	364.	447.	452.	454.	456.	460.	467.	48C.
502.	537.	567.	652.	723.	819.	955.	1097.	1237.	1358.
1459.	1546.	1623.	1697.	1761.	1813.	1856.	1889.	1914.	1932.
1944.	1952.	1955.	1956.	1953.	1948.	1941.	1933.	1923.	1912.
1900.	1886.	1876.	1863.	1851.	1839.	1826.	1814.	1802.	179C.
1778.	1766.	1754.	1743.	1731.	1720.	1708.	1697.	1686.	1675.
1664.	1654.	1643.	1633.	1623.	1613.	1604.	1594.	1586.	1577.
1569.	1561.	1553.	1545.	1537.	1529.	1521.	1513.	1505.	1498.
1490.	1482.	1474.	1467.	1460.	1453.	1445.	1436.	1431.	1424.
1417.	1410.	1403.	1396.	1389.	1382.	1375.	1368.	1361.	1354.
1347.	1340.	1333.	1327.	1320.	1313.	1307.	13C0.	1293.	1287.
1280.	1274.	1268.	1262.	1255.	1249.	1242.	1237.	1231.	1225.
1219.	1213.	1207.	1202.	1196.	1190.	1184.	1178.	1173.	1167.
1161.	1155.	1150.	1144.	1139.	1133.	1128.	1122.	1117.	1111.
1106.	1100.	1095.	1090.	1085.	1081.	1076.	1072.	1067.	1063.
1058.	1054.	1050.	1045.	1041.	1037.	1032.	1028.	1024.	1019.
1015.	1011.	1007.	1003.	998.	994.	99C.	986.	982.	978.
974.	97C.	966.	962.	958.	954.	95C.	946.	942.	938.
934.	931.	927.	924.	921.	918.	915.	911.	908.	905.

STORAGE

141891.	141894.	141895.	141896.	141898.	141900.	141903.	1419C8.	141917.	141929.
141945.	141962.	141978.	141999.	142041.	142139.	142342.	142720.	143377.	144545.
146587.	149823.	154356.	160025.	166444.	173081.	179376.	184938.	189656.	193590.
196837.	199494.	201652.	203395.	204790.	205896.	206760.	207423.	207920.	208278.
208520.	208667.	208735.	208738.	208666.	208590.	208456.	208292.	208101.	207888.
207657.	207413.	207165.	206916.	206666.	206415.	206164.	205913.	205661.	205409.
205159.	204906.	204654.	204402.	204151.	203900.	203649.	203398.	203148.	202899.
202650.	202401.	202153.	201905.	201659.	201412.	201167.	200922.	200678.	200434.
200191.	199948.	199706.	199464.	199223.	198983.	198744.	1985C5.	198267.	198C3C.
197794.	197558.	197323.	197089.	196856.	196624.	196392.	196162.	195932.	195703.
195474.	195247.	195021.	194795.	194570.	194347.	194124.	1939C2.	193681.	193461.
193242.	193024.	192806.	192590.	192375.	192160.	191947.	191735.	191523.	191313.
191103.	190895.	190687.	190481.	190275.	190070.	189866.	189664.	189462.	18926C.
189060.	188861.	188663.	188465.	188268.	188073.	187878.	187684.	187491.	187299.
187108.	186917.	186728.	186539.	186351.	186165.	185979.	185794.	185609.	185425.
185243.	185C62.	184881.	184701.	184522.	184343.	184165.	183988.	183812.	183637.
183462.	183288.	183114.	182941.	182769.	182598.	182427.	182257.	182088.	181919.
181752.	181584.	181418.	181252.	181087.	180922.	180759.	180595.	180433.	180271.
180110.	179950.	179790.	179631.	179472.	179314.	179157.	1790C1.	178845.	17869C.
178535.	178381.	178228.	178075.	177922.	177770.	177619.	177468.	177318.	177168.

STAGE

714.0	714.0	714.0	714.0	714.0	714.0	714.C	714.0	714.0	714.C
714.0	714.0	714.0	714.0	714.0	714.0	714.C	714.1	714.1	714.2
714.4	714.7	715.0	715.5	716.0	716.6	717.1	717.5	717.9	718.2
718.4	718.7	718.8	719.0	719.1	719.1	719.2	719.3	719.3	719.3
719.3	719.4	719.4	719.4	719.4	719.4	719.3	719.3	719.3	719.3
719.3	719.3	719.2	719.2	719.2	719.2	719.2	719.1	719.1	719.1
719.1	719.1	719.1	719.0	719.0	719.0	719.C	719.0	718.9	718.9
718.9	718.9	718.9	718.8	718.8	718.8	718.8	718.8	718.7	718.7
718.7	718.7	718.7	718.7	718.6	718.6	718.6	718.6	718.6	718.5

718.3	718.3	718.3	718.3	718.3	718.3	718.2	718.2	718.2	718.2
716.2	716.2	718.1	718.1	718.1	718.1	718.1	718.1	718.0	718.0
718.0	718.0	718.0	718.0	717.9	717.9	717.9	717.9	717.9	717.9
717.8	717.8	717.8	717.8	717.8	717.8	717.8	717.7	717.7	717.7
717.7	717.7	717.7	717.6	717.6	717.6	717.6	717.6	717.6	717.6
717.5	717.5	717.5	717.5	717.5	717.5	717.5	717.4	717.4	717.4
717.4	717.4	717.4	717.4	717.3	717.3	717.3	717.3	717.3	717.3
717.3	717.2	717.2	717.2	717.2	717.2	717.2	717.2	717.2	717.1
717.1	717.1	717.1	717.1	717.1	717.1	717.1	717.0	717.0	717.0
717.0	717.0	717.0	717.0	717.0	716.9	716.9	716.9	716.9	716.9

PEAK OUTFLOW IS 1956. AT TIME 88.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1956.	1955.	1938.	1842.	244306.
CMS	55.	55.	55.	52.	6918.
INCHES		0.10	0.40	1.13	4.16
MM		2.54	10.06	28.69	105.72
AC-FT		969.	3844.	10955.	40381.
THOUS CU M		1195.	4742.	13518.	49809.

STATION KLDAM, PLAN 1, RATIO 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

44.	68.	81.	90.	101.	116.	139.	180.	249.	350.
452.	453.	453.	455.	456.	459.	464.	474.	489.	515.
560.	635.	739.	946.	1305.	1778.	2455.	3148.	3734.	4238.
4665.	5019.	5306.	5536.	5717.	5855.	5957.	6029.	6076.	6103.
6112.	6106.	6089.	6062.	6027.	5987.	5940.	5890.	5837.	5780.
5722.	5662.	5602.	5543.	5484.	5426.	5368.	5311.	5255.	5199.
5143.	5088.	5034.	4980.	4927.	4874.	4822.	4771.	4720.	4670.
4620.	4571.	4522.	4474.	4427.	4380.	4334.	4288.	4243.	4198.
4154.	4111.	4068.	4025.	3983.	3942.	3901.	3861.	3821.	3782.
3743.	3704.	3666.	3629.	3592.	3556.	3520.	3484.	3449.	3415.
3381.	3347.	3314.	3281.	3249.	3215.	3181.	3147.	3113.	3080.
3048.	3016.	2984.	2953.	2922.	2892.	2862.	2832.	2803.	2775.
2746.	2719.	2691.	2664.	2637.	2611.	2585.	2559.	2534.	2509.
2485.	2461.	2437.	2413.	2390.	2367.	2345.	2323.	2301.	2279.
2259.	2237.	2217.	2196.	2176.	2157.	2137.	2118.	2099.	2080.
2062.	2044.	2026.	2009.	1991.	1974.	1957.	1941.	1925.	1908.
1893.	1877.	1862.	1847.	1832.	1817.	1803.	1789.	1775.	1761.
1747.	1734.	1721.	1708.	1696.	1684.	1671.	1660.	1648.	1637.
1626.	1615.	1604.	1594.	1585.	1576.	1568.	1559.	1551.	1542.
1534.	1525.	1517.	1509.	1500.	1492.	1484.	1476.	1469.	1461.

STORAGE

141896.	141902.	141906.	141908.	141911.	141914.	141920.	141931.	141948.	141974.
142011.	142061.	142132.	142233.	142392.	142661.	143142.	143971.	145360.	147768.
151926.	158472.	167608.	179012.	191892.	205166.	217700.	228659.	237950.	245588.
251813.	256823.	260811.	263949.	266381.	268226.	269585.	270540.	271161.	271509.
271622.	271550.	271324.	270971.	270515.	269975.	269364.	268698.	267985.	267233.
266450.	265648.	264842.	264041.	263243.	262451.	261662.	260879.	260100.	259326.
258558.	257794.	257036.	256283.	255536.	254794.	254057.	253327.	252601.	251882.
251169.	250459.	249757.	249060.	248369.	247684.	247004.	246330.	245662.	245000.
244343.	243692.	243047.	242407.	241773.	241145.	240522.	239904.	239293.	238686.
238085.	237490.	236900.	236315.	235736.	235162.	234593.	234029.	233470.	232917.
232368.	231825.	231286.	230753.	230224.	229703.	229188.	228678.	228173.	227673.
227177.	226686.	226200.	225719.	225242.	224769.	224301.	223838.	223379.	222924.
222474.	222028.	221586.	221148.	220715.	220286.	219860.	219439.	219022.	218608.
218199.	217793.	217391.	216993.	216599.	216208.	215821.	215438.	215058.	214681.
214308.	213939.	213572.	213209.	212850.	212493.	212140.	211790.	211443.	211099.
210757.	210419.	210084.	209752.	209422.	209096.	208772.	208450.	208132.	207816.
207503.	207192.	206883.	206578.	206274.	205973.	205675.	205379.	205085.	204793.
204505.	204216.	203931.	203648.	203367.	203088.	202811.	202536.	202263.	201992.
201723.	201455.	201190.	200925.	200663.	200402.	200142.	199884.	199627.	199372.
199118.	198865.	198614.	198364.	198116.	197868.	197622.	197378.	197135.	196893.

STAGE

714.0	714.0	714.0	714.0	714.0	714.0	714.0	714.0	714.0	714.0
714.0	714.0	714.0	714.0	714.0	714.1	714.1	714.2	714.3	714.5
714.8	715.4	716.1	717.0	718.1	719.1	720.1	720.9	721.6	722.1
722.5	722.9	723.2	723.4	723.5	723.7	723.8	723.8	723.9	723.9
723.9	723.9	723.9	723.9	723.8	723.8	723.8	723.7	723.7	723.6
723.6	723.5	723.4	723.4	723.3	723.3	723.2	723.2	723.1	723.1
723.0	722.9	722.9	722.8	722.8	722.7	722.7	722.6	722.6	722.5
722.5	722.4	722.4	722.3	722.3	722.2	722.2	722.1	722.1	722.0
722.0	722.0	721.9	721.9	721.8	721.8	721.7	721.7	721.7	721.6
721.6	721.5	721.5	721.4	721.4	721.4	721.3	721.3	721.2	721.2
721.2	721.1	721.1	721.1	721.0	721.0	720.9	720.9	720.9	720.8
720.8	720.7	720.7	720.7	720.6	720.6	720.6	720.5	720.5	720.5

720.1	720.1	720.0	720.0	720.0	719.9	719.9	719.9	719.9	719.8
719.8	719.8	719.7	719.7	719.7	719.7	719.6	719.6	719.6	719.5
719.5	719.5	719.5	719.4	719.4	719.4	719.4	719.3	719.3	719.3
719.3	719.2	719.2	719.2	719.2	719.2	719.1	719.1	719.1	719.1
719.0	719.0	719.0	719.0	719.0	718.9	718.9	718.9	718.9	718.8
718.8	718.8	718.8	718.8	718.7	718.7	718.7	718.7	718.7	718.6
718.6	718.6	718.6	718.6	718.5	718.5	718.5	718.5	718.5	718.5

PEAK OUTFLOW IS 6112. AT TIME 82.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6112.	6104.	6030.	5577.	582943.
CMS	173.	173.	171.	158.	16507.
INCHES		0.31	1.23	3.42	9.93
MM		7.93	31.31	86.89	252.27
AC-FT		3027.	11960.	33188.	56354.
THOLS CU M		3734.	14753.	40937.	110851.

OVN

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SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - SENECA LAKE SUBBASIN TO DAM

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	571.00	0.	753.00	0.	0.	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.	21.20	60.50	73.00	82.50	90.50	0.	0.

TRSPC COMPUTED BY THE PROGRAM IS 0.907

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.	0.	1.00	0.	0.	1.00	1.50	0.03	0.	0.12

UNIT HYDROGRAPH DATA

TP= 17.86 CP=0.63 NTA= 0

RECESSION DATA

STRTQ= 500.00 QRCSN= 2800.00 RTIOR= 1.60

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 9.91 AND R= 8.36 INTERVALS

UNIT HYDROGRAPH 50 END-OF-PERIOD ORDINATES, LAG= 17.84 HOURS, CP= 0.63 VOL= 1.00

471.	1750.	3530.	5566.	7758.	9863.	11537.	12633.	13137.	12897.
11850.	10513.	9326.	8274.	7340.	6512.	5777.	5125.	4547.	4033.
3578.	3174.	2816.	2498.	2216.	1966.	1744.	1547.	1373.	1218.
1080.	959.	850.	754.	669.	594.	527.	467.	415.	368.
326.	289.	257.	228.	202.	179.	159.	141.	125.	111.

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	2.00	1	0.02	0.00	0.02	478.	1.09	10.00	101	0.	0.	0.	502.
1.01	4.00	2	0.02	0.00	0.02	461.	1.09	12.00	102	0.	0.	0.	479.
1.01	6.00	3	0.02	0.00	0.02	450.	1.09	14.00	103	0.	0.	0.	457.
1.01	8.00	4	0.08	0.01	0.07	449.	1.09	16.00	104	0.	0.	0.	436.
1.01	10.00	5	0.08	0.01	0.07	463.	1.09	18.00	105	0.	0.	0.	416.
1.01	12.00	6	0.08	0.01	0.07	494.	1.09	20.00	106	0.	0.	0.	397.
1.01	14.00	7	0.29	0.03	0.26	557.	1.09	22.00	107	0.	0.	0.	379.
1.01	16.00	8	0.60	0.07	0.53	686.	1.10	0.	108	0.	0.	0.	361.
1.01	18.00	9	0.24	0.03	0.21	903.	1.10	2.00	109	0.	0.	0.	345.
1.01	20.00	10	0.04	0.00	0.03	1180.	1.10	4.00	110	0.	0.	0.	329.
1.01	22.00	11	0.04	0.00	0.03	1485.	1.10	6.00	111	0.	0.	0.	314.
1.02	0.	12	0.04	0.00	0.03	1793.	1.10	8.00	112	0.	0.	0.	299.
1.02	2.00	13	0.24	0.19	0.05	2161.	1.10	10.00	113	0.	0.	0.	286.
1.02	4.00	14	0.24	0.19	0.05	2705.	1.10	12.00	114	0.	0.	0.	272.
1.02	6.00	15	0.24	0.19	0.05	3502.	1.10	14.00	115	0.	0.	0.	260.
1.02	8.00	16	0.80	0.75	0.05	4856.	1.10	16.00	116	0.	0.	0.	248.
1.02	10.00	17	0.80	0.75	0.05	7242.	1.10	18.00	117	0.	0.	0.	237.
1.02	12.00	18	0.80	0.75	0.05	10932.	1.10	20.00	118	0.	0.	0.	226.
1.02	14.00	19	3.02	2.97	0.05	17083.	1.10	22.00	119	0.	0.	0.	215.
1.02	16.00	20	6.17	6.11	0.05	28991.	1.11	0.	120	0.	0.	0.	206.
1.02	18.00	21	2.44	2.39	0.05	48403.	1.11	2.00	121	0.	0.	0.	196.
1.02	20.00	22	0.37	0.31	0.05	73096.	1.11	4.00	122	0.	0.	0.	187.

1.02	22.00	23	0.37	0.31	0.05	139216.	1.11	6.00	123	0.	0.	0.	179.
1.03	0.	24	0.37	0.31	0.05	127641.	1.11	8.00	124	0.	0.	0.	170.
1.03	2.00	25	0.	0.	0.	152527.	1.11	10.00	125	0.	0.	0.	162.
1.03	4.00	26	0.	0.	0.	171548.	1.11	12.00	126	0.	0.	0.	155.
1.03	6.00	27	0.	0.	0.	183060.	1.11	14.00	127	0.	0.	0.	148.
1.03	8.00	28	0.	0.	0.	186617.	1.11	16.00	128	0.	0.	0.	141.
1.03	10.00	29	0.	0.	0.	181538.	1.11	18.00	129	0.	0.	0.	135.
1.03	12.00	30	0.	0.	0.	168749.	1.11	20.00	130	0.	0.	0.	128.
1.03	14.00	31	0.	0.	0.	152429.	1.11	22.00	131	0.	0.	0.	123.
1.03	16.00	32	0.	0.	0.	136353.	1.12	0.	132	0.	0.	0.	117.
1.03	18.00	33	0.	0.	0.	121488.	1.12	2.00	133	0.	0.	0.	112.
1.03	20.00	34	0.	0.	0.	107912.	1.12	4.00	134	0.	0.	0.	106.
1.03	22.00	35	0.	0.	0.	95740.	1.12	6.00	135	0.	0.	0.	102.
1.04	0.	36	0.	0.	0.	84942.	1.12	8.00	136	0.	0.	0.	97.
1.04	2.00	37	0.	0.	0.	75362.	1.12	10.00	137	0.	0.	0.	92.
1.04	4.00	38	0.	0.	0.	66863.	1.12	12.00	138	0.	0.	0.	88.
1.04	6.00	39	0.	0.	0.	59322.	1.12	14.00	139	0.	0.	0.	84.
1.04	8.00	40	0.	0.	0.	52633.	1.12	16.00	140	0.	0.	0.	80.
1.04	10.00	41	0.	0.	0.	46698.	1.12	18.00	141	0.	0.	0.	77.
1.04	12.00	42	0.	0.	0.	41433.	1.12	20.00	142	0.	0.	0.	73.
1.04	14.00	43	0.	0.	0.	36761.	1.12	22.00	143	0.	0.	0.	70.
1.04	16.00	44	0.	0.	0.	32617.	1.13	0.	144	0.	0.	0.	67.
1.04	18.00	45	0.	0.	0.	28940.	1.13	2.00	145	0.	0.	0.	63.
1.04	20.00	46	0.	0.	0.	25678.	1.13	4.00	146	0.	0.	0.	61.
1.04	22.00	47	0.	0.	0.	22784.	1.13	6.00	147	0.	0.	0.	58.
1.05	0.	48	0.	0.	0.	20216.	1.13	8.00	148	0.	0.	0.	55.
1.05	2.00	49	0.	0.	0.	17938.	1.13	10.00	149	0.	0.	0.	53.
1.05	4.00	50	0.	0.	0.	15917.	1.13	12.00	150	0.	0.	0.	50.
1.05	6.00	51	0.	0.	0.	14124.	1.13	14.00	151	0.	0.	0.	48.
1.05	8.00	52	0.	0.	0.	12533.	1.13	16.00	152	0.	0.	0.	46.
1.05	10.00	53	0.	0.	0.	11121.	1.13	18.00	153	0.	0.	0.	44.
1.05	12.00	54	0.	0.	0.	9868.	1.13	20.00	154	0.	0.	0.	42.
1.05	14.00	55	0.	0.	0.	8756.	1.13	22.00	155	0.	0.	0.	40.
1.05	16.00	56	0.	0.	0.	7769.	1.14	0.	156	0.	0.	0.	38.
1.05	18.00	57	0.	0.	0.	6891.	1.14	2.00	157	0.	0.	0.	36.
1.05	20.00	58	0.	0.	0.	6109.	1.14	4.00	158	0.	0.	0.	34.
1.05	22.00	59	0.	0.	0.	5419.	1.14	6.00	159	0.	0.	0.	33.
1.06	0.	60	0.	0.	0.	4809.	1.14	8.00	160	0.	0.	0.	31.
1.06	2.00	61	0.	0.	0.	4268.	1.14	10.00	161	0.	0.	0.	30.
1.06	4.00	62	0.	0.	0.	3788.	1.14	12.00	162	0.	0.	0.	29.
1.06	6.00	63	0.	0.	0.	3343.	1.14	14.00	163	0.	0.	0.	27.
1.06	8.00	64	0.	0.	0.	2949.	1.14	16.00	164	0.	0.	0.	26.
1.06	10.00	65	0.	0.	0.	2726.	1.14	18.00	165	0.	0.	0.	25.
1.06	12.00	66	0.	0.	0.	2601.	1.14	20.00	166	0.	0.	0.	24.
1.06	14.00	67	0.	0.	0.	2462.	1.14	22.00	167	0.	0.	0.	23.
1.06	16.00	68	0.	0.	0.	2368.	1.15	0.	168	0.	0.	0.	22.
1.06	18.00	69	0.	0.	0.	2259.	1.15	2.00	169	0.	0.	0.	21.
1.06	20.00	70	0.	0.	0.	2155.	1.15	4.00	170	0.	0.	0.	20.
1.06	22.00	71	0.	0.	0.	2056.	1.15	6.00	171	0.	0.	0.	19.
1.07	0.	72	0.	0.	0.	1962.	1.15	8.00	172	0.	0.	0.	18.
1.07	2.00	73	0.	0.	0.	1872.	1.15	10.00	173	0.	0.	0.	17.
1.07	4.00	74	0.	0.	0.	1786.	1.15	12.00	174	0.	0.	0.	16.
1.07	6.00	75	0.	0.	0.	1704.	1.15	14.00	175	0.	0.	0.	15.
1.07	8.00	76	0.	0.	0.	1626.	1.15	16.00	176	0.	0.	0.	15.
1.07	10.00	77	0.	0.	0.	1551.	1.15	18.00	177	0.	0.	0.	14.
1.07	12.00	78	0.	0.	0.	1480.	1.15	20.00	178	0.	0.	0.	13.
1.07	14.00	79	0.	0.	0.	1412.	1.15	22.00	179	0.	0.	0.	13.
1.07	16.00	80	0.	0.	0.	1347.	1.16	0.	180	0.	0.	0.	12.
1.07	18.00	81	0.	0.	0.	1285.	1.16	2.00	181	0.	0.	0.	12.
1.07	20.00	82	0.	0.	0.	1226.	1.16	4.00	182	0.	0.	0.	11.
1.07	22.00	83	0.	0.	0.	1170.	1.16	6.00	183	0.	0.	0.	11.
1.08	0.	84	0.	0.	0.	1116.	1.16	8.00	184	0.	0.	0.	10.
1.08	2.00	85	0.	0.	0.	1065.	1.16	10.00	185	0.	0.	0.	10.
1.08	4.00	86	0.	0.	0.	1016.	1.16	12.00	186	0.	0.	0.	9.
1.08	6.00	87	0.	0.	0.	969.	1.16	14.00	187	0.	0.	0.	9.

1.08	12.00	90	0.	0.	0.	842.	1.16	20.00	190	0.	0.	0.	8.
1.08	14.00	91	0.	0.	0.	803.	1.16	22.00	191	0.	0.	0.	7.
1.08	16.00	92	0.	0.	0.	766.	1.17	0.	192	0.	0.	0.	7.
1.08	18.00	93	0.	0.	0.	731.	1.17	2.00	193	0.	0.	0.	7.
1.08	20.00	94	0.	0.	0.	698.	1.17	4.00	194	0.	0.	0.	6.
1.08	22.00	95	0.	0.	0.	666.	1.17	6.00	195	0.	0.	0.	6.
1.09	0.	96	0.	0.	0.	635.	1.17	8.00	196	0.	0.	0.	6.
1.09	2.00	97	0.	0.	0.	606.	1.17	10.00	197	0.	0.	0.	6.
1.09	4.00	98	0.	0.	0.	578.	1.17	12.00	198	0.	0.	0.	5.
1.09	6.00	99	0.	0.	0.	552.	1.17	14.00	199	0.	0.	0.	5.
1.09	8.00	100	0.	0.	0.	526.	1.17	16.00	200	0.	0.	0.	5.
									SUM	17.40	15.41	1.98	2883315.
										(442.)	(391.)	(51.)	(81646.39)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	186617.	182073.	140986.	75824.	2883071.
CMS	5284.	5156.	4219.	2147.	81639.
INCHES		2.97	9.71	14.82	15.66
MM		75.34	246.60	376.51	397.67
AC-FT		90284.	295510.	451185.	476541.
THOLS CU M		111364.	364506.	556528.	587804.

