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NATIONAL DAM SAFETY PROGRAM. LAKE WELCH DAM (INVENTORY NUMBER N--ETC(U)
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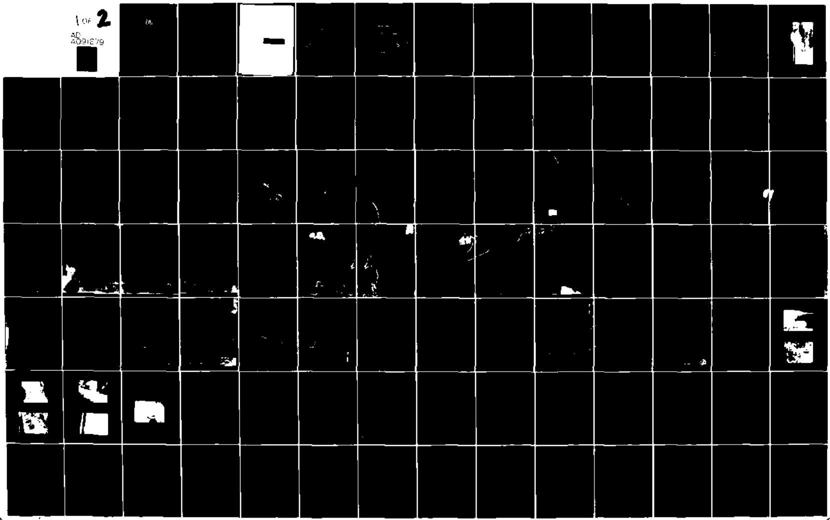

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Minisceongo Creek
Hudson River

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

This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.

Examination of the available documents and visual inspection of the Lake Welch Dam did not reveal conditions which constitute a hazard to human life or property.

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Using the Corps of Engineers screening criteria for review of spillway adequacy, it has been determined that concrete gravity section of the dam would be overtopped for all storms exceeding approximately 12 percent of the Probable Maximum Flood (PMF). Although the spillway capacity is inadequate from a hydraulic and hydrologic point of view, the hydraulic inadequacy will not affect the safety of the dam because the concrete dam is supported on the sound rock and overtopping of the dam will cause neither significant erosion at the toe or abutment nor undermine the foundation of the dam. In addition, the stability of the concrete dam section is adequate during overtopping.

The following remedial and maintenance actions should be completed within one year.

a. Establish a systematic program to observe changes of seepage occuring at the monoliths and the construction joints.

b. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.

c. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

In addition to above remedial and maintenance action the following should be considered:

a. Resurface the downstream face to the original geometry.

b. High level outlet made operable.

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~~HUDSON RIVER BASIN~~

National Dam Safety Program

LAKE WELCH DAM

(Inventory Number NY283), Hudson River Basin

ROCKLAND COUNTY, NEW YORK

[redacted]

PHASE I INSPECTION REPORT

~~NATIONAL DAM SAFETY PROGRAM~~

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PREFACE

This report is prepared under guidance containted 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 investigations, 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 aid 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.

NATIONAL DAM SAFETY PROGRAM
LAKE WELCH DAM
I.D. NO. N.Y. 283
D.E.C. #196-854
HUDSON RIVER BASIN
ROCKLAND COUNTY, NEW YORK
PHASE I INSPECTION REPORT

CONTENTS

APPENDICES

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Lake Welch Dam (I.D. No.N.Y. 283)
State Located:	New York
County Located:	Orange
Stream:	Minisceongo Creek
Basin:	Hudson River
Date of Inspection:	April 24, 1980

ASSESSMENT

Examination of the available documents and visual inspection of the Lake Welch Dam did not reveal conditions which constitute a hazard to human life or property.

Using the Corps of Engineers screening criteria for review of spillway adequacy, it has been determined that concrete gravity section of the dam would be overtopped for all storms exceeding approximately 12 percent of the Probable Maximum Flood (PMF). Although the spillway capacity is inadequate from a hydraulic and hydrologic point of view, the hydraulic inadequacy will not affect the safety of the dam because the concrete dam is supported on the sound rock and overtopping of the dam will cause neither significant erosion at the toe or abutment nor undermine the foundation of the dam. In addition, the stability of the concrete dam section is adequate during overtopping.

The following remedial and maintenance actions should be completed within one year.

a. Establish a systematic program to observe changes of seepage occuring at the monoliths and the construction joints.

b. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.

c. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

In addition to above remedial and maintenance action the following should be considered:

a. Resurface the downstream face to the original geometry.

b. High level outlet made operable.

Eugene O'Brien, P.E.
New York No. 29823

Approved by:

Col. W.M. Smith, Jr.
New York District Engineer

Date: 12 Sep 80

1. OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE WELCH DAM
I.D. NO. N.Y. 283
DEC #196-854
HUDSON RIVER BASIN
ROCKLAND COUNTY, NEW YORK

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

The Phase I inspection reported herein was authorized by the State of New York, Department of Environmental Conservation by a letter dated 7 January 1980, in fulfilment of the requirements of the National Dam Inspection, Public Law 92-367, 8 August 1972.

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 and Appurtenant Structures

Lake Welch Dam, formerly known as Beaver Pond Dam is located on the east side of Lake Welch. The maximum height of dam is 32 feet. The dam is 788 feet long and consists of a concrete gravity section (563 feet) and an earth embankment (right of gravity section) with a central concrete core wall (225 feet). The concrete dam, supported on a rock foundation consists of 18 monoliths which are anchored to the rock by 25-ton post-tensioned rock anchors. According to available drawings the rock anchors are spaced along the crest 10 feet center to center and are embedded 10 feet into rock. (See drawings given in the Appendix A). The gravity section has a maximum height of 32 feet and a crest width of 3.5 feet. The upstream slope is vertical and downstream slope is 1.6V to 1H. The concrete includes a 152 foot-long spillway portion, the crest of which is one foot below the top of the dam.

The earth embankment at the left side of the concrete dam is about 10 feet wide at the crest and has a maximum height of 19 feet. The upstream slope is about 1V on 2.5H and covered with riprap. The downstream slope is 1V on 3H. A central corewall extends 2 feet from dam crest to the rock.and is about 1.6 feet wide at the top. The slope of the upstream face of the wall is vertical; the downstream face is battered downstream at 4V on 1H from the top of wall to a depth of about 6 feet,and vertical to the remainder of the depth.

There are two regulating outlet pipes located through the concrete dam. The high level outlet is a 12 inch diameter cast iron pipe which discharges water from a square concrete intake structure located at the upstream face of the concrete section, about 210 feet from the left abutment. Water discharges from the reservoir into the intake structure over two 3.3-foot long by 4-inch wide slot openings, located on two walls of the structure. The sill of the openings is at El. 1010, about 6 feet below the top of the concrete dam. Discharge through the pipe may be controlled by a gate valve which is operated from the top of the structure. According to available documents, the outlet once served as a service spillway maintaining the pool at El. 1010 during low flows.

The low level outletis a 3-foot square sluiceway located through the concrete dam, about 180 feet from the left abutment. Discharge through the sluiceway is controlled by a manually operated sluice gate located at the upstream face of the dam, the control of which is located at the crest of the dam.

The two outlets and the spillway discharge into the natural channel of Minisceongo Creek.

b. Location

The dam is located within the Palisades Interstate Park. Harriman Section, about 2 miles west of the Town of Willow Grove, in Rockland County,New York.

c. Size Classification

The dam is 32 feet high, and has a lake storage capacity of 4,750 acre-feet (1,000 and to 50,000 acre-feet). Therefore, the dam is classified as "Intermediate".

d. Hazard Classification

The dam is in the high hazard potential category because a campsite, several homes along the creek and in the Town of Willor Grove, state Route 210 and the Palisades Interstate Parkway are all located within 1.5 miles downstream from the dam.

e. Ownership

Lake Welch Dam is owned, operated and maintained by the Palisades Interstate Park Commission of the New York State Department of Parks and Recreation, Administration Building, Bear Mountain, New York 10911, Tel. No. (914)786-2701.

f. Purpose of Dam

The impoundment provided by the dam is used mainly for recreation. This lake also supplies water via pipelines to campsites at the lake.

g. Design and Construction History

Original design and construction records are not available. It is reported the construction of the dam was completed in 1937. The designer of the original dam was Mr. W.A.Welch, Chief Engineer, Palisades Park Commission. The name of the Contractor is unknown. The concrete dam was rehabilitated in 1959 and 1979. Because of leakage the entire concrete dam was resurfaced in 1959 by applying a 3-inch "gunite" layer. In 1979, the concrete dam was again repaired because of leakage problems; in addition, the stability of the dam was improved. According to available documents, the entire concrete dam was strengthened by installing post-tensioned rock anchors from the crest of dam into the foundation. The post-tensioned rock anchors were installed and grouted in drill holes spaced at 10 feet center to center along the crest. Additional holes were drilled through the dam from the crest and pressure grouted. The design and supervision of the repairs were carried out by the engineering firm of Charles T. Main, Boston. In addition, the existing gunite surface of the downstream face was partially removed and the original concrete exposed in preparation for resurfacing later this year.

h. Normal Operating Procedure

The USGS map and available drawings show that the normal pool level once was maintained at El 1010, the level of the sill at the high level regulating outlet. Since the high level outlet pipe is now inoperative and the gate in the closed position, the lake level is maintained at the crest of the ungated principal spillway, El. 1015, about 1.3 feet below the top of the concrete dam.

1.3 PERTINENT DATA

a. Drainage Area (sq.miles) 2.87

b. Discharge at Damsite (cfs)

Principal spillway, Top of dam (El. 1016.3)	591
Sluiceway, Top of dam (El. 1016.3)	250
12-inch CI outlet pipe	Inoperative

c. Elevation (feet above MSL)

Top of dam (concrete dam)	1016.3
Top of dam (earth dam)	1019.0
Principal spillway crest	1015.0
Sluiceway invert	984

d. Reservoir

Length of normal pool (miles)	0.6
Surface area (acres)	218

e. Storage (acre-feet)

Top of principal spillway crest	4450
Top of dam	4750

f. Dam

Type: concrete gravity and earth embankment
Length (ft): concrete-563; embankment-225
Height (ft): concrete- 32; embankment- 19
Crest width (ft); concrete-3.6;embankment-10
Side Slopes: upstream - concrete-vertical; embankment-1V on 3H
downstream - concrete-1.6V on 1H
embankment-1V on 2.5H
Impervious core: embankment - concrete wall
Concrete wall (top width - ft): embankment-1.5 ft
Side slopes: upstream - vertical
downstream-4V on 1H (up to 6.0 ft from top of wall and vertical to rock foundation)

g. Spillway

Type: Broad-crested,concrete
Length (ft): 152
Crest Elevation (ft):1015.0

h. Regulating Outlets

Type:	High level - 12-inch diameter CI pipe	
	Low level - 3 foot square concrete sluiceway	
Elevation (ft):	(High level)-intake - 1010	
	outlet - 984	
	(Low level) -intake - 991.5	
	outlet - 984-	

SECTION 2 - ENGINEERING DATA

2.1 GEOLOGY

Lake Welch Dam is located in the New England Upland physiographic province of New York State. These uplands, with relief ranging from 500 to 1,300 feet above sea level, trend northeast-southwest;folds striking northeasterly and plunging slightly to the north are characteristic of the province. Fault lines throughout the New England uplands are generally parallel to the strike of the rocks. Bedrock in the vicinity of Lake Welch includes crystalline metasedimentary hornblende gneisses and leucogranitic gneisses of Precambrian Age.

2.2 SUBSURFACE INVESTIGATION

No subsurface investigation could be located for the project. However, the "General Soil Map of New York State" prepared by the Cornell University Experiment Station (1963) indicates that the surficial soils around Lake Welch Dam are of the Rockland-Chatfield Association. The Rockland, about 70% of the area, is steep slopes, gneiss rock outcrop with shallow, stony soil developed from glacial till. The remaining area is predominantly Chatfield soils that are moderately deep (less than 30 inches to bedrock), very stony and well drained,developed from glacial till derived from gneiss.

2.3 DESIGN RECORDS

The original dam was designed by Mr.W.A.Welch,Chief Engineer of the Palisades Interstate Park Commission. The dam is reported built in 1937. There are no design data or specific design memoranda available for the project features. Two contract drawings dated February 1928 were obtained from the New York State Department of Environmental Conservation and are given in Appendix A. The drawings show the plan, profile and details of the dam.

The concrete dam was resurfaced in 1959 by applying a 3 inch thick gunite surface. The details of modifications are shown on a drawing entitled "Details of Dam Repairs"dated July 17, 1958, prepared by the Palisades Interstate Park Commission and given in Appendix A.

Because of excessive seepage at the concrete dam, major modifications were made in 1979 in accordance with recommendations by Charles T. Main, Consulting Engineers, Boston, Massachusetts. The recommendations included chemical and cement grouting to control seepage through horizontal and construction joints and strengthening of the dam by installing rock anchors. The details of the modifications, shown on a construction drawing entitled "Lake Welch Dam Repairs",dated April 4, 1978 and prepared by Charles T. Main, Inc., Boston, Massachusetts, are given in the Appendix A.

2.4 CONSTRUCTION RECORDS

No detailed construction records of the original dam and the subsequent modifications are available; however, photographs and daily narratives of the 1979 repairs are available.

2.5 OPERATION RECORDS

There is no formal operation and maintenance manual for the project. There are no records of rainfall and operation of the gates and the sluiceways.

2.6 EVALUATION OF DATA

Existing information was made available by the New York State Department of Environmental Conservation, Albany, New York, and the owner.

The information obtained from the available data, the personal interviews and the visual inspection are considered adequate for the Phase I inspection and evaluation. Reviews of the original and subsequent drawings indicate some discrepancies, as follow:

a. Crest elevation of the concrete dam is incorrectly shown on 1978 repair drawings.

b. The length of spillway shown on the original drawing shows about 89.5 feet, whereas repair drawings of 1978 show about 152 feet. There are no construction records of the spillway modifications available; however, the spillway length of 152 feet was confirmed during the inspection.

c. Geometry of the downstream face of the dam is in accordance with 1978 repair drawings and not as shown on the 1929 drawings.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

The visual inspection of the Lake Welch Dam was made on 24 April 1980. The weather was sunny with the temperature at about 60°F. The reservoir level was El.1015.4 at the time of inspection, about 3 inches above spillway crest.

b. Dam

(i) The Gravity Section Including Spillway:

The concrete gravity section appears to be in generally good condition. The horizontal and vertical alignment are uniform and there is no indication of movement. The crest and the upstream face above the waterline appears to be in good condition. At the crest there are grouted holes which were drilled during the recent repairs.

The gunite surface at the downstream face of the dam has been removed and the original concrete exposed. The exposed concrete surface appears in good condition. There is minor seepage through several construction and monolith joints. Several construction joints are packed with oakum to prevent seepage.

(ii) Embankment: The earth embankment appears to be in generally good condition. The horizontal and vertical alignment of the crest are uniform.

The downstream slope does not exhibit any evidence of subsidence,erosion and sloughing. The slope is covered with ground cover, seedlings, shrubs and trees. There are no signs of seepage at the slope, toe and downstream from the toe. There is heavy vegetation, including large trees, downstream of the toe area.

The upstream slope does not show any sloughing or erosion. The slope is covered with ground cover and shrubs and trees.

c. Appurtenant Structure

The concrete surface of the low level sluiceway is in good condition. The physical condition of the downstream face of the sluice gate appears in good condition except for minor rusting. Although the gate is closed there is minor discharge emerging from the sluiceway. The operating control for the gates located at the crest appears to be in good condition. The gate was not operated during the inspection because the owner's representative did not have the keys for a padlock; the owner reports that the gate is in operating condition.

The 12-inch cast iron outlet pipe is closed and reported to be inoperable. However, there was discharge of about 1 cfs through the pipe.

d. Downstream Channel

The channel downstream of the concrete dam is Minisceongo Creek. In the vicinity of the dam, the channel floor and the side slopes are in rock. There is some vegetation including bushes and large trees, which will not impede flows over the spillway.

e. Reservoir Area

In the vicinity upstream of the dam there was no evidence of sloughing, potentially unstable slopes, or other unusual conditions which would adversely affect the dam.

3.2 EVALUATION OF OBSERVATIONS

Visual observation made during the course of the investigation revealed several deficiencies which at present do not adversely affect the adequacy of the dam. However, these deficiencies do require attention and should be corrected.

The following is a summary of the problem areas encountered, in order of importance, with the appropriate recommended action:

1. Establish a systematic program to observe and monitor changes in seepage occuring at the monoliths and construction joints.
2. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.
3. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

In addition to above remedial and maintenance the following should be considered:

a. Resurface the downstream face to the original geometry.

b. High level outlet made operable.

SECTION 4 - OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

There is no specified required release of water from the lake. The lake level is maintained at the principal spillway crest level the entire year. The low level outlet which is a 3-foot square sluiceway, is usually kept closed. The 12-inch diameter cast iron pipe is closed and reported inoperative.

4.2 MAINTENANCE OF THE DAM

The dam is maintained by the owner, Palisades Interstate Park Commission. Maintenance of the dam is considered inadequate as evidenced by the seepage through the monolith joints; at the concrete section there is extensive vegetative growth on the earth embankment and an inoperable regulation gate at the high level outlet.

4.3 WARNING SYSTEM IN EFFECT

There is no warning system in effect or in preparation.

4.4 EVALUATION

The dam and appurtenances have not been maintained in satisfactory condition as noted in Section 3: Visual Inspection.

SECTION 5 - HYDROLOGIC/HYDRAULIC

5.1 DRAINAGE BASIN CHARACTERISTICS

Lake Wlech Dam is located about 2 miles west of Willow Grove in Rockland County, New York. The total drainage area contributing to the lake is 2.87 square miles of which the lake occupies 234 acres or 13% of the area. The basin is a part of the Palisades Interstate Park and is mainly undeveloped except for a few campsites. Relief in the drainage area is fairly steep, varying from E. 1015 (lake surface) to ridges above El 1200.

5.2 ANALYSIS OF CRITERIA

The analysis of Lake Welch Dam was performed using the U.S. Army Corps of Engineers HEC-1 computer program 1/. The Probable Maximum Precipitation (PMP) was obtained from Hydrometeorological Report No. 51 4/. The unit hydrograph was computed using the Snyder method 6/ and average regional coefficients were 2 and 400 for C_t and 640 C_p, respectively. It was assumed that there would be an initial rainfall loss of 2 inches and that the constant loss rate would be 0.5 inches per hour. It was also assumed that both outlets were closed during the flood event. In accordance with the recommended guidelines of the Corps of Engineers 7/, the adequacy of the spillway was analyzed using the Probable Maximum Flood (PMF) and one-half the PMF.

5.3 SPILLWAY CAPACITY

The principal spillway is located at the concrete dam. The length of spillway is about 152 feet with a 3.5-foot wide concrete sill at El 1015. The maximum discharge capacity of the principal spillway is 591 cfs.

5.4 RESERVOIR CAPACITY

Normal capacity of Lake Welch at El 1010 (equivalent to the intake elevation of high level outlet) is reported to be about 3440 acre-feet 7/. The computed storage between El 1010 and El 1015 (principal spillway crest) is about 1010 acre-feet. Total reservoir capacity to the top of the concrete dam (El 1016.3) is about 4750 acre-feet. The available surcharge storage between the spillway crest and the top of the dam is about 291 acre-feet which is equivalent to about 1.9 inches of runoff over the entire basin.

5.5 FLOODS OF RECORD

There are no available records of floods or maximum lake elevations.

5.6 OVERTOPPING POTENTIAL

The potential of the dam being overtopped was investigated on the basis of the spillway discharge capacity and the available surcharge storage to meet the selected design flood inflows.

The Probable Maximum Flood routed through the lake caused the lake surface to rise to El 1018.41, 2.11 feet above the concrete dam, but does not overtop the embankment (El 1019.0). The one-half Probable Maximum Flood routed through the lake caused the lake surface to rise to El 1017.41, 1.11 feet above the concrete dam. The peak outflow discharge was 4765 cfs.

Using the Corps of Engineers criteria, the maximum spillway capacity without overtopping the dam is 12% of PMF outflow.

5.7 EVALUATION

The dam does not have sufficient spillway capacity to pass either the PMF or one-half the PMF without overtopping the dam. On the basis of this investigation the project discharge capacity is considered to be inadequate from a hydrologic and hydraulic point of view; however, overtopping of the dam under the PMF would cause neither significant erosion at the toe or abutment nor undermine the foundation of the dam.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Visual observations did not indicate condition which would adversely affect the structural stability of the dam. The observed seepage through the monolith and construction joints of the concrete dam are not detrimental to the dam's stability or safety at the present time.

b. Design and Construction Data

The original preconstruction design computations regarding the structural stability of the dam or spillway are not available. Stability analysis of the concrete dam with the rock anchors was carried out by Charles T. Main, Inc., Consulting Engineers, Boston, Massachusetts, for the 1979 rehabilitation program; these are given in the Appendix F.

c. Operating Records

There are no available records of reservoir elevation and gate operation. No major operational problems which would affect the stability of the dam were reported.

d. Post Construction Changes

The concrete dam was resurfaced in 1959 by applying a 3 inch thick gunite surface. The details of modifications are shown on a drawing entitled "Details of Dam Repairs" dated July 17, 1958, prepared by the Palisades Interstate Park Commission and given in Appendix A.

Because of excessive seepage the concrete dam, major modifications were made in 1979 in accordance with recommendations by Charles T. Main, Consulting Engineers, Boston, Massachusetts. The recommedations included chemical and cement grouting to control seepage through horizontal and construction joints and strengthening of the dam by installing rock anchors. The details of the modifications, shown on a construction drawing entitled "Lake Welch Dam Repairs", dated April 4, 1978 and prepared by Charles T. Main, Inc., Boston, Massachusetts, are given in the Appendix A.

e. Seismic Stability

According to the recommended Corps guidelines, the dam is located in Seismic Zone No.1. However, based on past earthquake history, the New York State Geological Survey considers the site to be in Zone 2. Based on this assessment the dam is considered in the Seismic Zone 2. The results of Seismic Stability are described in Section 6.2.

6.2 STRUCTURAL STABILITY ANALYSIS

The available structural stability analysis of the non-overflow section of the concrete dam was reviewed. The method of analysis and stability criteria, except the values of sliding coefficients, were computed in accordance with EM 1110-2-2200 published by the Corps of Engineers, U.S. Army. The sliding coefficient values used were higher than recommended. The spacing of rock anchors used in the structural stability analysis is not the same as that shown on 1978 construction drawings. The analysis shows that rock anchors at the gravity section are spaced 5 feet center to center, whereas the 1978 drawings show a 10-foot spacing. The owner was unable to verify the discrepancy. Since a 10-foot spacing of the rockbolts at the gravity section would be more critical, additional analyses of structural stability using this anchor spacing were performed. These are included in the Appendix E, and summarized as follows:

	Loading Condition	Location of Resultant	Sliding F.S. (see Appendix E)
a.	Normal loading condition, reservoir level at spillway crest, no ice load	Within middle third	1.53
b.	Normal loading condition, reservoir level at spillway crest, with ice load	-3.09 feet outside middle third	1.30
c.	Unusual loading: flood level equal to 1/2 PMF at gravity section	Within middle half	1.17
d.	Extreme loading: flood level equal to PMF at the gravity section	Within middle half	1.06
e.	Unusual loading: reservoir level at spillway crest, and earthquake forces	Within the middle half	1.30

The results of the stability analysis indicate that stability of the gravity section of the dam against overturning is inadequate for all loading conditions except normal loading.

The analysis indicates that in order for the resultant of the force to be within the middle third under the other loading cases, the rock bolts would have to be stressed 30.5 tons, which is above the working load(25 tons) and less than the ultimate limit (37 tons). Because of the additional force (5.5 tons) that can be developed in the anchors, the stability of the gravity section of the dam against overturning is considered adequate. The sliding stability is considered adequate for all cases.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Examination of available documents and the visual inspection of the Lake Welch Dam and appurtenant structures did not reveal any conditions which constitute a hazard to human or property. The dam (earth and concrete gravity sections) are not considered to be unsafe.

Using the Corps of Engineers screening criteria for review of spillway adequacy, it has been determined that the concrete gravity dam would be overtopped for all storms exceeding approximately 12 percent of the PMF. Although the spillway capacity is inadequate from a hydraulic and hydrologic point of view, the hydraulic inadequacy will not affect the safety of the dam because the concrete dam is supported on sound rock and overtopping of the dam will cause neither significant erosion at the toe or abutment, nor undermine the foundation of the dam. In addition, the concrete dam is stable under all loading conditions.

b. Adequacy of Information

The information and data available were adequate for performance of this investigation.

c. Necessity of Additional Investigations

No additional investigations are required.

d. Urgency

The recommended measures 1 through 3 as described below must be corrected within 1 year from notification.

7.2 RECOMMENDED MEASURES

The following are the recommended measures:

1. Establish a systematic program to observe and monitor changes in seepage occuring at the monoliths and construction joints.

2. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.

3. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

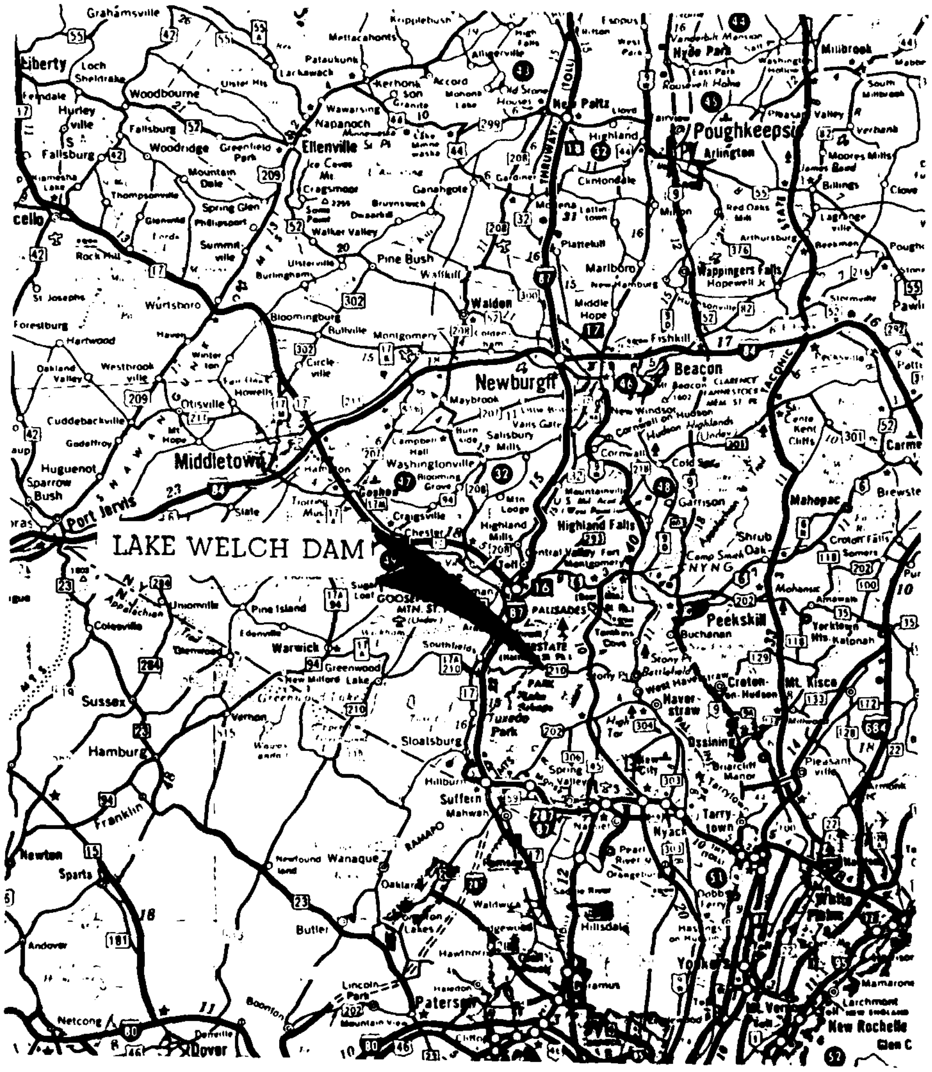
In addition to above remedial and maintenance, the following should be considered:

a. Resurface the downstream face to the original geometry.

b. High level outlet made operable.

DRAWINGS

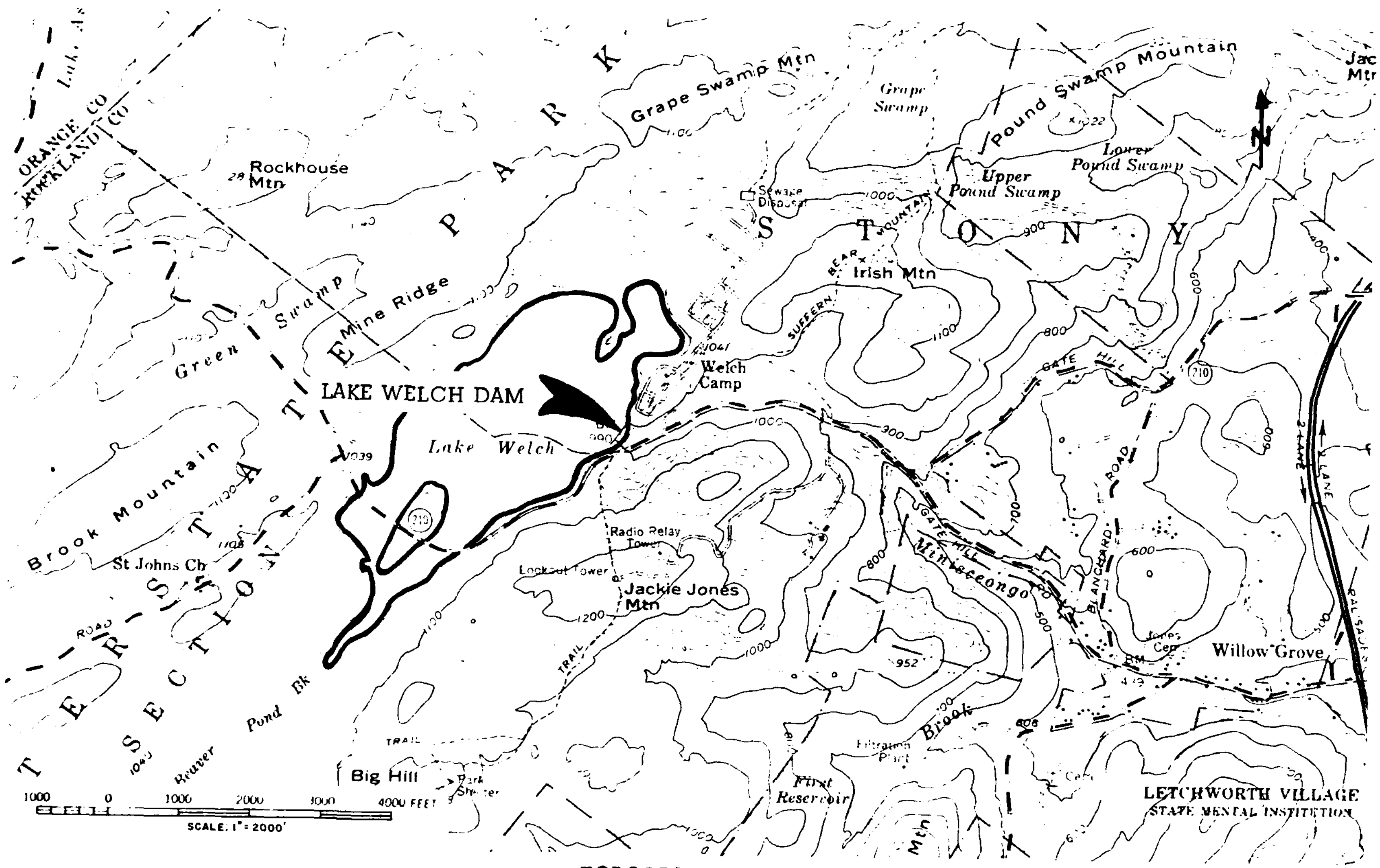
APPENDIX A



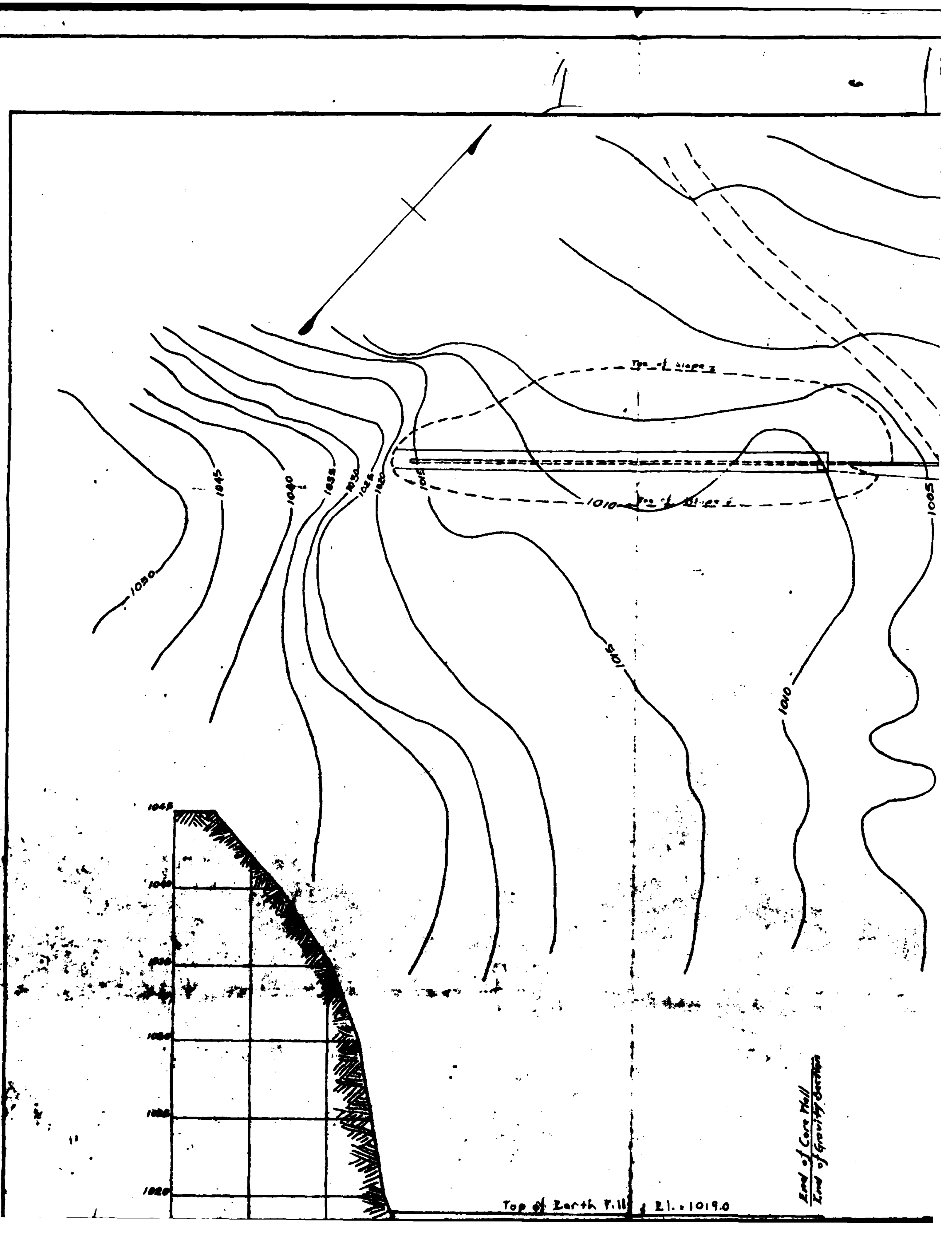
SCALE 1 Inch = 11.2 Miles

VICINITY MAP
LAKE WELCH DAM

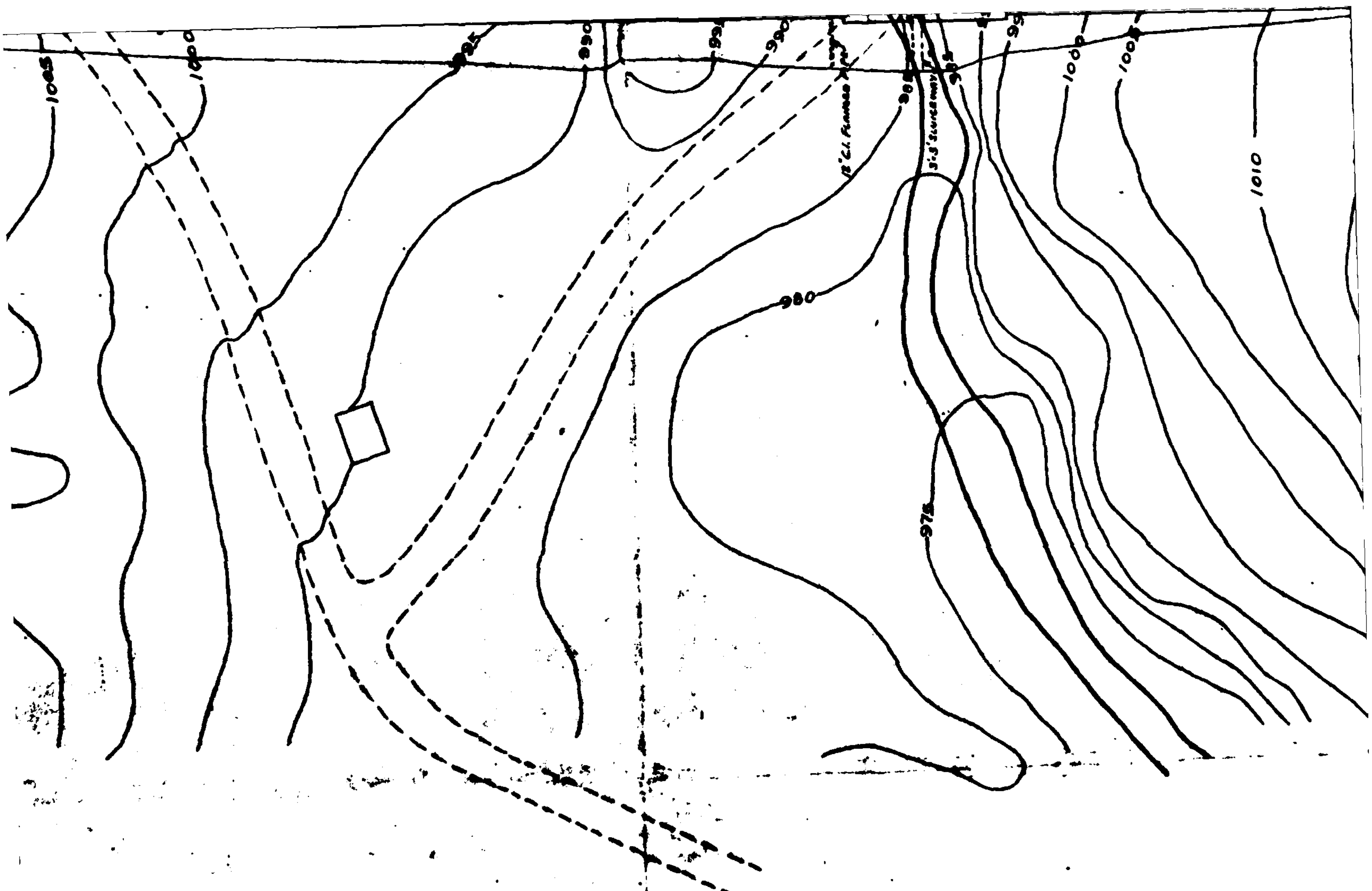
THIELLS QUADRANGLE
NEW YORK



TOPOGRAPHIC MAP
LAKE WELCH DAM

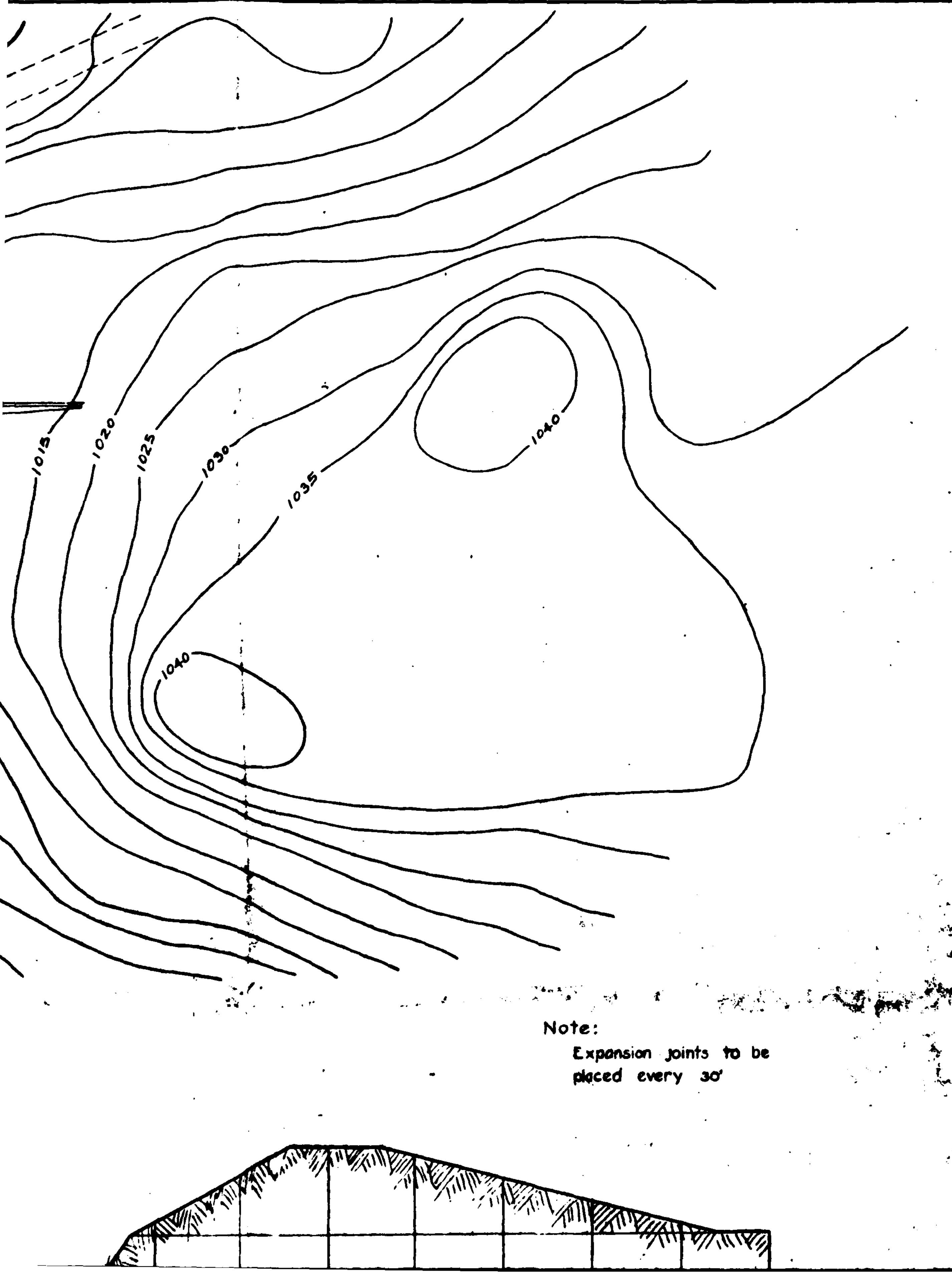


1050
1045
1040
1035
1030
1025
1020
1015
1010
1005
Toe of Slope
End of Core Wall
End of Gravity Section
Top of Earth Fill El. 1019.0

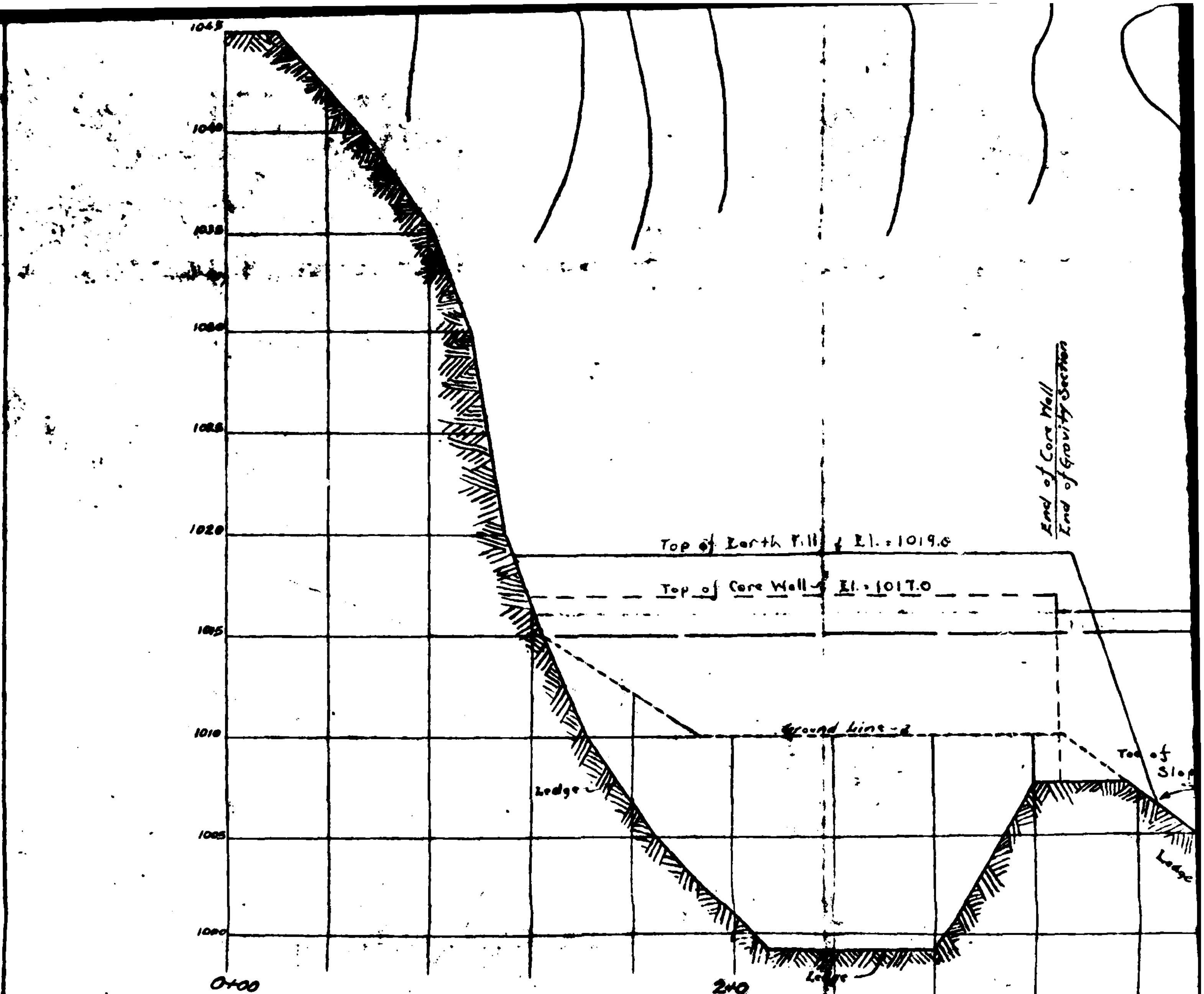


PLAN

3



Note:
Expansion joints to be placed every 30'



U.S. DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

STATE PARK EMERGENCY CONSERVATION WORK
NEW YORK STATE PARK № 26

PALISADES INTERSTATE PARK

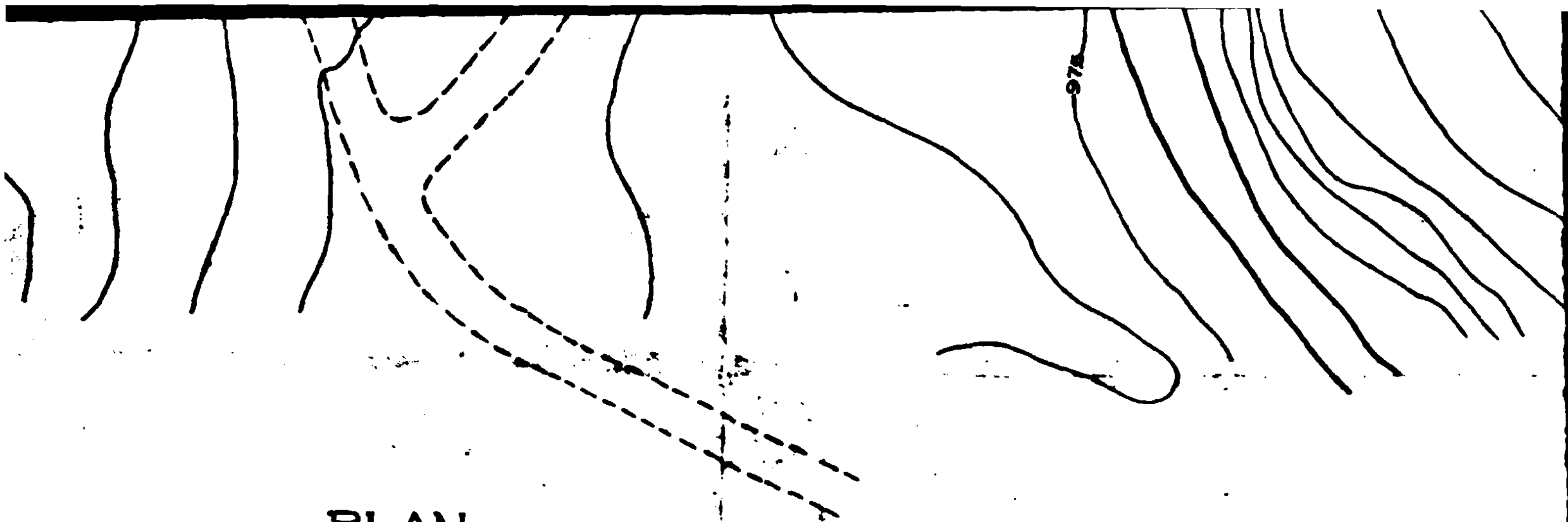
TOWN OF STONY POINT ROCKLAND COUNTY NEW YORK

BEAVER POND DAM

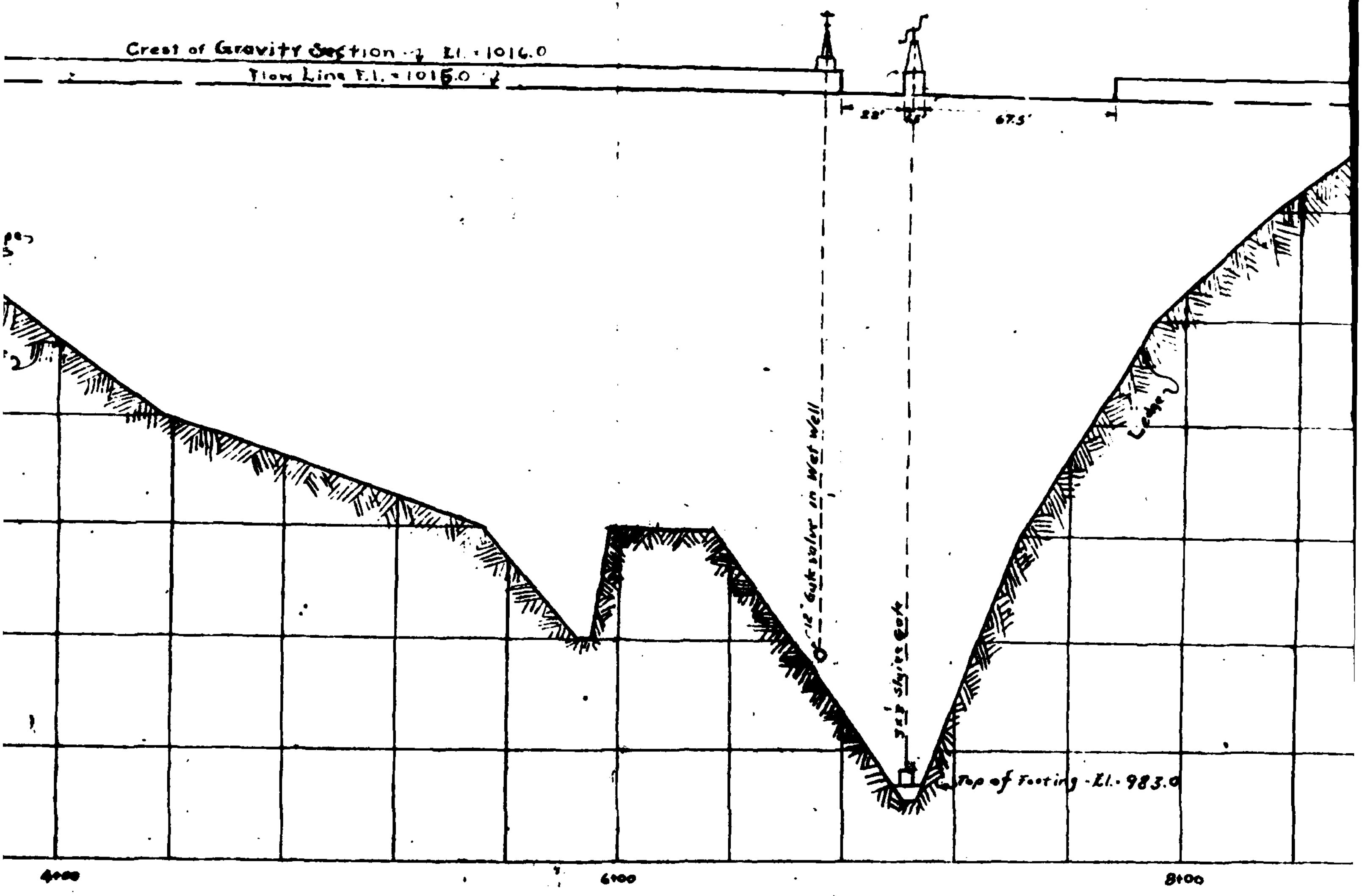
SCALES AS SHOWN DECEMBER 1, 1933 PREPARED BY.