HYDROGRAPH AT STASENECA FOR PLAN 1, RTIO 1

239.	231.	225.	224.	231.	247.	278.	343.	451.	590.
742.	897.	1081.	1353.	1751.	2420.	3621.	5466.	8542.	14466.
24202.	36548.	50104.	63820.	76263.	85774.	91530.	93308.	90769.	84375.
76215.	68177.	60744.	53956.	47870.	42471.	37681.	33421.	29661.	26316.
23349.	20716.	18381.	16309.	14470.	12839.	11392.	10108.	8969.	7959.
7062.	6266.	5560.	4934.	4378.	3885.	3446.	3055.	2710.	2405.
2134.	1894.	1672.	1474.	1303.	1301.	1241.	1184.	1129.	1078.
1028.	981.	936.	893.	852.	813.	775.	740.	706.	674.
643.	613.	585.	558.	532.	508.	485.	462.	441.	421.
402.	383.	366.	349.	333.	318.	303.	289.	276.	263.
251.	239.	228.	218.	208.	198.	189.	181.	172.	164.
157.	150.	143.	136.	130.	124.	118.	113.	108.	103.
98.	94.	89.	85.	81.	78.	74.	71.	67.	64.
61.	58.	56.	53.	51.	48.	46.	44.	42.	40.
38.	37.	35.	33.	32.	30.	29.	28.	26.	25.
24.	23.	22.	21.	20.	19.	18.	17.	16.	16.
15.	14.	14.	13.	12.	12.	11.	11.	10.	10.
9.	9.	9.	8.	8.	7.	7.	7.	6.	6.
6.	6.	5.	5.	5.	5.	4.	4.	4.	4.
4.	3.	3.	3.	3.	3.	3.	3.	3.	2.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	93308.	91037.	74493.	37912.	1441536.
CMS	2642.	2578.	2109.	1074.	40820.
INCHES		1.48	4.85	7.41	7.83
MM		37.67	123.30	188.26	198.84
AC-FT		45142.	147755.	225592.	238270.
THOLS CU M		55682.	182253.	278264.	293902.

HYDROGRAPH AT STASENECA FOR PLAN 1, RTIO 2

478.	461.	450.	449.	463.	494.	557.	686.	903.	1180.
1485.	1793.	2161.	2705.	3502.	4856.	7242.	10932.	17083.	28991.
46403.	73096.	100208.	127641.	152527.	171549.	183600.	186617.	181538.	168749.
152429.	136353.	121488.	107912.	95740.	84942.	75362.	66863.	59322.	52633.
46698.	41433.	36761.	32617.	28940.	25678.	22784.	20216.	17938.	15917.
14124.	12533.	11121.	9868.	8756.	7769.	6891.	6109.	5419.	4809.
4268.	3788.	3343.	2949.	2726.	2601.	2482.	2368.	2259.	2155.
2056.	1962.	1872.	1786.	1704.	1626.	1551.	1480.	1412.	1347.
1285.	1226.	1170.	1116.	1065.	1016.	969.	925.	882.	842.

503.	471.	457.	436.	416.	397.	379.	361.	345.	329.
314.	299.	286.	272.	260.	248.	237.	226.	215.	206.
196.	187.	179.	170.	162.	155.	148.	141.	135.	128.
123.	117.	112.	106.	102.	97.	92.	88.	84.	80.
77.	73.	70.	67.	64.	61.	58.	55.	53.	50.
48.	46.	44.	42.	40.	38.	36.	34.	33.	31.
30.	29.	27.	26.	25.	24.	23.	22.	21.	20.
19.	18.	17.	16.	15.	15.	14.	13.	13.	12.
12.	11.	11.	10.	10.	9.	9.	8.	8.	8.
7.	7.	7.	6.	6.	6.	6.	5.	5.	5.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	186617.	182073.	148986.	75824.	2883071.
CMS	5284.	5156.	4219.	2147.	81639.
INCHES		2.97	9.71	14.82	15.66
MM		75.34	246.60	376.51	397.67
AC-FT		90284.	295510.	451185.	476541.
THOUS CU M		111364.	364506.	556528.	587804.

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COMBINE HYDROGRAPHS

COMBINED HYDROGRAPH - KL OUTFLOW WITH SENECA LAKE INFLOW

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	2	0	0	2	0	1	0	0

SUM OF 2 HYDROGRAPHS AT DAM PLAN 1 RTIO 1

261.	264.	265.	269.	282.	305.	348.	433.	576.	765.
960.	1198.	1445.	1800.	2203.	2882.	4077.	5926.	9009.	14975.
24704.	37086.	50691.	64473.	76985.	86593.	92485.	94405.	92006.	85732.
77674.	69723.	62367.	55653.	49631.	44284.	39537.	35320.	31575.	28248.
25293.	22669.	20336.	18264.	16423.	14787.	13333.	12041.	10892.	9871.
8962.	8154.	7436.	6797.	6229.	5723.	5272.	4869.	4512.	4195.
3912.	3660.	3426.	3217.	3094.	3020.	2949.	2881.	2816.	2753.
2693.	2635.	2579.	2526.	2475.	2426.	2379.	2334.	2292.	2251.
2212.	2174.	2138.	2103.	2070.	2037.	2006.	1976.	1947.	1919.
1891.	1865.	1840.	1816.	1793.	1770.	1748.	1727.	1707.	1687.
1668.	1649.	1631.	1614.	1596.	1580.	1564.	1548.	1533.	1518.
1504.	1490.	1476.	1463.	1450.	1437.	1425.	1413.	1401.	1390.
1378.	1367.	1357.	1347.	1337.	1327.	1317.	1308.	1299.	1289.
1281.	1272.	1263.	1255.	1246.	1238.	1230.	1222.	1215.	1207.
1199.	1192.	1185.	1178.	1170.	1163.	1156.	1150.	1143.	1136.
1130.	1123.	1117.	1111.	1105.	1100.	1094.	1089.	1084.	1079.
1073.	1068.	1063.	1058.	1053.	1048.	1044.	1039.	1034.	1029.
1025.	1020.	1015.	1011.	1006.	1002.	997.	993.	988.	984.
980.	975.	971.	967.	962.	958.	954.	950.	946.	942.
938.	934.	931.	927.	924.	921.	917.	914.	911.	907.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	94405.	92063.	75688.	39388.	1483842.
CMS	2673.	2607.	2143.	1115.	42038.
INCHES		1.14	3.74	5.64	6.94
MM		28.89	95.00	148.31	176.33
AC-FT		45651.	150125.	234377.	278652.
THOUS CU M		56310.	185177.	289100.	343712.

DVR

SUM OF 2 HYDROGRAPHS AT DAM PLAN 1 RTIC 2

522.	529.	531.	539.	563.	610.	696.	866.	1151.	1530.
1937.	2246.	2615.	3160.	3958.	5316.	7707.	11405.	17572.	29506.
48964.	73731.	100947.	128587.	153832.	173326.	185515.	189765.	185272.	172587.
157094.	141272.	126794.	113448.	101457.	90797.	81319.	72852.	65399.	58735.
52810.	47539.	42850.	38679.	34960.	31665.	28724.	26107.	23775.	21697.
19846.	18195.	16723.	15411.	14240.	13195.	12260.	11420.	10674.	10008.
9411.	8874.	8377.	7929.	7653.	7475.	7304.	7139.	6979.	6825.
6676.	6533.	6394.	6260.	6131.	6006.	5885.	5768.	5655.	5545.
5439.	5337.	5238.	5141.	5048.	4958.	4870.	4786.	4703.	4623.
4546.	4471.	4398.	4327.	4258.	4191.	4126.	4062.	4001.	3941.
3883.	3826.	3771.	3717.	3665.	3612.	3559.	3508.	3458.	3409.
3362.	3315.	3270.	3225.	3182.	3140.	3099.	3058.	3019.	2980.
2943.	2906.	2870.	2834.	2800.	2766.	2733.	2701.	2669.	2638.
2607.	2578.	2548.	2520.	2492.	2464.	2437.	2411.	2385.	2360.
2335.	2310.	2286.	2263.	2240.	2217.	2195.	2173.	2152.	2131.
2110.	2090.	2070.	2050.	2031.	2012.	1993.	1975.	1957.	1940.
1923.	1906.	1889.	1873.	1857.	1841.	1825.	1810.	1795.	1781.
1766.	1752.	1738.	1725.	1711.	1698.	1686.	1673.	1661.	1649.
1637.	1626.	1615.	1605.	1595.	1586.	1577.	1568.	1559.	1550.
1541.	1532.	1524.	1515.	1507.	1498.	1490.	1481.	1474.	1466.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	189765.	184860.	152433.	80184.	3466014.
CMS	5374.	5235.	4316.	2271.	98147.
INCHES		2.28	7.53	11.89	14.27
MM		58.01	191.32	301.93	362.53
AC-FT		91666.	302346.	477129.	572855.
THOLS CU M		113068.	372939.	588530.	706655.

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HYDROGRAPH ROUTING

ROUTED HYDROGRAPH AT DAM (G1-G3 CLOSED G6 OPEN)

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

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPRP	LSTR
0.	0.	0.	1	1	0	C	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0. 0.		0.	-446.	-1

STAGE	446.00	447.00	448.00	448.49	448.50	449.00	450.00	451.00	452.00	453.00
	454.00	455.00	456.00							
FLOW	0.	19.00	52.00	69.00	3557.00	3951.00	5213.00	6853.00	8778.00	10943.00
	13321.00	15890.00	18637.00							
CAPACITY=	412500.	457100.	500000.	542900.	585700.	628600.	671400.	692900.	798250.	
ELEVATION=	445.	446.	447.	448.	449.	450.	451.	451.	456.	

CREL	SPWID	CUOW	EXPW	ELEVL	CCOL	CAREA	EXPL
446.0	0.	0.	0.	0.	0.	0.	0.

DAM DATA

TOPEL	COOD	EXPD	DAMWID
448.5	2.6	1.5	170.

STATION DAM, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	1.	1.	1.	1.	2.	2.	3.
4.	7.	10.	14.	20.	30.	41.	53.	66.	3790.
4164.	4647.	5096.	5509.	5875.	6234.	6577.	6878.	7139.	7365.
7559.	7724.	7863.	7978.	8073.	8150.	8210.	8256.	8289.	8310.
8317.	8318.	8315.	8308.	8289.	8266.	8237.	8205.	8169.	8130.
8089.	8045.	8000.	7952.	7904.	7855.	7806.	7757.	7707.	7658.
7609.	7559.	7509.	7460.	7410.	7361.	7311.	7262.	7213.	7164.
7117.	7070.	7023.	6976.	6929.	6883.	6836.	6789.	6743.	6696.
6650.	6604.	6558.	6512.	6467.	6422.	6377.	6333.	6289.	6245.
6201.	6158.	6115.	6072.	6031.	5995.	5960.	5925.	5890.	5855.
5821.	5787.	5753.	5719.	5686.	5653.	5620.	5587.	5555.	5522.
5490.	5458.	5427.	5396.	5365.	5334.	5303.	5273.	5243.	5213.
5184.	5154.	5125.	5096.	5067.	5039.	5011.	4983.	4955.	4928.
4901.	4873.	4846.	4819.	4793.	4767.	4741.	4715.	4689.	4664.
4639.	4613.	4589.	4564.	4539.	4515.	4491.	4467.	4444.	4420.
4397.	4374.	4351.	4328.	4306.	4284.	4262.	4240.	4218.	4196.
4175.	4154.	4133.	4112.	4091.	4071.	4051.	4032.	4012.	3993.
3974.	3954.	3936.	3916.	3897.	3879.	3861.	3843.	3825.	3807.
3789.	3772.	3755.	3738.	3721.	3704.	3687.	3671.	3655.	3639.

STORAGE

474301.	474347.	474390.	474435.	474480.	474520.	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	506172.	517869.	531375.	546169.	561065.	576999.	591370.
604217.	615671.	625702.	634060.	642429.	649181.	655050.	660124.	664494.	668240.
671431.	674132.	676398.	678279.	679819.	681037.	682029.	682765.	683293.	683637.
683744.	683768.	683717.	683600.	683305.	682924.	682469.	681948.	681370.	680743.
680072.	679365.	678624.	677855.	677066.	676269.	675468.	674664.	673857.	673047.
672235.	671422.	670607.	669792.	668977.	668161.	667346.	666531.	665717.	664904.
664126.	663345.	662562.	661777.	660991.	660205.	659419.	658633.	657848.	657064.
656282.	655501.	654723.	653947.	653174.	652404.	651638.	650875.	650116.	649360.
648609.	647862.	647119.	646380.	645645.	644913.	644185.	643460.	642738.	642020.
641305.	640593.	639884.	639179.	638477.	637779.	637084.	636392.	635704.	635019.
634338.	633660.	632985.	632314.	631647.	630983.	630322.	629665.	629011.	628361.
627714.	627071.	626431.	625794.	625161.	624531.	623904.	623281.	622661.	622045.
621431.	620821.	620214.	619611.	619010.	618413.	617819.	617228.	616641.	616056.
615475.	614896.	614321.	613749.	613179.	612613.	612050.	611490.	610933.	610380.
609829.	609281.	608736.	608194.	607655.	607119.	606585.	606055.	605527.	605002.
604480.	603961.	603444.	602930.	602419.	601909.	601400.	600894.	600389.	599886.
599385.	598885.	598387.	597890.	597395.	596902.	596410.	595920.	595431.	594944.
594456.	593974.	593491.	593010.	592530.	592052.	591576.	591101.	590628.	590156.

STAGE

446.0	446.0	446.0	446.0	446.0	446.0	446.0	446.0	446.0	446.0
446.0	446.0	446.0	446.0	446.0	446.0	446.1	446.1	446.1	446.2
446.2	446.4	446.5	446.7	447.0	447.3	447.7	448.0	448.4	448.7
449.0	449.3	449.5	449.7	449.9	450.1	450.2	450.3	450.4	450.5
450.6	450.7	450.7	450.8	450.8	450.8	450.8	450.9	450.9	450.9
450.9	450.9	450.9	450.9	450.9	450.9	450.9	450.8	450.8	450.8
450.8	450.8	450.8	450.8	450.7	450.7	450.7	450.7	450.7	450.6
450.6	450.6	450.6	450.6	450.5	450.5	450.5	450.5	450.5	450.4
450.4	450.4	450.4	450.4	450.4	450.3	450.3	450.3	450.3	450.3
450.2	450.2	450.2	450.2	450.2	450.2	450.1	450.1	450.1	450.1
450.1	450.1	450.0	450.0	450.0	450.0	450.0	449.9	449.9	449.9
449.9	449.9	449.9	449.8	449.8	449.8	449.8	449.8	449.8	449.7
449.7	449.7	449.7	449.7	449.7	449.7	449.6	449.6	449.6	449.6
449.6	449.6	449.5	449.5	449.5	449.5	449.5	449.5	449.5	449.4
449.4	449.4	449.4	449.4	449.4	449.4	449.3	449.3	449.3	449.3
449.3	449.3	449.3	449.3	449.2	449.2	449.2	449.2	449.2	449.2
449.2	449.1	449.1	449.1	449.1	449.1	449.1	449.1	449.1	449.0
449.0	449.0	449.0	449.0	449.0	449.0	449.0	449.0	448.9	448.9
448.9	448.9	448.9	448.9	448.9	448.9	448.8	448.8	448.8	448.8
448.8	448.8	448.8	448.8	448.8	448.7	448.7	448.7	448.7	448.7

PEAK OUTFLOW IS 8318. AT TIME 104.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8318.	8316.	8275.	7962.	986250.
CMS	236.	235.	234.	225.	27929.
INCHES		0.10	0.41	1.18	4.06
MM		2.61	10.39	29.98	103.16
AC-FT		4124.	16413.	47380.	163023.
THOLS CU M		5086.	20245.	58442.	201086.

STATION DAM, PLAN 1, RATIO 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
1.	1.	1.	1.	1.	2.	2.	3.	4.	6.
9.	13.	20.	34.	52.	3688.	4673.	6074.	7853.	10547.
14512.	18399.	22024.	25282.	28109.	30484.	32447.	34039.	35299.	36266.
36972.	37452.	37734.	37844.	37807.	37644.	37373.	37011.	36573.	36072.
35520.	34926.	34299.	33647.	32976.	32291.	31598.	30901.	30203.	29508.
28817.	28133.	27456.	26792.	26139.	25503.	24886.	24286.	23703.	23143.
22614.	22099.	21599.	21111.	20637.	20176.	19727.	19289.	18874.	18478.
18093.	17717.	17350.	16993.	16645.	16305.	15974.	15651.	15336.	15038.
14755.	14478.	14208.	13944.	13686.	13434.	13188.	12947.	12712.	12482.
12257.	12036.	11823.	11620.	11429.	11242.	11059.	10880.	10704.	10532.
10363.	10198.	10036.	9878.	9722.	9570.	9421.	9274.	9131.	8990.
8696.	8618.	8750.	8682.	8616.	8556.	8496.	8436.	8377.	8319.
8261.	8203.	8145.	8088.	8031.	7975.	7919.	7864.	7809.	7754.
7700.	7646.	7592.	7539.	7486.	7433.	7381.	7329.	7278.	7227.
7176.	7128.	7080.	7032.	6985.	6937.	6890.	6842.	6795.	6749.
6702.	6656.	6610.	6564.	6519.	6474.	6429.	6385.	6341.	6298.
6254.	6211.	6169.	6127.	6085.	6043.	6007.	5973.	5938.	5904.
5870.	5837.	5803.	5770.	5738.	5705.	5672.	5641.	5609.	5577.
5546.	5515.	5484.	5454.	5423.	5393.	5363.	5334.	5304.	5275.

STORAGE

474346.	474433.	474521.	474609.	474700.	474797.	474905.	475034.	475201.	475422.
475709.	476054.	476456.	476933.	477521.	478287.	479362.	480942.	483336.	487226.
493710.	503649.	518282.	537247.	560581.	587309.	616275.	646401.	676245.	704333.
729541.	751488.	770310.	786255.	799603.	810650.	819673.	826923.	832622.	836966.
840132.	842275.	843531.	844023.	843857.	843128.	841920.	840304.	838345.	836099.
833616.	830938.	828102.	825143.	822087.	818960.	815784.	812576.	809352.	806126.
802911.	799716.	796547.	793411.	790325.	787307.	784364.	781494.	778695.	775964.
773298.	770694.	768151.	765667.	763241.	760871.	758556.	756295.	754085.	751924.
749809.	747740.	745716.	743735.	741798.	739901.	738046.	736231.	734454.	732714.
731010.	729339.	727701.	726096.	724522.	722979.	721466.	719983.	718529.	717103.
715705.	714334.	712990.	711671.	710376.	709104.	707854.	706625.	705417.	704229.
703062.	701914.	700786.	699677.	698587.	697515.	696461.	695425.	694406.	693404.
692419.	691436.	690462.	689493.	688529.	687569.	686615.	685664.	684719.	683777.
682841.	681909.	680981.	680059.	679141.	678227.	677319.	676415.	675516.	674622.
673733.	672849.	671969.	671095.	670225.	669360.	668501.	667646.	666796.	665951.
665111.	664312.	663512.	662712.	661914.	661117.	660322.	659529.	658738.	657951.
657166.	656384.	655606.	654831.	654060.	653294.	652531.	651773.	651020.	650271.
649527.	648787.	648053.	647323.	646597.	645877.	645161.	644448.	643739.	643034.
642333.	641635.	640941.	640250.	639564.	638881.	638202.	637527.	636855.	636188.
635524.	634864.	634207.	633554.	632905.	632260.	631618.	630979.	630344.	629713.

STAGE

446.0	446.0	446.0	446.0	446.0	446.0	446.0	446.0	446.0	446.0
446.0	446.0	446.1	446.1	446.1	446.1	446.1	446.2	446.2	446.3
446.5	446.7	447.0	447.5	448.0	448.6	449.3	450.0	450.7	451.6
452.8	453.8	454.7	455.4	456.1	456.6	457.0	457.3	457.6	457.8
457.9	458.0	458.1	458.1	458.1	458.1	458.0	458.0	457.9	457.8
457.6	457.5	457.4	457.3	457.1	457.0	456.8	456.7	456.5	456.4
456.2	456.1	455.9	455.8	455.6	455.5	455.4	455.2	455.1	455.0
454.8	454.7	454.6	454.5	454.4	454.3	454.2	454.0	453.9	453.8
453.7	453.7	453.6	453.5	453.4	453.3	453.2	453.1	453.0	453.0
452.9	452.8	452.7	452.6	452.6	452.5	452.4	452.4	452.3	452.2
452.2	452.1	452.0	452.0	451.9	451.9	451.8	451.7	451.7	451.6

450.7	450.6	450.6	450.6	450.6	450.6	450.6	450.7	450.7	450.7
450.7	450.6	450.6	450.6	450.6	450.6	450.5	450.5	450.5	450.5
450.5	450.4	450.4	450.4	450.4	450.4	450.3	450.3	450.3	450.3
450.3	450.2	450.2	450.2	450.2	450.2	450.2	450.1	450.1	450.1
450.1	450.1	450.1	450.0	450.0	450.0	450.0	450.0	450.0	449.9
449.9	449.9	449.9	449.9	449.9	449.8	449.8	449.8	449.8	449.8
449.8	449.7	449.7	449.7	449.7	449.7	449.7	449.7	449.6	449.6

PEAK OUTFLOW IS 37844. AT TIME 88.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	37844.	37780.	37013.	32088.	2527346.
CMS	1072.	1070.	1048.	909.	71566.
INCHES		0.47	1.83	4.76	10.41
MM		11.85	46.46	120.82	264.35
AC-FT		18734.	73414.	190935.	417743.
THOUS CU M		23108.	90555.	235514.	515278.

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

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS	
				RATIO 1	RATIO 2
				0.50	1.00
HYDROGRAPH AT	KEUKA	182.00	1	41098.	82196.
	(	0.00)		(1163.77)(	2327.53)(
ROUTED TO	KLDAM	182.00	1	1956.	6112.
	(	0.00)		(55.38)(	173.06)(
HYDROGRAPH AT	SENECA	571.00	1	93308.	186617.
	(	0.00)		(2642.20)(	5284.39)(
2 COMBINED	DAM	753.00	1	94405.	189765.
	(	0.00)		(2673.25)(	5373.53)(
ROUTED TO	DAM	753.00	1	8318.	37844.
	(	0.00)		(235.55)(	1071.63)(

SUMMARY OF DAM SAFETY ANALYSIS

KEUKA LAKE OUTLET DAM

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	713.99	714.00	718.75
STORAGE	141385.	142000.	200750.
OUTFLOW	0.	452.	1588.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	719.36	0.61	208738.	1956.	92.00	88.00	0.
1.00	723.91	5.16	271622.	6112.	318.00	82.00	0.

SUMMARY OF DAM SAFETY ANALYSIS

WATERLOO DAM

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	446.00	446.00	446.50
STORAGE	474260.	474260.	581420.
OUTFLOW	0.	0.	3557.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	450.89	2.39	683768.	8318.	342.00	104.00	0.
1.00	458.13	9.63	844023.	37844.	350.00	88.00	0.

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
  MODIFIED FOR HONEYWELL APR 79
**********************************

**********************************
NEW YORK STATE
DEPT OF ENVIRONMENTAL CONSERVATION
FLOOD PROTECTION BUREAU
**********************************

     1  A WATERLOO DAM AT LOCK C/S - 4  NY-709                    OSWEGO RIVER BASIN
     2  A                               NYS WATERWAYS MAINT SUBDIV SENECA COUNTY
     3  A                                                          PMF - SNYDER UH
     4  B    200       2       0       0       0       0       0       0       0       0
     5  B1     5
     6  J      1       7       1
     7  J1  0.20    0.21    0.22    0.23    0.24    0.25       1
     8  K      C   KEUKA                                         1
     9  K1                     INFLOW HYDROGRAPH - KEUKA LAKE SUBBASIN
    10  M      1       1     182             753                                1
    11  P             21.2    60.5      73    82.5    90.5
    12  T                                                   1.5    0.03            0.1
    13  W  12.26   0.625
    14  X    100     800     1.6
    15  K      1   KLDAM                                         1
    16  K1                     ROUTED HYDROGRAPH - KEUKA LAKE DAM - CENTER SPWAY & GATES
    17  Y                                     1       1
    18  Y1     1                                                -713.99      -1
    19  Y4708.43  713.99     714     715   715.6     716   716.5     717   717.5     718
    20  Y4 718.5  718.75     719
    21  Y5     0       0     452     583     666     717     802     933    1091    1277
    22  Y5  1480    1598    1701
    23  $S 76000   97000  119000  142000  166000  191000  217000  230000  240000
    24  $E   708     710     712     714     716     718     720     721   721.7
    25  $$   714
    26  $0718.75     3.1     1.5    60.2
    27  K      C   SENECA                                        1
    28  K1                     INFLOW HYDROGRAPH - SENECA LAKE SUBBASIN TO DAM
    29  M      1       1     571             753                                1
    30  P             21.2    60.5      73    82.5    90.5
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OVERTOPPING ANALYSIS [% OF PMF]

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32  W  17,86   0,025
33  X   50C    280C     1,6
34  K    2     DAM                                        1
35  K1          COMBINED HYDROGRAPH - KL OUTFLOW WITH SENECA LAKE INFLOW
36  K    1     DAM                                        1
37  K1          ROUTED HYDROGRAPH AT DAM  (G1-G3 CLOSED  G6 OPEN)
38  Y                                  1      1
39  Y1   1                                                -446      -1
40  Y4  446     447      448   448,49  448,5     449      450      451      452      453
41  Y4  454     455      456
42  Y5    C      19       52      69    3557     3951     5213     6853     8778    10943
43  Y5 13221   15890    18637
44  $S41250C  457100   500000   542900   585700   628600   671400   692900   798250
45  $E 444,6   445,6    446,6    447,6    448,6    449,6    450,6    451,1     456
46  $$  446
47  $C 448,5   2,63      1,5      170
48  K    99
49  A
50  A
51  A
52  A
53  A
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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS						
				RATIO 1 0.20	RATIO 2 0.21	RATIO 3 0.22	RATIO 4 0.23	RATIO 5 0.24	RATIO 6 0.25	RATIO 7 1.00
HYDROGRAPH AT	KEUKA	162.00 (97649.89)	1	16439. (465.51)(	17261. 488.78)(	18083. 512.06)(	18905. 535.33)(	19727. 558.61)(	20549. 581.88)(	82196. 2327.53)(
ROUTED TO	KLDAM	162.00 (97649.89)	1	744. (21.08)(	763. 21.62)(	782. 22.16)(	802. 22.70)(	820. 23.92)(	860. 24.34)(	6112. 173.06)(
HYDROGRAPH AT	SENECA	591.00 (97849.89)	1	37323. (1056.68)(	39189. 1109.72)(	41056. 1162.57)(	42922. 1215.41)(	44788. 1268.25)(	46654. 1321.10)(	186617. 5284.39)(
2 COMBINED	DAM	753.00 (97649.89)	1	37959. (1074.88)(	39835. 1128.01)(	41712. 1181.14)(	43588. 1234.27)(	45463. 1287.38)(	47339. 1340.49)(	189765. 5373.53)(
ROUTED TO	DAM	753.00 (97649.89)	1	659. (18.65)(	877. 24.83)(	1501. 42.50)(	3558. 100.76)(	3600. 101.94)(	3665. 103.78)(	37844. 1071.63)(

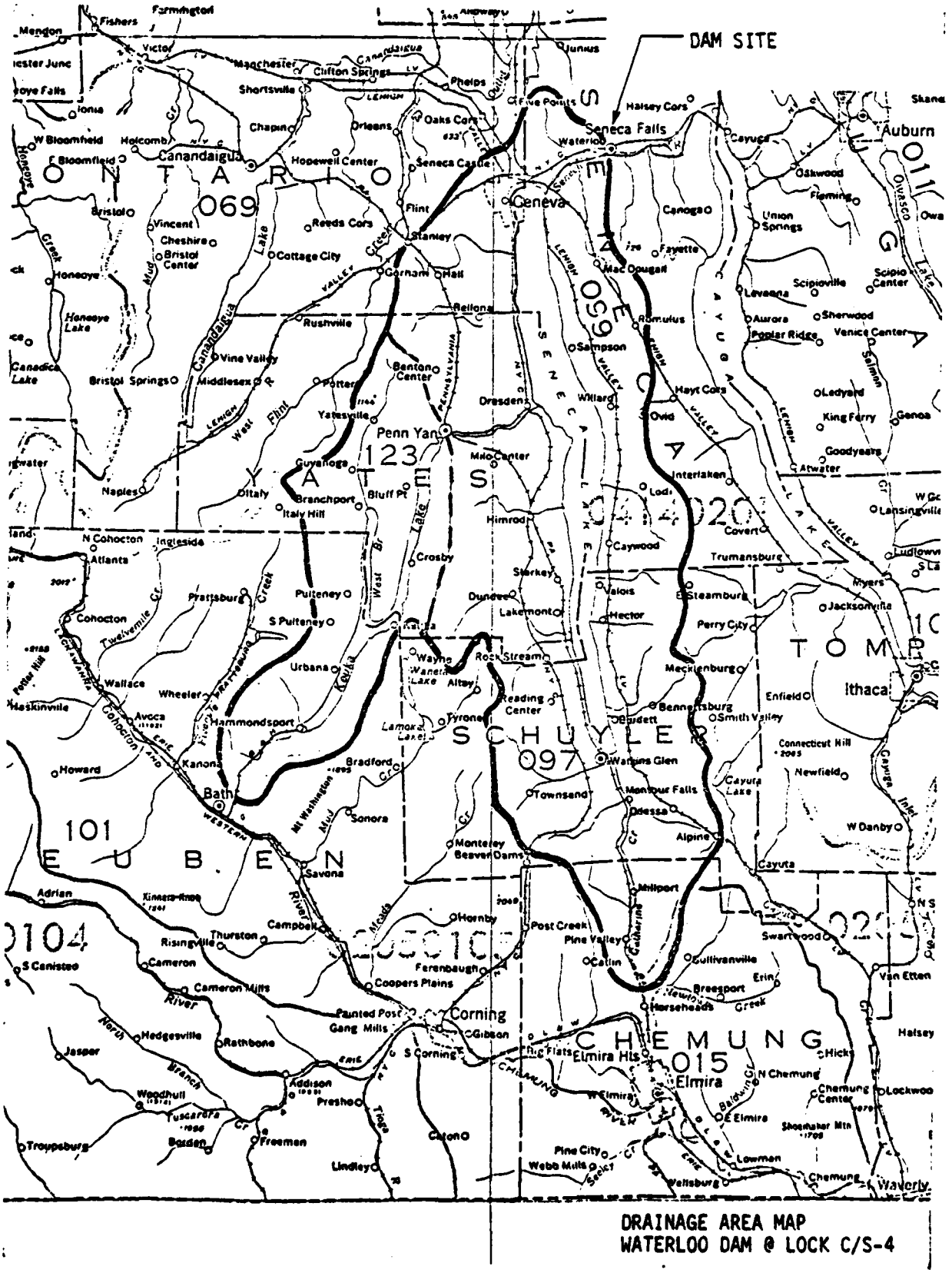
SUMMARY OF DAM SAFETY ANALYSIS

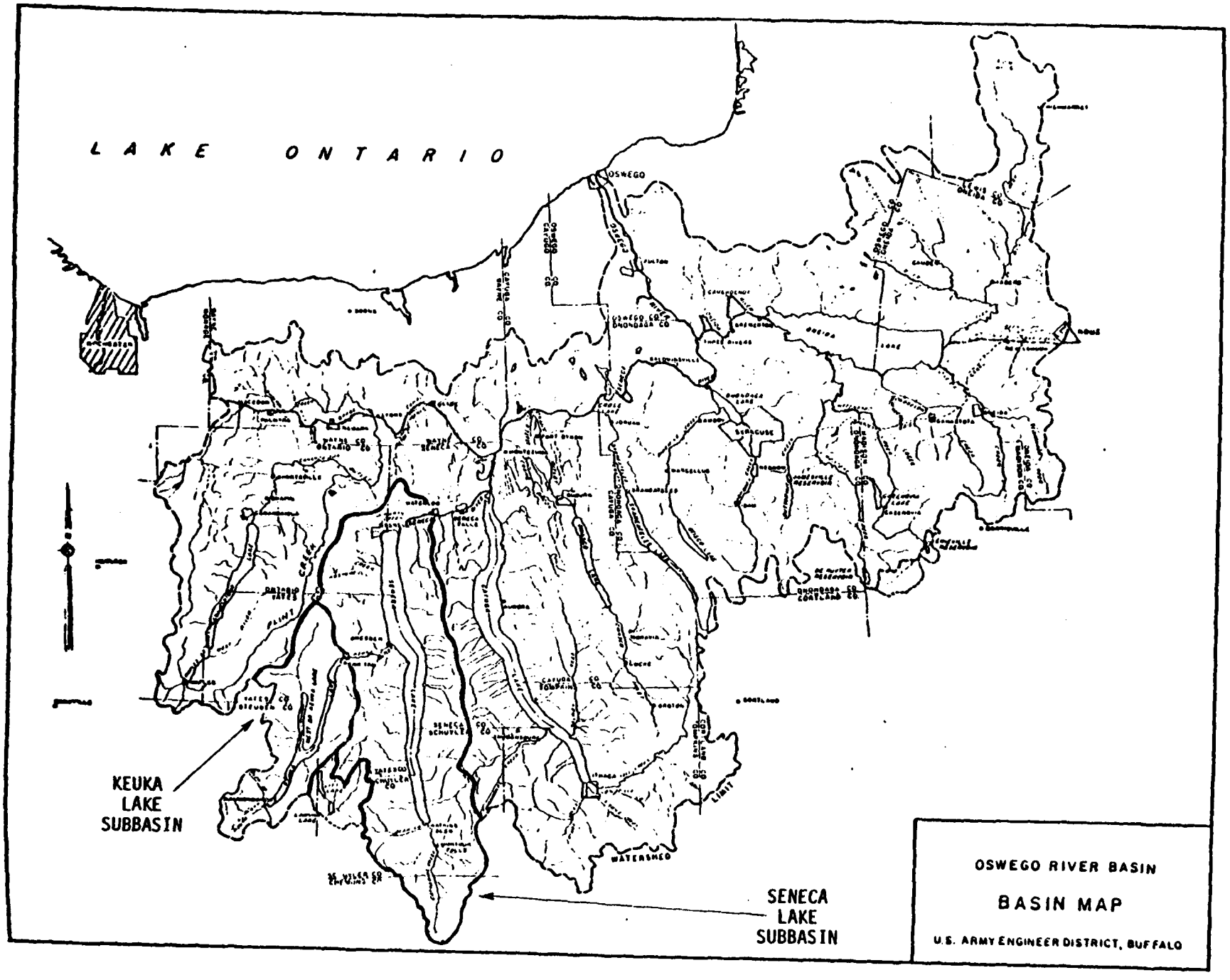
PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	446.00	446.00	448.50
STORAGE	474260.	474260.	581420.
OUTFLOW	0.	0.	3557.

WATERLOO DAM

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.20	448.49	0.	581064.	659.	0.	266.00	0.
0.21	448.49	0.	581091.	877.	0.	140.00	0.
0.22	448.49	0.	581168.	1501.	0.	126.00	0.
0.23	448.50	0.00	581483.	3558.	6.00	104.00	0.
0.24	448.55	0.05	583499.	3600.	36.00	106.00	0.
0.25	448.61	0.11	586342.	3665.	58.00	106.00	0.
1.00	456.13	9.63	844023.	37844.	350.00	88.00	0.


DAM SITE
Seneca Falls
Waterloo
Geneva
Penn Yan
Corning
Elmira
Canandaigua
Auburn
Ithaca
Bath
ONTARIO
069
YATES
123
SENECA
097
TOMPKINS
109
CAYUGA
011
STEUBEN
101
SCHUYLER
097
CHEMUNG
015
SCHOHARIE
095
TIOGA
107
CORTLAND
023
ONONDAGA
067
DRAINAGE AREA MAP
WATERLOO DAM @ LOCK C/S-4


LAKE ONTARIO
OSWEGO
KEUKA LAKE SUBBASIN
SENECA LAKE SUBBASIN
OSWEGO RIVER BASIN
BASIN MAP
U.S. ARMY ENGINEER DISTRICT, BUFFALO

04232400 SENECA LAKE AT WATKINS GLEN, NY

LOCATION.--Lat 42°23'00", long 76°52'05", Schuyler County, Hydrologic Unit 04140201, on east bank about 300 ft (91 m) from lake on shorter of two boat slips at Watkins Glen.

DRAINAGE AREA.--704 mi² (1,823 km²).

PERIOD OF RECORD.--October 1956 to current year.

REVISED RECORDS.--WSP 2112: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is National Geodetic Vertical Datum of 1929 (1.59 ft or 0.485 m, Barge Canal datum). Prior to Oct. 1, 1975, at datum 438.41 ft (133.627 m) higher.

REMARKS.--Area of water surface, 67.6 mi² (175 km²). Diversion from Susquehanna River basin enters lake through Keuka Lake Outlet at Dresden. For table of diversion, see station 01528700. Lake regulated by taintor gates on Seneca River at lock 4, Waterloo, for operation of Erie (Barge) Canal and power generation by New York State Electric and Gas Corp.

EXTREMES FOR PERIOD OF RECORD.--Maximum elevation, 448.88 ft (136.819 m) June 25, 1972; minimum, 442.64 ft (134.917 m) Mar. 14, 1978.

EXTREMES FOR CURRENT YEAR.--Maximum elevation, 445.39 ft (135.755 m) Apr. 12; minimum, 443.05 ft (135.042 m) Feb. 23.

ELEVATION, IN FEET NGVD, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	444.49	444.49	444.17	444.24	444.38	443.35	445.05	444.97	445.02	444.91	445.12	444.90
2	444.58	444.45	444.20	444.58	444.32	443.40	445.01	444.92	445.02	444.96	445.16	444.90
3	444.50	444.40	444.18	444.64	444.24	443.47	445.04	444.85	445.00	444.95	445.14	444.90
4	444.44	444.37	444.20	444.58	444.17	443.75	445.02	444.83	444.98	444.93	445.16	444.90
5	444.51	444.39	444.19	444.58	444.12	444.39	445.02	444.85	444.95	444.92	445.09	444.90
6	444.48	444.39	444.18	444.55	444.10	444.93	444.98	444.87	444.94	444.95	445.13	444.90
7	444.47	444.41	444.18	444.56	444.04	445.13	444.99	444.87	444.90	444.87	445.04	445.20
8	444.51	444.41	444.19	444.56	444.01	445.23	444.95	444.86	444.87	444.85	445.01	445.20
9	444.46	444.36	444.26	444.49	443.98	445.25	445.02	444.83	444.90	444.87	445.06	445.15
10	444.42	444.35	444.26	444.46	443.92	445.28	445.10	444.86	444.89	444.85	444.98	445.15
11	444.44	444.38	444.24	444.42	443.89	445.31	445.17	444.89	444.95	444.86	445.08	445.10
12	444.41	444.40	444.21	444.36	443.82	445.24	445.24	444.89	444.93	444.88	445.04	445.05
13	444.48	444.34	444.17	444.35	443.78	445.20	445.24	444.93	444.91	444.89	445.01	445.05
14	444.63	444.29	444.16	444.34	443.71	445.22	445.25	444.94	444.85	444.87	444.98	445.00
15	444.80	444.33	444.13	444.34	443.65	445.22	445.26	444.94	444.82	444.88	444.99	445.00
16	444.56	444.36	444.14	444.33	443.60	445.16	445.26	444.96	444.83	444.90	444.90	445.00
17	444.57	444.31	444.18	444.29	443.54	445.13	445.25	444.96	444.86	444.94	444.90	444.95
18	444.50	444.31	444.18	444.32	443.44	445.11	445.22	444.97	444.87	444.91	444.85	444.87
19	444.49	444.33	444.13	444.26	443.42	445.07	445.14	444.96	444.89	444.88	444.85	444.91
20	444.55	444.35	444.09	444.18	443.35	445.03	445.12	444.96	444.85	444.91	444.85	444.78
21	444.49	444.32	444.13	444.23	443.28	445.00	445.07	444.97	444.81	444.97	444.85	444.66
22	444.45	444.29	444.09	444.20	443.24	444.96	445.03	444.99	444.84	444.84	444.85	444.80
23	444.55	444.24	444.11	444.16	443.15	444.91	444.98	444.98	444.93	444.86	444.85	444.74
24	444.54	444.27	444.11	444.15	443.22	444.95	444.93	445.04	444.96	444.91	444.85	444.68
25	444.44	444.32	444.26	444.32	443.31	445.04	444.91	445.10	444.94	444.93	444.85	444.64
26	444.45	444.38	444.25	444.45	443.43	445.09	444.91	445.13	444.88	444.95	444.85	444.63
27	444.55	444.26	444.22	444.46	443.43	445.05	444.91	445.13	444.83	445.04	444.85	444.57
28	444.53	444.26	444.22	444.47	443.38	444.97	444.98	445.16	444.88	444.99	444.85	444.53
29	444.52	444.20	444.17	444.46	---	444.94	445.01	445.17	444.93	444.99	444.90	444.62
30	444.51	444.20	444.13	444.46	---	444.95	445.02	445.14	444.92	445.00	444.90	444.61
31	444.48	---	444.14	444.42	---	445.00	---	445.08	---	444.92	444.90	---
MEAN	444.50	444.34	444.18	444.39	443.71	444.86	445.07	444.97	444.91	444.91	444.96	444.88
MAX	444.63	444.49	444.26	444.64	444.38	445.31	445.26	445.17	445.02	445.04	445.16	445.20
MIN	444.41	444.20	444.09	444.15	443.15	443.35	444.91	444.83	444.81	444.84	444.85	444.53

CAL YR 1978 MEAN 444.53 MAX 445.56 MIN 442.77
WTR YR 1979 MEAN 444.65 MAX 445.31 MIN 443.15

KEUKA LAKE OUTLET
DAM

NY - 390

OSWEGO RIVER BASIN

DD-15-1 (3/78)
Formerly GA-17

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
KEUKA LAKE	3/		
SUBJECT		**COMPUTED BY**	**DATE**
WATERSHED PARAMETERS		WCL	6/18/80

PMP - RAINFALL:

HMR #51 PLOT OF D+A-D:

FOR DA = 182 SQ MI.

DURATION =	6	12	24	48	72
DEPTH (INS) ⟶	16.6	19.7	22	24.6	25.8
(USING INDEX = 24 HR EVENT) % :	75.5	89.5	100	111.8	117.3

SNYDER SYNTHETIC UNIT HYDROGRAPH:

DA = 182 SQ MI.

LONGEST DRAINAGE PATH = L = 29.4 MI.

DIST. TO CENTROID OF DA = L_{CA} = 14.6 MI.

(USE) C_t = 2.0 SLOPES (MODERATE TO STEEP)

LAG TIME = $t_p = C_t (L \times L_{CA})^{0.3}$

$t_p = 2 (29.4 \times 14.6)^{0.3}$

t_p = 12.32 HRS

UNIT RAINFALL DURATION = $t_r = \frac{t_p}{5.5}$

t_r = 2.24 HRS

(USE) t_R = 2

ADJUSTED LAG TIME = $T_p = t_p + 0.25(t_R - t_r)$

$T_p = 12.32 + 0.25(2 - 2.24)$

TP = 12.26 HRS

PEAKING COEFF = C_p = 0.625

00-15-1 (3/78)
Formerly GA-17

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

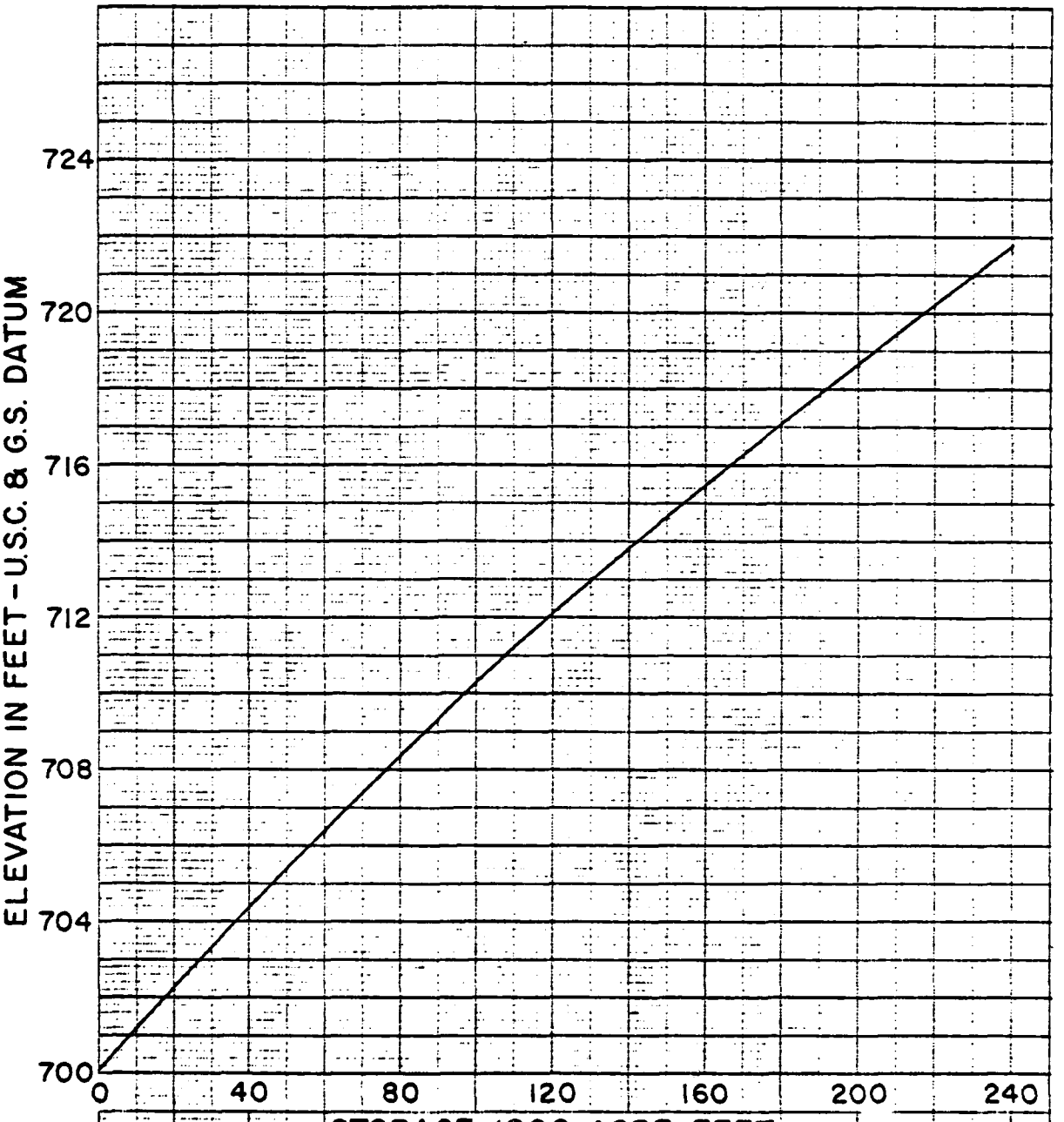
PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
KEUKA LAKE	5/		
SUBJECT		**COMPUTED BY**	**DATE**
STAGE - STORAGE DATA		WCL	6/19/80

CORPS ENGINEERS (6/1960 REPORT)
PLATE I - 11 : KEUKA OUTLET

ELEV.	AC-FT (x 1000)	
721.7	240	
721	230	
720	217	
718	191	
716	166	
714	142	— [USE AS NORMAL POOL]
712	119	
710	97	
708	76	

5A/



OSWEGO RIVER WATERSHED, NEW YORK

KEUKA LAKE OUTLET

PENN YAN, NEW YORK

STORAGE CAPACITY CURVE KEUKA LAKE

U.S. ARMY ENGINEER DISTRICT, BUFFALO

TO ACCOMPANY PROJECT REPORT (PUBLIC LAW 685)

DATED: JUNE 1960

APPENDIX PLATE I-11

00-15-1 (3/78)
Formerly GA-17

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
KEUKA LAKE	6/		
SUBJECT		**COMPUTED BY**	**DATE**
MASONRY SPILLWAY (CENTER) - DISCHARGE CAPACITY		WCL	6/20/80

SINGLE SPILLWAY @ 50.9' = CREST LENGTH (FIELD MEASURED)

CORPS ENGINEERS (6/1940 RPT) - KEUKA OUTLET

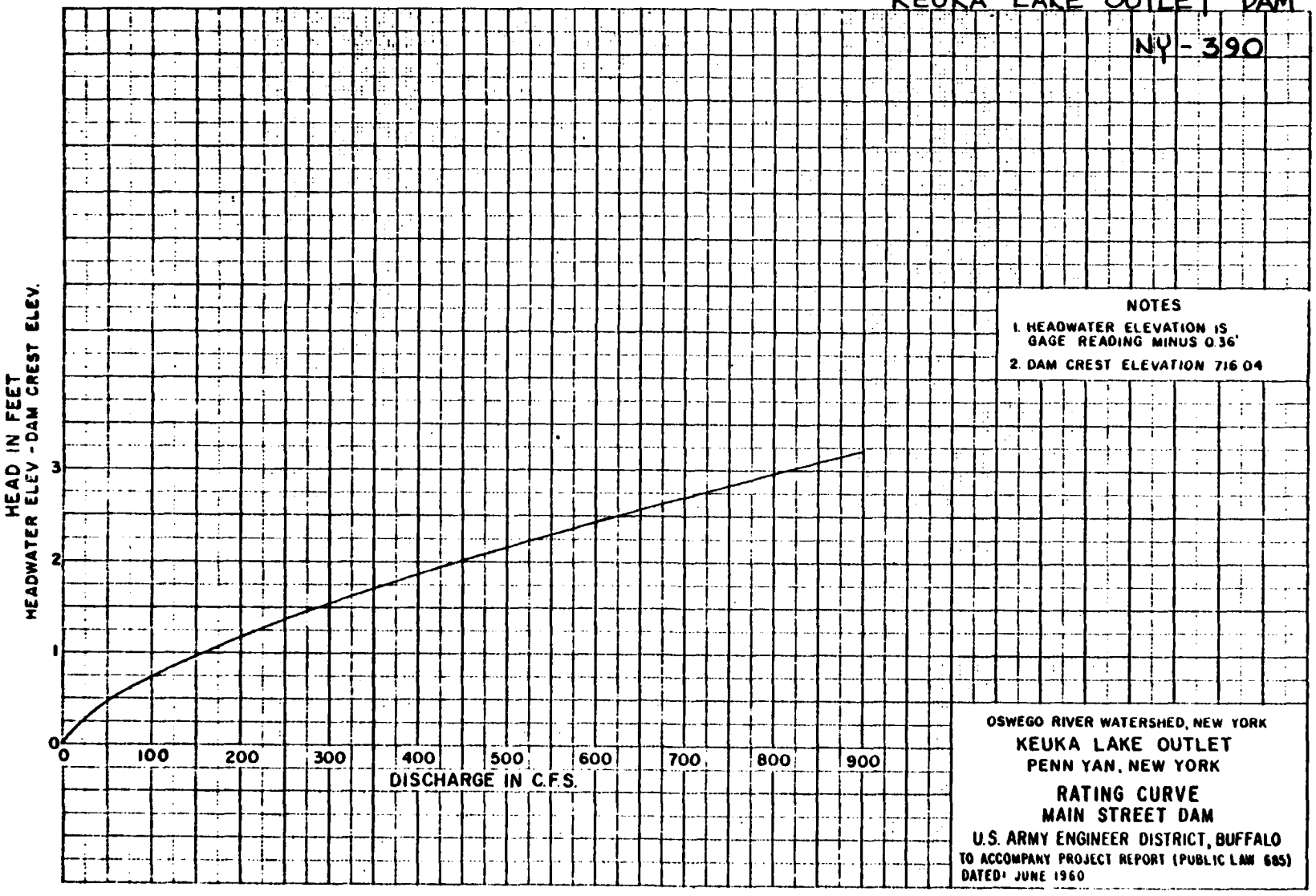
RATING CURVE USING $Q = CLH^{3/2}$: PLATE I-9