Recommended for Approval [redacted] General Superintendent.
Approved By: [redacted] Chief Engr. and Gen'l. Mngr.
Approved By: [redacted] District Inspector E.C.W.
Approved By: [redacted] District Officer E.C.W.

4

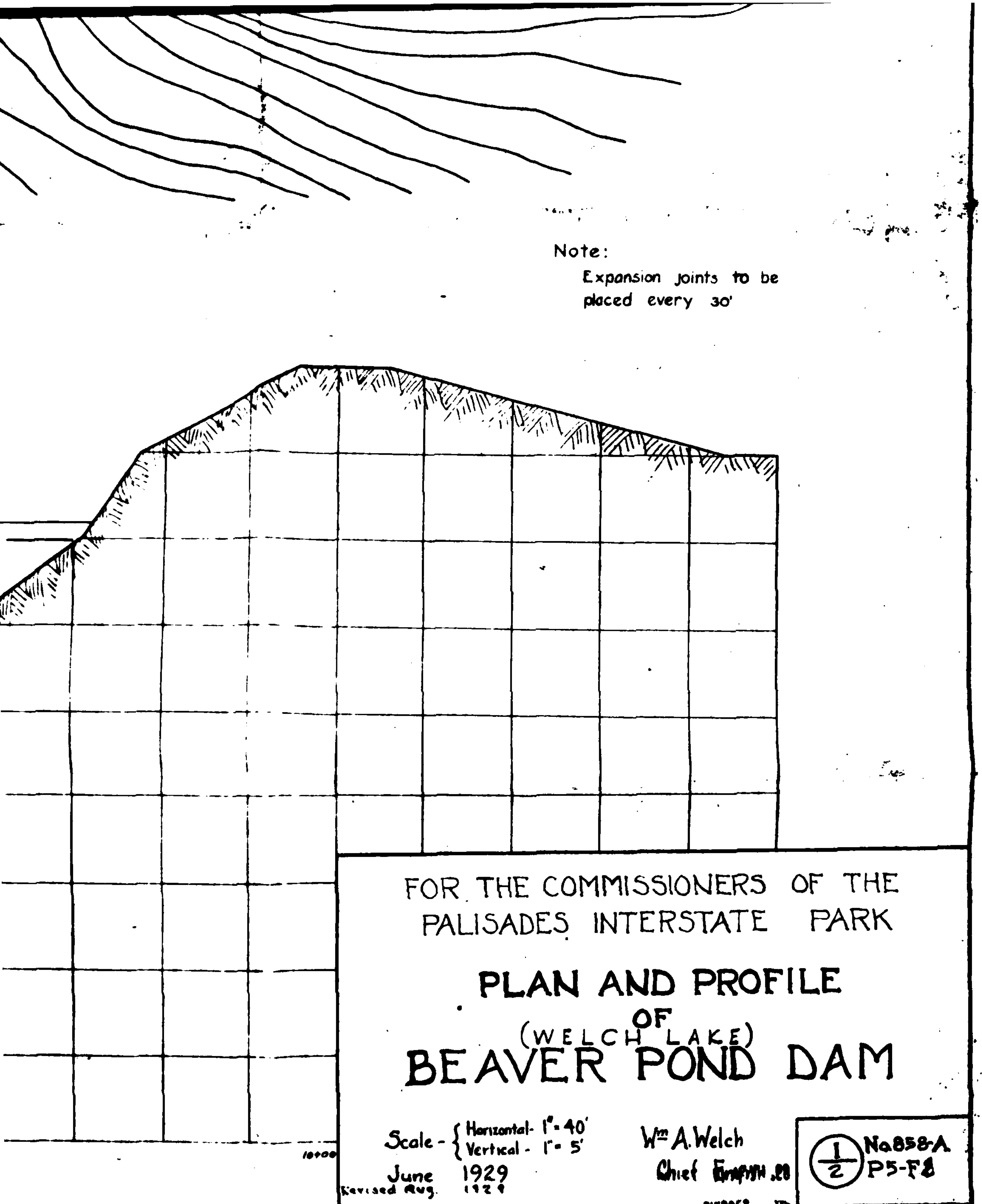


PLAN



PROFILE

5



Note:
Expansion joints to be placed every 30'

FOR THE COMMISSIONERS OF THE PALISADES INTERSTATE PARK

PLAN AND PROFILE OF (WELCH LAKE) BEAVER POND DAM

Scale - { Horizontal - 1" = 40' ; Vertical - 1" = 5' }

June 1929

Revised Aug. 1929

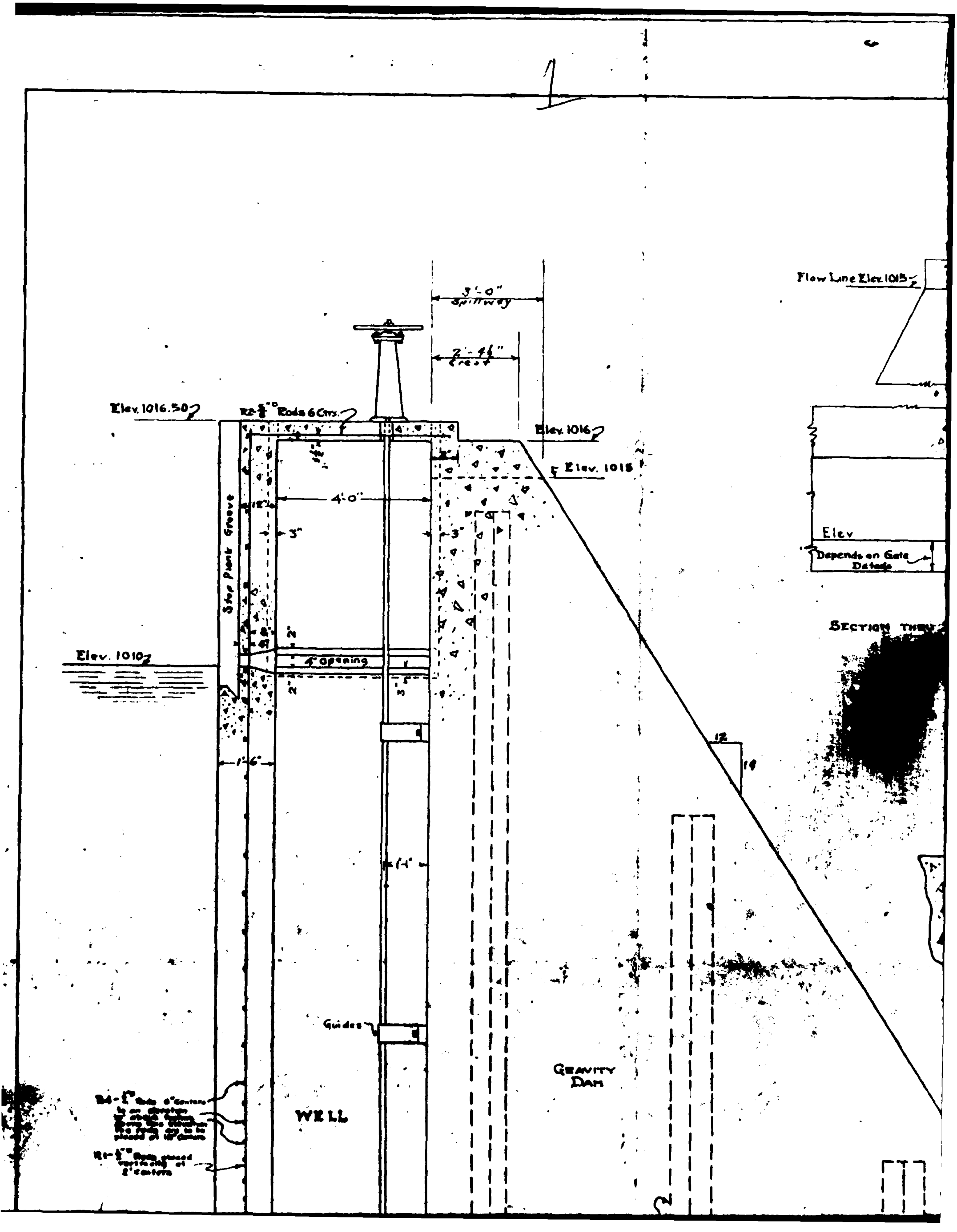
Wm A. Welch
Chief Engineer

1/2 No. 858-A P5-F8

12

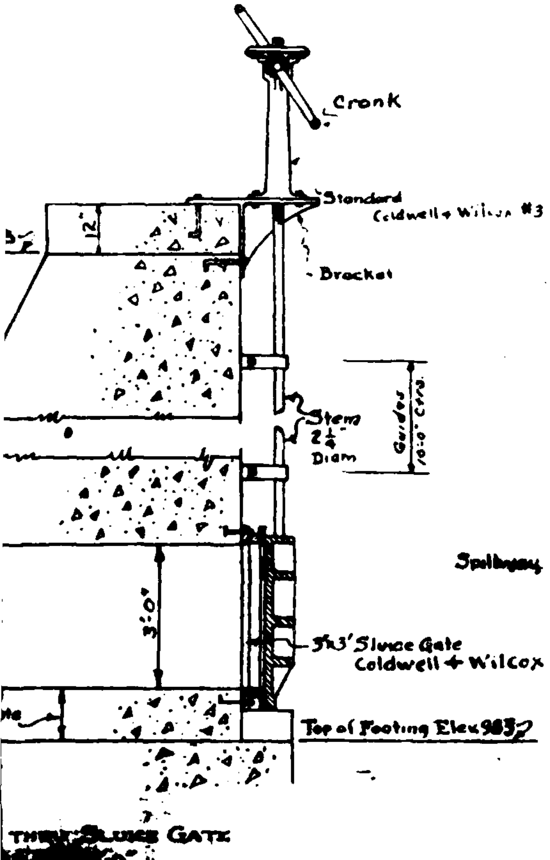
6

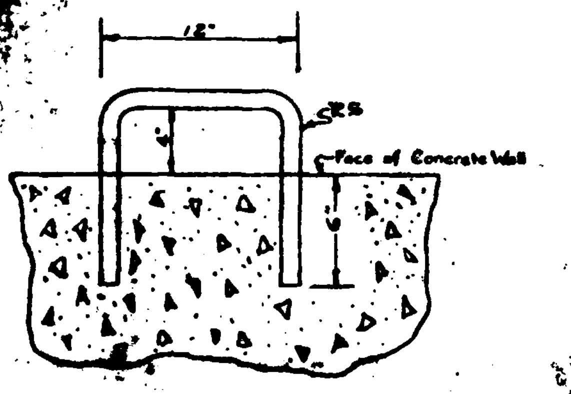
Revised print received 10/22/68



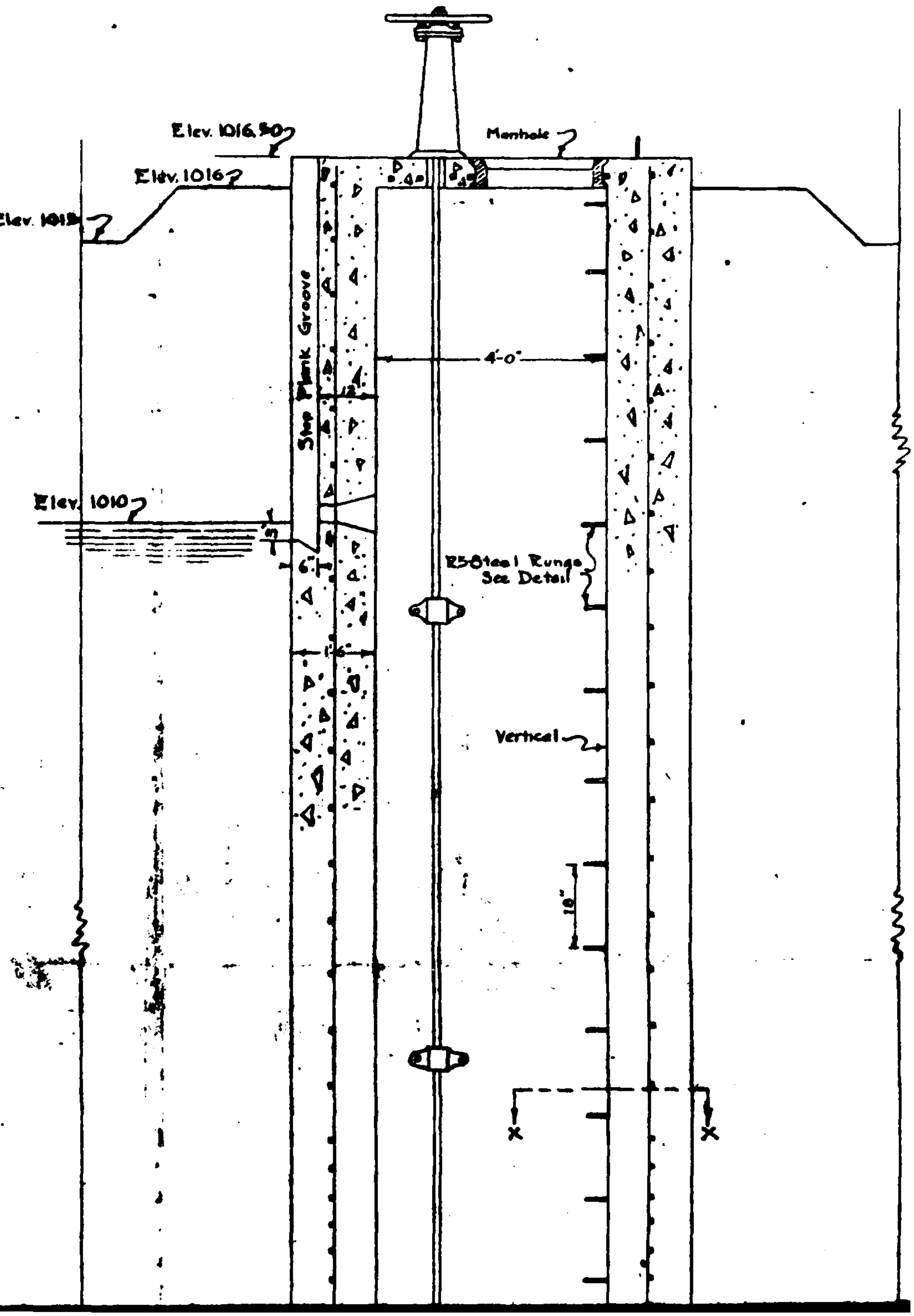
Elev. 1016.50
Rods 6 Ctrs.
3'-0"
Spillway
2'-4½"
Crest
Elev. 1016
Elev. 1015
4'-0"
3"
Stop Plank Groove
4" opening
Elev. 1010
1'-6"
1'-1"
Guides
Gravity Dam
Well
Flow Line Elev. 1015
Elev
Depends on Gate Details

2

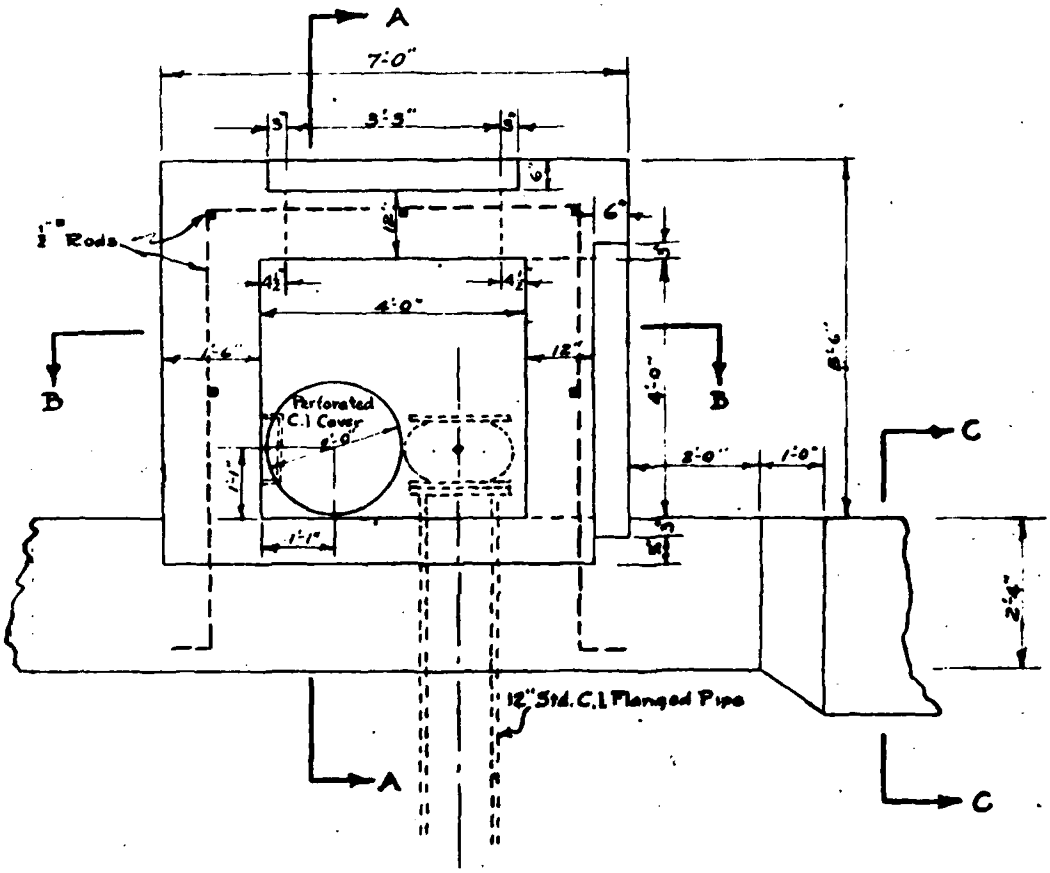




Section - XX
Scale - 1½" = 1'-0"

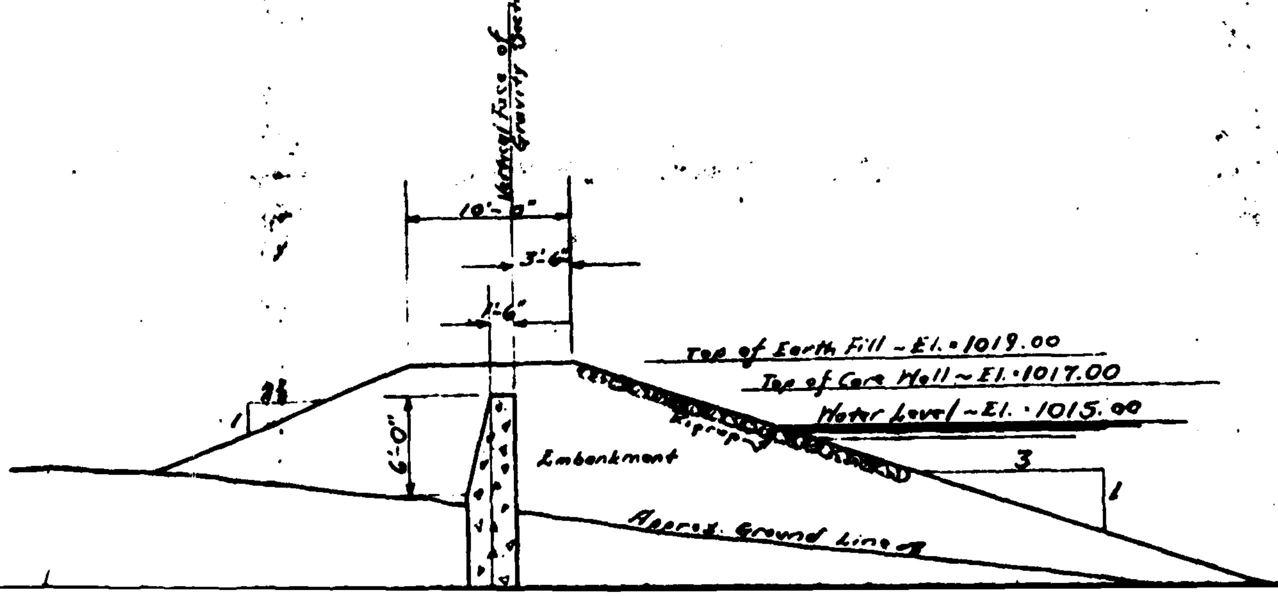


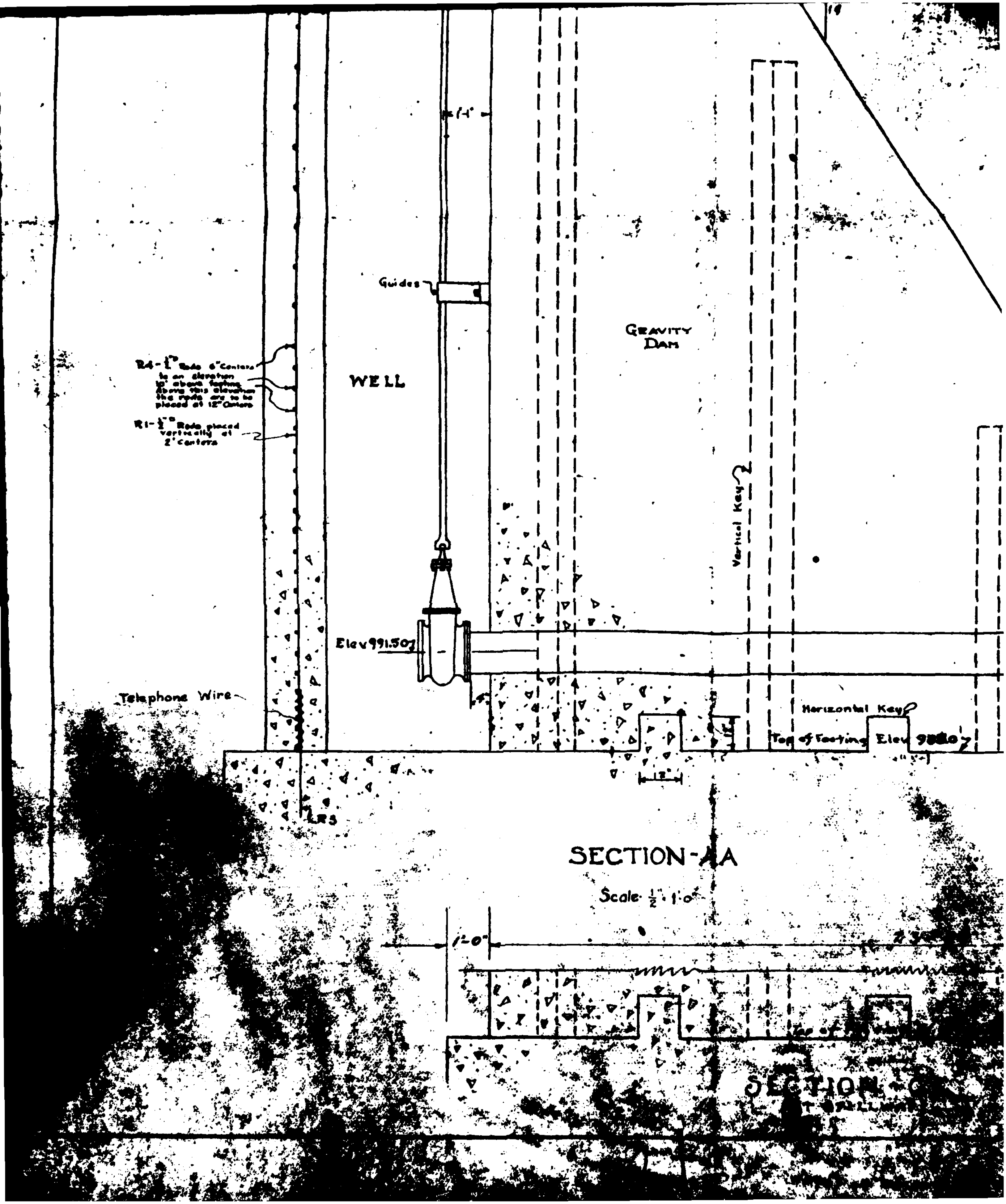
3



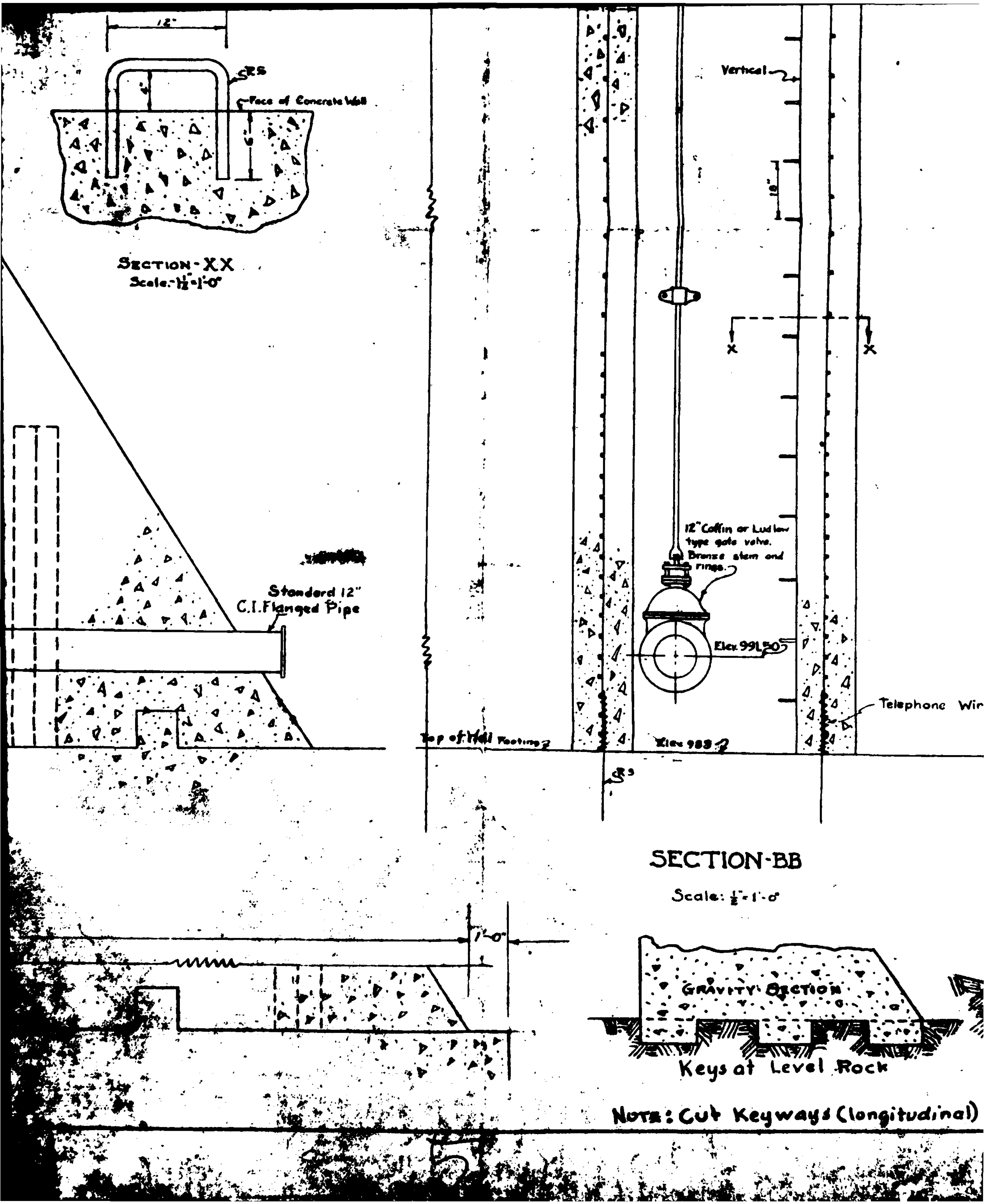
PLAN OF WELL

Scale ½" = 1'-0"