CREST @ 716.04
L = 50.8' C = 3.1

WATER SURF. ELEV.	H	Q	
716.04 (USE 716)	—	—	
716.5	0.5	55	
717	1	155	
717.5	1.5	285	
718	2	445	
718.5	2.5	620	
718.75	2.75	715	TOP ABUT
719	3	815	

KEUKA LAKE OUTLET DAM

NY-390



NOTES

1. HEADWATER ELEVATION IS GAGE READING MINUS 0.36'
2. DAM CREST ELEVATION 716.04

OSWEGO RIVER WATERSHED, NEW YORK

KEUKA LAKE OUTLET

PENN YAN, NEW YORK

RATING CURVE

MAIN STREET DAM

U.S. ARMY ENGINEER DISTRICT, BUFFALO

TO ACCOMPANY PROJECT REPORT (PUBLIC LAW 685)

DATED: JUNE 1960

APPENDIX PLATE 1-9

6A/

08-15-1 (3/78)
Formerly GA-17

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
KEUKA LAKE	7/		
SUBJECT		**COMPUTED BY**	**DATE**
RODNEY HUNT SLUICE GATES - DISCHARGE CAPACITY		WCL	6/20/80

TWIN 54" x 54" GATES — VARIABLE OPENING:
(4.5' x 4.5')

ORIFICE C ≈ 0.7 AREA = 20.25 SQ FT.
INVERT = 708.43
TOP OPENING = 712.93

WEIR FLOW: $Q = CL H^{3/2}$
ORIFICE FLOW: $Q = CA\sqrt{2gH}$

CONDITION: GATE FULLY OPEN (MAX CAPACITY):

L = 4.5
C = 2.77 (SIMILAR TO BIRKETT GATE)

	WATER SURF ELEV	H	Q	2Q
INV.	708.43	—	—	—
	709	0.57	5.4	10.8
	710	1.57	24.5	49
	712	3.57	84	168
TOP	712.93	4.5	119	238
	713	4.57	122	244
	714	5.57	164	328
	714.4	5.97	182	364
	715	6.57	210	420
→	715.6	7.17	239	478

ORIFICE $H = (H_T - 2.25)$

$Q = (0.7)(20.25)\sqrt{2gH}$

$Q = 113.75\sqrt{H}$

ASSUME SAME ELEV CAUSES ORIFICE FLOW TO OCCUR AT THESE GATES

	H_T	H	Q	2Q
	716	7.57	262	524
	716.5	8.07	274	548
	717	8.57	286	572
	717.5	9.07	297	594
	718	9.57	307	614
	718.5	10.07	318	636
TOP ABUT	713.75	10.32	323	646
	719	10.57	328	656

00-1S-1 (3/78)
Formerly GA-17

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
KEUKA LAKE	8/		
SUBJECT		**COMPUTED BY**	**DATE**
BIRKETT GATE - DISCHARGE CAPACITY		WCL	6/20/80

SINGLE 4' x 5.4' (48" x 64.8") GATE — NORMALLY @ FIXED OPENING:

ORIFICE AREA = 21.6 SQ FT

INVERT = 709.0

TOP OPENING = 714.4 TOP OF CONC @ GATE = 719.1 (FIELD MEASURED)

CORPS ENGINEERS (6/1960 RPT.) - KEUKA OUTLET

RATING CURVES FOR WEIR & ORIFICE FLOW: PLATES I-7 & I-8

CONDITION: GATE FULLY OPEN (MAX CAPACITY):

RECALCULATE "C": $C = \frac{Q}{LH^{3/2}}$, L = 4', NO TAILWATER

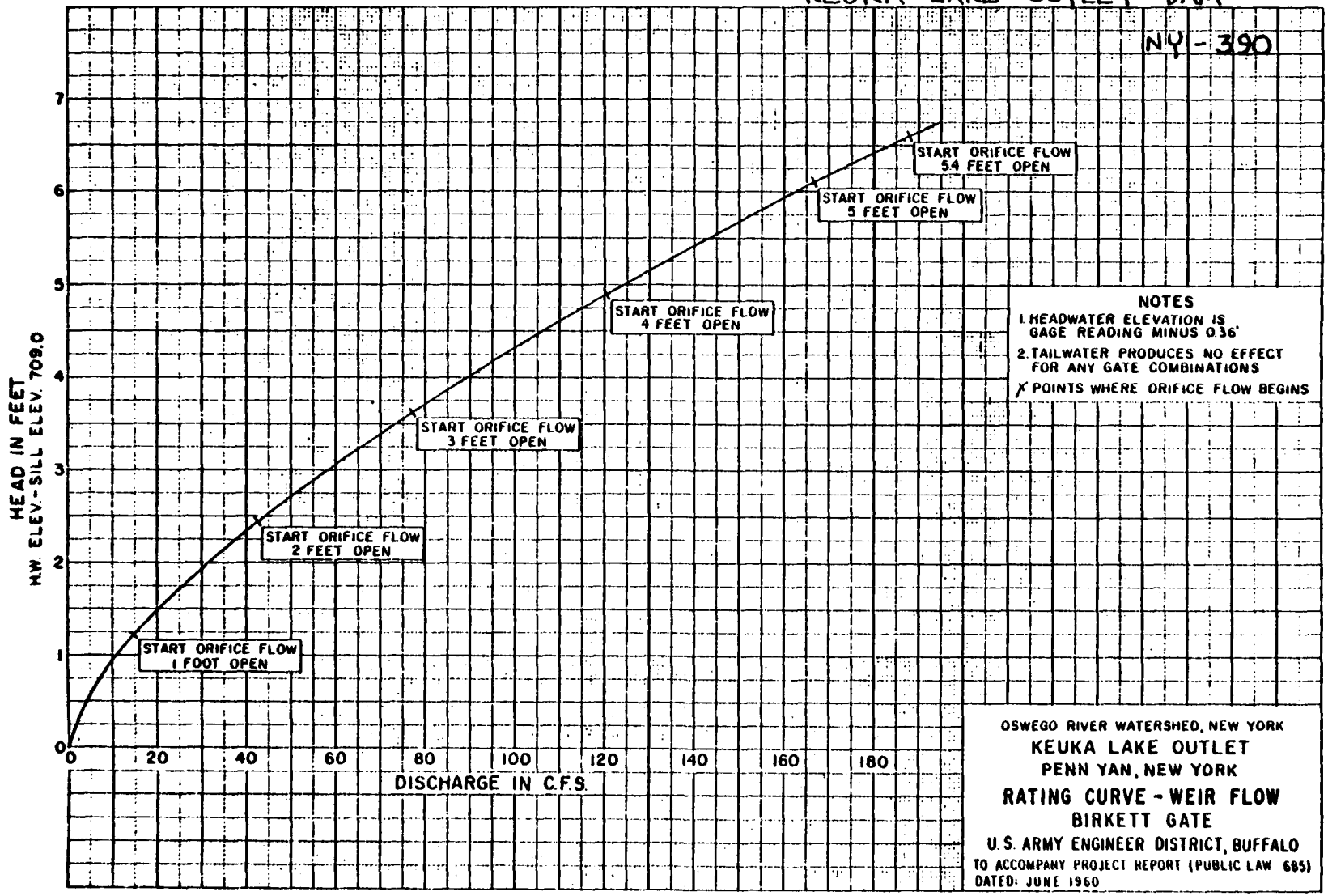
WATER SURF. ELEV.	H	Q		C
INV. 709	—	—		
710	1	11	WEIR FLOW (PLATE I-7)	2.73
712	3	58		2.79
712.93	3.93	86		
713	4	89		2.78
714	5	124		2.77
TOP 714.4	5.4	139		2.77
715	6	163		2.77
715.6	6.6	188		2.77
716	7	193	ORIFICE FLOW (PLATE I-8)	0.42 / 0.537
716.5	7.5	199		
717	8	206		0.412 / 0.516
717.5	8.5	212		
718	9	218		0.419 / 0.501
718.75	9.75	227		
719	10	230		0.419 / 0.491
718.5	9.5	224		

ORIFICE FLOW: $C = \frac{Q}{A\sqrt{2gH}}$, A = 21.6

H = HEIGHT OF WATER ABOVE ORIFICE

KEUKA LAKE OUTLET DAM

NY-390



NOTES

1. HEADWATER ELEVATION IS GAGE READING MINUS 0.36'
2. TAILWATER PRODUCES NO EFFECT FOR ANY GATE COMBINATIONS

✗ POINTS WHERE ORIFICE FLOW BEGINS

OSWEGO RIVER WATERSHED, NEW YORK

KEUKA LAKE OUTLET

PENN YAN, NEW YORK

RATING CURVE - WEIR FLOW

BIRKETT GATE

U.S. ARMY ENGINEER DISTRICT, BUFFALO

TO ACCOMPANY PROJECT REPORT (PUBLIC LAW 685)

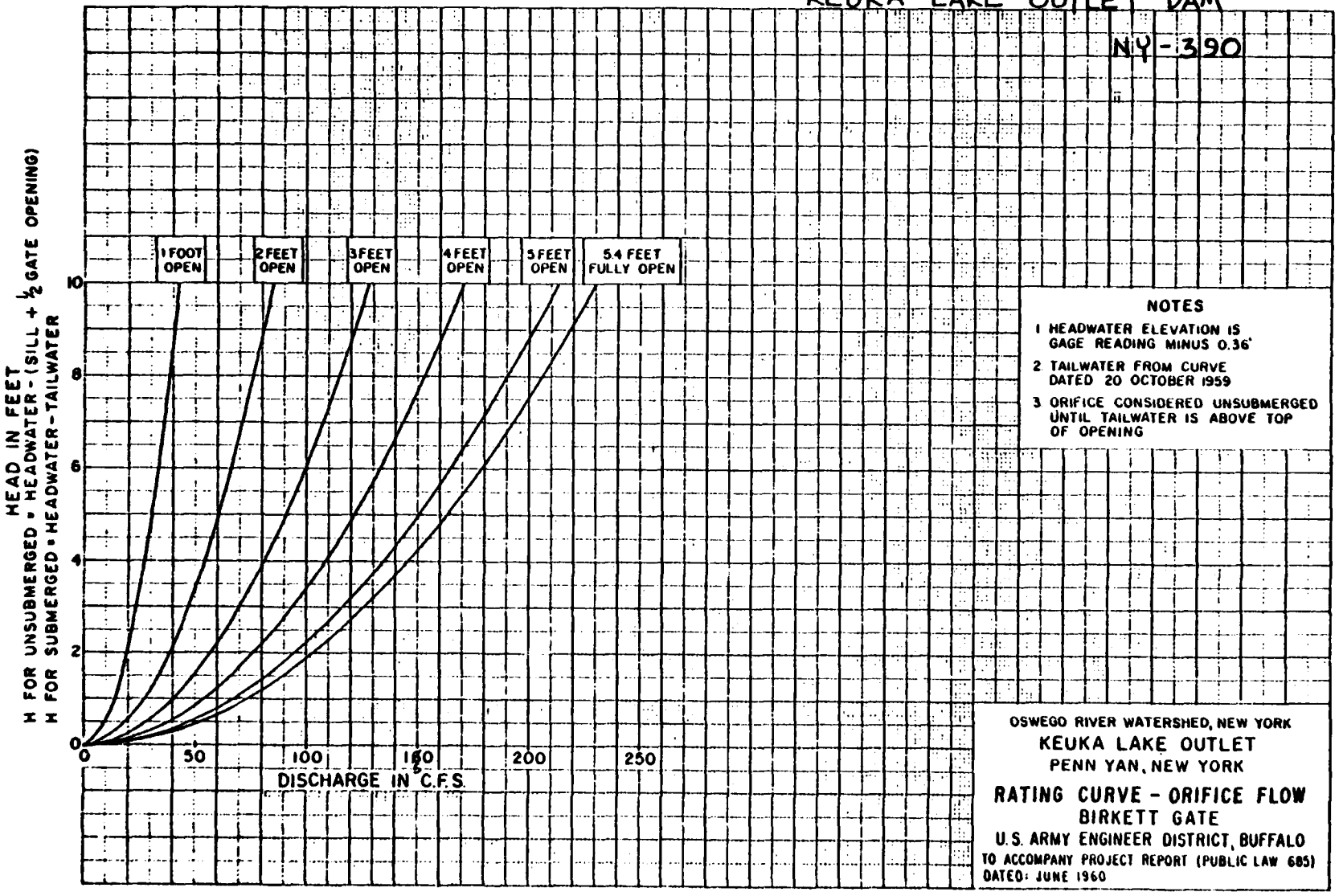
DATED: JUNE 1960

APPENDIX PLATE I-7

84

KEUKA LAKE OUTLET DAM

NY-390



NOTES

1 HEADWATER ELEVATION IS GAGE READING MINUS 0.36'

2 TAILWATER FROM CURVE DATED 20 OCTOBER 1959

3 ORIFICE CONSIDERED UNSUBMERGED UNTIL TAILWATER IS ABOVE TOP OF OPENING

OSWEGO RIVER WATERSHED, NEW YORK

KEUKA LAKE OUTLET

PENN YAN, NEW YORK

RATING CURVE - ORIFICE FLOW

BIRKETT GATE

U.S. ARMY ENGINEER DISTRICT, BUFFALO

TO ACCOMPANY PROJECT REPORT (PUBLIC LAW 685)

DATED: JUNE 1960

APPENDIX PLATE I-8

00-15-1 (3/78)
Formerly CA-17

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PROJECT GRID

JOB	SHEET NO.	CHECKED BY	DATE
KEUKA LAKE	10/		
SUBJECT		**COMPUTED BY**	**DATE**
STAGE - DISCHARGE : SUMMARY		WCL	6/23/80

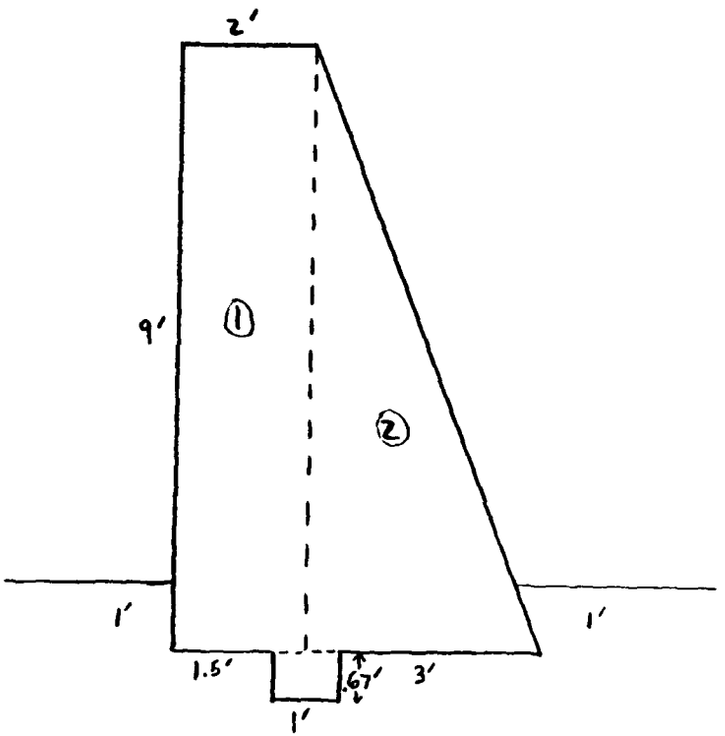
STAGE (ELEV)	CENTER MASONRY SPILLWAY	R-H GATES (2) (FULLY-OPEN)	BIRKETT GATE (FULLY-OPEN)	RR UNDERPASS	NON-OVERFLOW SECTIONS(3)	(cfs) TOTAL
708.43	—	—	—	—	—	—
709	—	10.8	—	—	—	10.8
710	—	49	11	—	—	60
711	—	168	58	—	—	226
712	—	244	89	—	—	333
713	—	328	124	—	—	452
714	—	420	163	—	—	583
715	—	478	188	—	—	666
715.46	—	524	193	—	—	717
716	—	548	199	—	—	747
716.5	55	572	206	—	—	933
717	155	594	212	—	—	1091
717.5	285	614	218	—	—	1277
718	445	636	224	3	—	1483
718.5	620	646	227	10	—	1598
718.75	715	654	230	20	16	1737
719	815					

USE AS NEEDED

APPENDIX D

STABILITY COMPUTATIONS

WATERLOO DAM - AUXILIARY SPILLWAY SECTION



SEGMENT	AREA	DISTANCE TO CENTROID
1	$2(9) = 18\ FT^2$	4.5'
2	$\frac{1}{2}(3.5)(9) = 15.75\ FT^2$	2.3'

CALCULATION OF EFFECT OF SHEAR KEY

1. CALCULATE SHEAR STRENGTH OF CONCRETE

ACCORDING TO:

Assume 2000 psi concrete

$$\text{SHEAR STRENGTH} = 2\sqrt{f'_c} = 2\sqrt{2000} = 89.44 \text{ psi}$$

$$\frac{(\text{STRENGTH})(\text{AREA})}{1000 \text{ lb/K}} = \frac{(89.44 \text{ psi})(144 \text{ in}^2)}{1000 \text{ \#/K}} = 12.88 \text{ K}$$

TOTAL SHEAR KEY RESISTANCE = 12.88 K

CONDITIONS ANALYZED

CONDITION 1. NORMAL CONDITIONS

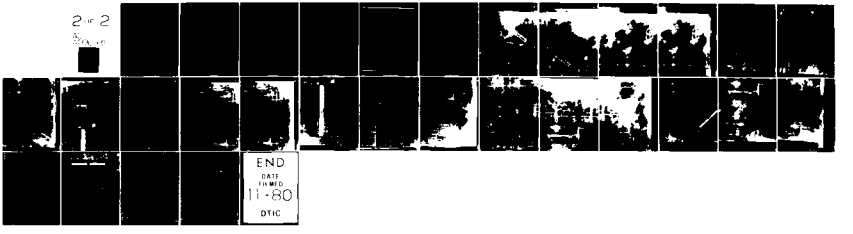
CONDITION 2 NORMAL CONDITIONS PLUS ICE LOAD OF 5,000 lb/ft

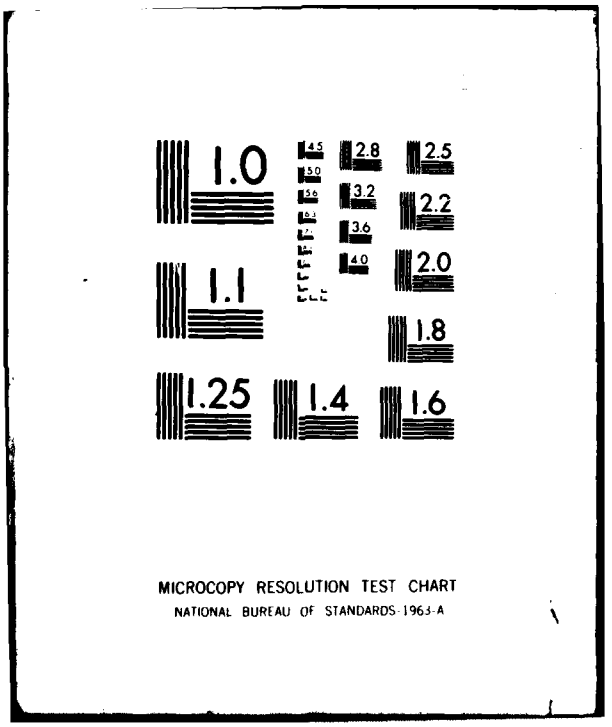
CONDITION 3 ½ PMF WATER LEVAL 2.39 FEET ABOVE SPILLWAY CREST

CONDITION 4 SEISMIC ANALYSIS - NORMAL CONDITIONS WITH SEISMIC COEFFICIENT OF 0.1

AD-A090 935 NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/13
NATIONAL DAM SAFETY PROGRAM. WATERLOO DAM (I.D. NUMBER NY 709),--ET
SEP 80 G KOCH DACW51-79-C-0001

UNCLASSIFIED NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

WATERLOO DAM

NY 709

STABILITY ANALYSIS PROGRAM - WORK SHEET

INPUT ENTRY		ANALYSIS CONDITION 1	2	3	4	5
Unit Weight of Dam (K/ft^3)	0	0.15	0.15	0.15	0.15	
Area of Segment No. 1 (ft^2)	1	18	18	18	18	
Distance from Center of Gravity of Segment No. 1 to Downstream Toe (ft)	2	4.5	4.5	4.5	4.5	
Area of Segment No. 2 (ft^2)	3	15.75	15.75	15.75	15.75	
Distance from Center of Gravity of Segment No. 2 to Downstream Toe (ft)	4	2.3	2.3	2.3	2.3	
Area of Segment No. 3 (ft^2)	5	—	—	—	—	
Distance from Center of Gravity of Segment No. 3 to Downstream Toe (ft)	6	—	—	—	—	
Base Width of Dam (Total) (ft)	7	5.5	5.5	5.5	5.5	
Height of Dam (ft)	8	9	9	9	9	
Ice Loading (K/L ft.)	9	—	5	—	—	
Coefficient of Sliding	10	0.60	0.60	0.60	0.60	
Unit Weight of Soil (K/ft^3) (deduct 18)	11	0.055	0.055	0.055	0.055	
Active Soil Coefficient - Ka	12	0.33	0.33	0.33	0.33	
Passive Soil Coefficient - Kp	13	3.0	3.0	3.0	3.0	
Height of Water over Top of Dam or Spillway (ft)	14	—	—	2.39	—	
Height of Soil for Active Pressure (ft)	15	1	1	1	1	
Height of Soil for Passive Pressure (ft)	16	1	1	1	1	
Height of Water in Tailrace Channel (ft)	17	—	—	—	—	
Weight of Water (K/ft^3)	18	.0624	.0624	.0624	0.0624	
Area of Segment No. 4 (ft^2)	19	—	—	—	—	
Distance from Center of Gravity of Segment No. 4 to Downstream Toe (ft)	20	—	—	—	—	
Height of Ice Load or Active Water (ft) (does not include 14)	46	9	9	9	9	
Seismic Coefficient (g)	50	—	—	—	0.1	
RESULTS OF ANALYSIS						
Factor of Safety vs. Overturning		1.33	0.30	0.91	1.10	
Distance From Toe to Resultant (ft)		1.24	*	*	0.45	
Factor of Safety vs. Sliding		5.94	2.00	3.89	4.54	

* OUTSIDE OF BASE

APPENDIX E

REFERENCES

APPENDIX D

REFERENCES

1) M.G. Cline and R.L. Marshall, General Soil Map of New York State, Cornell University Agriculture Experiment Station, March 1977.

2) Y.W. Isachsen and W.G. McKendree, Brittle Structures Map of New York State, New York State Museum, 1977.

3) H.W. King and E.F. Brater, Handbook of Hydraulics, 5th edition, McGraw-Hill, 1963.

4) H.L. Shindel, et al; Time-of-Travel and Dye-Dispersion Studies of Selected Streams and Lakes in the Oswego River Basin, New York, 1967-75; Investigation Report RI-17, U.S. Geological Survey, 1977.

5) University of the State of New York, Geology of New York, Education Leaflet 20, Reprinted 1973.

U.S. Army Corps of Engineers:

6) HEC-1 Flood Hydrograph Package - Dam Safety Version, September 1978.

7) Engineering Manual 1110-2-1405; Flood-Hydrograph Analyses and Computations, August 1959.

8) Keuka Lake Outlet Dam - Phase I Inspection Report, August 1980

9) U.S. Army: Corps of Engineers; Buffalo District:

Keuka Outlet at Penn Yan, New York, Detailed Project Report for Flood Control, June 1960.

10) Oswego River Basin, Water Resources Management Study, Preliminary Feasibility Report Appendices, May 1978.

11) U.S. Department of Agriculture, Soil Conservation Service; National Engineering Handbook; Section 4 - Hydrology, August 1972.

12) U.S. Department of Commerce; Weather Bureau; Hydrometeorological Report No. 33: Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 square miles and durations of 6, 12, 24, and 48 hours; April 1956.

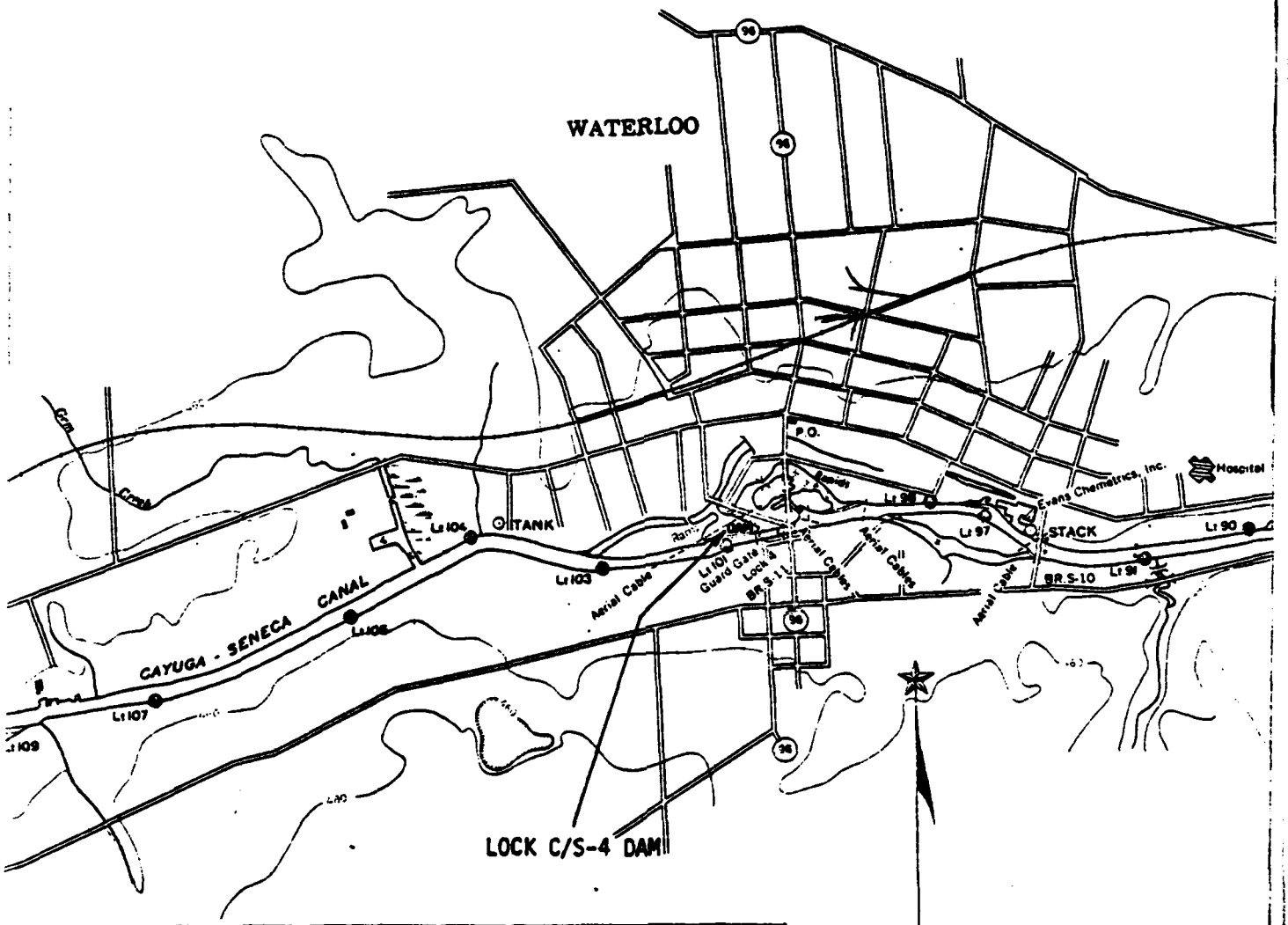
13) U.S. Geological Survey; Water Resources Data for New York - Water Year 1979, Water Data Report NY-79-1, Volume 1, May 1980.

US Department of Interior; BUREC;