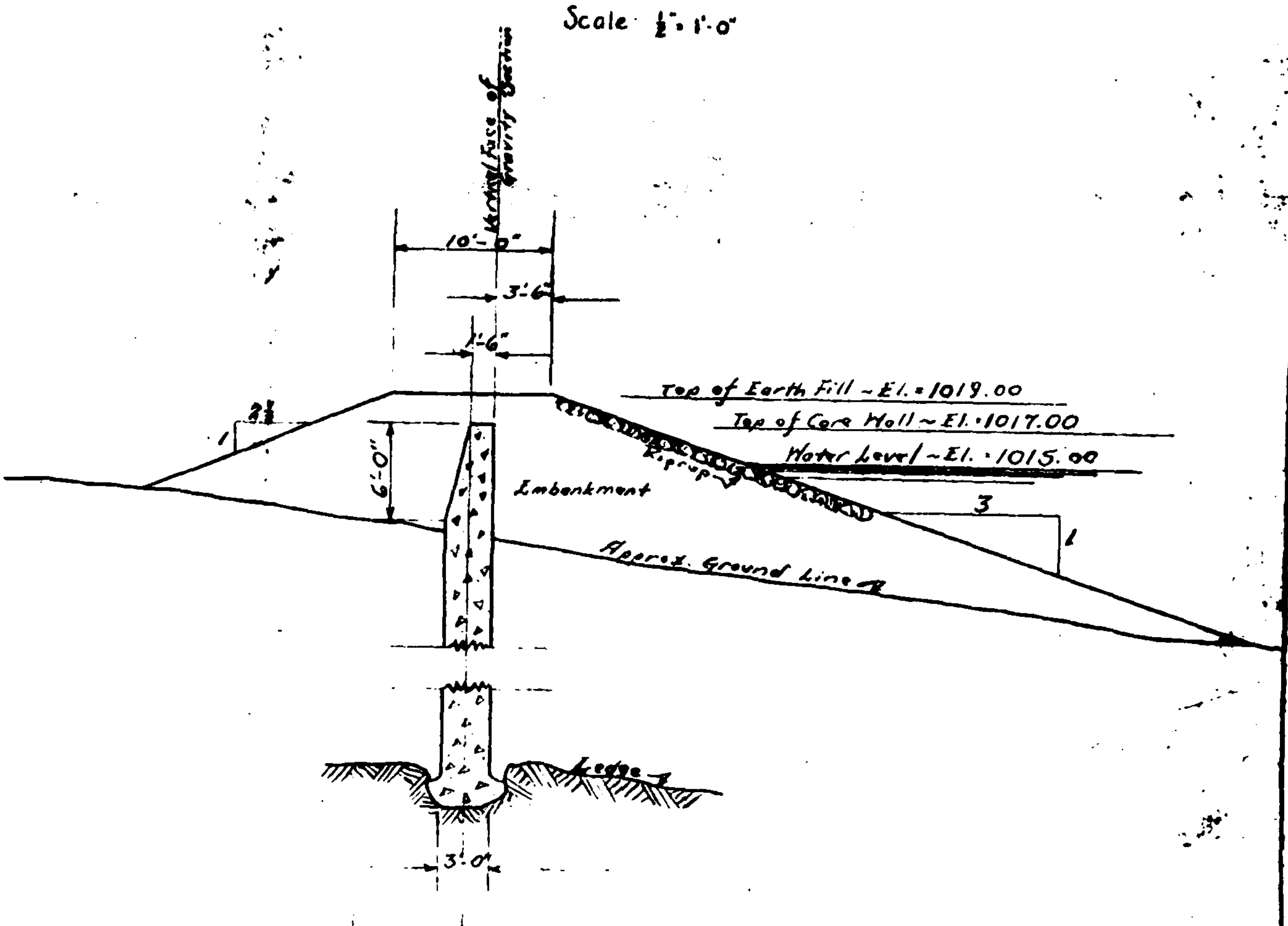
Guides
GRAVITY DAM
WELL
Rods 6" Centers to an elevation above footing. Above this elevation the rods are to be placed at 12" Centers
Rods placed vertically at 2' Centers
Vertical Key
Elev 991.50
Telephone Wire
Horizontal Key
Top of Footing Elev
12"
SECTION-AA
Scale 1/2" = 1'-0"
1'-0"
SECTION



12"
RS
Face of Concrete Wall
6
SECTION-XX
Scale:-1½"=1'-0"
Vertical
10"
X
X
12" Coffin or Ludlow type gate valve. Bronze stem and rings.
Elev. 991.50
Telephone Wir
Standard 12" C.I. Flanged Pipe
Top of Wall Footing
Elev. 989
RS
SECTION-BB
Scale: ½"=1'-0"
1'-0"
GRAVITY SECTION
Keys at Level Rock
NOTE: Cut Keyways (longitudinal)

PLAN OF WELL

Scale 1/2" = 1'-0"



TYPICAL CORE WALL SECTION

Scale 1/8" = 1'-0"

Keys at Sloped Rock

1) in rock at base of Dam

FOR THE COMMISSIONERS OF THE PALISADES INTERSTATE PARK

DETAILS OF (WELCH LAKE) BEAVER POND DAM

Scale: as shown
June 1929
Revised Aug. 1933

Wm A. Welch
Chief Eng'r.

2/2 No. 858-B
RS-F3

DAM-12

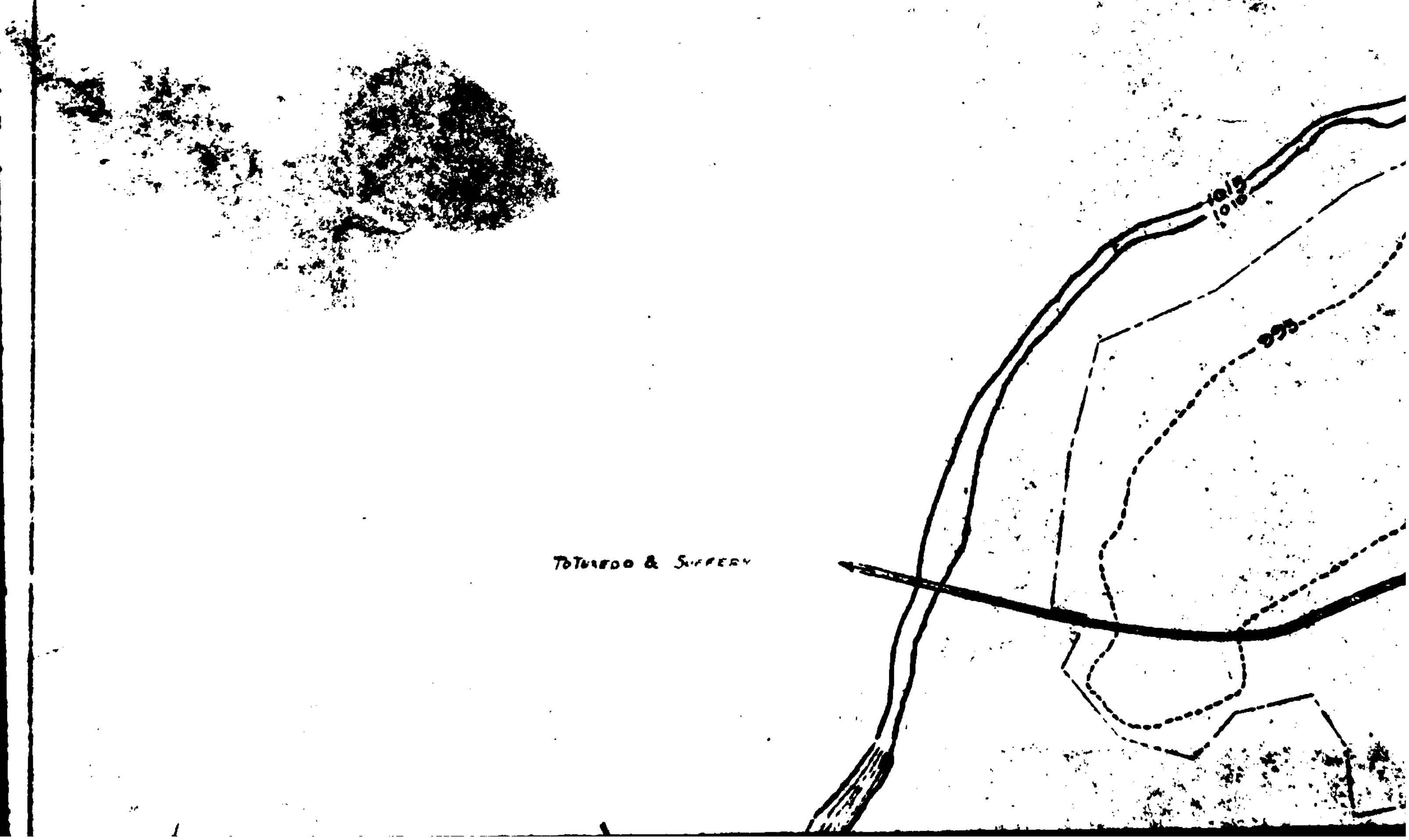
Revised print received.

6

[illegible] Elevations referred to U.S. Geological Survey Datum.

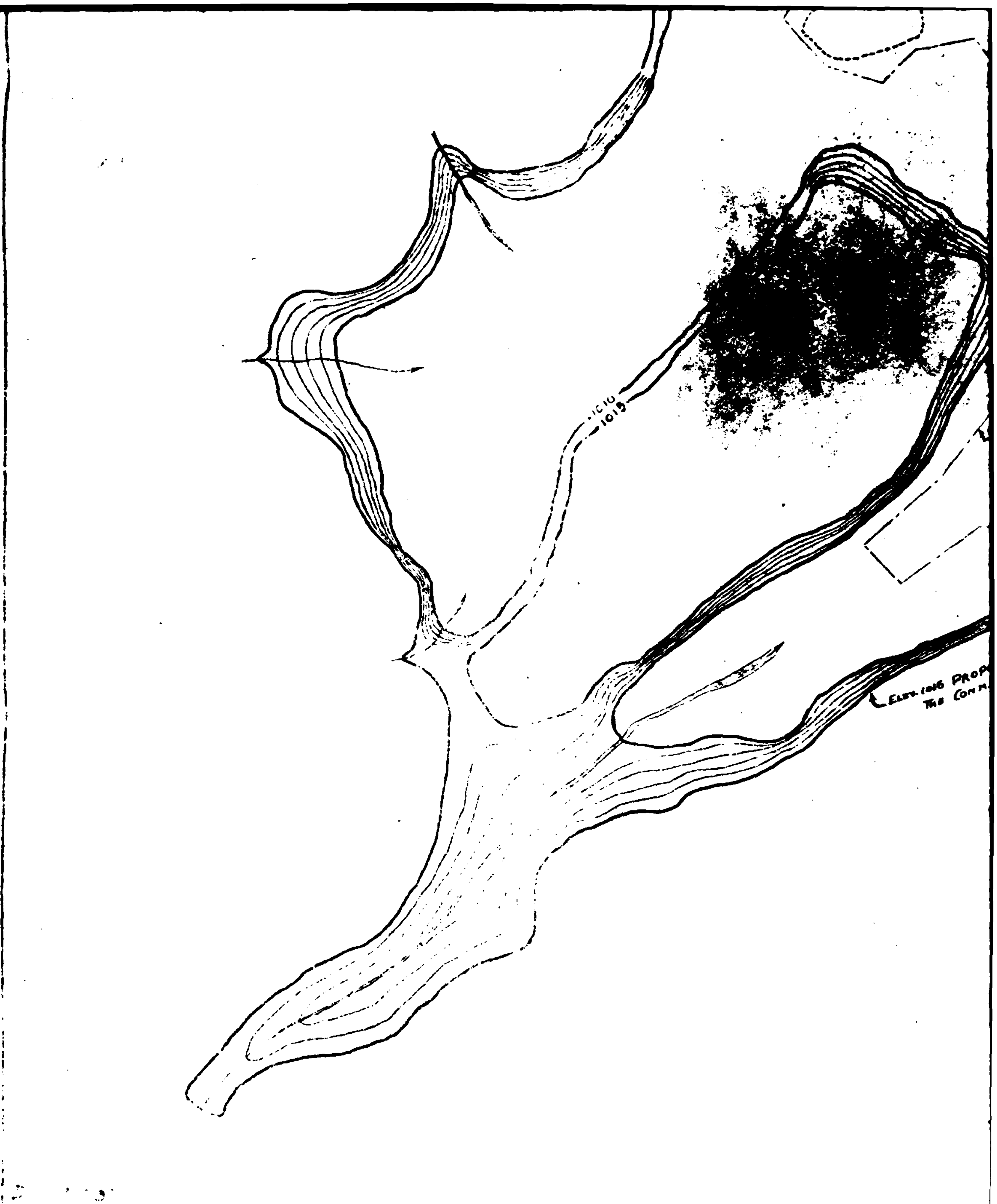
COMPARATIVE TABLE OF DATA

	[illegible]	[illegible]	DIFFERENCE
Elevation of H.W.	1015	[illegible]	22 feet
Max Height of Dam	32 feet	10 feet	22 feet
Capacity	1,213,755,130 gals.	164,50[illegible],000 gals	1,049,255,130 gals
Area Water Surface	216 acres	91.5 acres	124.5 acres
Average Depth	27.5 feet	5.5 feet	22 feet
Max. Depth	35 feet	13 [illegible]	22 feet
Area Land owned		108.3[illegible] acres	



1015
1010
PROPOSED FLOW LINE
BY ROCKLAND FINISHING CO.
1015
1010

1 3



4

CAPACITIES BETWEEN GIVEN ELEVATIONS

ELEV.	CAPACITIES (GALLONS)	CAPACITIES FROM ELEV. 1015 TO GIVEN ELEV. (GAL
1015		
	68,840,310	
1014		68,840,310
	65,650,090	
1013		134,490,400
	62,992,820	
1012		19[illegible] 483 220
	60,498,240	
1011		257 981,460
	58,196,270	
1010		316,[illegible]77,730
	733,077,400	
993		[illegible]9 255,130
	164,500,000	
Bottom		[illegible]55,1[illegible]

FOR THE COMMISSIONERS OF THE
PALISADES INTERSTATE PARK

PROPOSED

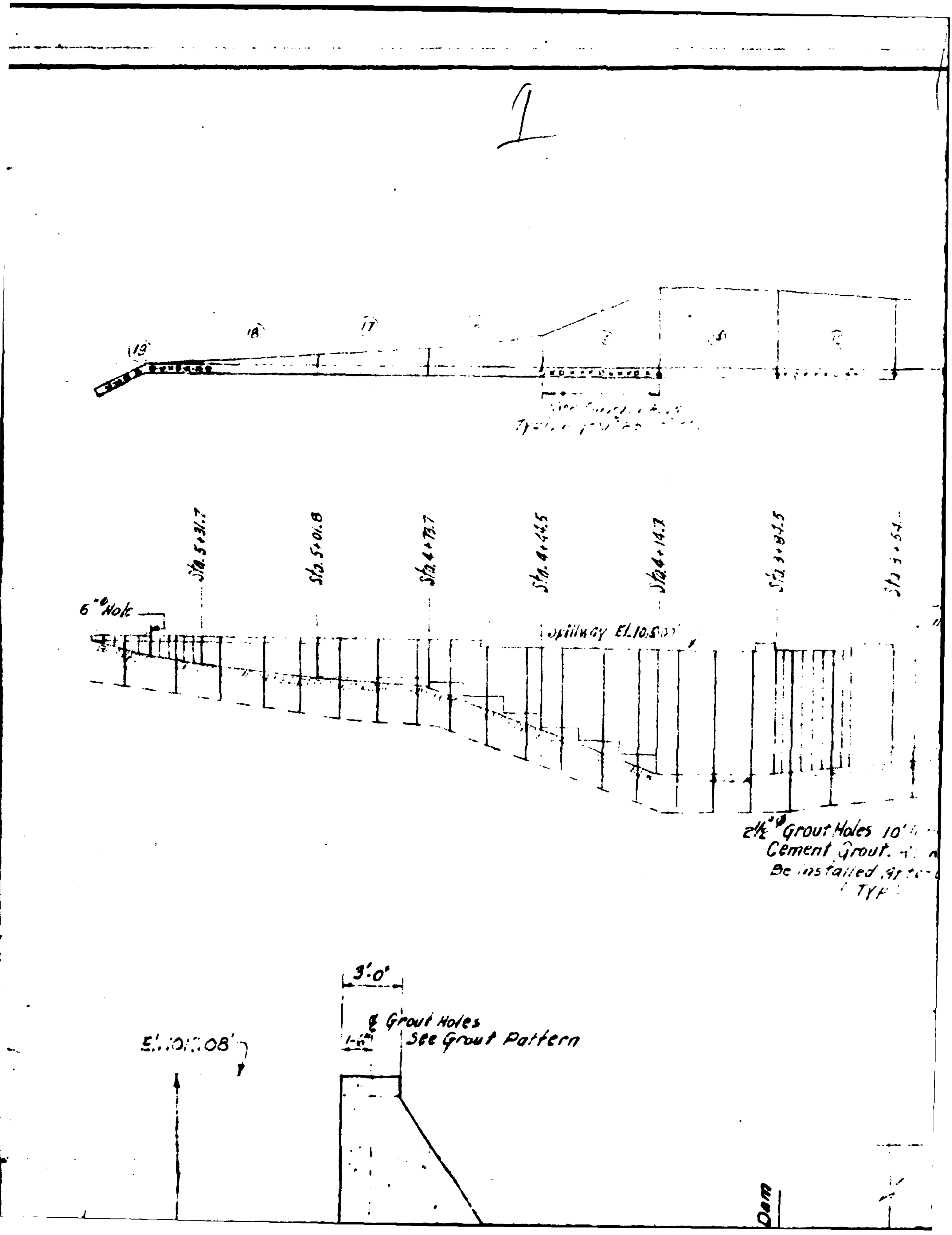
LAKE AT BEAVER POND

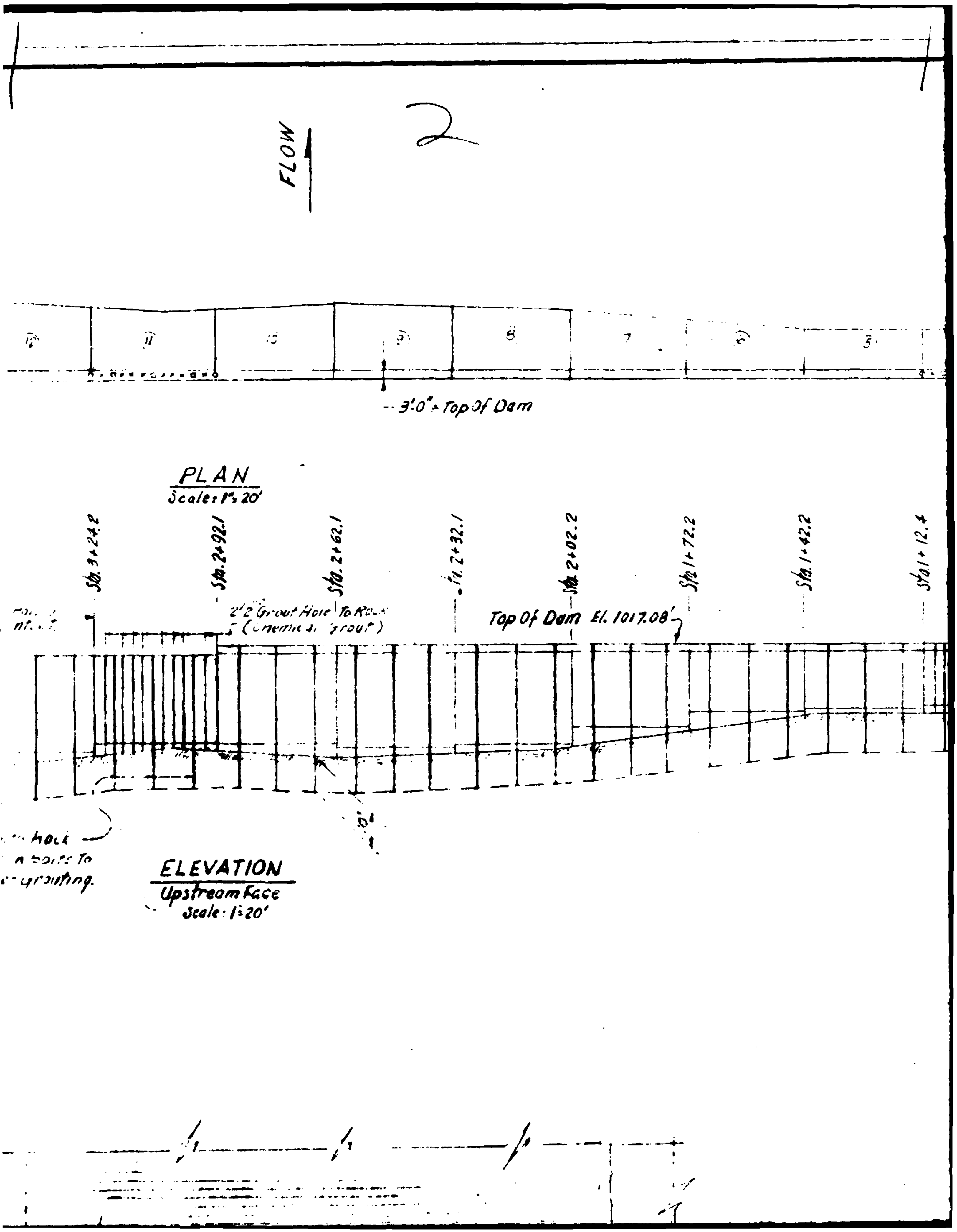
TOWNS OF HAVERSTRAW AND STONY POINT
ROCKLAND COUNTY

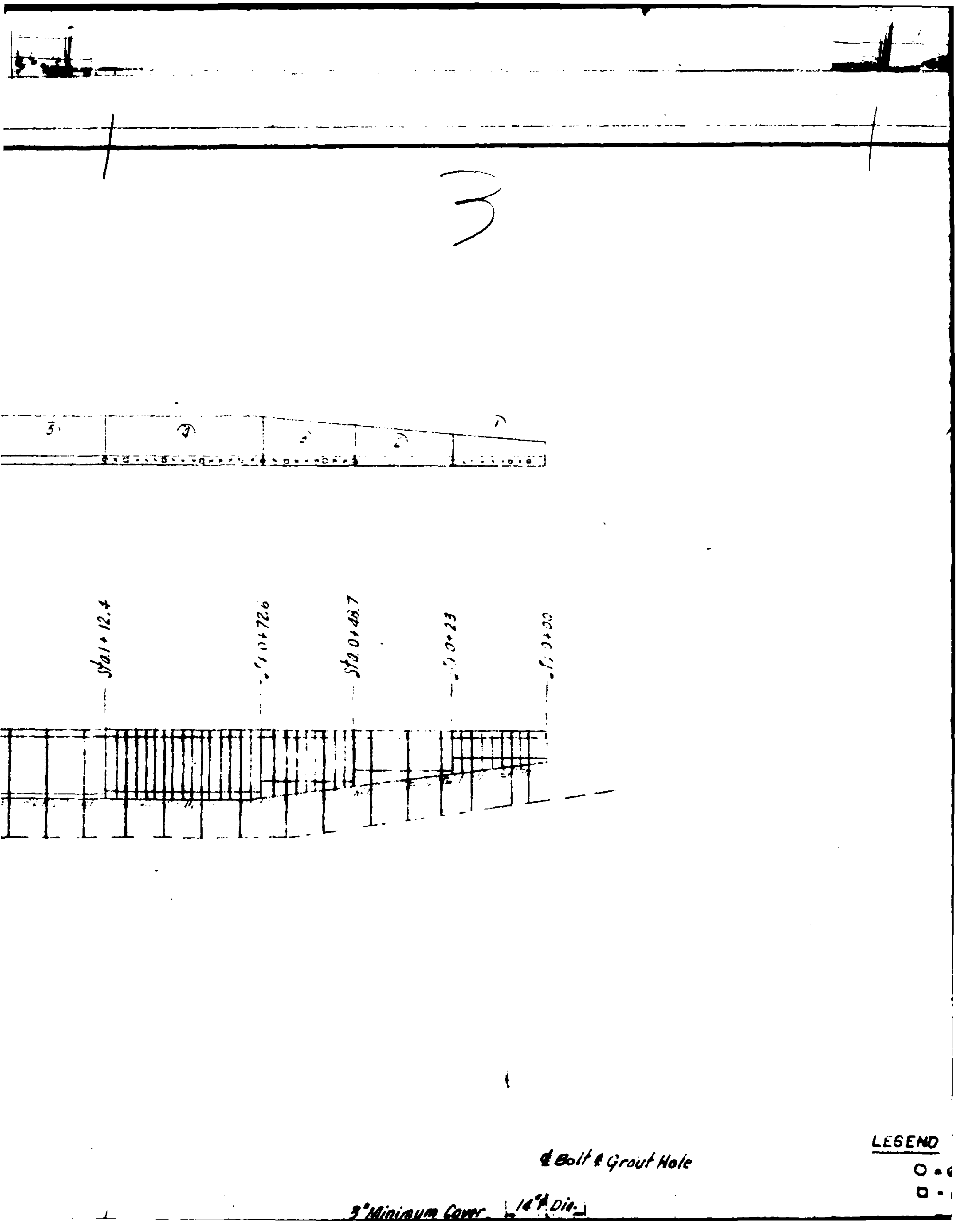
SCALE 1"=200'