14) Design of Small Dams, 2nd edition (rev. reprint), 1977

APPENDIX F

DRAWINGS



NEW YORK STATE BARGE CANAL SYSTEM

CAYUGA AND SENECA CANALS

SCALE 1:20,000

SOUNDINGS IN FEET

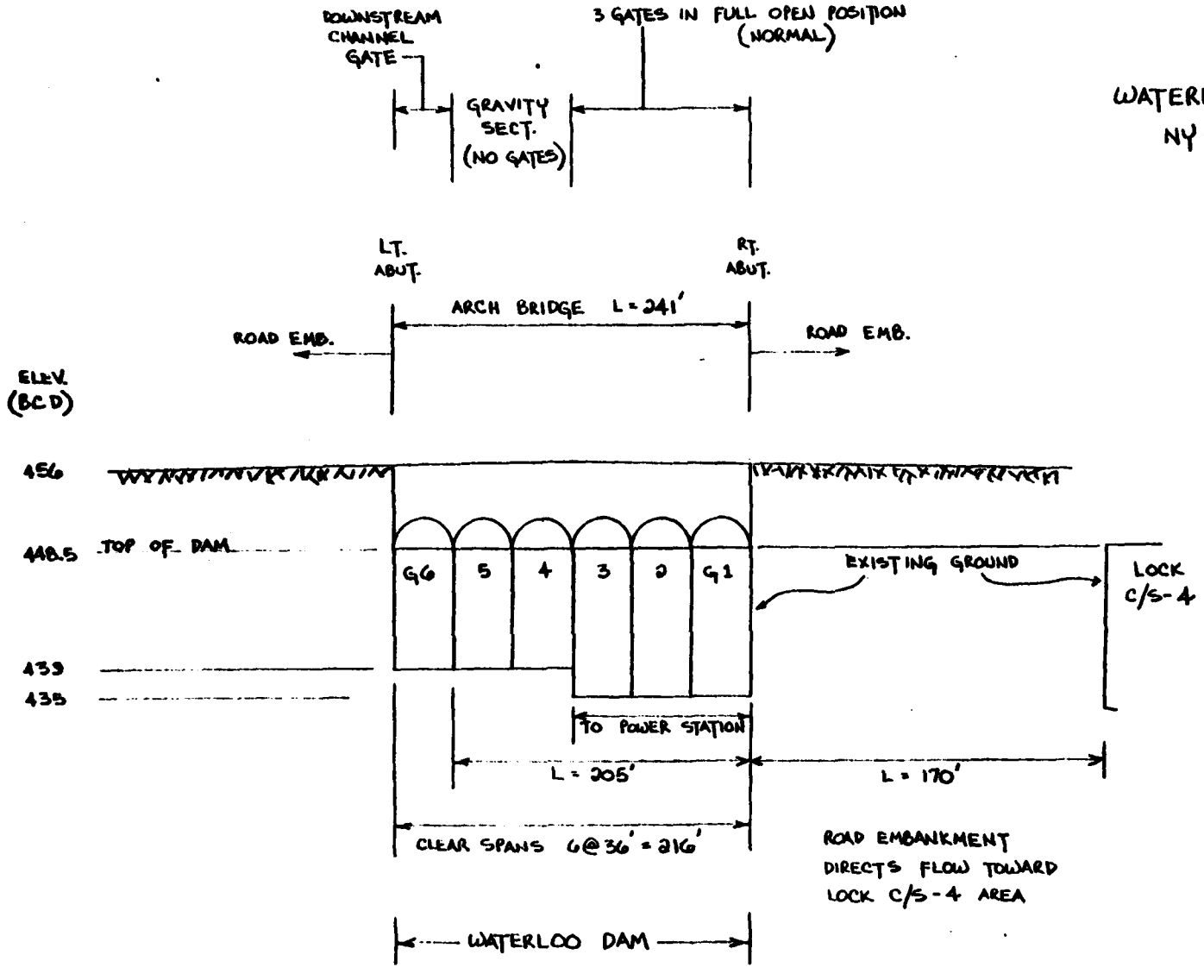
FEET

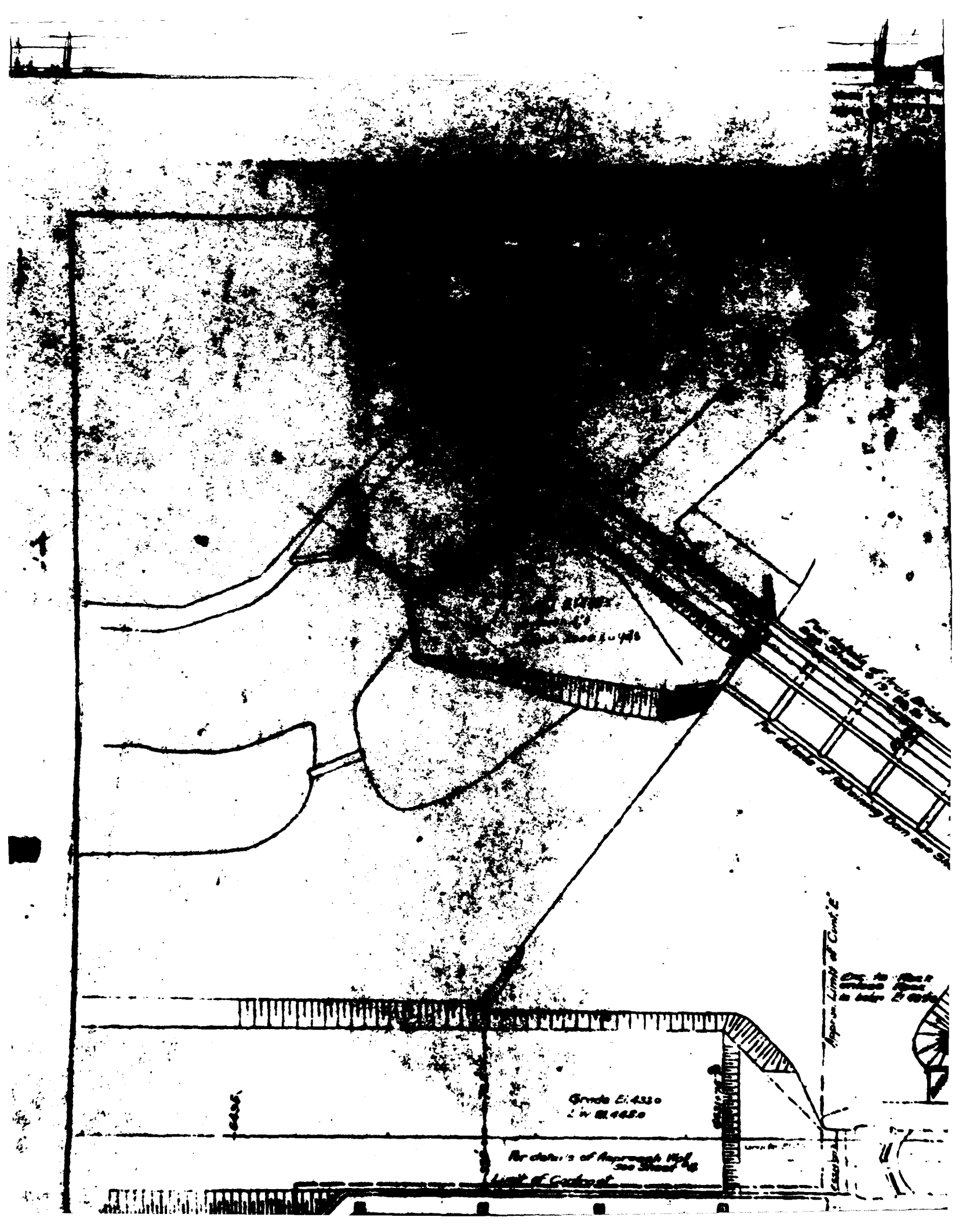
STATUTE MILES

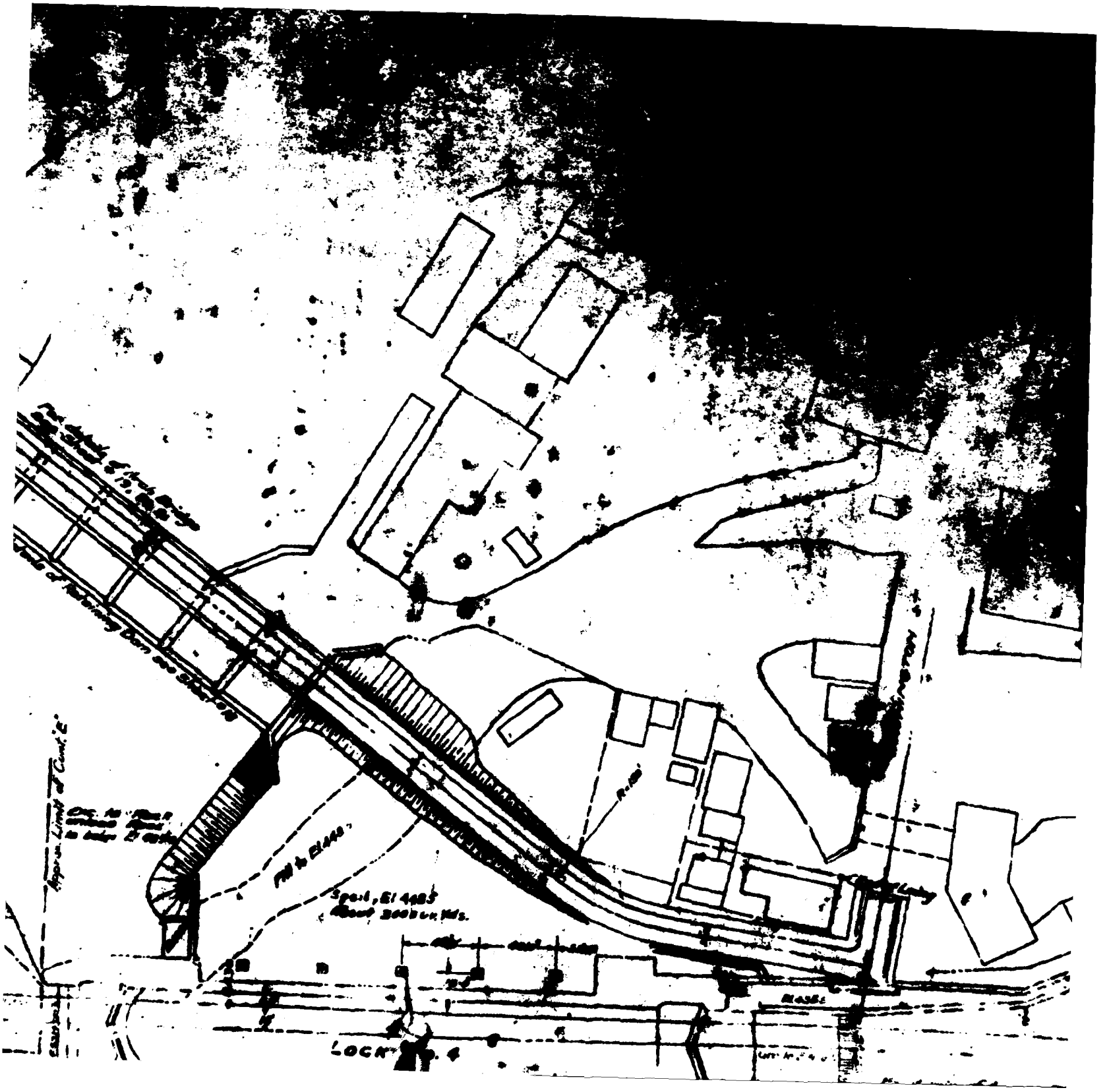
CS-3

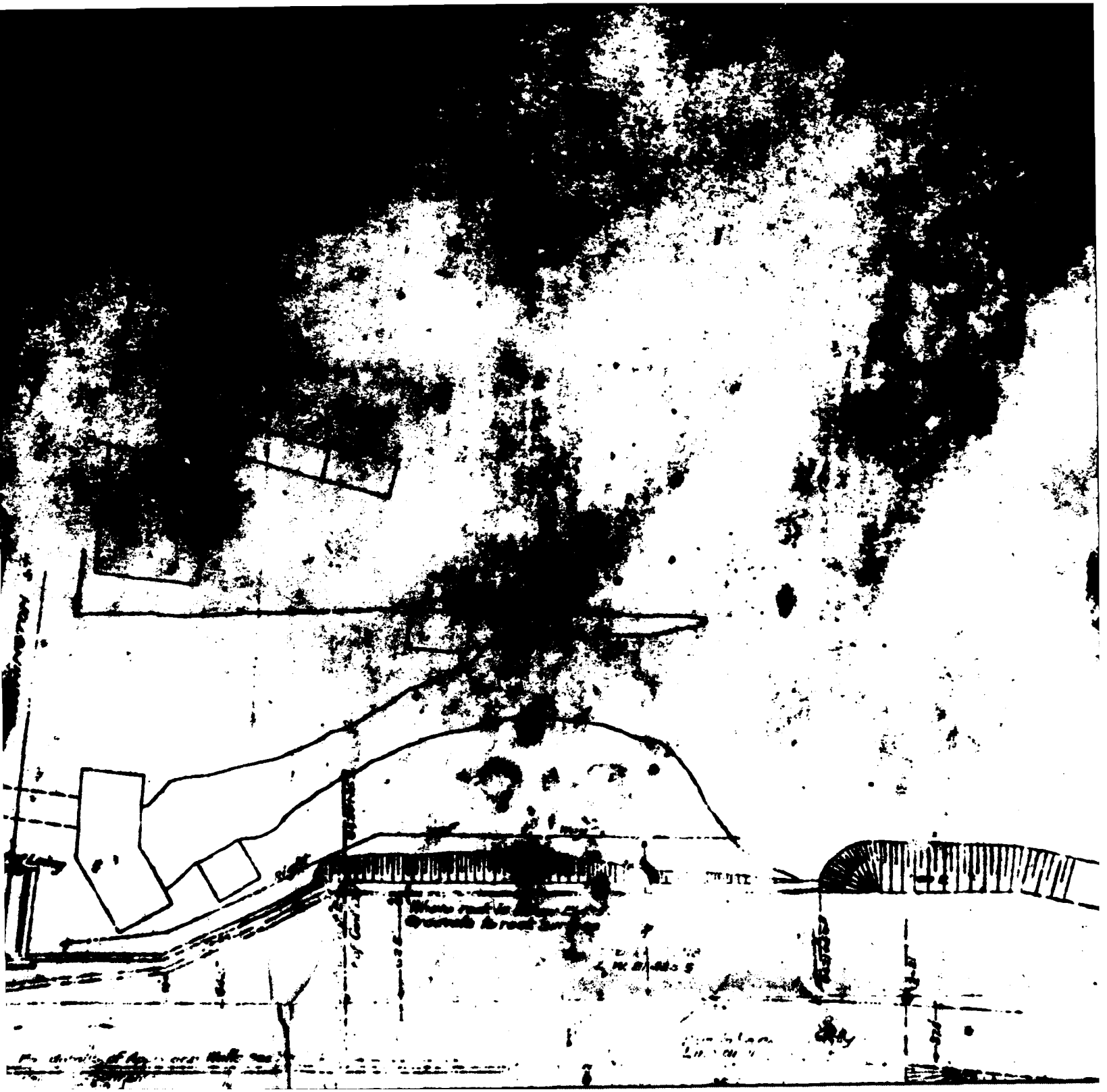
MAY-1980

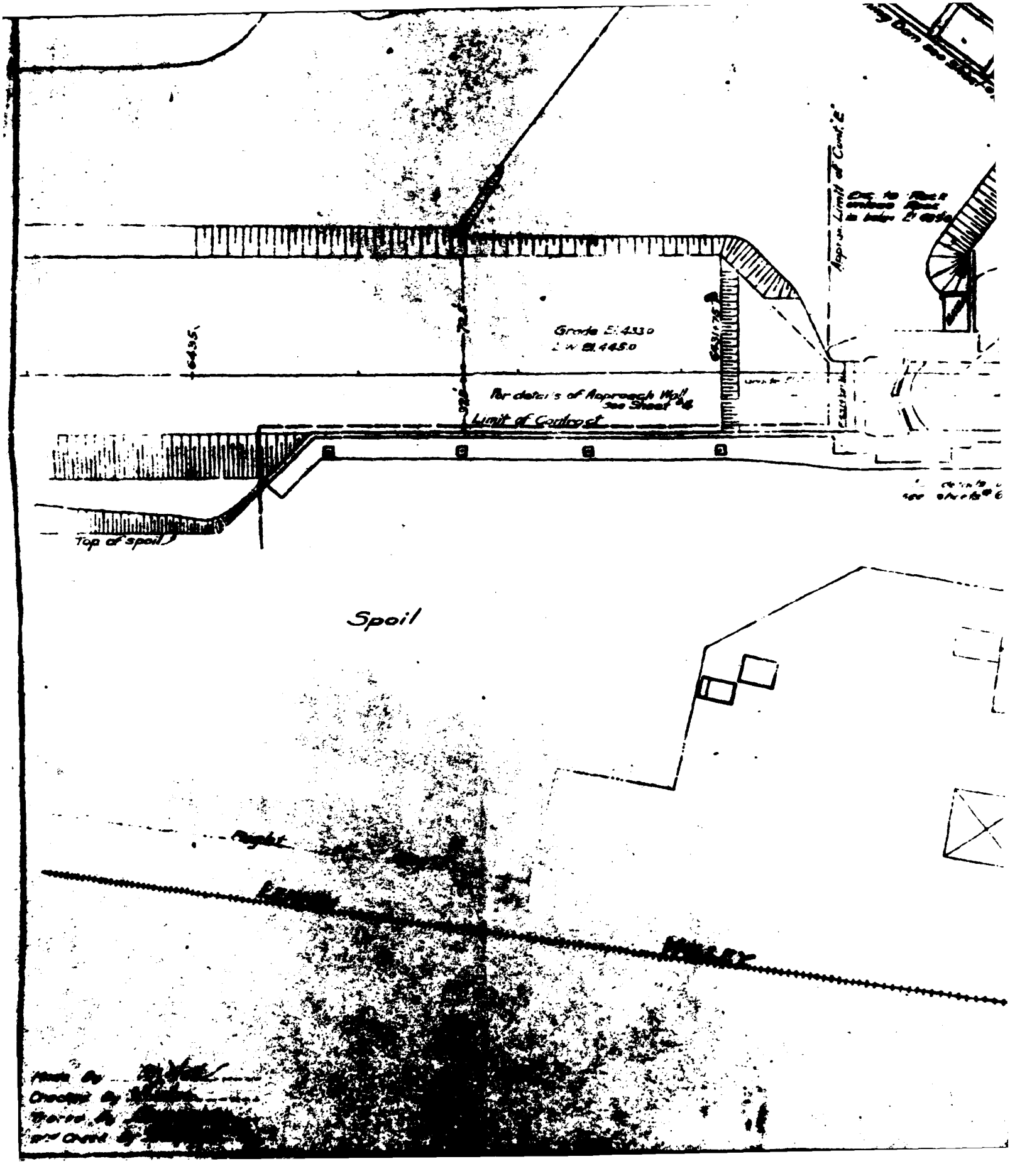
WATERLOO DAM
NY - 709

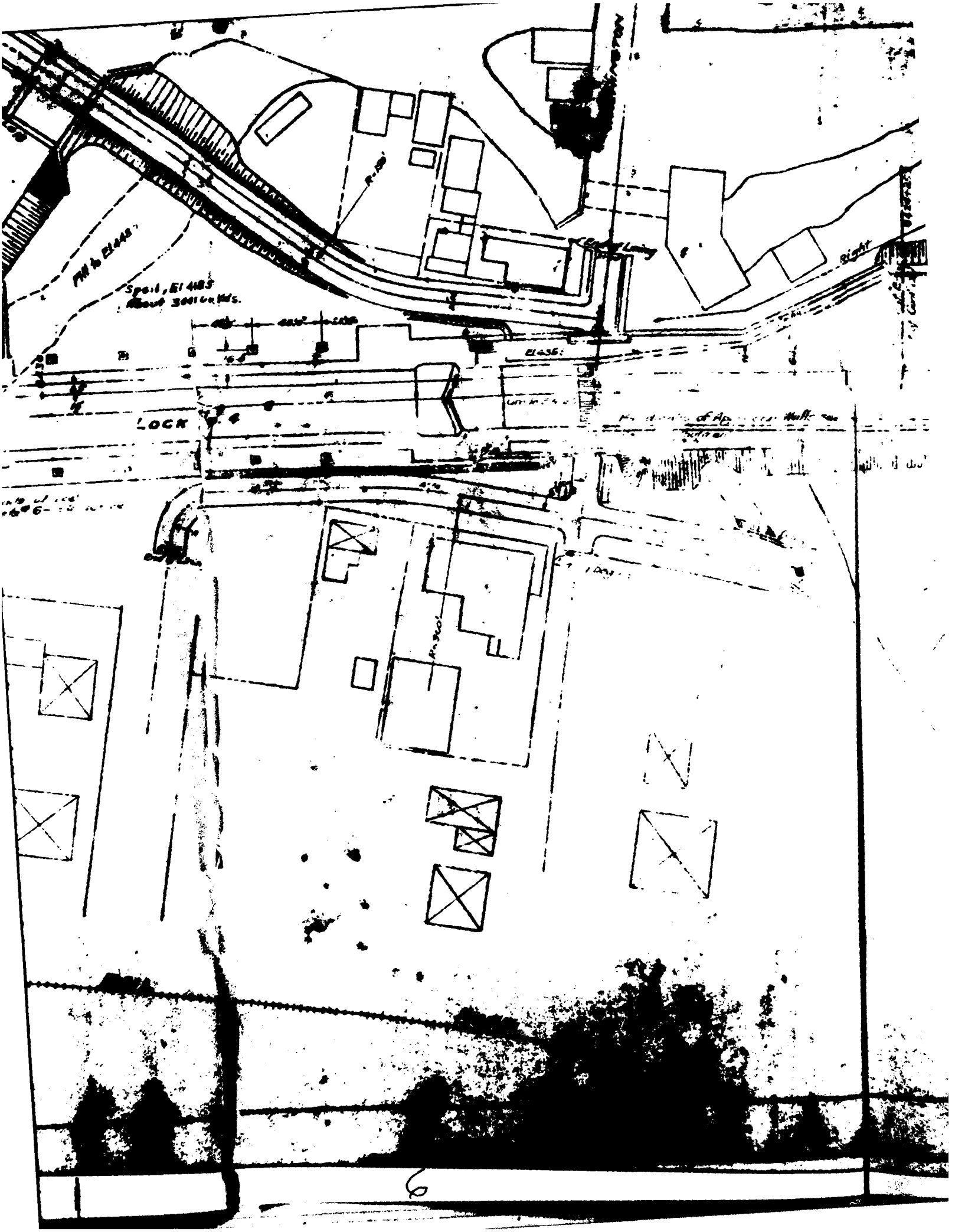


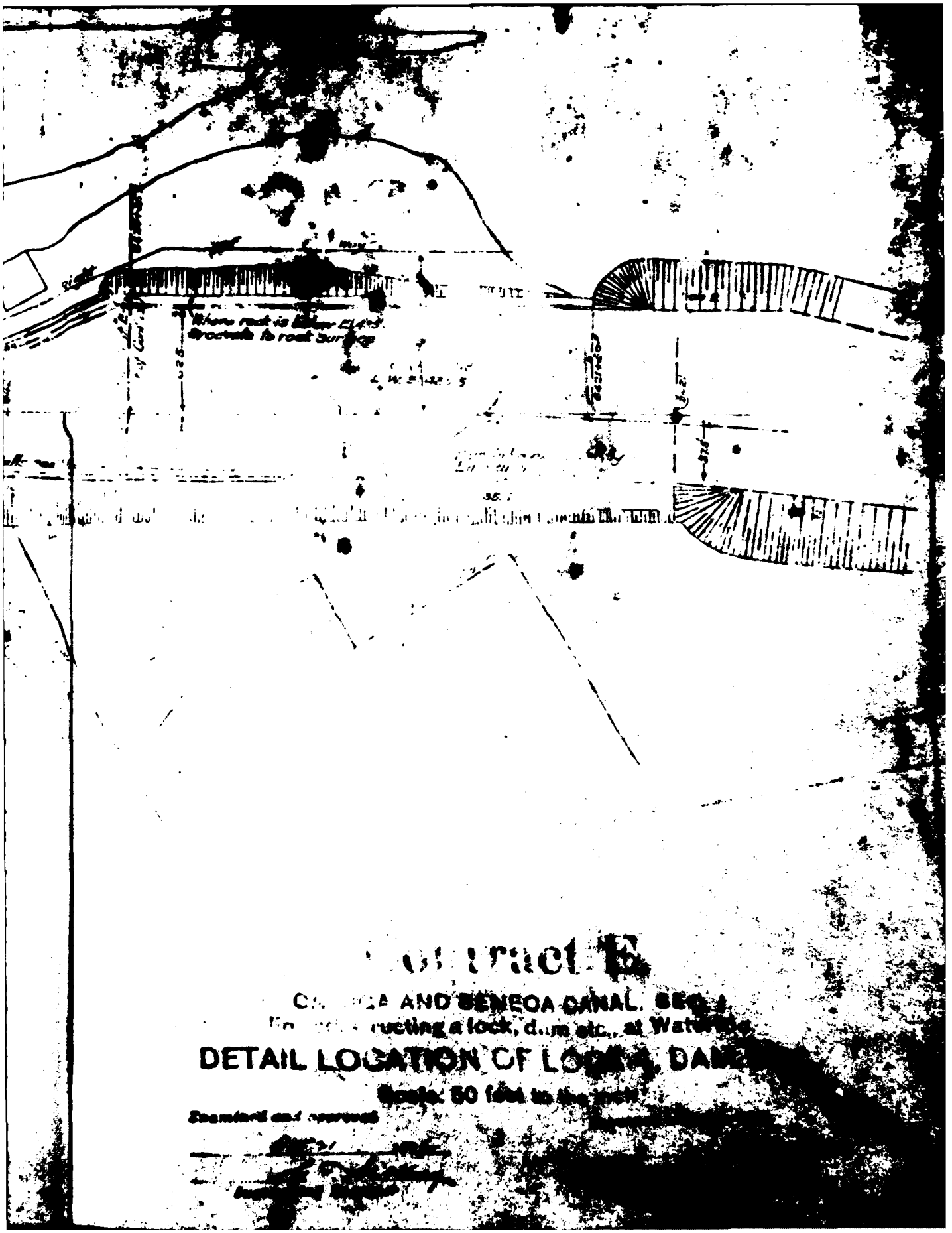

Grade El. 433.0
Limit of Cofferdam

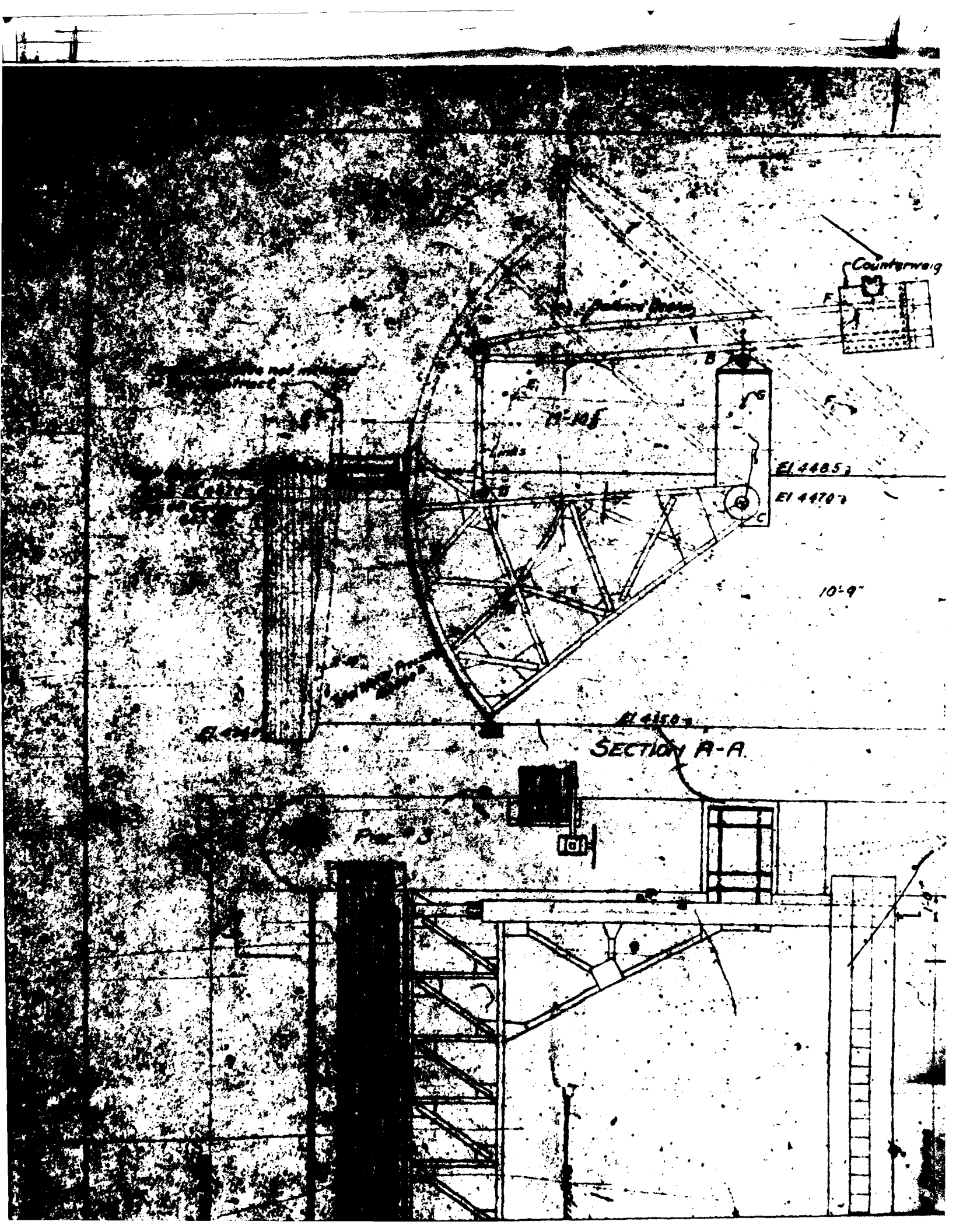

Spoil, El 445
LOCK




Approx. Limit of Const. 2
Grade El. 433.0
El. 445.0
6435
726
653.75
For details of Approach Wall see Sheet
Limit of Contract
Top of spoil
Spoil
Right
Left


LOCK

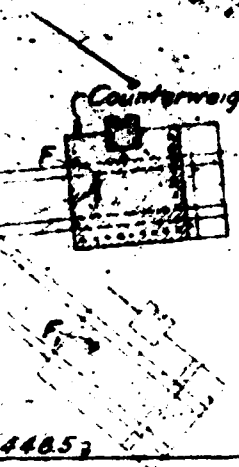

Where rock is below elevation
proceed to rock surface
Contract E
DETAIL LOCATION OF LOCK

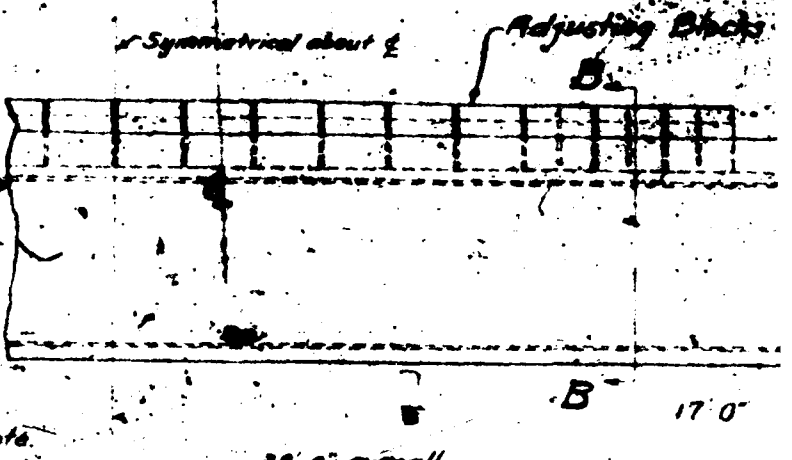

Counterweig
El 4485
El 4470
10'-9"
El 4350
SECTION A-A

2

Description

E is the center of gravity of the gate and one half of the links (figured as concentrated at D) weight about 33000 #
E same as above but gate raised.
F is the center of gravity of the counterweight, Balance Beams and one half of the Links (figured as concentrated at A) weight about 18000 #
The figure A-B-C-D is a parallelogram. The lines BF and CE are parallel in all positions of the gate.
G is the center of gravity of all the moving parts in all positions of the gate.





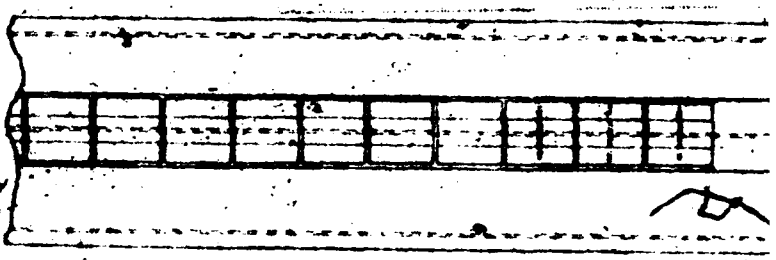
38'-0" overall

Counterweight

After shop drawings (except for counterweight, have been approved the exact size and position of the counterweight will be furnished.

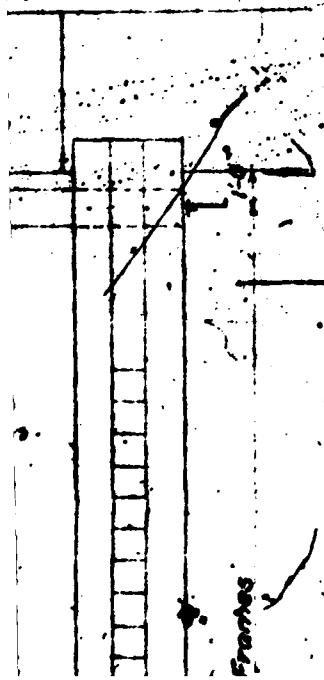
After the gate is erected and main counterweight is in place, test gate with operating machinery and add Adjustment Blocks so as to obtain approximately equal ease of operation in either direction.

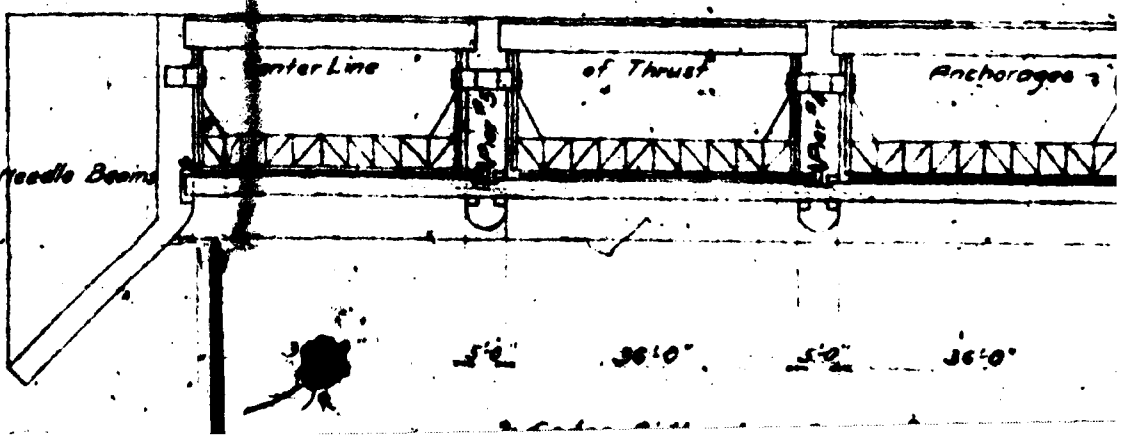
Adjustment Blocks must be finally grouted in place, and must be placed symmetrically from center to ends, leaving ends of recess open for drainage.

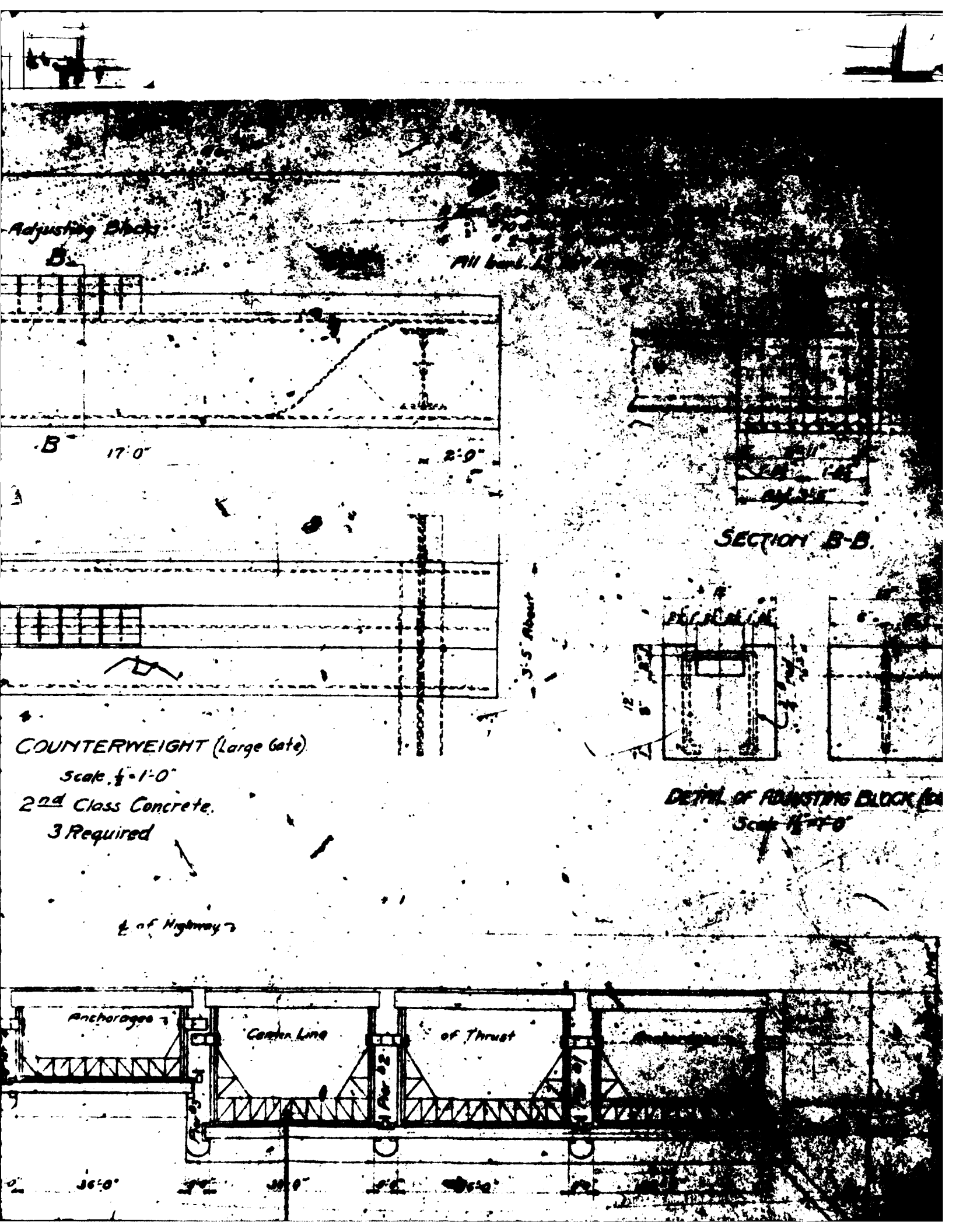


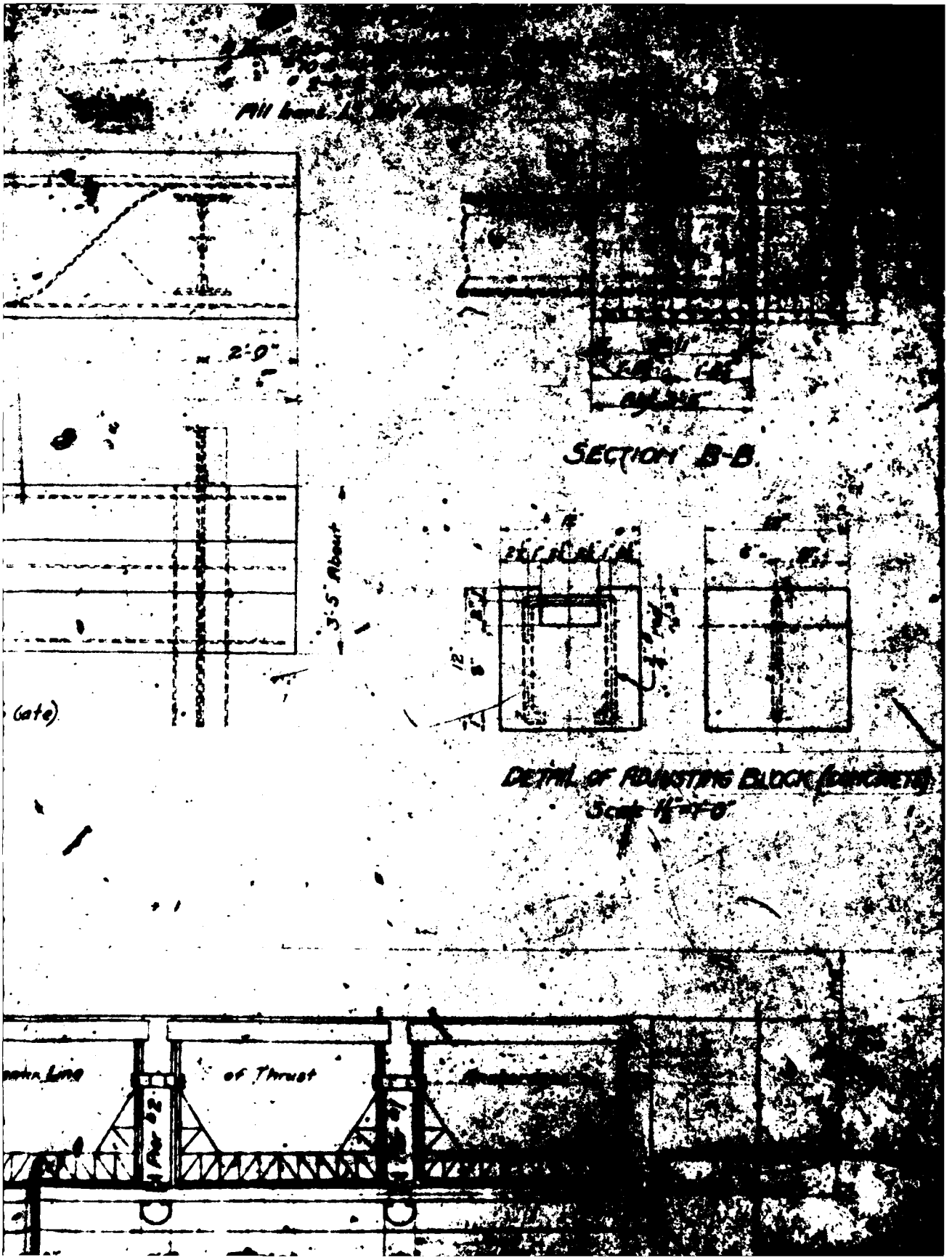
COUNTERWEIG
Scale ½"=1'-0"
2nd Class Concr
3 Required

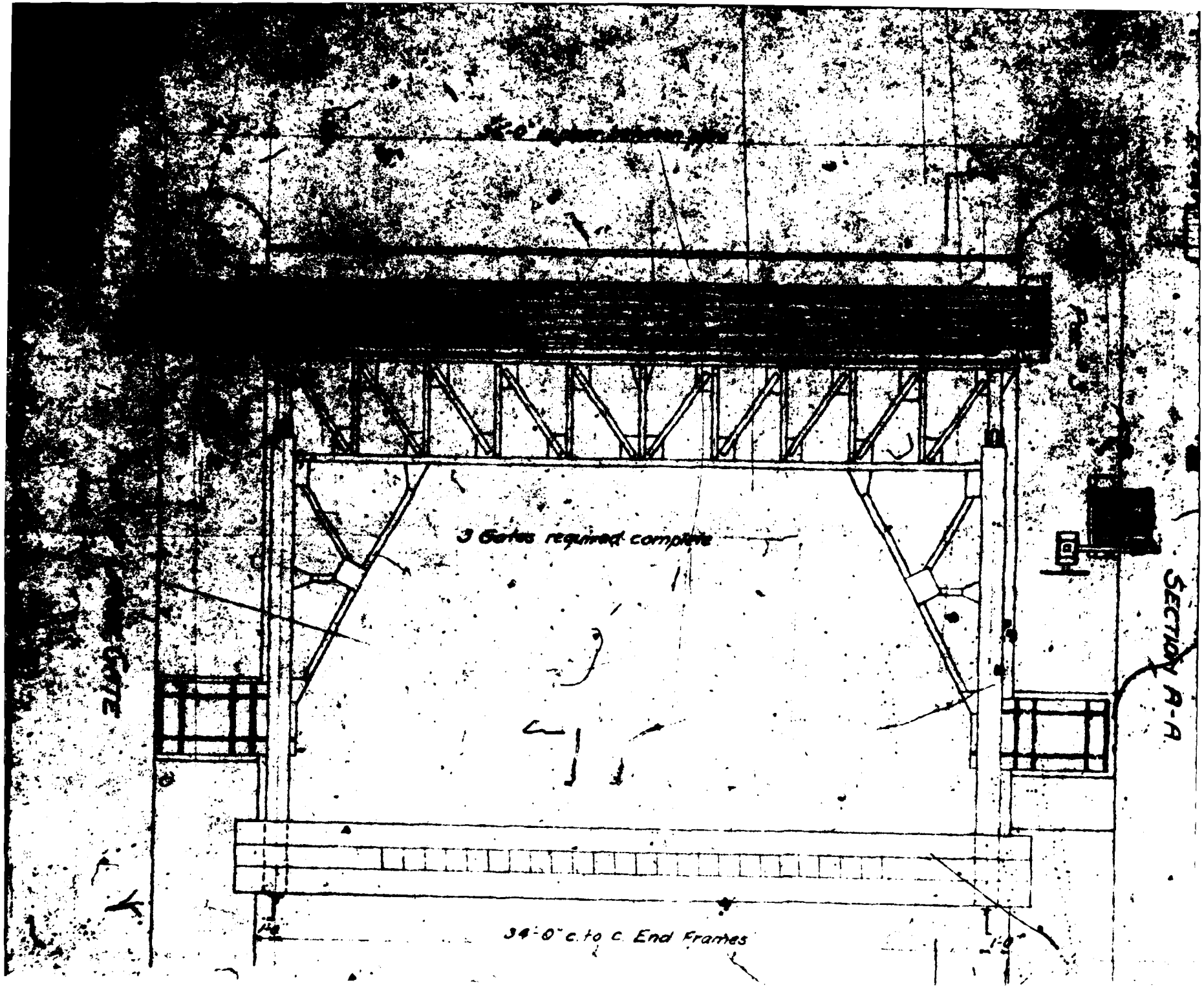
4465
4470
10'-9"
Clearance Line






Adjusting Blocks
B
B
17'-0"
2'-0"
SECTION B-B
3'-5" About
COUNTERWEIGHT (Large Gate)
Scale, ½"=1'-0"
2nd Class Concrete.
3 Required
DETAIL OF ADJUSTING BLOCK
Scale ½"=1'-0"
℄ of Highway
Anchorages
Center Line
of Thrust
36'-0"
36'-0"

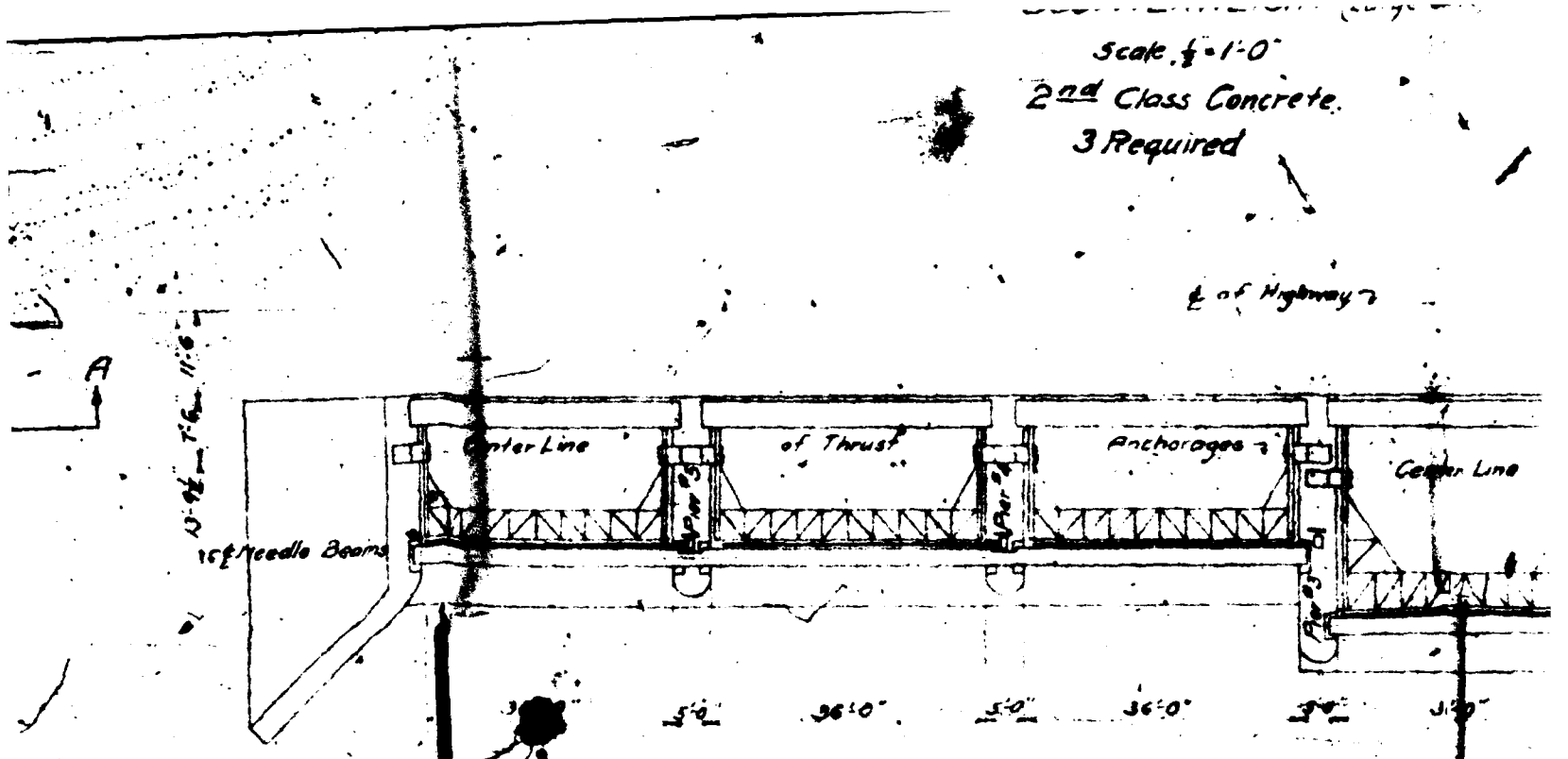

2'-0"
3'-5" About
(gate)
SECTION B-B
DETAIL OF ADJUSTING BLOCK (CONCRETE)
Scale 1/2"=1'-0"
of Thrust


3 Gates required complete
34'-0" c. to c. End Frames
SECTION A-A.

Scale ½" = 1'-0"

2nd Class Concrete.

3 Required

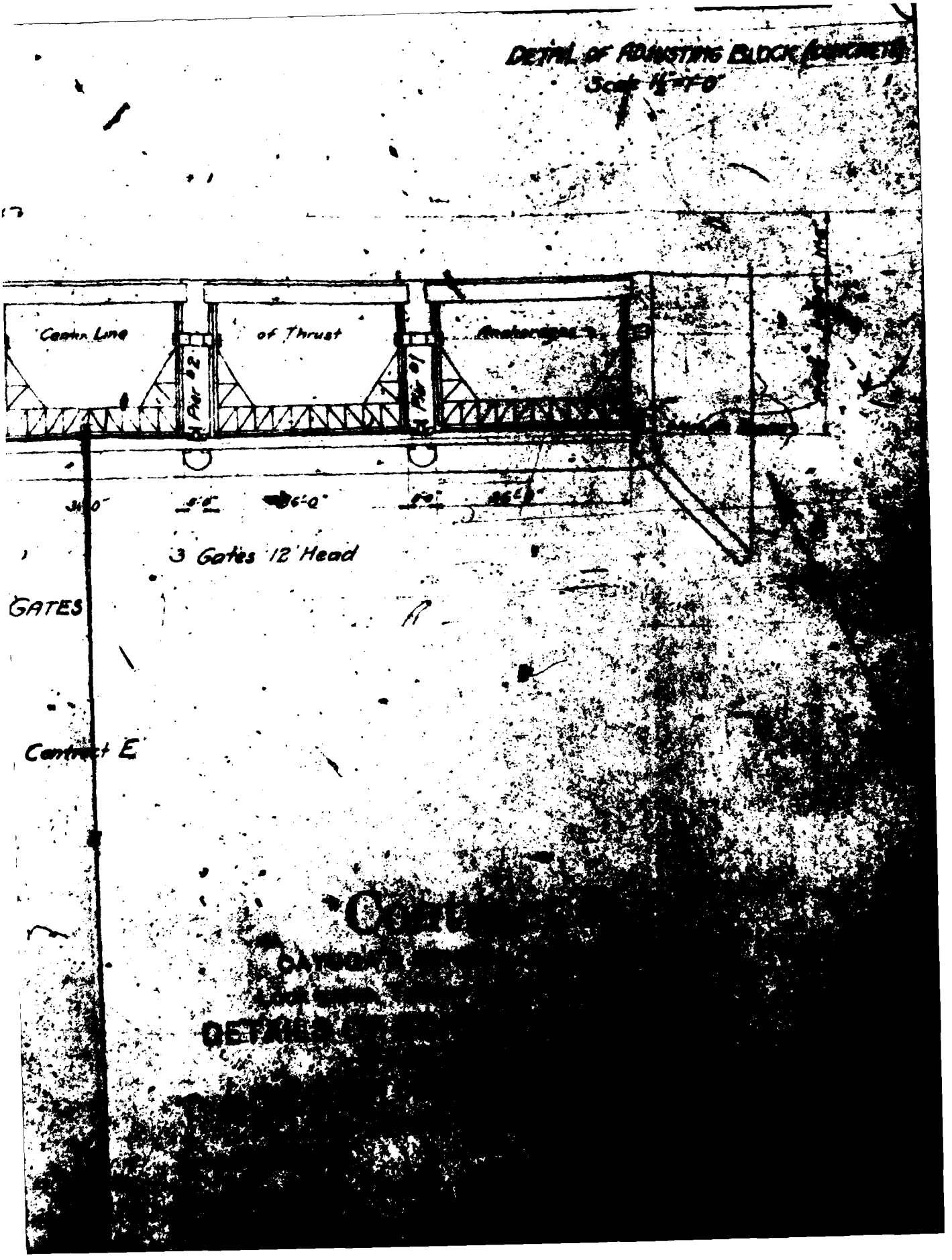


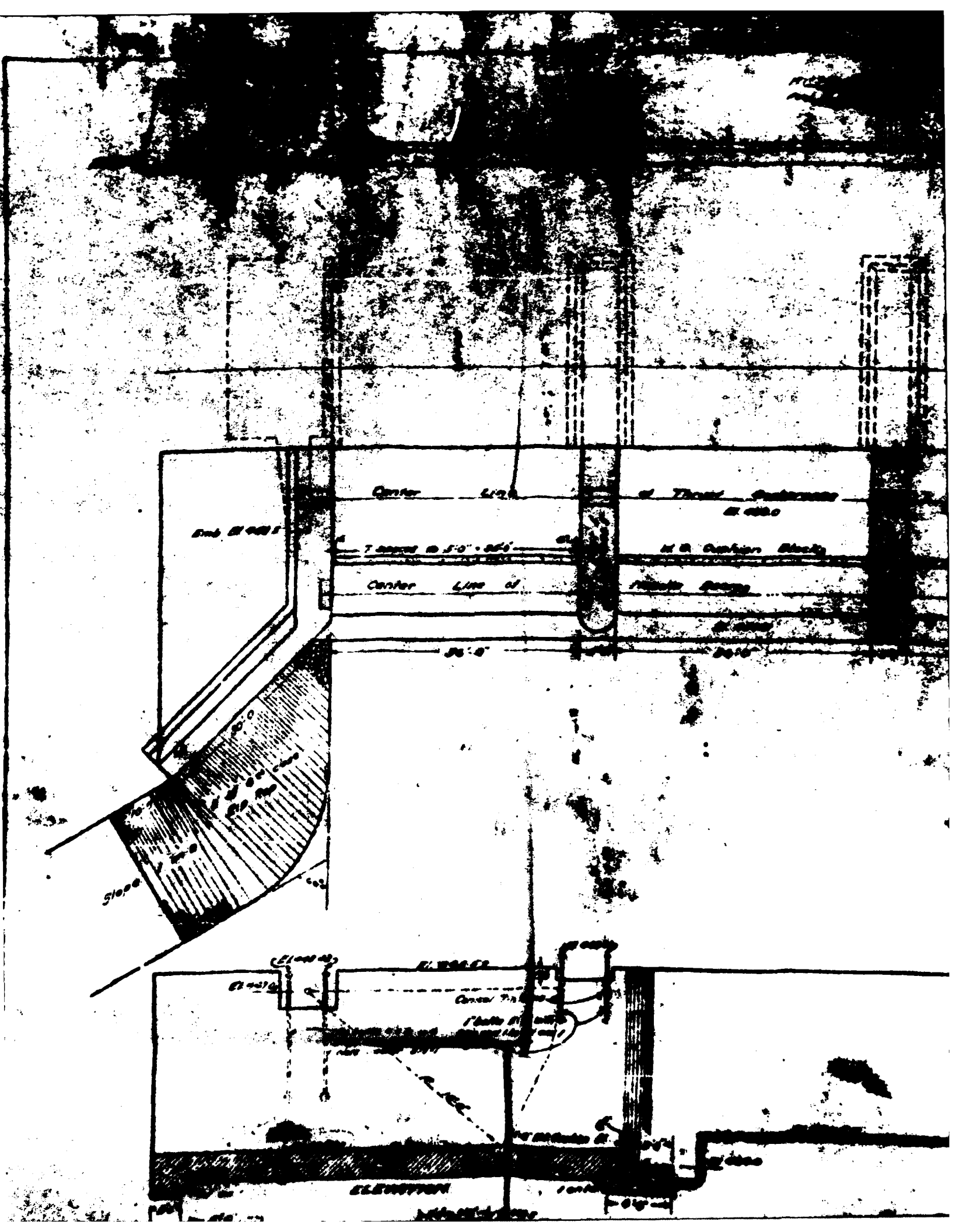
3 Gates 8' Head

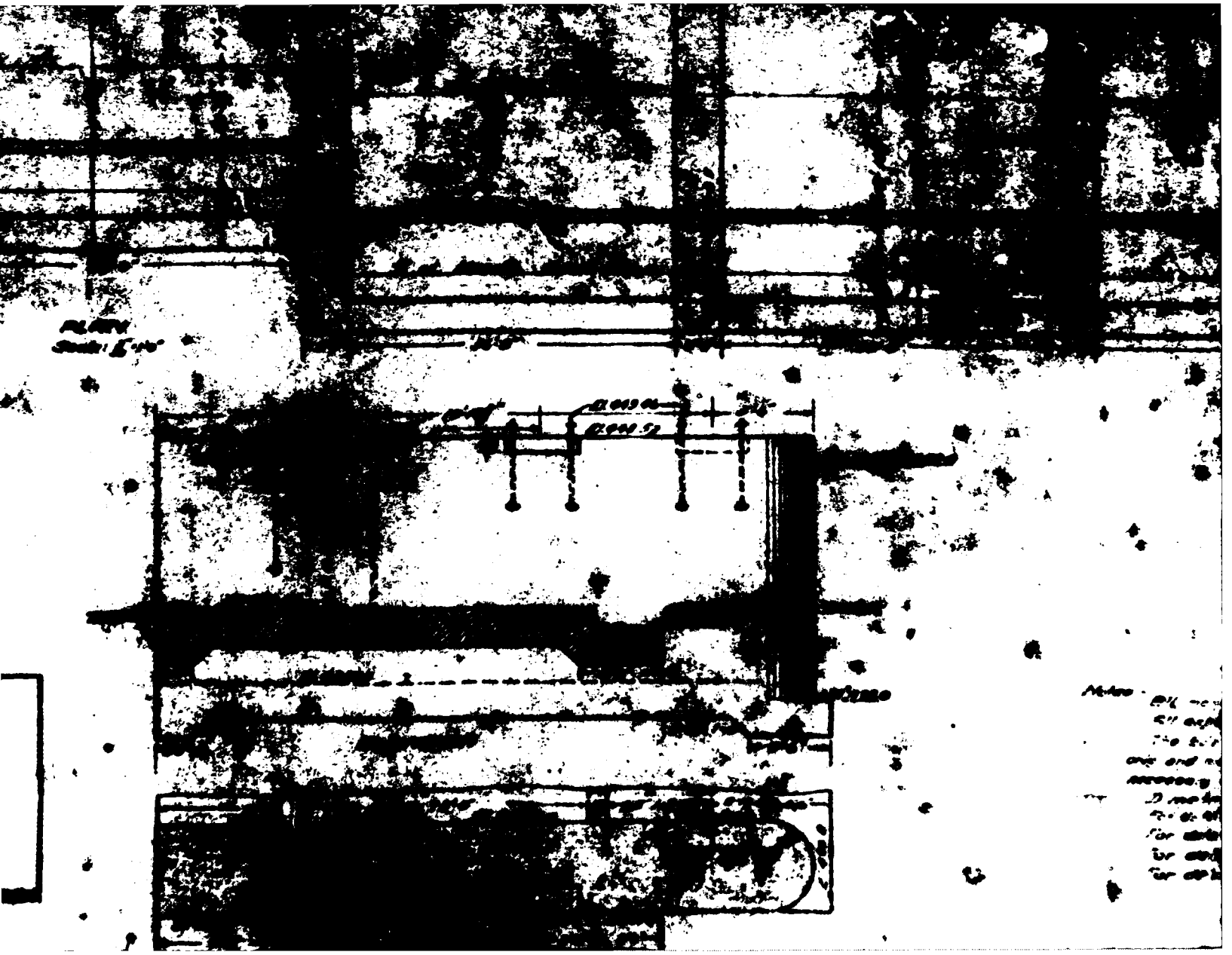
PLAN OF TAINTOR GATES

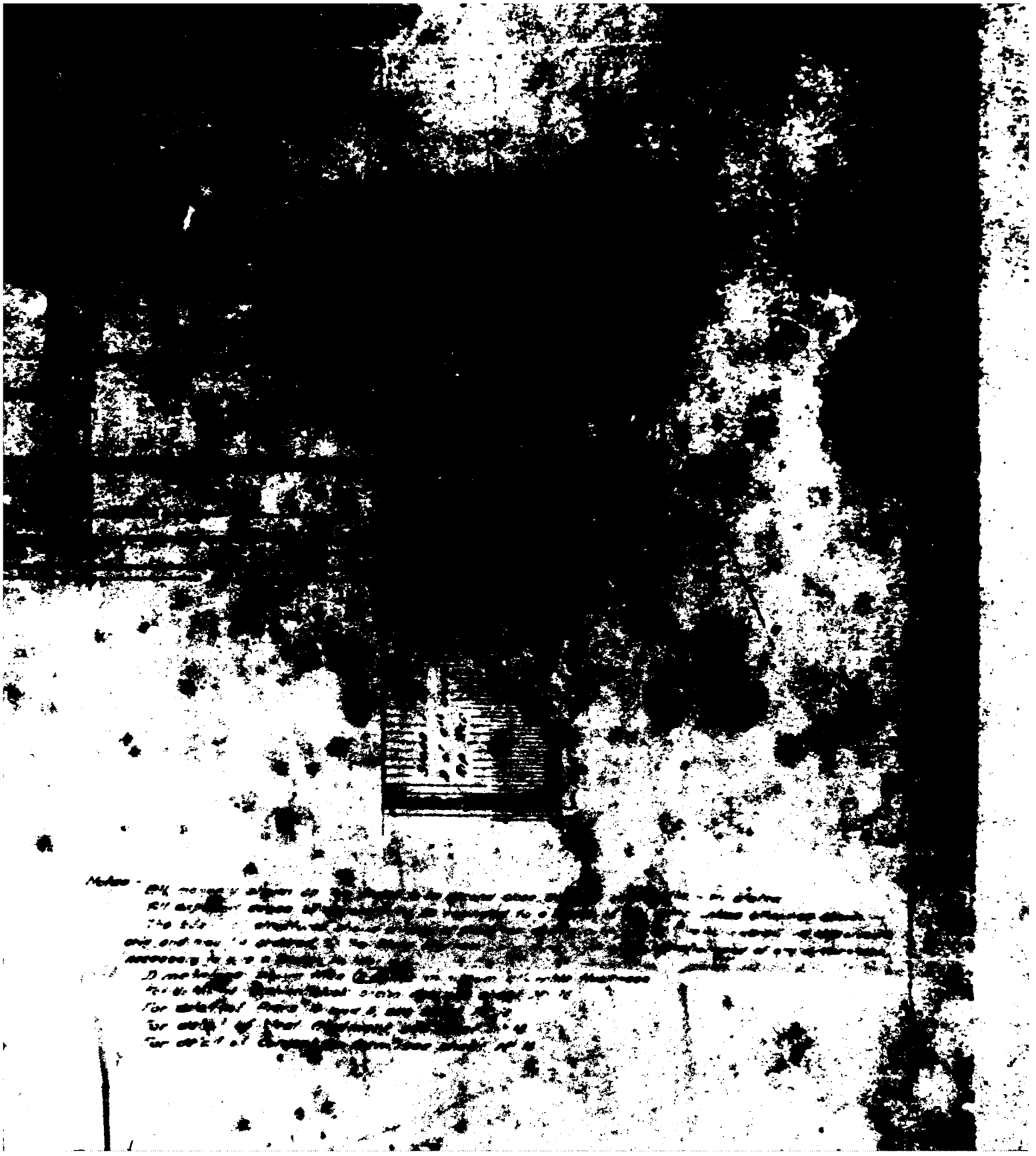
Scale ½" = 1'-0"

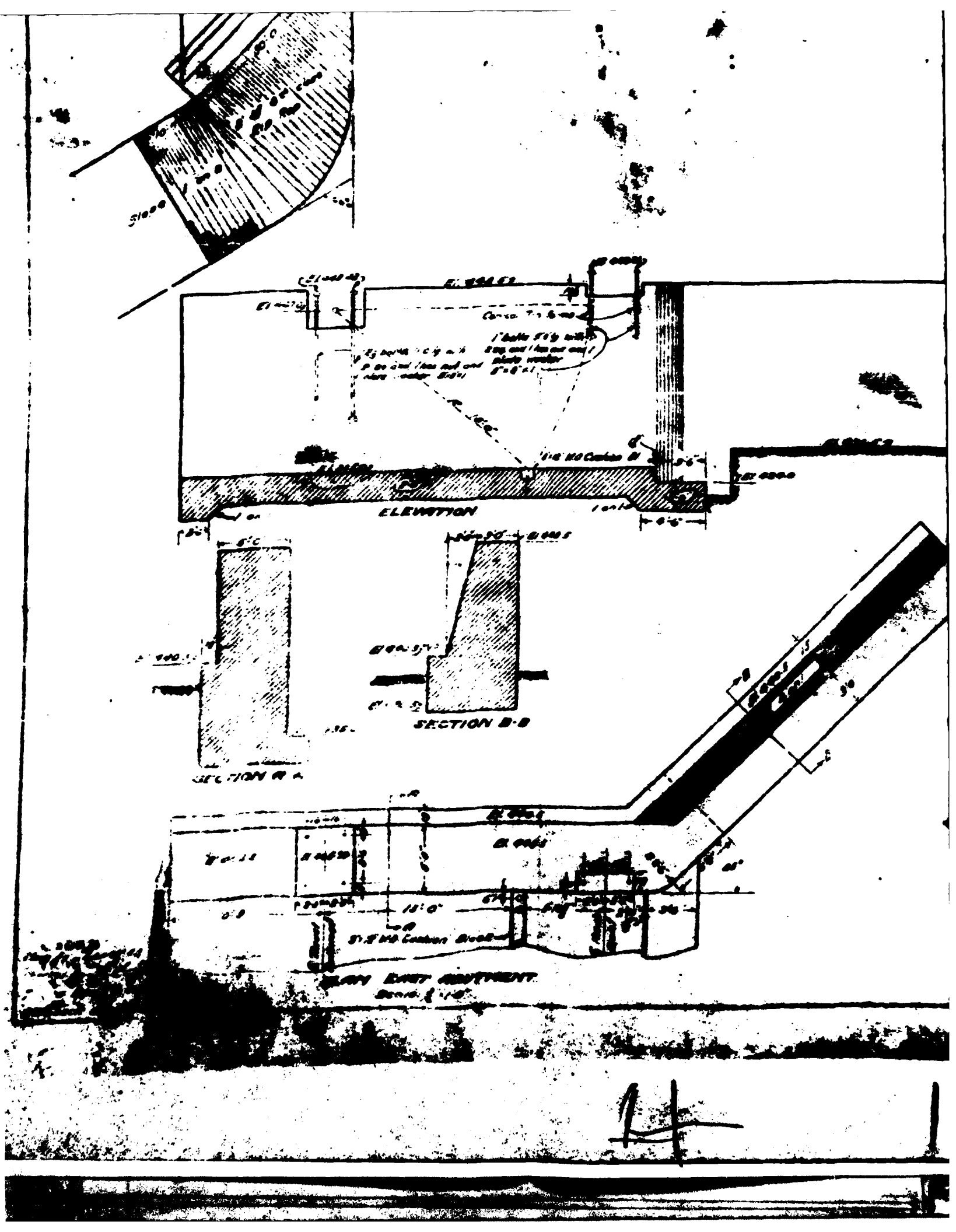
For details of substructure see Contract E sheets 18 and 25.