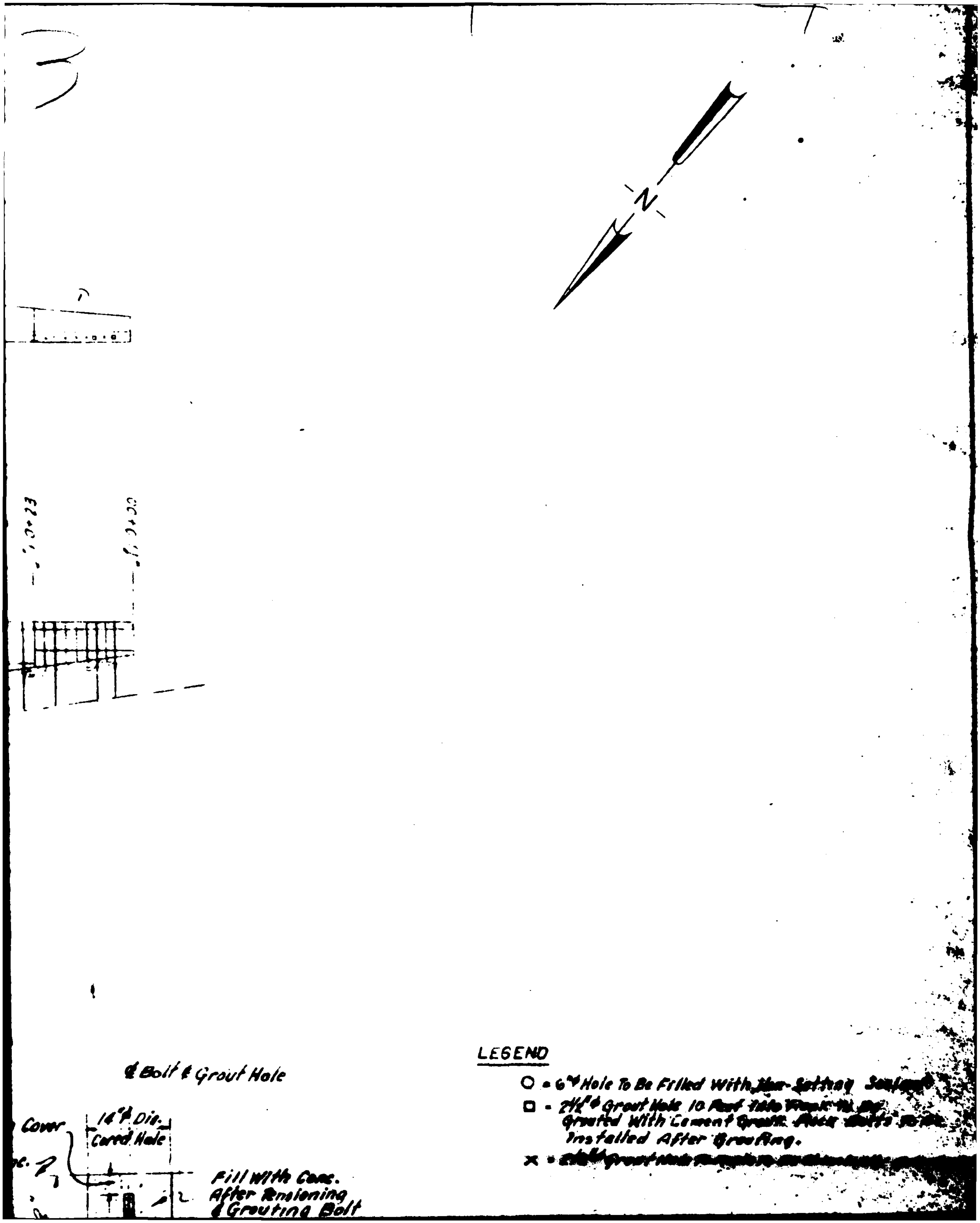
Revised - FEB. 1928

6

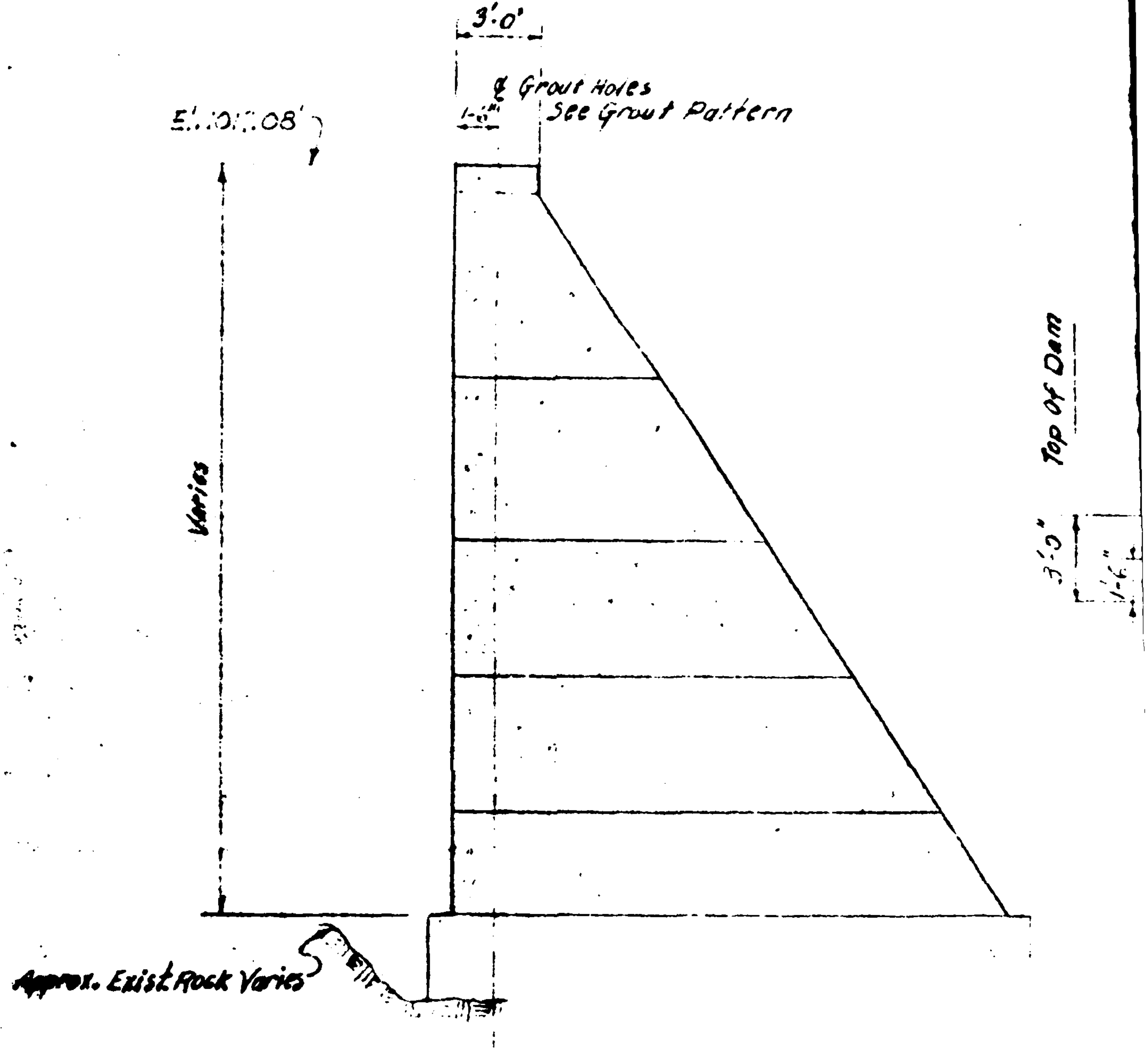

1
19
18
17
Sta. 5+31.7
Sta. 5+01.8
Sta. 4+73.7
Sta. 4+44.5
Sta. 4+14.7
6" Ø Hole
Spillway El. 10.50'
2½" Ø Grout Holes 10'
Cement Grout.
Be installed
TYP
3'-0"
1'-6"
℄ Grout Holes
See Grout Pattern
Dam


FLOW
2
11
8
7
5
3'-0" ± Top Of Dam
PLAN
Scale: 1"= 20'
Sta. 3+22.2
Sta. 2+92.1
Sta. 2+62.1
Sta. 2+32.1
Sta. 2+02.2
Sta. 1+72.2
Sta. 1+42.2
Sta. 1+12.4
Top Of Dam El. 1017.08'
(Chemical Grout)
ELEVATION
Upstream Face
Scale: 1=20'


3
Sta.1+12.4
Sta.0+48.7
℄ Bolt & Grout Hole
3" Minimum Cover
14" Dia.
LEGEND

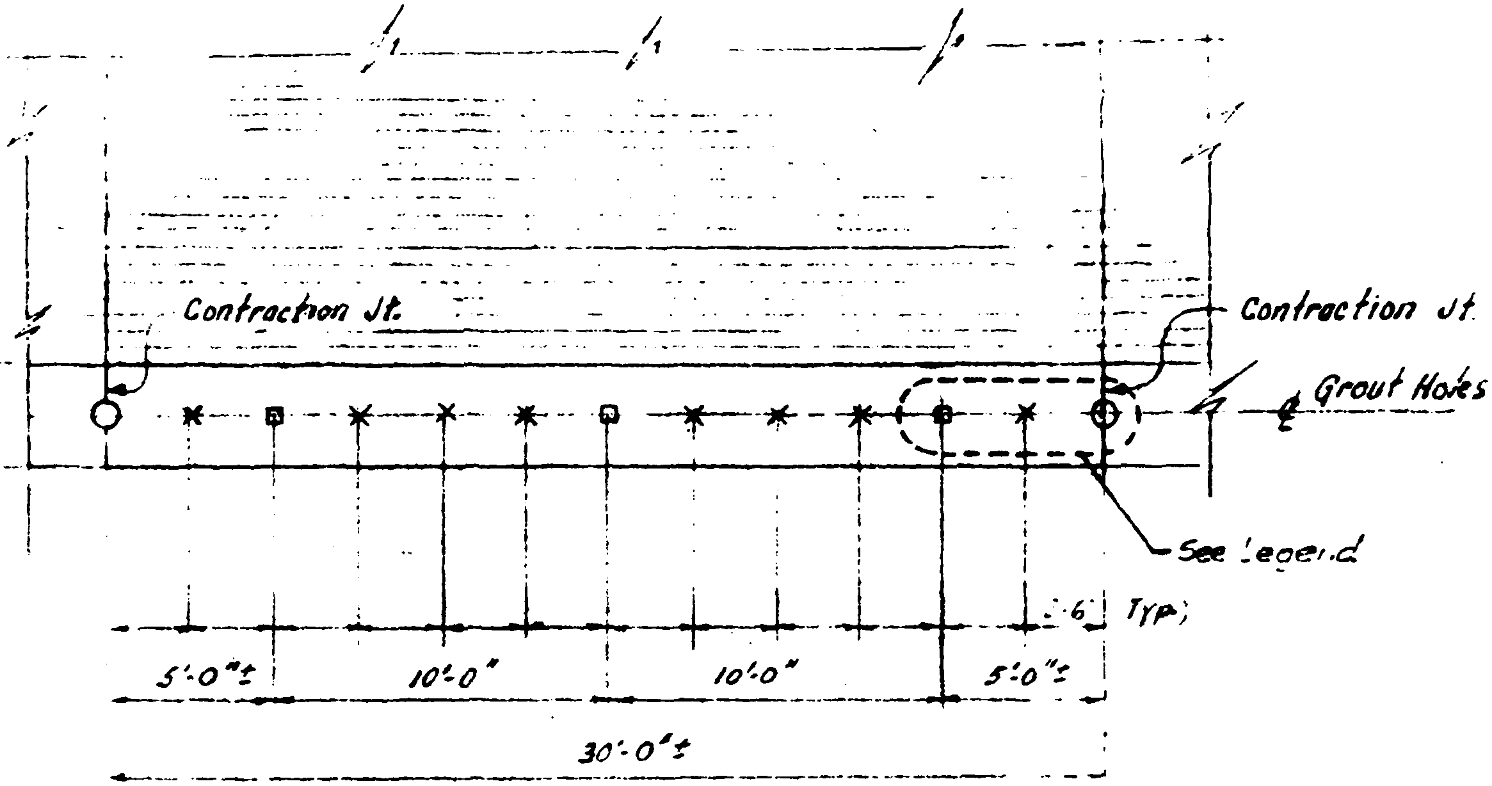


3
N
LEGEND
O = 6" Hole To Be Filled With
□ - 2½" Grout Hole 10
Grouted With Cement
Installed After
¢ Bolt ¢ Grout Hole
Cover
14" Dia.
Cored Hole
Fill With Conc.
After
¢ Grouting Bolt



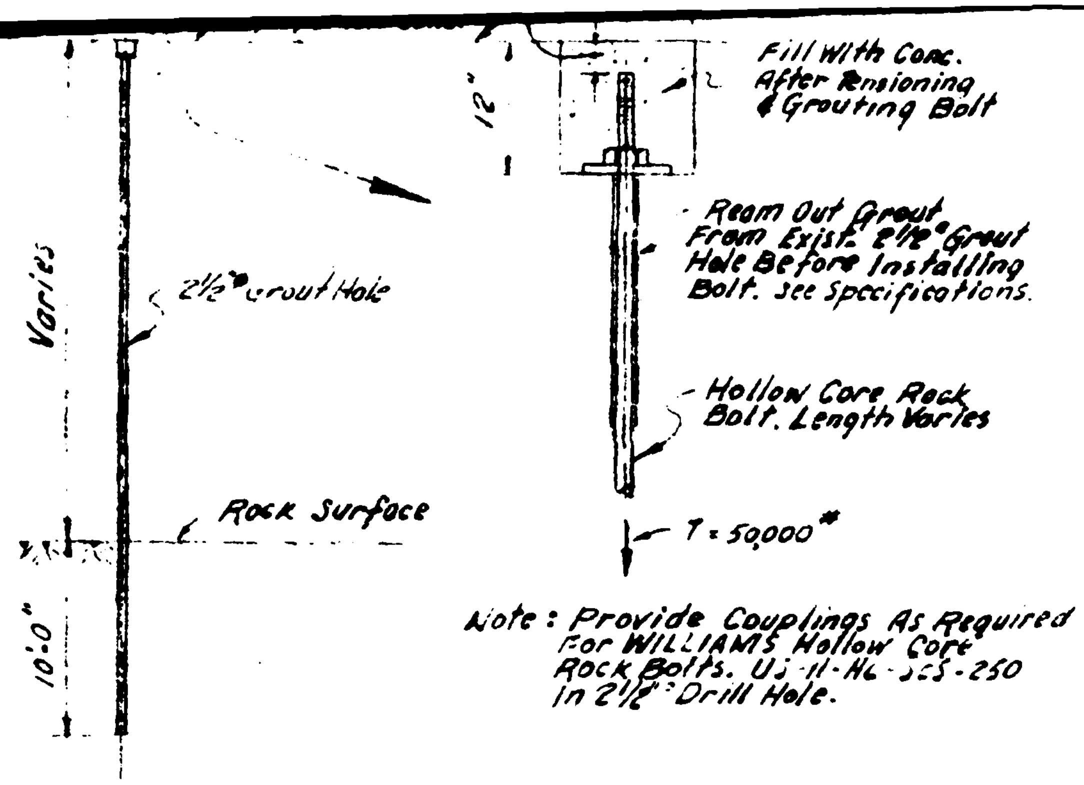
TYPICAL DAM CROSS SECTION
Scale 1/4" = 1'-0"

Upstream Face
Scale: 1"=20'



TYPICAL GROUT HOLE PATTERN
BAYS ① TO ⑲
Scale 4"=1'-0"

6



ROCK BOLT DETAIL

No Scale

20 0 20 40

Scale 1" = 20'

4 0 4 8

Scale ¼" = 1'-0"

7

4-18-78	Construction	No.	Revisions	Date	
Date	Issued For	Drawn	E. Battista	Checked	
Date Made 4-18-78		In Charge		Approved	

PALIS…

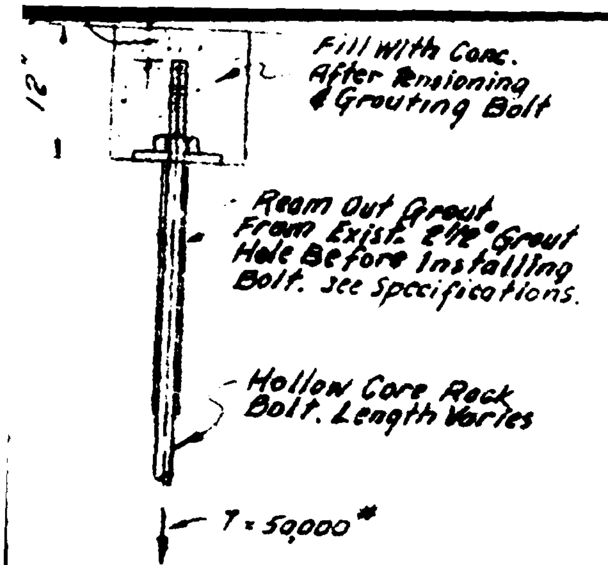
BEAR…

LAK…

M…

CHAS. T…

BOSTON, MASS.



X = 2½" Grout Hole To Rock To Be Chemically Grouted.

Note: Provide Couplings As Required For WILLIAMS Hollow Core Rock Bolts. US-11-HL-265-250 In 2⅝" Drill Hole.

K BOLT DETAIL

No Scale

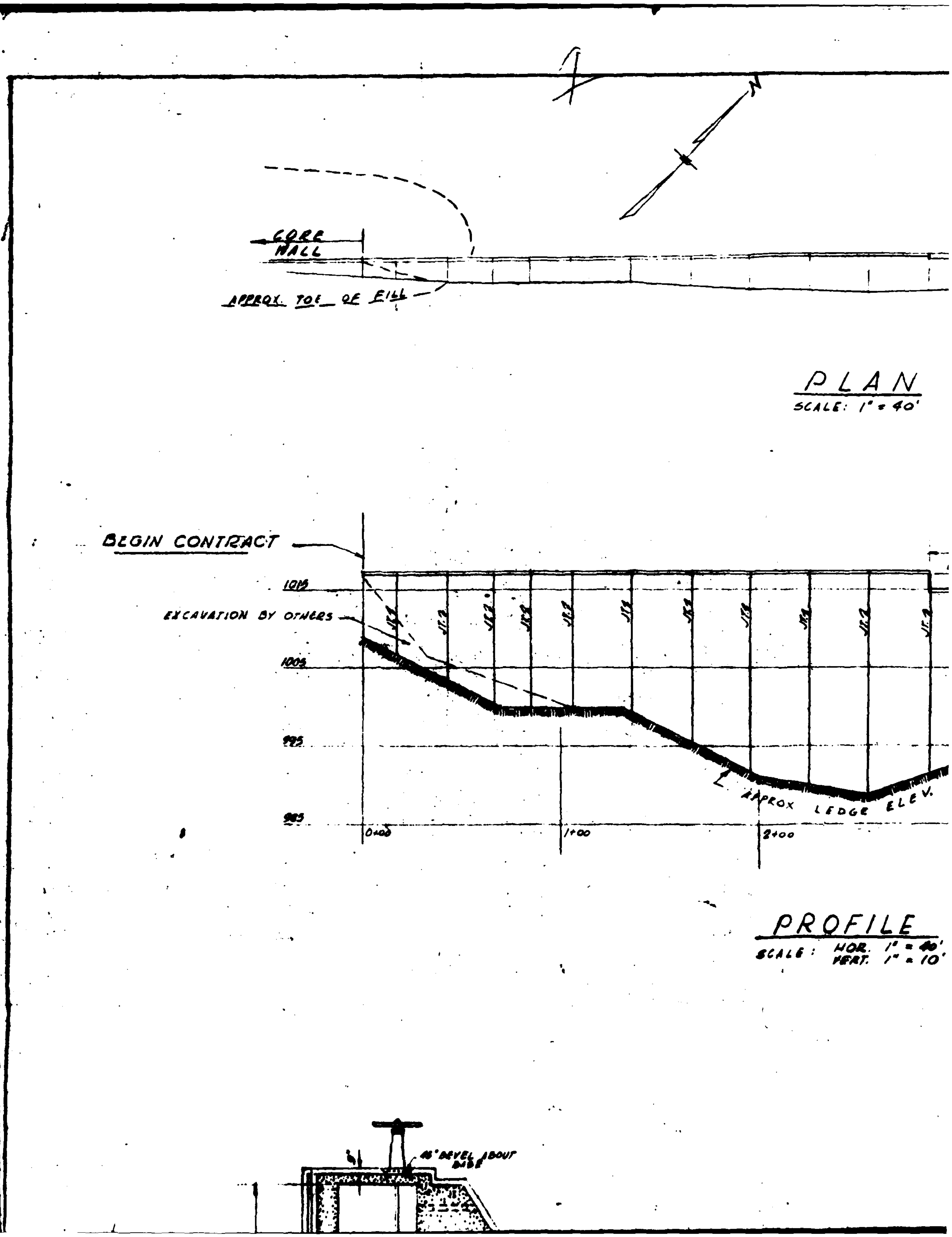
40

8

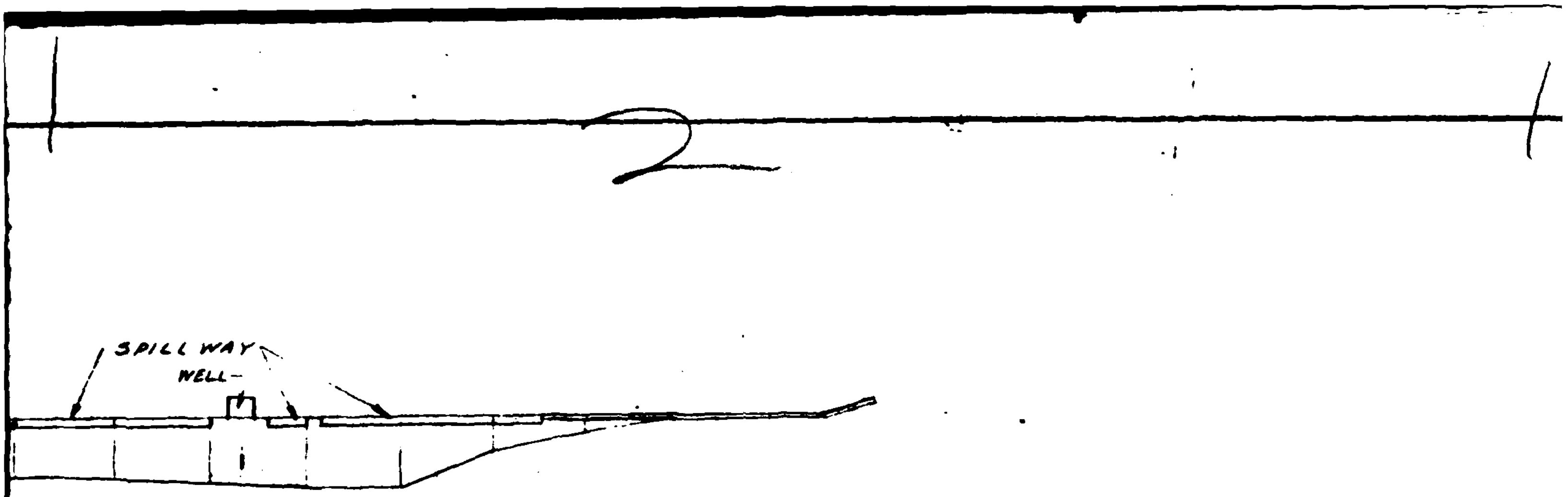
7

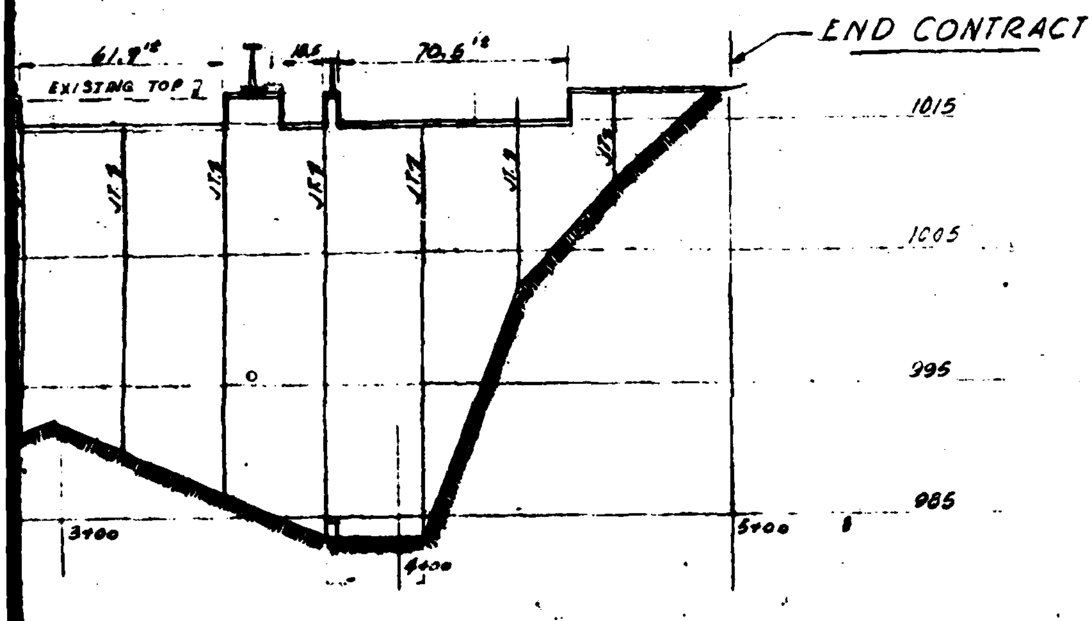
8

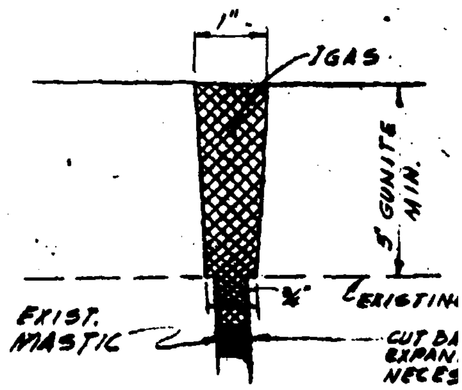
REC'D MAY 9, 1978
FINAL DRAWS
NSF



N
CORE WALL
APPROX. TOE OF FILL
PLAN
SCALE: 1" = 40'
BEGIN CONTRACT
EXCAVATION BY OTHERS
1015
1005
995
985
0+00
1+00
2+00
APPROX LEDGE ELEV.
PROFILE
SCALE: HOR. 1" = 40'
VERT. 1" = 10'
45° BEVEL ABOUT BASE