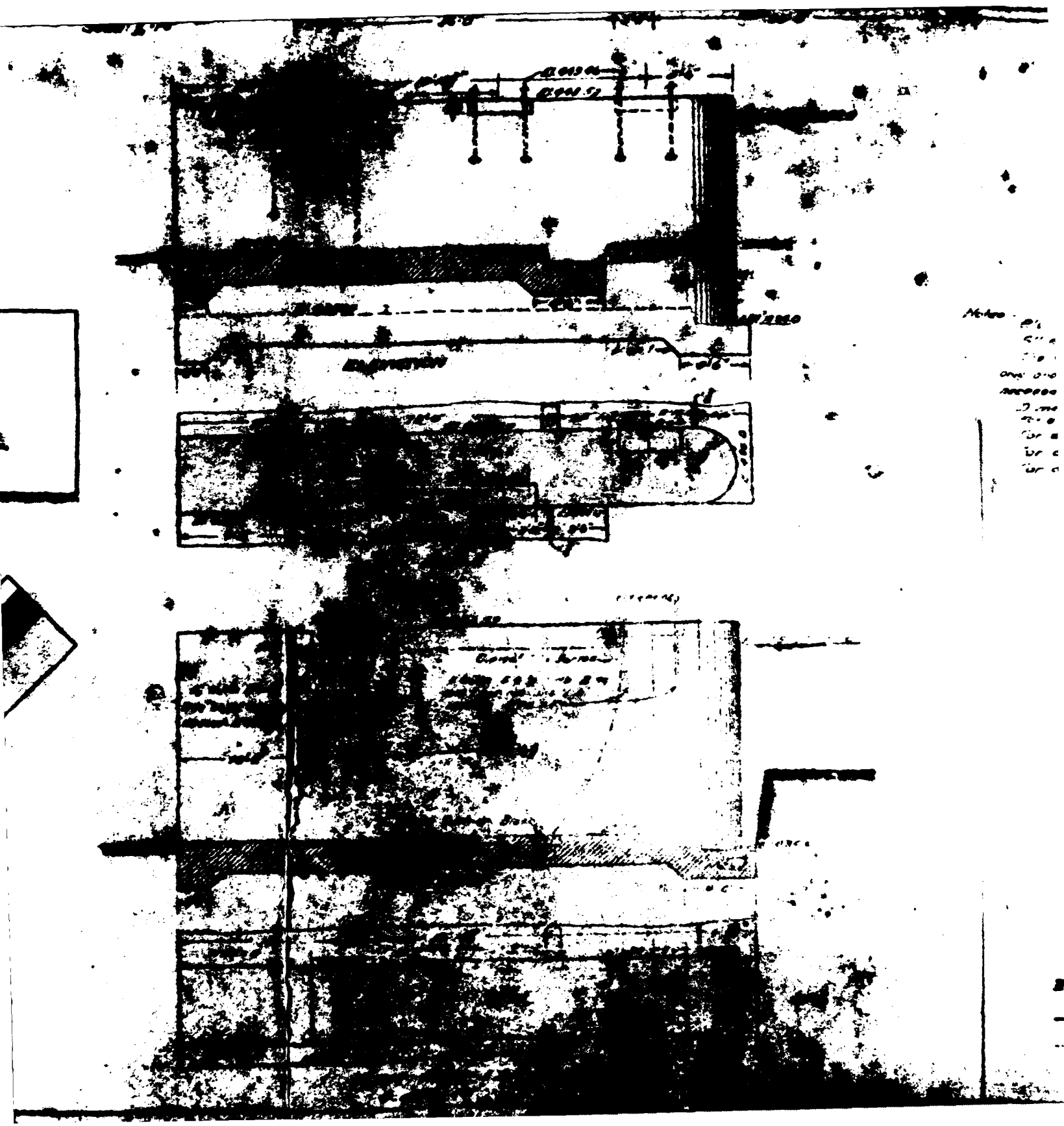

DETAIL OF ADJUSTING BLOCK (CONCRETE)
Scale 1/2"=1'-0"
Center Line
of Thrust
Pier #2
Pier #1
3'-0"
5'-0"
6'-0"
5'-0"
3 Gates 12' Head
GATES
Contract E

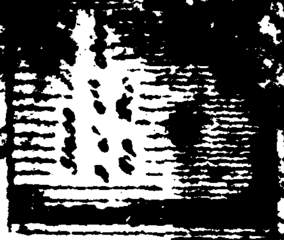

Center Line of Thrust
Center Line of
ELEVATION






ELEVATION
SECTION B-B
SECTION A-A

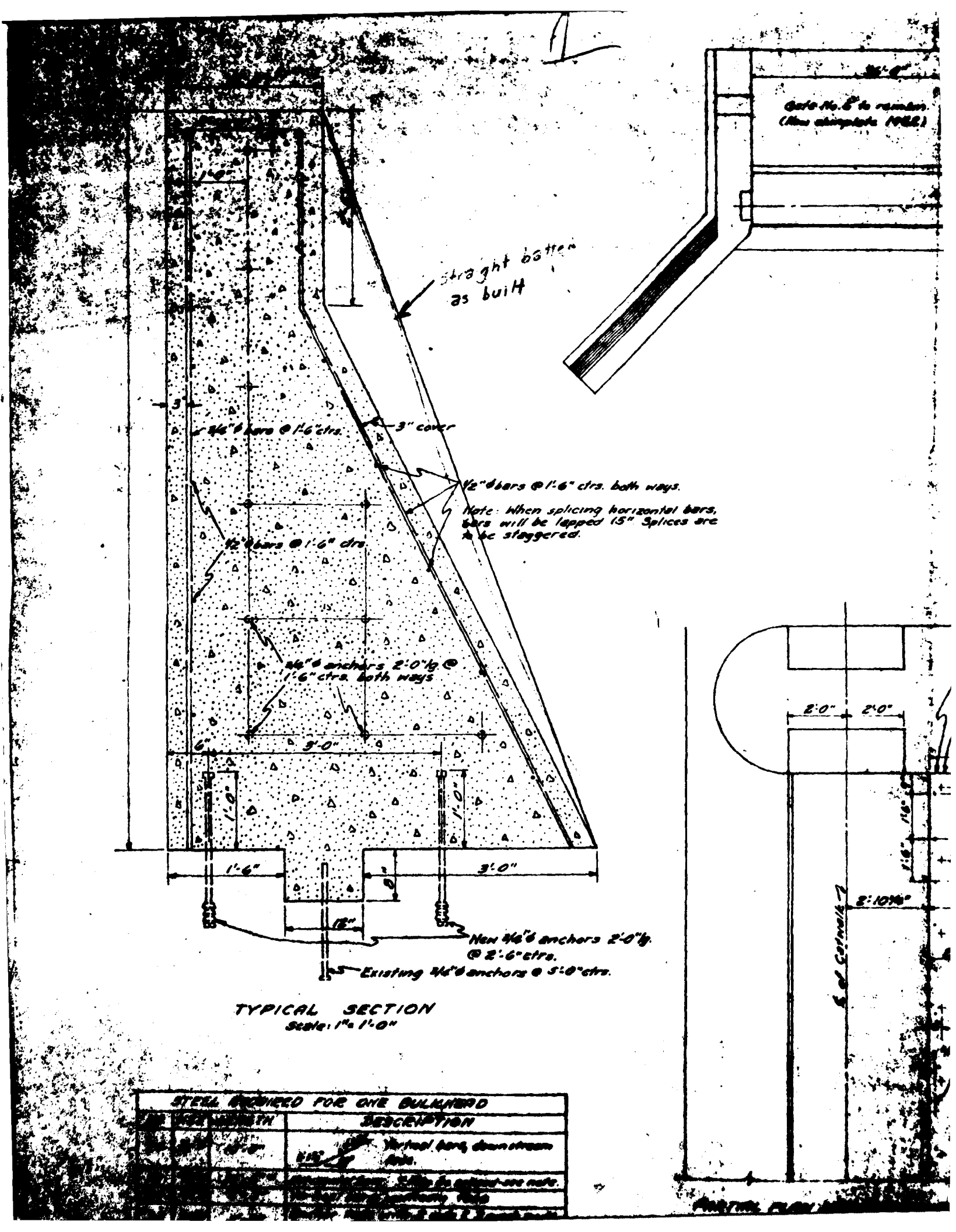




Notes - [illegible] to be placed clear [illegible]
[illegible] edges of [illegible] to be rounded [illegible] unless otherwise shown [illegible]
[illegible] structure [illegible] approved
and [illegible] ordered by the State Engineer [illegible]
necessary [illegible]
Dimensions [illegible]
For details [illegible]
For details [illegible]
For details of [illegible] Alignment [illegible]
For details of [illegible]

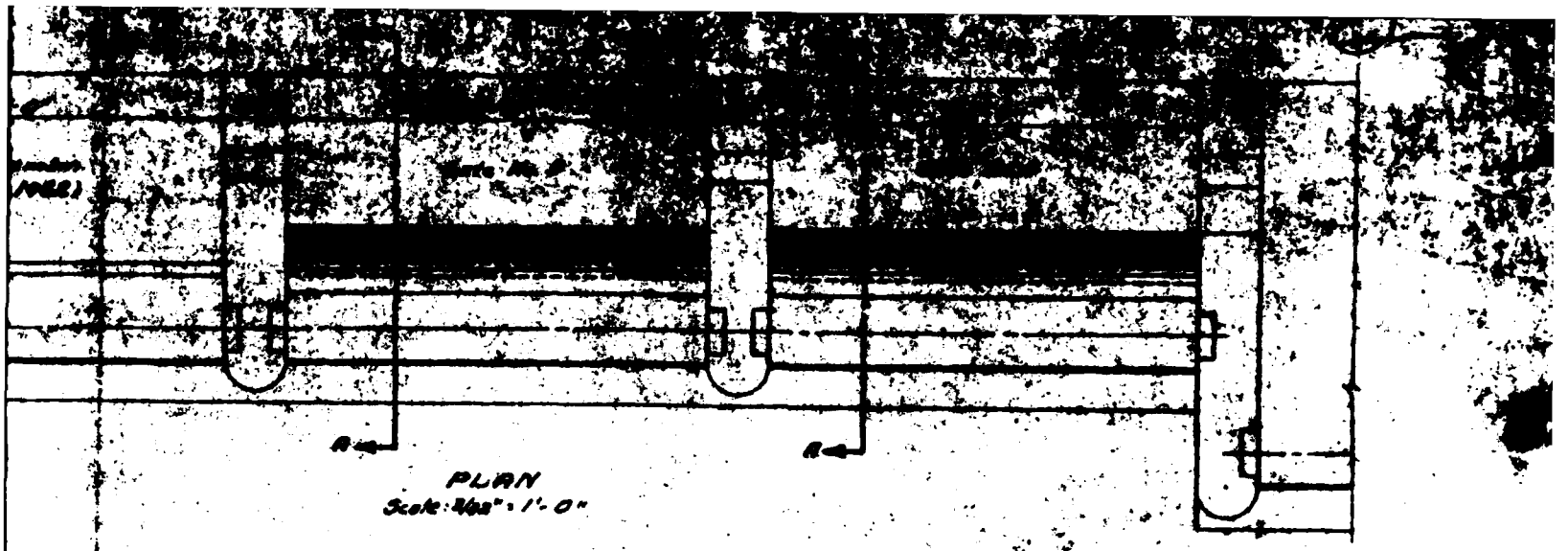
Contr [illegible]

DET [illegible]



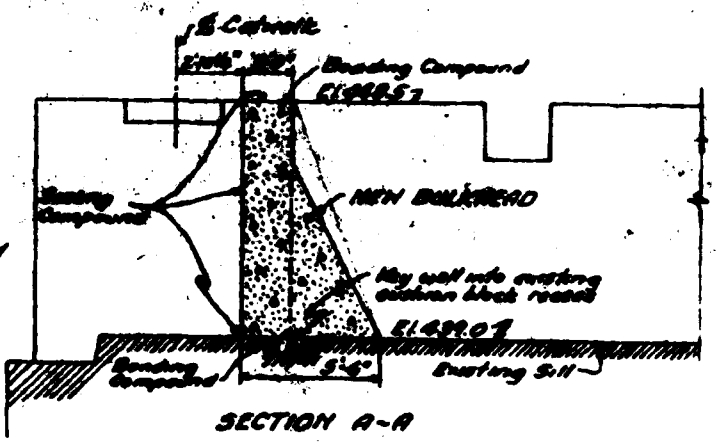
TYPICAL SECTION
Scale: 1" = 1'-0"

STEEL REQUIRED FOR ONE BULKHEAD			
			DESCRIPTION
			Vertical bars, downstream face.



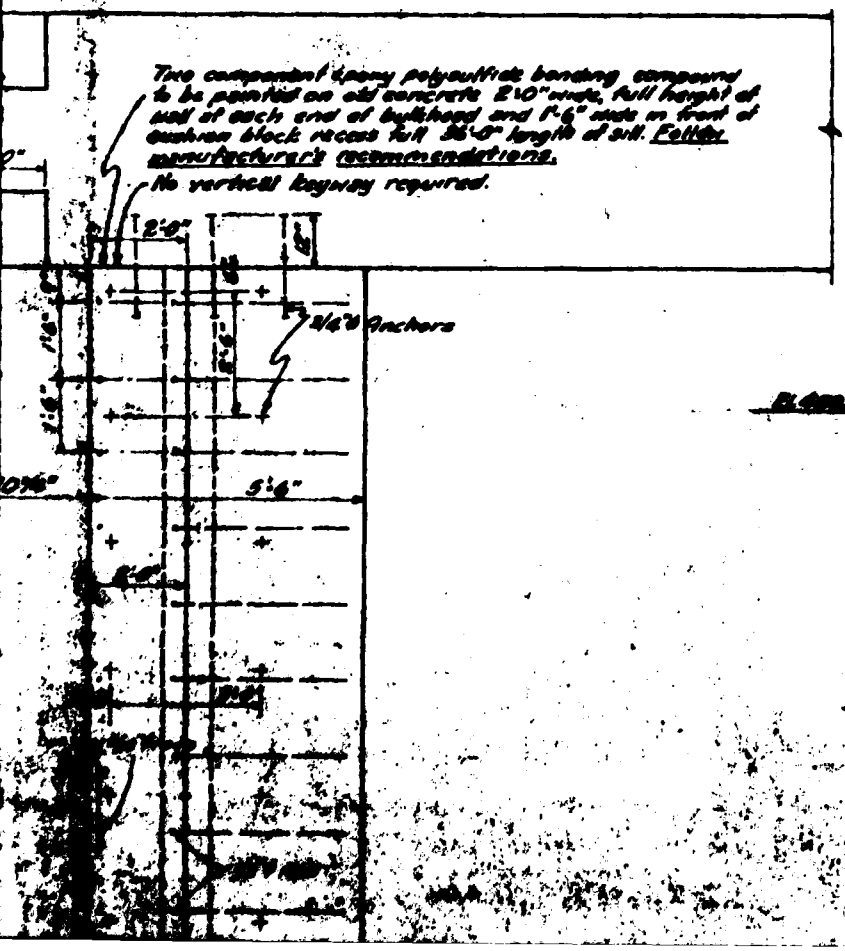
PLAN
Scale: 1/4" = 1'-0"

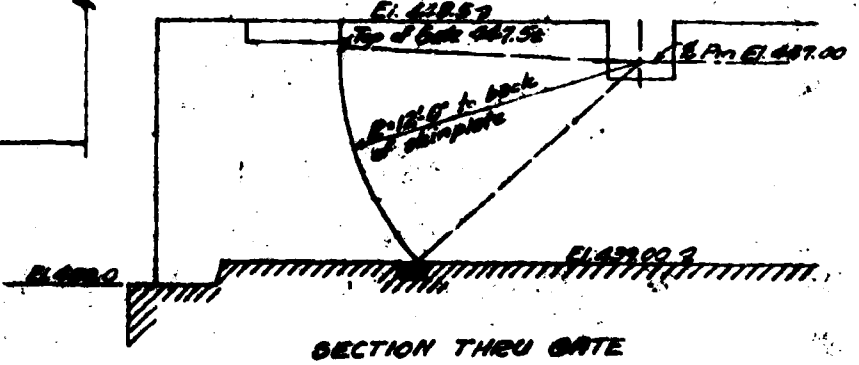
NOTE: Seal all construction joints on upstream face of bulkheads on top, bottom and ends, 6" inside - 3" on old concrete and 3" on new concrete - with clear two component Epoxy Resin Sealing Compound after removing forms. Follow manufacturer's recommendations.



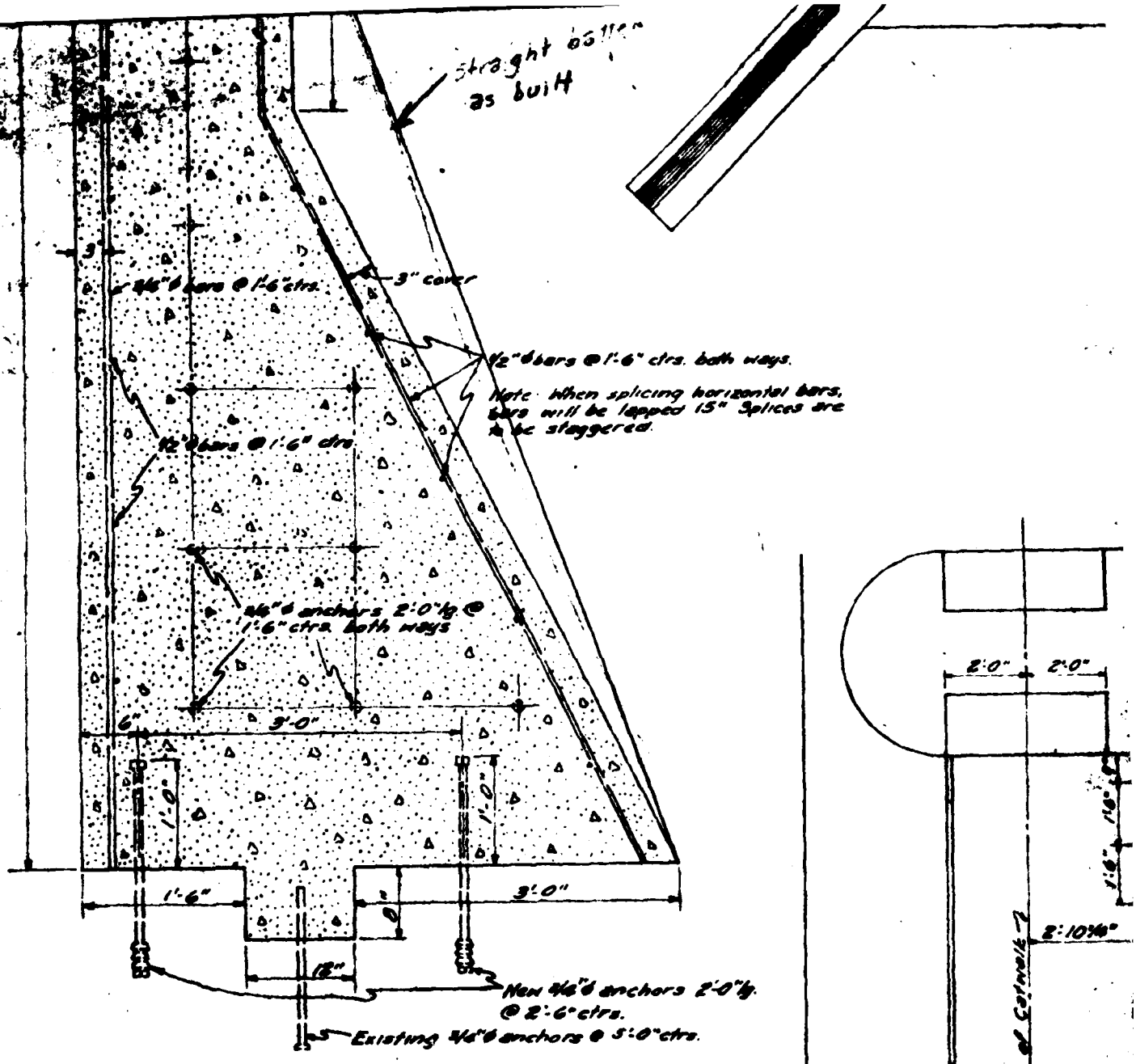
SECTION A-A

Two component Epoxy polysulfide bonding compound to be painted on old concrete 2'-0" inside, full height of wall at each end of bulkhead and 1'-6" inside in front of cushion block recess full 36'-0" length of sill. Follow manufacturer's recommendations.
No vertical keyway required.





SECTION THRU GATE



TYPICAL SECTION
Scale: 1" = 1'-0"

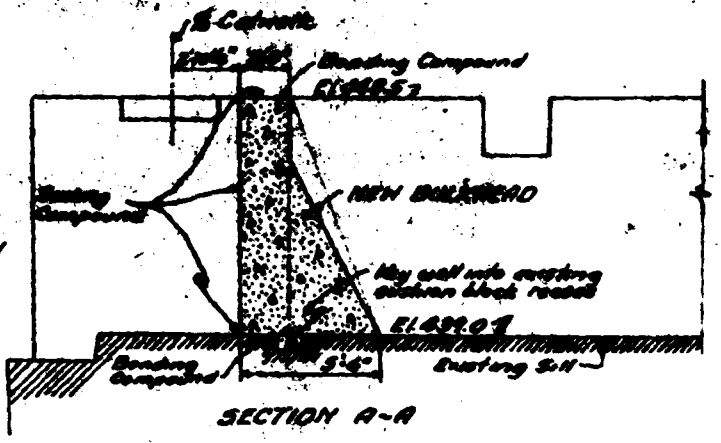
FRONTAL PLAN

STEEL REQUIRED FOR ONE BULKHEAD			
NO.	SIZE	LENGTH	DESCRIPTION
24	#6	10'-0"	Vertical bars, downstream face.
[illegible]	[illegible]	[illegible]	Horizontal bars. May be spliced-see note.
[illegible]	[illegible]	[illegible]	Vertical bars upstream face
[illegible]	[illegible]	[illegible]	Anchor rods with 2 nuts & 2 washers each end. Base and side of bulkhead.

[illegible] cubic concrete (footer and) for each bulkhead.

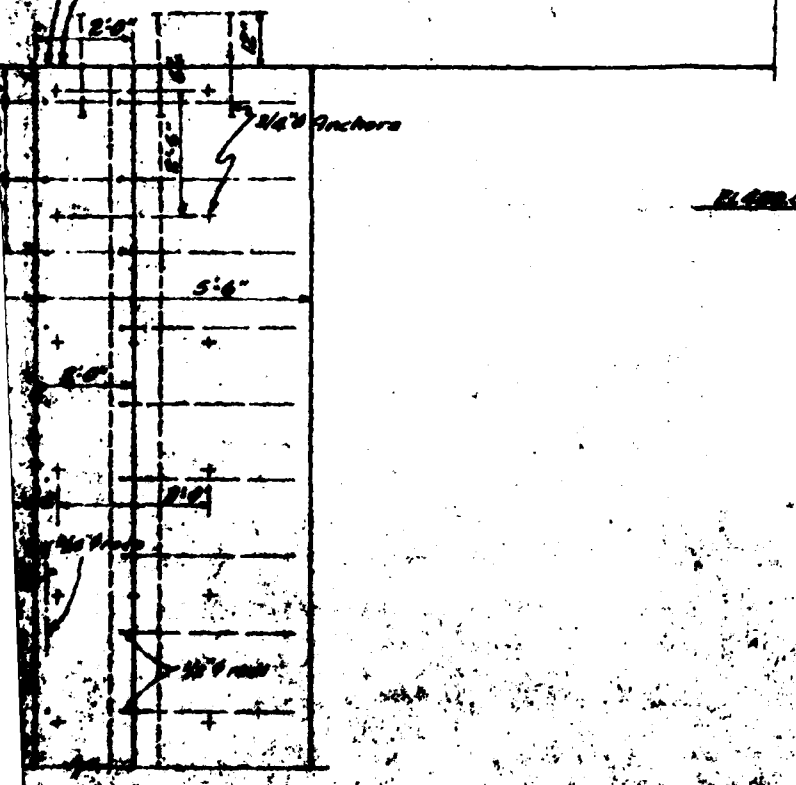
PLAN
Scale: 3/8" = 1'-0"

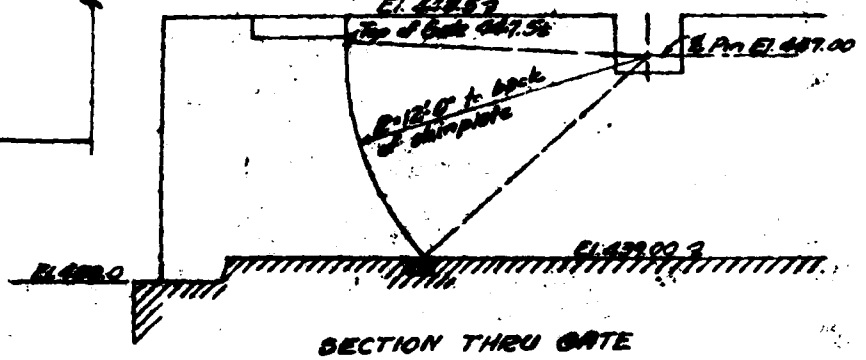
NOTE: Seal all construction joints on upstream face of bulkheads on top, bottom and ends 6" wide - 3" on old concrete and 3" on new concrete - with clear two component Epoxy Resin Sealing Compound after removing forms. Follow manufacturer's recommendations.



SECTION A-A

Two component Epoxy polysulfide bonding compound to be painted on old concrete 2'-0" wide, full height of wall at each end of bulkhead and 1'-6" wide in front of ovehion block recess full 36'-0" length of sill. Follow manufacturer's recommendations.
No vertical keyway required.





SECTION THRU GATE

PLAN FOR BULKHEADS TO REPLACE
GATES NOS 1 TO 5, WATERLOO DAM, C I S
AUGUST 1963