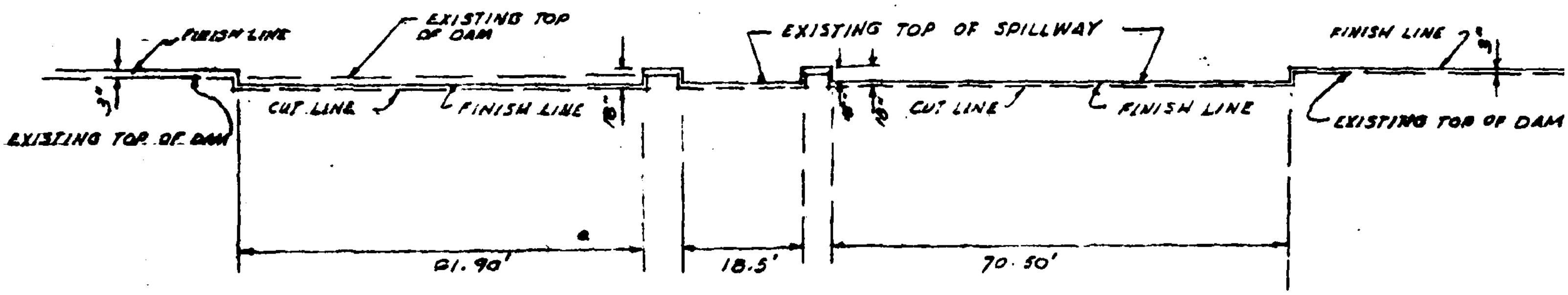




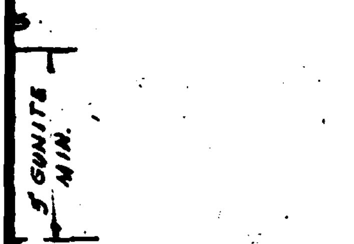
DETAIL OF EXPANSIC

SCALE ½" = 1'-0"

3

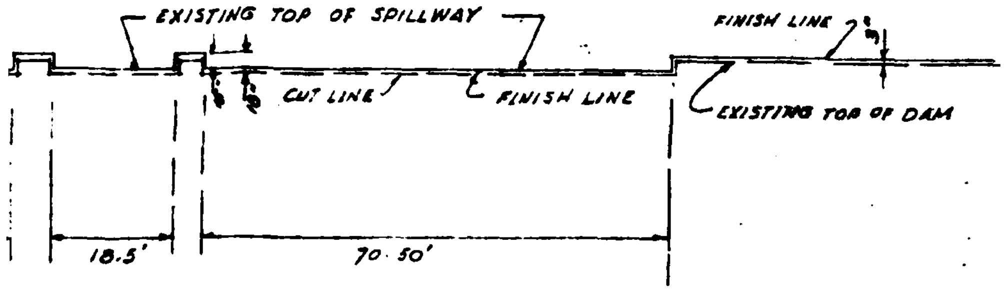


· SPILLWAY ·
· EXISTING CONCRETE TO BE REMOVED ·
ITEM # 80 A
SCALE 1" = 20'



...NSION JOINT

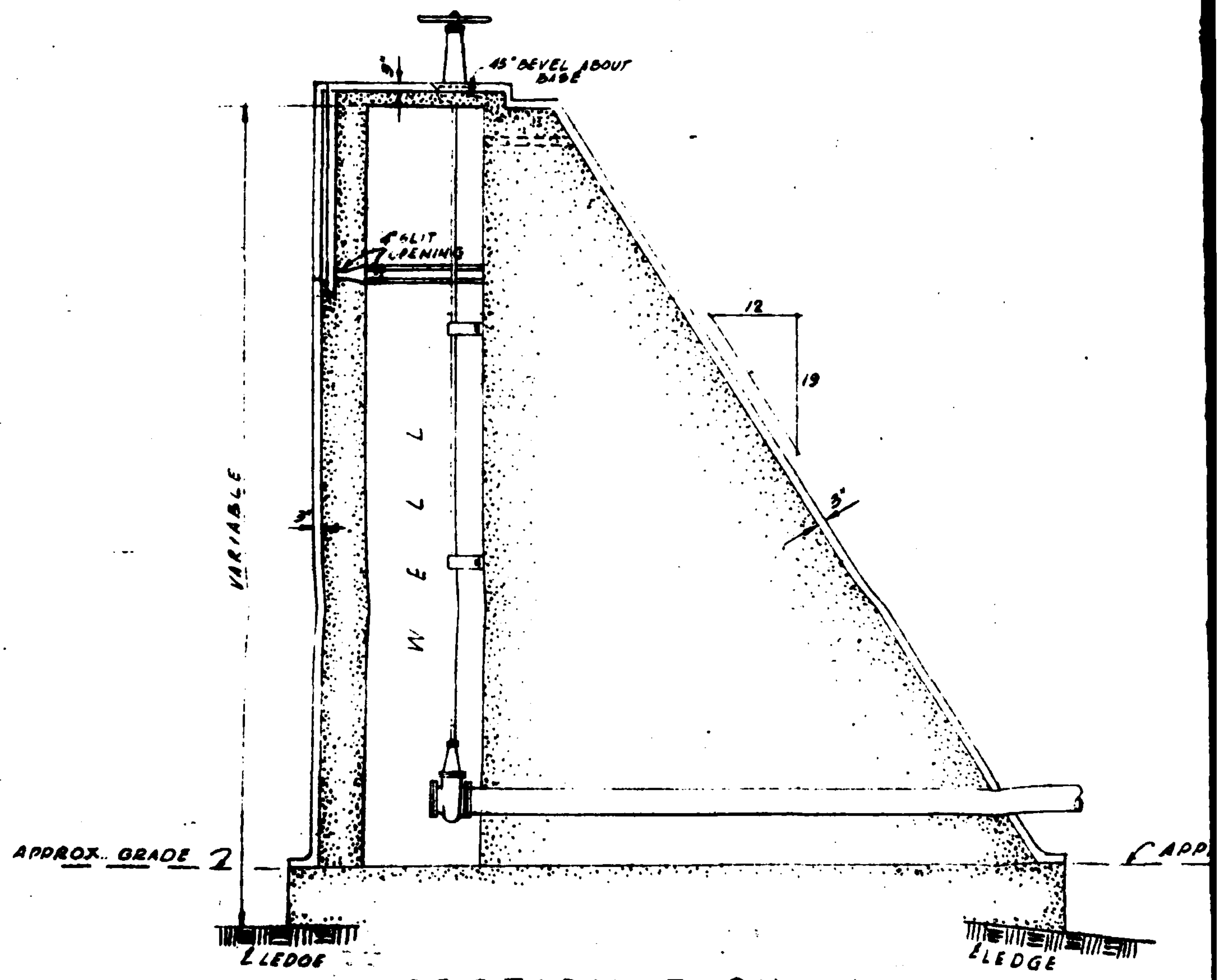
7'-0"



SPILLWAY·
CONCRETE TO BE REMOVED ·
M. "80 A
LE 1" = 20'

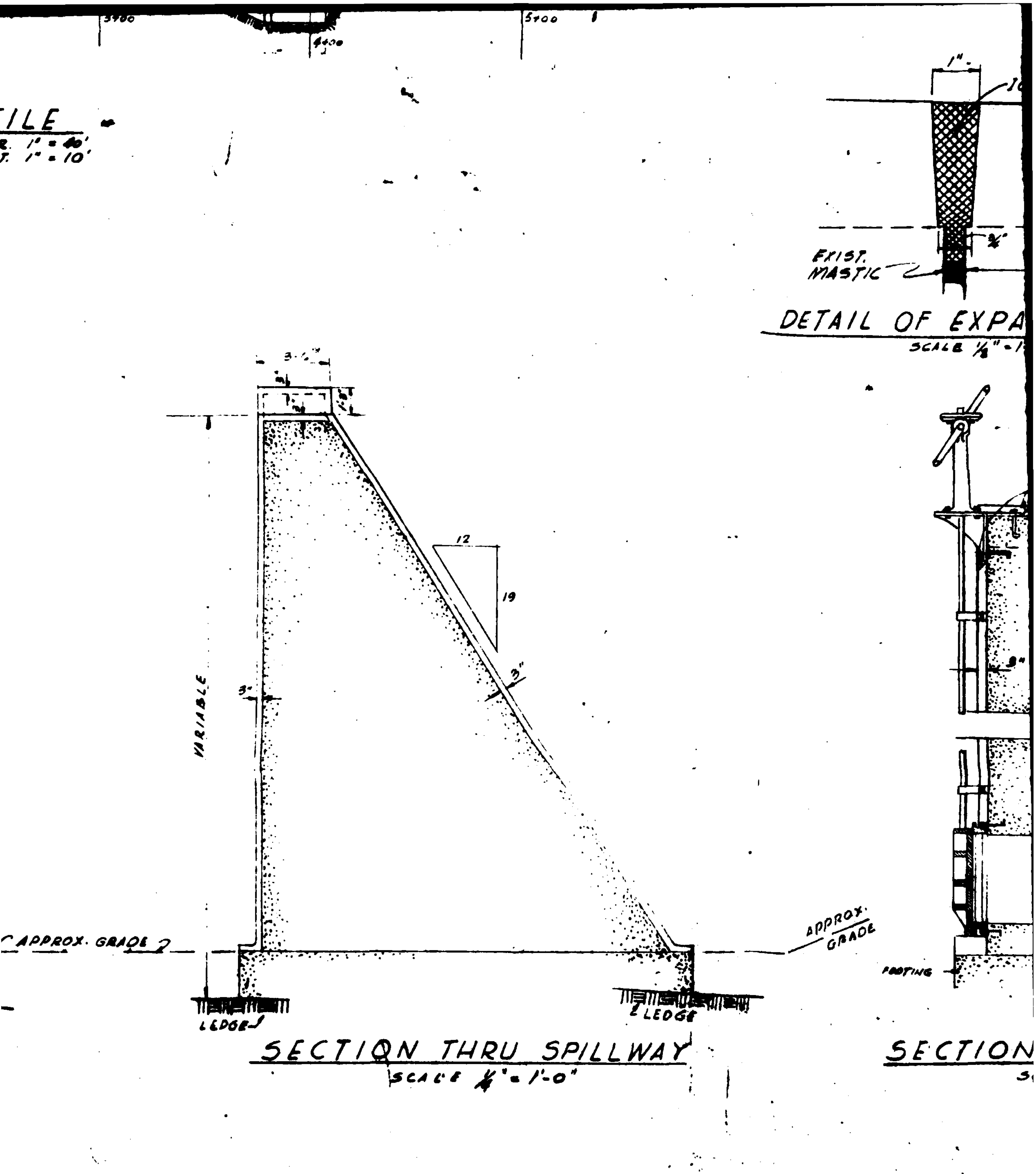
0+00
1+00
2+00

PROFIL
SCALE: HOR. 1
VERT. 1



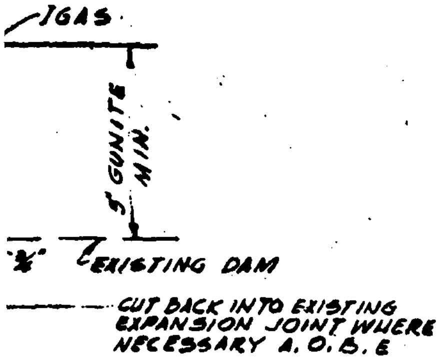
SECTION THRU WELL
SCALE 1/4" = 1'-0"

5



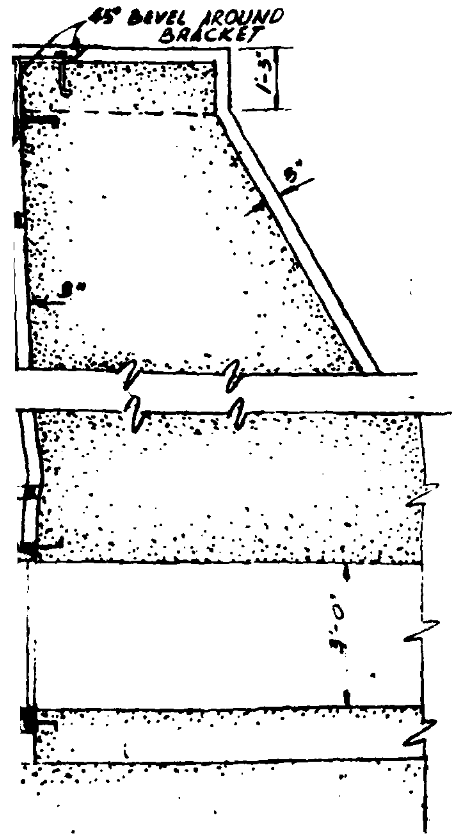
5400
6400
5400
ILE
DETAIL OF EXPA
SCALE 1/8" = 1
EXIST. MASTIC
1"
12
19
3"
3"
VARIABLE
APPROX. GRADE
APPROX. GRADE
LEDGE
LEDGE
FOOTING
SECTION THRU SPILLWAY
SCALE 1/4" = 1'-0"
SECTION

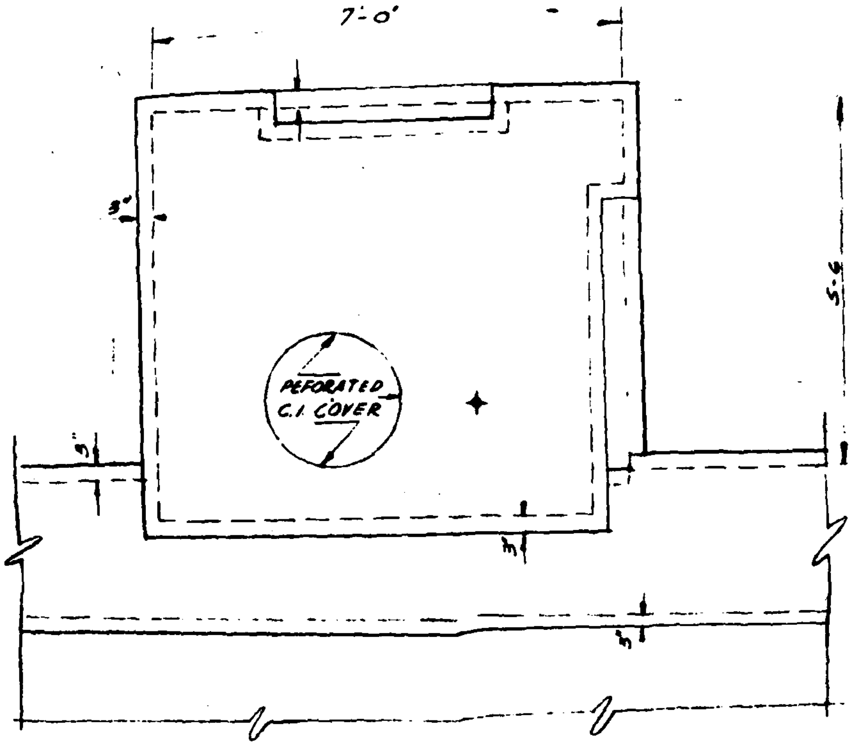
SCALE 1" = 20'



PANSION JOINT

"=1'-0"



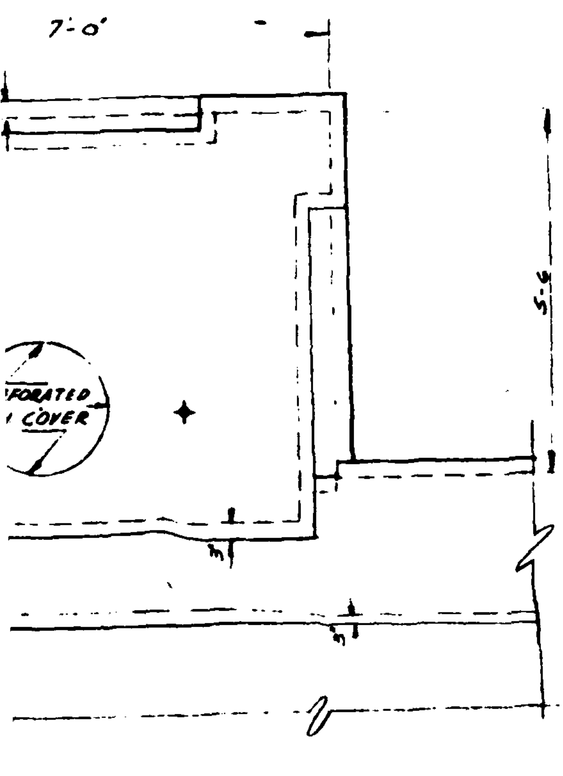


PLAN OF WELL

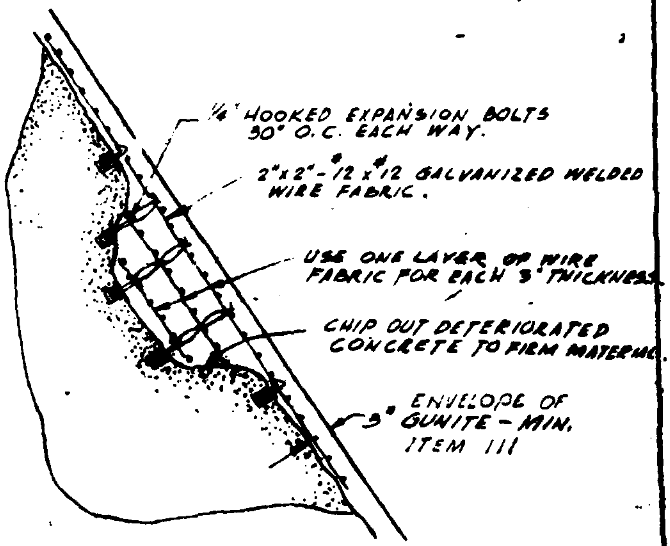
SCALE 1/2" = 1'-0"

ION THRU SLUICE GATE

SCALE 3/8" = 1'-0"



...AN OF WELL
SCALE ½" = 1'-0"



TYPICAL DAM REPAIR
NOT TO SCALE

REPAIR - LAKE WELCH DAM
HARRIMAN STATE PARK ROCKLAND CO.
NEW YORK

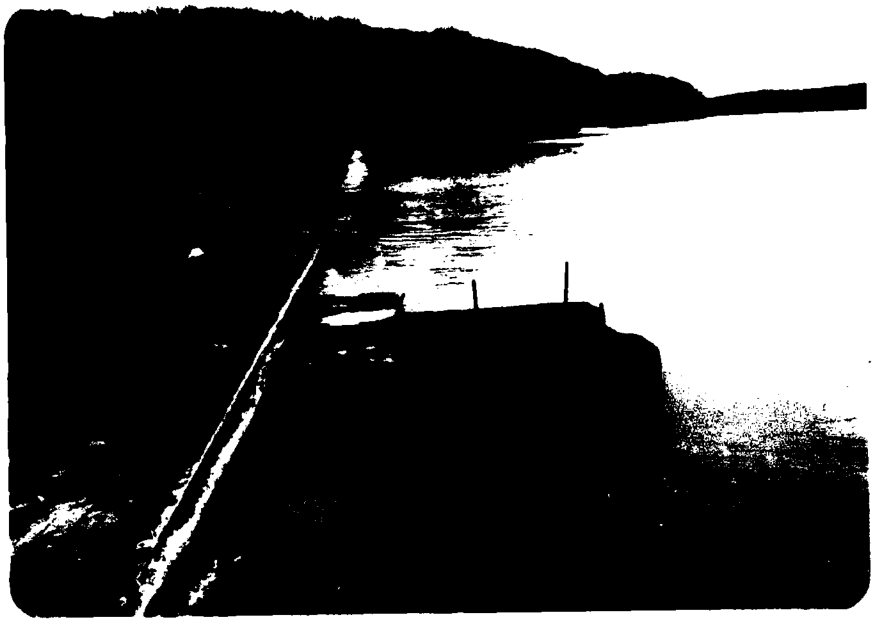
DESIGNED BY		TITLE	DRAWING No.
DRAWN BY	PCS	DETAILS OF DAM REPAIRS	2
TRACED BY			
CHECKED BY	HMD		SCALE AS SHOWN
DATE	7/17/51		

PALISADES INTERSTATE PARK COMMISSION
BEAR MOUNTAIN NEW YORK

6

PHOTOGRAPHS

APPENDIX B

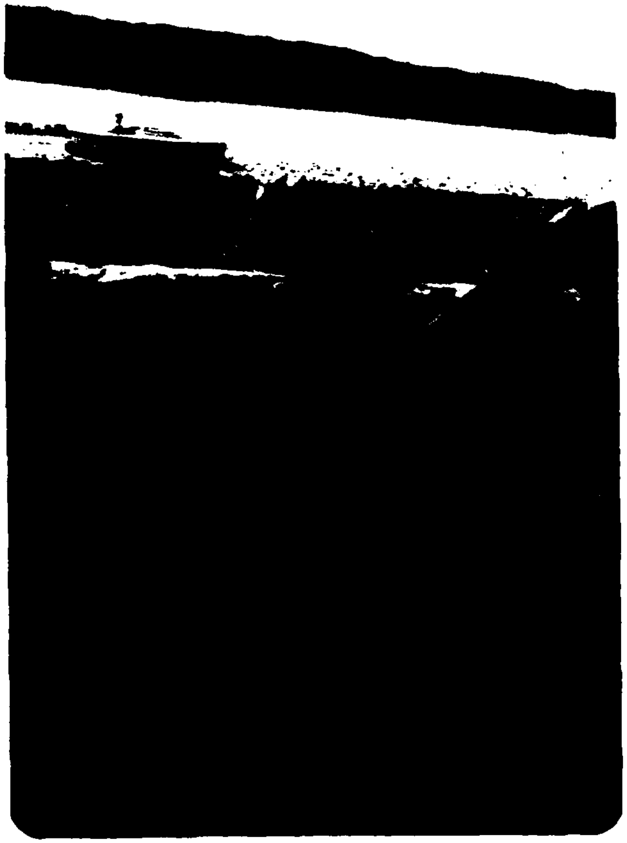


2. VIEW OF CREST OF SPILLWAY AND INTAKE STRUCTURE FOR HIGH LEVEL OUTLET.

3. VIEW OF DOWNSTREAM CHANNEL. NOTE VEGETATION.

4. VIEW OF DOWNSTREAM FACE OF DAM. NOTE SEEPAGE THROUGH CONSTRUCTION JOINT AND GUNITE SURFACE REMOVED.

5. VIEW OF DOWNSTREAM FACE OF SPILLWAY AND HIGH LEVEL OUTLET. NOTE FLOW THROUGH OUTLET AND THE EXPOSED ROCK OF THE DOWNSTREAM CHANNEL.



6. VIEW AT DAM CREST. NOTE GUNITE SURFACE OVER THE CONCRETE.

7. VIEW OF OPERATING MECHANISM FOR SLUICE GATE. (RESERVOIR DRAIN)

8. VIEW OF CREST AND DOWNSTREAM FACE
OF EARTH EMBANKMENT. (LOOKING RIGHT)

VISUAL INSPECTION CHECKLIST

APPENDIX C

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam LAKE WELCH (FORMERLY KNOWN AS BEAVER POND DAM)

Fed. I.D. # NY 283 DEC Dam No. 196-854

River Basin HUDSON

Location: Town LETCHWORTH VILLAGE County ROCKLAND

Stream Name MINISCEONGO CREEK

Tributary of HUDSON RIVER

Latitude (N) 41° 13' 44" Longitude (W) 74° 4' 20"

Type of Dam CONCRETE GRAVITY & EARTH WITH CENTRAL CONCRETE CORE WALL.

Hazard Category HIGH

Date(s) of Inspection APRIL 24, 1980

Weather Conditions 75° SUNNY

Reservoir Level at Time of Inspection 1015.1 Ft. (MSL)

b. Inspection Personnel TONY DOLICMASCOLO AND JYOTINDRA PATEL

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

ROBERT SANTORO, SENIOR PARK ENGINEER, PALISADES INTERSTATE PARK COMMISSION, ADMINISTRATION BUILDING, BEAR MOUNTAIN, NY 10911, PHONE NO. (914) 786-2701

d. History:

Date Constructed 1929-1937 Date(s) Reconstructed 1959 and 1978

Designer MR. W. A. WELCH

Constructed By [illegible]

Owner NEW YORK STATE PARKS & RECREATION
PALISADES INTERSTATE PARK COMMISSION

2) Embankment — EARTH WITH CENTER CONCRETE CORE WALL (225 FT. LONG)

a. Characteristics

(1) Embankment Material

(2) Cutoff Type NONE

(3) Impervious Core CONCRETE COREWALL LOCATED IN THE CENTER OF EMBANKMENT

(4) Internal Drainage System NONE

(5) Miscellaneous —

b. Crest

(1) Vertical Alignment GOOD

(2) Horizontal Alignment STRAIGHT AND ALIGNMENT GOOD

(3) Surface Cracks NONE OBSERVED

(4) Miscellaneous —

c. Upstream Slope

(1) Slope (Estimate) (V:H)

(2) Undesirable Growth or Debris, Animal Burrows

(3) Sloughing, Subsidence or Depressions NONE OBSERVED

(4) Slope Protection NONE

(5) Surface Cracks or Movement at Toe NONE OBSERVED

d. Downstream Slope

(1) Slope (Estimate - V:H)

(2) Undesirable Growth or Debris, Animal Burrows LARGE BUSHES AND A FEW SAPLING SIZE TREES.

(3) Sloughing, Subsidence or Depressions NONE OBSERVED

(4) Surface Cracks or Movement at Toe NONE OBSERVED

(5) Seepage NONE OBSERVED

(6) External Drainage System (Ditches, Trenches; Blanket) NOT APPLICABLE

(7) Condition Around Outlet Structure NOT APPLICABLE

(8) Seepage Beyond Toe NONE OBSERVED.

e. Abutments - Embankment Contact (SOUTHERLY). NORTHERLY CONTACT IS WITH CONCRETE GRAVITY DAM.

(1) Erosion at Contact NONE OBSERVED

(2) Seepage Along Contact NONE OBSERVED

3) Drainage System — NONE

a. Description of System

b. Condition of System

c. Discharge from Drainage System

4) Instrumentation (Momumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.)

NONE

5) Reservoir

a. Slopes WITHIN VICINITY OF THE DAM RESERVOIR SLOPES ARE STABLE AND NO INCIDENCE OF ADVERSE CONDITION REPORTED TO THE OWNER.

b. Sedimentation NO EVIDENCE OF EXCESSIVE SEDIMENTATION OBSERVED. LAKE WATER RELATIVELY CLEAR; NO FLOATING DEBRIS OBSERVED.

c. Unusual Conditions Which Affect Dam —

6) Area Downstream of Dam

a. Downstream Hazard (No. of Homes, Highways, etc.) WELCH CAMP SITE; SEVERAL HOMES; STATE Rt. 210 AND PALISADES INTERSTATE PARKWAY.

b. Seepage, Unusual Growth NO SEEPAGE OBSERVED, NO UNUSUAL GROWTH

c. Evidence of Movement Beyond Toe of Dam NONE OBSERVED

d. Condition of Downstream Channel CHANNEL IS ALSO SPILLWAY CHANNEL WHICH IS OVERGROWN WITH TREES AND OTHER VEGETATION. (ALSO SEE ITEM #7.

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

SPILLWAY IS BROAD CRESTED WEIR AND IS PART OF CONCRETE DAM.

a. General THE ORIGINAL SPILLWAY WAS REHABILITATED BY APPLYING A GUNITE SURFACE

b. Condition of ~~Service~~ Spillway GENERALLY IN GOOD CONDITION. FEW FEET OF GUNITE SURFACE IS NOT EXISTING ALONG THE CREST OF THE SPILLWAY (SEE PHOTOGRAPH)

c. Condition of Auxiliary Spillway NOT APPLICABLE

d. Condition of Discharge Conveyance Channel IN VICINITY OF DAM THE CHANNEL BANKS AND FLOOR OF CHANNEL IS ROCK AND IS IN GOOD CONDITION. OVERGROWN WITH TREES AND OTHER VEGETATION.

8) Reservoir ~~Drain~~ and Outlet LOW LEVEL - 3'x3' SLUICE WAY (1)
HIGH LEVEL - 12" CI OUTLET PIPE (2)

Type: Pipe (2) Conduit ______ Other SLUICEWAY (1)

Material: Concrete (2) Metal (1) Other ______

Size: AS NOTED ABOVE Length —

Invert Elevations: Entrance (1) 984.0 (2) 1010 Exit (1) 984 ± (2) 991.5 ±

Physical Condition (Describe): Unobservable (1) & (2) except note below.

Material: —

Joints: — Alignment —

Structural Integrity: CONCRETE WALLS OF SLUICEWAY ARE IN GOOD CONDITION.

Hydraulic Capability: —

—

Means of Control: Gate (2) Valve (1) Uncontrolled ______

Operation: Reported Operable (1) Inoperable (2) Other ______

Present Condition (Describe): CONTROL FOR HIGHLEVEL IS NOT EXISTING EXCEPT THE STEM; SLUICEGATE CONTROL IN GOOD CONDITION AND REPORTED OPERABLE

9) Structural

a. Concrete Surfaces ORIGINAL CONCRETE DAM RESURFACED WITH GUNITE (3 inches). MOST OF WHICH HAS BEEN REMOVED AT DOWNSTREAM FACE. THE CONDITION EXPOSE CONCRETE IS GOOD.

b. Structural Cracking NONE OBSERVED

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

d. Junctions with Abutments or Embankments NO EVEDENCE OF PROBLEMS.

e. Drains - Foundation, Joint, Face NONE

f. Water Passages, Conduits, Sluices 2 OUTLETS — HIGH LEVEL OUTLET & LOW LEVEL OUTLET ARE 12 inch CI PIPE AND 3 FT SQUARE SLUICEWAY. THE CONDITION OF HIGH LEVEL OUTLET UNDETERMINED; SLUICEWAY IN SATISFACTORY CONDITION

g. Seepage or Leakage MINOR SEEPAGE OBSERVED AT THE MONOLITH & CONSTRUCTION JOINTS.

h. Joints - Construction, etc. SOME JOINTS FILLED WITH OAKUM TO PREVENT SEEPAGE.

i. Foundation IS ROCK ACCORDING TO AVAILABLE DOCUMENTS & VISUAL INSPECTION OF DOWNSTREAM DAM

j. Abutments NO EVIDENCE OF SEEPAGE

k. Control Gates HIGHLEVEL OUTLET - INOPERABLE
LOWLEVEL OUTLET IS REPORTED OPERABLE

l. Approach & Outlet Channels NONE

m. Energy Dissipators (Plunge Pool, etc.) NONE

n. Intake Structures FOR HIGH LEVEL OUTLET ; STRUCTURE COMPLETED FULL OF WATER.

o. Stability THERE ARE NO VISUAL INDICATIONS THAT SPILLWAY SHOWS ANY EVIDENCE OF STABILITY PROBLEMS

p. Miscellaneous

HYDROLOGIC DATA AND COMPUTATION

APPENDIX D

TAMS

Job No. 1551 Sheet 1 of 4

Project LAKE WELCH PHASE 1 INSPECTION Date MAY 14 1980

Subject By D.L.C

LOCATION LAT 41° 13' 45" LONG 74° 4' 15" Ch'k. by

EM 1110-2-1405

$L = 9.5" = 3.6$ miles

$L_{CA} = 2.9" = 1.1$ miles

Use $C_T = 2$

$640 C_p = 400$

$T_p = C_T (L L_{CA})^{.3}$

$= 3.02$ hours

$t_r = 3.02/5.5 = 0.5$ hours.

$q_p = \frac{640 C_p}{t_p} = \frac{400}{3.0}$ 133 cfs/sq mi

$Q_p = 133 \times 2.87 = 382$ cfs

HYDROMET REPORT NO. 51.

PMP 24 hour 200 SQ.MI INDEX RAINFALL = 24.5"

10 SQ.MI.	6 HR	12 HR	24 HR	48 HR
	26	30	33	37
% index Ppt	106.1	122.4	134.7	151.

TAMS

Job No. 1551-11

Project LAKE WELCH PHASE I INSPECTION

Subject EL-AREA-STORAGE RELATION

Sheet 2 of 4

Date MAY 14 1980

By DLC

Ch'k. by

EL	Δ H	AREA	MEAN AREA	Δ STORAGE	STORAGE	(* Ref 5)
984		0				
1010		186			3444*	
	5		202	1010		
1015		218			4454	
	1		221.5	221.5		
1016		225			4675.5	1016.5 4791.3
	2		231.5	463		
1018		238			5138.5	
	2		244.5	489		
1020		251			5627.5	

Total Surcharge Storage 5630 − 4450 = 1180 Acre feet
~ 7.7 inches of R/O

CROSS SECTIONS BELOW DAM (Minisceongo. Creek)

400 ft		26+00		52+00		76+00	
		1120	960	720	8760		~~560~~
3130	1020	1180	940	700	8820	7500	540
3280	1000	1250	920	680	8860	7600	520
3380	980	1370	917	660	8930	7680	500
3385	975	1440	917	640	9000	8060	480
3450	975	2000	900	660	9120	8100	500
3500	970	2090	920	680	9230	8110	505
3590	980	2150	940	700	9330	8160	505
3630	1000	2210	960	720	9400	8210	520
3690	[illegible]					8270	540

TAMS

Job No. 1551-11 | Sheet 3 of 4

Project LAKE WELCH PHASE 1 INSPECTION | Date MAY 14 1980

Subject | By D L C

Ch'k. by

BROAD CRESTED SPILLWAY CREST EL 1015. LENGTH 152.0'

USE C = 0.85 x 3.087 = 2.624

DAM 1016.3. DAM 788 TOP 1010

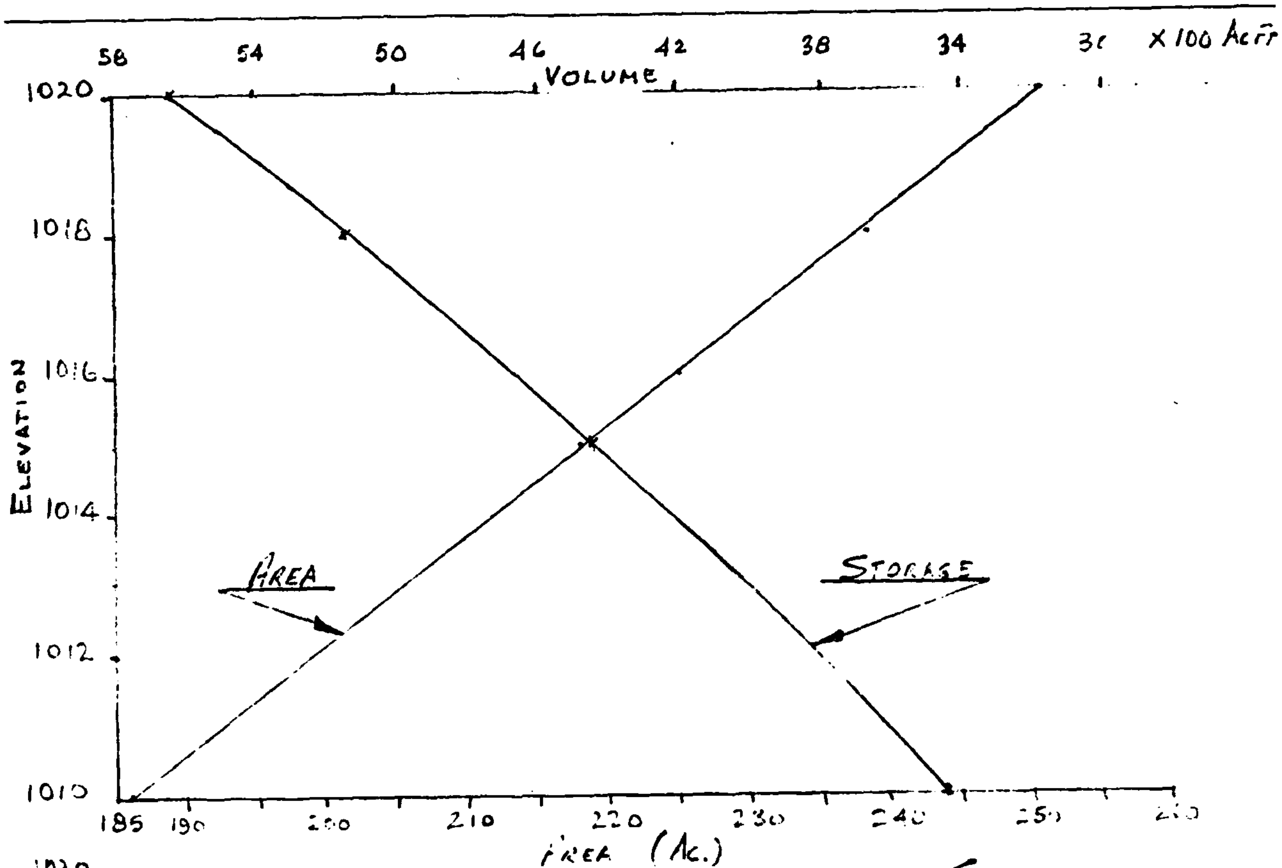
EL	H_s	Q_s	H_D	Q_G (L = 411)	Q_E	Q_T
1015		0				0
1016		400				400
1016.5		730				730
1017		1130	0.5	381		1510
1019		3190	2.5	4263		7450
1020		4460	3.5	7062	590	12110

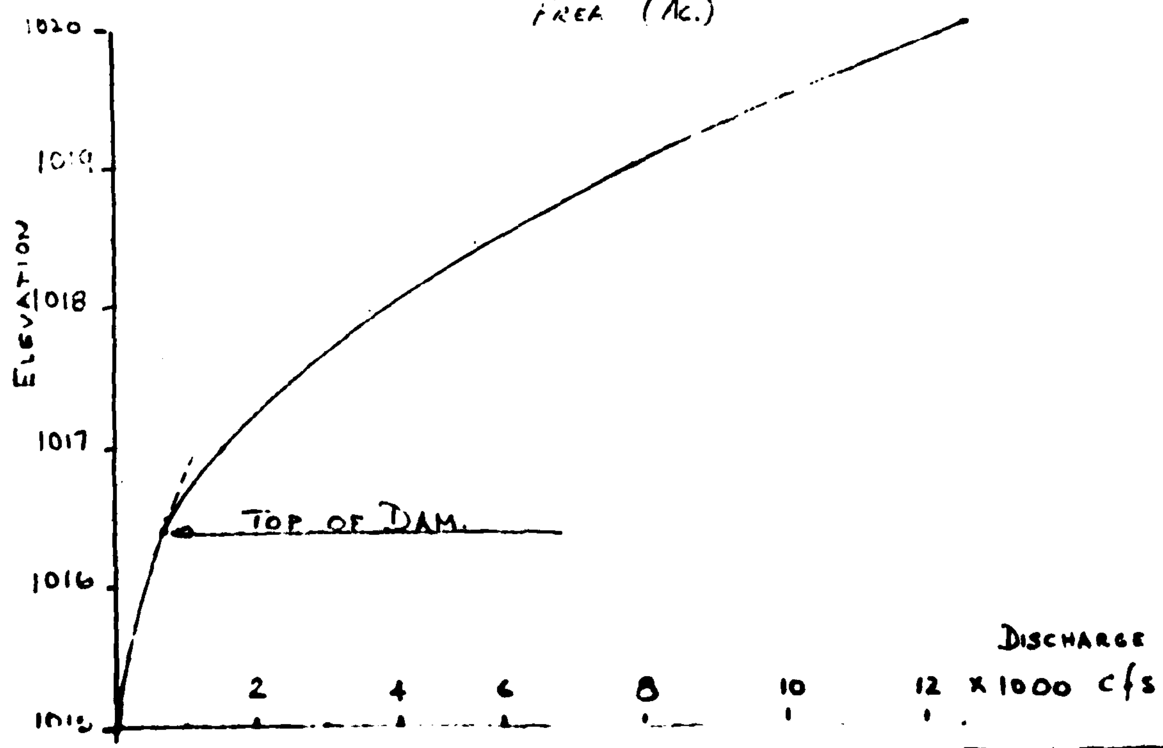
TOP OF GRAVITY DAM 1016.3

EL	A	S	D
981	0	0	0
1015	218	4454	0
1016.5	228	4791.3	730
1017	232	4907	1510
1019	245	5383	7450
1020	251	5627.5	12110

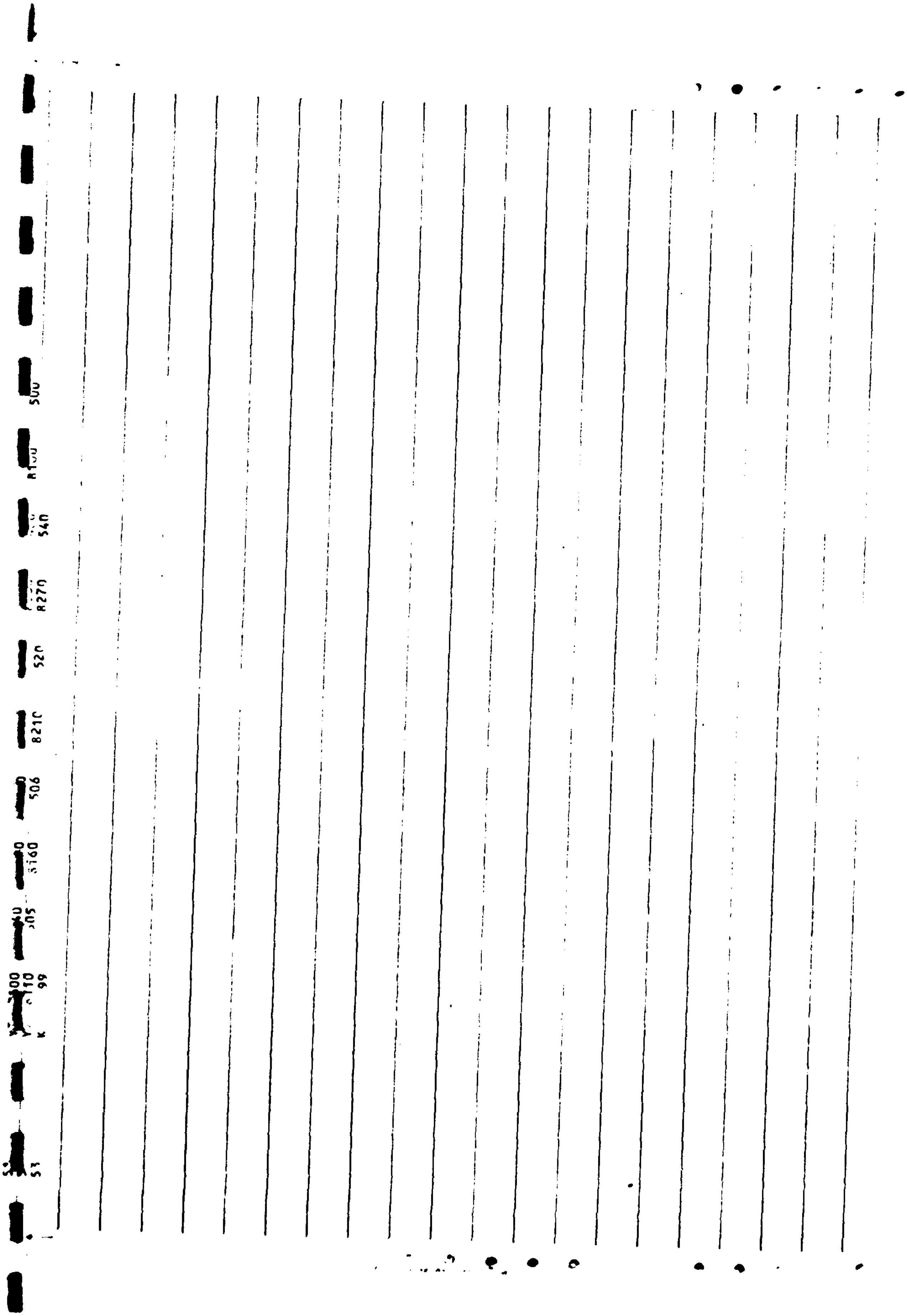
TAMS

Job No. 1551-11 | Sheet 4 of 4
Project: Lake Welch Phase 1 Inspection | Date: May 14 1980
Subject: Hydrologic/Hydraulic Computation | By: DLC
Ch'k. by





```
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
*********************************
A1      PHASE 1 INSPECTION AND SAFETY EVALUATION OF LAKE WELCH DAM      1551-11
A2           SPILLWAY ADEQUACY TESTS USING PROBABLE MAXIMUM FLOOD
A3                TAMS ENGINEERS & ARCHITECTS
B      100       0      30       0       0       0       0       0       0       0
B1       5
J        1       2       1
J1       1      .5
K        0       1
K1      UNIT HYDROGRAPH AND INFLOW HYDROGRAPH COMPUTATION
P        1       1    2.87                                               1
P             24.5   106.1   122.4   134.7     151
T                                                      2     .05             .15
W     3.02   0.625
X       -1    -.05       3
K        1       2
K1      RESERVOIR ROUTING
Y                                1       1
Y1       1                                           4454      -1
Y4     981    1015  1016.5    1017    1019    1020
Y5       0       0     730    1510    7450   12110
SS       0    4454  4791.3    4907    5383  5627.5
SE     981    1015  1016.5    1017    1019    1020
SS1015.0
SD1016.3       0     1.5     788
K        1       3
K1      CHANNEL ROUTING-TOE OF DAM TO  STN  4+00
Y                                1       1
Y1       1
Y6     .04     .04     .04     970    1020     400   0.028
Y7    3130    1020    3280    1000    3380     980    3385     978    3450     977
Y7    3500     970    3590     980    3630    1000    3690    1020
K        1       4
K1     CHANNEL ROUTING STN 4+00 TO 26+00
Y                                1       1
Y1       1
Y6     .04     .04     .04     900     960    2200   0.032
Y7    1120     960    1180     940    1250     920    1370     917    1440     917
Y7    2000     900    2090     920    2150     940    2200     960
K        1       5
K1     CHANNEL ROUTING STN 26+00 TO STN 52+00
Y                                1       1
Y1       1
Y6     .04     .04     .04     640     720    2600    .062
Y7    8760     720    8820     700    8860     680    8930     660    9000     640
Y7    9120     660    9250     680    9330     700    9400     720
K        1       6
K1     CHANNEL ROUTING STN 52+00 TO 76+00
Y                                1       1
Y1       1
Y6     .04     .04     .04     480     540    2400    .067
```



PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
ROUTE HYDROGRAPH TO	3
ROUTE HYDROGRAPH TO	4
ROUTE HYDROGRAPH TO	5
ROUTE HYDROGRAPH TO	6
END OF NETWORK	

```
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  26 FEB 79
**********************************

RUN  DATE= 80/05/21.
     TIME= 19.02.01.


                    PHASE 1 INSPECTION AND SAFETY EVALUATION OF LAKE WELCH DAM        1551-11
                         SPILLWAY ADEQUACY TESTS USING PROBABLE MAXIMUM FLOOD
                              TAMS ENGINEERS & ARCHITECTS

                                        JOB SPECIFICATION
          NQ       NHR      NMIN      IDAY      IHR      IMIN    METRC     IPLT     IPRT    NSTAN
         100         0        30         0        0         0        0        0        0        0
                                     JOPER      NWT     LROPT    TRACE
                                         5        0         0        0

                                 MULTI-PLAN ANALYSES TO BE PERFORMED
                                       NPLAN= 1 NRTIO= 2 LRTIO= 1
                 RTIOS=   1.00    .50


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

                                    SUB-AREA RUNOFF COMPUTATION

                   UNIT HYDROGRAPH AND INFLOW HYDROGRAPH COMPUTATION

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

                                              HYDROGRAPH DATA
           IHYDG     IUHG    TAREA     SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
               1        1     2.87     0.00     2.87     0.00    0.000        0        1        0

                                                PRECIP DATA
                        SPFE      PMS       R6      R12      R24      R48      R72      R96
                        0.00    24.50   106.10   122.40   134.70   151.00     0.00     0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800

                                                  LOSS DATA
        LROPT    STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
            0     0.00     0.00     1.00     0.00     0.00     1.00     2.00      .05     0.00      .15

                                           UNIT HYDROGRAPH DATA
                                     TP=  3.02     CP=  .63     NTA=  0

                                              RECESSION DATA
                              STRTQ=    -1.00     QRCSN=      -.05     RTIOR= 3.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 6.90 AND R= 5.43 INTERVALS

              UNIT HYDROGRAPH 33 END-OF-PERIOD ORDINATES, LAG=   3.00 HOURS, CP=  .63  VOL= 1.00
          24.        89.       176.       270.       346.       387.       386.       342.       284.       236.
         196.       163.       136.       113.        94.        78.        65.        54.        45.        37.
          31.        26.        21.        18.        15.        12.        10.         8.         7.         6.
           5.         4.         3.

                                            END-OF-PERIOD FLOW
```

1.01	.30	1	.01	.00	.01	3.	1.02	1.30	51	.08	.06	.02	75.
1.01	1.00	2	.01	.00	.01	2.	1.02	2.00	52	.08	.06	.02	82.
1.01	1.30	3	.01	.00	.01	2.	1.02	2.30	53	.08	.06	.02	95.
1.01	2.00	4	.01	.00	.01	3.	1.02	3.00	54	.08	.06	.02	111.
1.01	2.30	5	.01	.00	.01	3.	1.02	3.30	55	.08	.06	.02	128.
1.01	3.00	6	.01	.00	.01	3.	1.02	4.00	56	.08	.06	.02	143.
1.01	3.30	7	.01	.00	.01	4.	1.02	4.30	57	.08	.06	.02	156.
1.01	4.00	8	.01	.00	.01	4.	1.02	5.00	58	.08	.06	.02	166.
1.01	4.30	9	.01	.00	.01	4.	1.02	5.30	59	.08	.06	.02	175.
1.01	5.00	10	.01	.00	.01	5.	1.02	6.00	60	.08	.06	.02	183.
1.01	5.30	11	.01	.00	.01	5.	1.02	6.30	61	.27	.24	.02	193.
1.01	6.00	12	.01	.00	.01	5.	1.02	7.00	62	.27	.24	.02	215.
1.01	6.30	13	.03	.00	.03	5.	1.02	7.30	63	.27	.24	.02	252.
1.01	7.00	14	.03	.00	.03	6.	1.02	8.00	64	.27	.24	.02	305.
1.01	7.30	15	.03	.00	.03	6.	1.02	8.30	65	.27	.24	.02	371.
1.01	8.00	16	.03	.00	.03	7.	1.02	9.00	66	.27	.24	.02	445.
1.01	8.30	17	.03	.00	.03	8.	1.02	9.30	67	.27	.24	.02	519.
1.01	9.00	18	.03	.00	.03	10.	1.02	10.00	68	.27	.24	.02	584.
1.01	9.30	19	.03	.00	.03	11.	1.02	10.30	69	.27	.24	.02	638.
1.01	10.00	20	.03	.00	.03	12.	1.02	11.00	70	.27	.24	.02	684.
1.01	10.30	21	.03	.00	.03	13.	1.02	11.30	71	.27	.24	.02	721.
1.01	11.00	22	.03	.00	.03	14.	1.02	12.00	72	.27	.24	.02	753.
1.01	11.30	23	.03	.00	.03	15.	1.02	12.30	73	1.04	1.02	.02	798.
1.01	12.00	24	.03	.00	.03	15.	1.02	13.00	74	1.04	1.02	.02	888.
1.01	12.30	25	.13	.02	.11	16.	1.02	13.30	75	1.25	1.23	.02	1048.
1.01	13.00	26	.13	.02	.11	18.	1.02	14.00	76	1.25	1.23	.02	1290.
1.01	13.30	27	.15	.02	.13	21.	1.02	14.30	77	1.56	1.54	.02	1614.
1.01	14.00	28	.15	.02	.13	25.	1.02	15.00	78	1.56	1.54	.02	2008.
1.01	14.30	29	.19	.03	.16	31.	1.02	15.30	79	1.90	1.88	.02	2450.
1.01	15.00	30	.19	.03	.16	38.	1.02	16.00	80	6.01	5.98	.02	3016.
1.01	15.30	31	.23	.03	.20	46.	1.02	16.30	81	1.46	1.43	.02	3744.
1.01	16.00	32	.73	.43	.30	64.	1.02	17.00	82	1.46	1.43	.02	4533.
1.01	16.30	33	.18	.15	.02	101.	1.02	17.30	83	1.14	1.12	.02	5283.
1.01	17.00	34	.18	.15	.02	155.	1.02	18.00	84	1.14	1.12	.02	5866.
1.01	17.30	35	.14	.12	.02	220.	1.02	18.30	85	.12	.10	.02	6169.
1.01	18.00	36	.14	.12	.02	287.	1.02	19.00	86	.12	.10	.02	6130.
1.01	18.30	37	.01	.00	.01	342.	1.02	19.30	87	.12	.10	.02	5749.
1.01	19.00	38	.01	.00	.01	374.	1.02	20.00	88	.12	.10	.02	5181.
1.01	19.30	39	.01	.00	.01	374.	1.02	20.30	89	.12	.10	.02	4564.
1.01	20.00	40	.01	.00	.01	351.	1.02	21.00	90	.12	.10	.02	3942.
1.01	20.30	41	.01	.00	.01	315.	1.02	21.30	91	.12	.10	.02	3360.
1.01	21.00	42	.01	.00	.01	273.	1.02	22.00	92	.12	.10	.02	2855.
1.01	21.30	43	.01	.00	.01	231.	1.02	22.30	93	.12	.10	.02	2435.
1.01	22.00	44	.01	.00	.01	193.	1.02	23.00	94	.12	.10	.02	2085.
1.01	22.30	45	.01	.00	.01	162.	1.02	23.30	95	.12	.10	.02	1795.
1.01	23.00	46	.01	.00	.01	136.	1.03	0.00	96	.12	.10	.02	1553.
1.01	23.30	47	.01	.00	.01	114.	1.03	.30	97	0.00	0.00	0.00	1350.
1.02	0.00	48	.01	.00	.01	96.	1.03	1.00	98	0.00	0.00	0.00	1174.
1.02	.30	49	.08	.06	.02	83.	1.03	1.30	99	0.00	0.00	0.00	1018.
1.02	1.00	50	.08	.06	.02	76.	1.03	2.00	100	0.00	0.00	0.00	876.
									SUM	29.60	26.63	2.97	94075.
										(752.)	(676.)	(75.)	(2663.91)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6169.	4788.	1859.	936.	93635.
CMS	175.	136.	53.	27.	2651.
INCHES		15.52	24.10	25.29	25.29
MM		394.19	612.06	642.39	642.39
AC-FT		2374.	3687.	3869.	3869.
THOUS CU M		2929.	4547.	4773.	4773.

[illegible]	[illegible]	[illegible]	[illegible]	6.	7.	8.	[illegible]	[illegible]	[illegible]
13.	14.	15.	15.	16.	18.	21.	25.	31.	38.
46.	64.	101.	155.	220.	287.	342.	374.	374.	351.
315.	273.	231.	193.	162.	136.	114.	96.	83.	76.
75.	82.	95.	111.	128.	143.	156.	166.	175.	183.
193.	215.	252.	305.	371.	445.	519.	584.	638.	684.
721.	753.	798.	888.	1048.	1290.	1614.	2008.	2450.	3016.
3744.	4533.	5283.	5866.	6169.	6130.	5749.	5181.	4564.	3942.
3360.	2855.	2435.	2085.	1795.	1553.	1350.	1174.	1018.	876.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6169.	4788.	1859.	936.	93635.
CMS	175.	136.	53.	27.	2651.
INCHES		15.52	24.10	25.29	25.29
MM		394.19	612.06	642.39	642.39
AC-FT		2374.	3687.	3869.	3869.
THOUS CU M		2929.	4547.	4773.	4773.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

1.	1.	1.	1.	1.	2.	2.	2.	2.	2.
2.	2.	3.	3.	3.	4.	4.	5.	6.	6.
7.	7.	7.	8.	8.	9.	10.	12.	15.	19.
23.	32.	51.	77.	110.	144.	171.	187.	187.	175.
157.	136.	115.	97.	81.	68.	57.	48.	41.	38.
38.	41.	47.	55.	64.	72.	78.	83.	88.	91.
97.	107.	126.	153.	186.	223.	260.	292.	319.	342.
361.	376.	399.	444.	524.	645.	807.	1004.	1225.	1508.
1872.	2267.	2641.	2933.	3085.	3065.	2875.	2590.	2282.	1971.
1680.	1427.	1217.	1043.	897.	777.	675.	587.	509.	438.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3085.	2394.	929.	468.	46817.
CMS	87.	68.	26.	13.	1326.
INCHES		7.76	12.05	12.65	12.65
MM		197.09	306.03	321.20	321.20
AC-FT		1187.	1843.	1935.	1935.
THOUS CU M		1464.	2274.	2386.	2386.

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HYDROGRAPH ROUTING

RESERVOIR ROUTING

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

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	4454.	-1

STAGE	981.00	1015.00	1016.50	1017.00	1019.00	1020.00
FLOW	0.00	0.00	730.00	1510.00	7450.00	12110.00
CAPACITY=	0.	4454.	4791.	4907.	5383.	5628.
ELEVATION=	981.	1015.	1017.	1017.	1019.	1020.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1015.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1016.3	0.0	1.5	788.

STATION 2, PLAN 1, RATIO 1

ELEVATION 981. 1015. 1017. 1017. 1019. 1020.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1015.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1016.3	0.0	1.5	788.

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	1.	1.	1.	1.	1.	2.	2.	2.
2.	2.	3.	3.	3.	4.	4.	4.	5.	5.
6.	7.	7.	8.	9.	9.	10.	11.	13.	15.
17.	20.	26.	34.	47.	65.	86.	110.	132.	152.
167.	178.	185.	187.	186.	183.	178.	172.	165.	157.
150.	144.	139.	136.	135.	135.	136.	138.	141.	144.
148.	153.	160.	170.	184.	203.	227.	255.	286.	318.
351.	384.	417.	454.	497.	555.	632.	738.	1103.	1501.
2265.	3033.	3802.	4529.	5139.	5553.	5711.	5611.	5309.	4876.
4374.	3855.	3359.	2908.	2511.	2168.	1874.	1623.	1450.	1327.

STORAGE

4454.	4454.	4454.	4454.	4454.	4455.	4455.	4455.	4455.	4455.
4455.	4455.	4455.	4455.	4455.	4456.	4456.	4456.	4456.	4457.
4457.	4457.	4457.	4458.	4458.	4458.	4459.	4459.	4460.	4461.
4462.	4463.	4466.	4470.	4476.	4484.	4494.	4505.	4515.	4524.
4531.	4536.	4539.	4540.	4540.	4539.	4536.	4533.	4530.	4527.
4523.	4521.	4518.	4517.	4516.	4516.	4517.	4518.	4519.	4521.
4522.	4525.	4528.	4532.	4539.	4548.	4559.	4572.	4586.	4601.
4616.	4631.	4647.	4664.	4684.	4710.	4746.	4792.	4847.	4906.
4968.	5029.	5091.	5149.	5198.	5231.	5244.	5236.	5211.	5177.
5136.	5095.	5055.	5019.	4987.	4960.	4936.	4916.	4898.	4880.

STAGE

1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.1	1015.1	1015.1	1015.1	1015.2	1015.2	1015.3	1015.3
1015.3	1015.4	1015.4	1015.4	1015.4	1015.4	1015.4	1015.4	1015.3	1015.3
1015.3	1015.3	1015.3	1015.3	1015.3	1015.3	1015.3	1015.3	1015.3	1015.3
1015.3	1015.3	1015.3	1015.3	1015.4	1015.4	1015.5	1015.5	1015.6	1015.7
1015.7	1015.8	1015.9	1015.9	1016.0	1016.1	1016.3	1016.5	1016.7	1017.0
1017.3	1017.5	1017.8	1018.0	1018.2	1018.4	1018.4	1018.4	1018.3	1018.1
1018.0	1017.8	1017.6	1017.5	1017.3	1017.2	1017.1	1017.0	1017.0	1016.9

PEAK OUTFLOW IS 5711. AT TIME 43.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5711.	4591.	1678.	833.	83336.
CMS	162.	130.	48.	24.	2360.
INCHES		14.88	21.75	22.51	22.51
MM		377.93	552.45	571.74	571.74
AC-FT		2276.	3327.	3444.	3444.
THOUS CU M		2808.	4104.	4248.	4248.

STATION 2, PLAN 1, RATIO 2

END-OF-PERIOD HYDROGRAPH ORDINATES

FLOW

0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	1.	1.	1.	2.	2.	2.	2.	2.	3.
3.	3.	4.	4.	4.	5.	5.	6.	6.	7.
8.	10.	13.	17.	24.	33.	43.	55.	66.	76.
84.	89.	92.	93.	93.	91.	89.	86.	82.	79.
75.	72.	70.	68.	67.	67.	68.	69.	71.	72.
74.	76.	80.	85.	92.	102.	114.	128.	143.	159.
175.	192.	209.	227.	249.	278.	316.	366.	430.	510.
611.	748.	1165.	1597.	2176.	2544.	2719.	2724.	2606.	2410.
2170.	1917.	1674.	1475.	1352.	1226.	1104.	988.	880.	781.

STORAGE

4454.	4454.	4454.	4454.	4454.	4454.	4454.	4454.	4454.	4454.
4455.	4455.	4455.	4455.	4455.	4455.	4455.	4455.	4455.	4455.
4455.	4456.	4456.	4456.	4456.	4456.	4456.	4457.	4457.	4457.
4458.	4459.	4460.	4462.	4465.	4469.	4474.	4479.	4485.	4489.
4493.	4495.	4497.	4497.	4497.	4496.	4495.	4494.	4492.	4490.
4489.	4487.	4486.	4485.	4485.	4485.	4485.	4486.	4487.	4487.
4488.	4489.	4491.	4493.	4497.	4501.	4507.	4513.	4520.	4527.
4535.	4543.	4550.	4559.	4569.	4582.	4600.	4623.	4653.	4690.
4737.	4794.	4856.	4914.	4960.	4990.	5004.	5004.	4995.	4979.
4960.	4940.	4920.	4902.	4884.	4865.	4847.	4830.	4814.	4799.

STAGE

1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.1	1015.1	1015.1	1015.1	1015.2
1015.2	1015.2	1015.2	1015.2	1015.2	1015.2	1015.2	1015.2	1015.2	1015.2
1015.2	1015.1	1015.1	1015.1	1015.1	1015.1	1015.1	1015.1	1015.1	1015.1
1015.2	1015.2	1015.2	1015.2	1015.2	1015.2	1015.2	1015.3	1015.3	1015.3
1015.4	1015.4	1015.4	1015.5	1015.5	1015.6	1015.6	1015.8	1015.9	1016.0
1016.3	1016.5	1016.8	1017.0	1017.2	1017.3	1017.4	1017.4	1017.4	1017.3
1017.2	1017.1	1017.1	1017.0	1016.9	1016.8	1016.7	1016.7	1016.6	1016.5

PEAK OUTFLOW IS 2724. AT TIME 44.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2724.	2106.	772.	385.	38476.
CMS	77.	60.	22.	11.	1090.
INCHES		6.83	10.01	10.39	10.39
MM		173.37	254.32	263.97	263.97
AC-FT		1044.	1532.	1590.	1590.
THOUS CU M		1288.	1889.	1961.	1961.

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HYDROGRAPH ROUTING

CHANNEL ROUTING-TOE OF DAM TO STN 4+00

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

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

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0400	.0400	.0400	970.0	1020.0	400.	.02800

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
3130.00 1020.00 3280.00 1000.00 3380.00 980.00 3385.00 978.00 3450.00 977.00
3500.00 970.00 3590.00 980.00 3630.00 1000.00

STORAGE	0.00	.51	2.05	4.83	9.68	15.06	20.90	27.17	33.89	41.06
	48.67	56.73	65.24	74.22	83.68	93.62	104.03	114.92	126.29	138.13
OUTFLOW	0.00	416.21	2642.77	6988.12	19153.91	38446.46	63477.32	94185.31	130597.13	172788.90
	220866.28	274953.54	336658.22	406106.93	482573.71	566213.01	657190.44	755677.16	861847.10	975875.40
STAGE	970.00	972.63	975.26	977.89	980.53	983.16	985.79	988.42	991.05	993.68
	996.32	998.95	1001.58	1004.21	1006.84	1009.47	1012.11	1014.74	1017.37	1020.00
FLOW	0.00	416.21	2642.77	6988.12	19153.91	38446.46	63477.32	94185.31	130597.13	172788.90
	220866.28	274953.54	336658.22	406106.93	482573.71	566213.01	657190.44	755677.16	861847.10	975875.40

STATION 3, PLAN 1, RTIO 1

OUTFLOW

0.	0.	1.	1.	1.	1.	1.	1.	2.	2.
2.	2.	3.	3.	3.	3.	4.	4.	5.	5.
6.	7.	7.	8.	9.	9.	10.	11.	13.	14.
17.	20.	25.	34.	47.	64.	86.	109.	132.	151.
167.	178.	184.	187.	186.	183.	178.	172.	165.	158.
151.	144.	140.	136.	135.	135.	136.	138.	141.	144.
148.	153.	159.	170.	184.	203.	227.	254.	285.	317.
350.	383.	416.	453.	496.	554.	630.	736.	1092.	1498.
2244.	3030.	3782.	4525.	5124.	5555.	5705.	5620.	5309.	4888.
4377.	3867.	3362.	2919.	2514.	2177.	1876.	1630.	1449.	1332.

STOR

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	1.	1.	1.	1.	1.	1.	1.	1.
2.	2.	3.	3.	4.	4.	4.	4.	4.	3.
3.	3.	3.	2.	2.	2.	2.	1.	1.	1.

STAGE

970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0
970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0
970.0	970.0	970.0	970.1	970.1	970.1	970.1	970.1	970.1	970.1
970.1	970.1	970.2	970.2	970.3	970.4	970.5	970.7	970.8	971.0
971.1	971.1	971.2	971.2	971.2	971.2	971.1	971.1	971.0	971.0
971.0	970.9	970.9	970.9	970.9	970.9	970.9	970.9	970.9	970.9
970.9	971.0	971.0	971.1	971.2	971.3	971.4	971.6	971.8	972.0
972.2	972.4	972.6	972.7	972.7	972.8	972.9	973.0	973.4	973.9
974.8	975.5	976.0	976.4	976.8	977.0	977.1	977.1	976.9	976.6
976.3	976.0	975.7	975.4	975.1	974.7	974.4	974.1	973.9	973.7

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	[illegible]	[illegible]	[illegible]47.	24[illegible]	[illegible]9.
INCHES		14.88	21.74	22.50	22.50
MM		377.94	552.29	571.55	571.55
AC-FT		2276.	3327.	3443.	3443.
THOUS CU M		2808.	4103.	4246.	4246.

MAXIMUM STORAGE = 4.

MAXIMUM STAGE IS 977.1

STATION 3, PLAN 1, RTIO 2

OUTFLOW

0.	0.	0.	0.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	2.	2.	2.	2.	2.	3.
3.	3.	4.	4.	4.	5.	5.	6.	6.	7.
8.	10.	13.	17.	23.	32.	43.	54.	66.	76.
84.	89.	92.	93.	93.	92.	89.	86.	82.	79.
75.	72.	70.	68.	67.	67.	68.	69.	70.	72.
74.	76.	80.	85.	92.	101.	113.	127.	142.	158.
175.	191.	208.	226.	248.	277.	315.	365.	429.	510.
609.	746.	1154.	1594.	2160.	2547.	2711.	2732.	2603.	2419.
2169.	1927.	1673.	1482.	1349.	1232.	1101.	994.	879.	786.

STOR

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
1.	1.	1.	1.	2.	2.	2.	2.	2.	2.
2.	2.	1.	1.	1.	1.	1.	1.	1.	1.

STAGE

970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0
970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0
970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0
970.1	970.1	970.1	970.1	970.1	970.2	970.3	970.3	970.4	970.5
970.5	970.6	970.6	970.6	970.6	970.6	970.6	970.5	970.5	970.5
970.5	970.5	970.4	970.4	970.4	970.4	970.4	970.4	970.4	970.5
970.5	970.5	970.5	970.5	970.6	970.6	970.7	970.8	970.9	971.0
971.1	971.2	971.3	971.4	971.6	971.7	972.0	972.3	972.6	972.7
972.9	973.0	973.5	974.0	974.7	975.2	975.3	975.3	975.2	975.0
974.7	974.4	974.1	973.9	973.7	973.6	973.4	973.3	973.2	973.1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2732.	2106.	772.	385.	38457.
CMS	77.	60.	22.	11.	1089.
INCHES		6.82	10.01	10.39	10.39
MM		173.35	254.21	263.84	263.84
AC-FT		1044.	1531.	1589.	1589.
THOUS CU M		1288.	1889.	1960.	1960.

MAXIMUM STORAGE = 2.

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                                   HYDROGRAPH ROUTING

                    CHANNEL ROUTING STN 4+00 TO 26+00

                         ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                             4       1       0       0       0       0       0       0       0
                                                  ROUTING DATA
                 QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                   0.0   0.000    0.00       1       1       0       0               0

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

NORMAL DEPTH CHANNEL ROUTING
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     QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
     .0400   .0400   .0400   900.0   960.0   2200.  .03200

     CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
      1120.00  960.00 1180.00  940.00 1250.00  920.00 1370.00  917.00 1440.00  917.00
      2000.00  900.00 2090.00  920.00 2150.00  940.00

STORAGE        0.00        9.43       37.71       84.86      150.86      235.72      346.99      480.45      618.24      759.30
             903.64     1051.25     1202.14     1356.20     1512.16     1669.64     1828.62     1989.12     2151.13     2314.65

OUTFLOW        0.00     1683.10    10687.04    31508.97    67858.48   123035.62   192777.64   316989.76   477106.25   664032.53
          876793.21  1114693.07  1377225.42  1666521.17  1984701.22  2326227.66  2690629.97  3077507.77  3486516.94  3917359.43

STAGE        900.00      903.16      906.32      909.47      912.63      915.79      918.95      922.11      925.26      928.42
             931.58      934.74      937.89      941.05      944.21      947.37      950.53      953.68      956.84      960.00

FLOW           0.00     1683.10    10687.04    31508.97    67858.48   123035.62   192777.64   316989.76   477106.25   664032.53
          876793.21  1114693.07  1377225.42  1666521.17  1984701.22  2326227.66  2690629.97  3077507.77  3486516.94  3917359.43

                               STATION       4, PLAN 1, RTIO 1

                                             OUTFLOW
                1.         0.         1.         1.         1.         1.         1.         2.         2.         2.
                2.         2.         3.         3.         3.         3.         4.         4.         5.         5.
                6.         7.         7.         8.         9.         9.        10.        11.        12.        14.
               16.        20.        24.        33.        45.        62.        83.       106.       129.       149.
              165.       177.       184.       187.       186.       184.       179.       173.       166.       159.
              151.       145.       140.       137.       135.       135.       136.       138.       141.       144.
              147.       152.       158.       168.       182.       200.       223.       250.       280.       312.
              345.       378.       412.       448.       490.       545.       619.       720.      1026.      1449.
             2157.      2990.      3712.      4479.      5079.      5531.      5702.      5632.      5341.      4921.
             4421.      3902.      3403.      2947.      2546.      2198.      1900.      1648.      1477.      1340.

                                              STOR
                0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
                0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
                0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
                0.         0.         0.         0.         0.         0.         0.         1.         1.         1.
                1.         1.         1.         1.         1.         1.         1.         1.         1.         1.
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AD-A091 279 NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/13
NATIONAL DAM SAFETY PROGRAM. LAKE WELCH DAM (INVENTORY NUMBER N--ETC(U)
SEP 80 E O'BRIEN DACW51-79-C-0001

UNCLASSIFIED NL

2 OF 2

AD
A091279

END
DATE
FILMED
11-80
DTIC

1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	2.	2.
2.	2.	2.	3.	3.	3.	3.	4.	6.	8.
11.	14.	16.	18.	20.	22.	22.	22.	21.	20.
18.	16.	15.	13.	12.	11.	10.	9.	8.	8.

STAGE

900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0
900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0
900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0
900.0	900.0	900.0	900.1	900.1	900.1	900.2	900.2	900.2	900.3
900.3	900.3	900.3	900.4	900.3	900.3	900.3	900.3	900.3	900.3
900.3	900.3	900.3	900.3	900.3	900.3	900.3	900.3	900.3	900.3
900.3	900.3	900.3	900.3	900.3	900.4	900.4	900.5	900.5	900.6
900.6	900.7	900.8	900.8	900.9	901.0	901.2	901.4	901.9	902.7
903.3	903.6	903.9	904.1	904.3	904.5	904.6	904.5	904.4	904.3
904.1	903.9	903.8	903.6	903.5	903.3	903.2	903.1	902.8	902.5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5702.	4591.	1674.	831.	83127.
CMS	161.	130.	47.	24.	2354.
INCHES		14.88	21.70	22.45	22.45
MM		377.96	551.18	570.30	570.30
AC-FT		2277.	3320.	3435.	3435.
THOUS CU M		2808.	4095.	4237.	4237.

MAXIMUM STORAGE = 22.

MAXIMUM STAGE IS 904.6

STATION 4, PLAN 1, RTIO 2

OUTFLOW

0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	1.	1.	1.	2.	2.	2.	2.	2.	3.
3.	3.	4.	4.	4.	5.	5.	6.	6.	7.
8.	10.	12.	16.	22.	31.	41.	53.	64.	74.
83.	88.	92.	93.	93.	92.	89.	86.	83.	79.
76.	73.	70.	68.	67.	67.	68.	69.	70.	72.
74.	76.	79.	84.	91.	100.	112.	125.	140.	156.
173.	189.	206.	224.	245.	272.	309.	357.	419.	498.
595.	725.	1079.	1543.	2108.	2534.	2699.	2738.	2615.	2434.
2191.	1943.	1695.	1509.	1362.	1250.	1119.	1006.	896.	796.

STOR

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	1.	1.	1.	1.	1.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	2.	2.	2.	2.	3.
3.	4.	6.	9.	11.	12.	13.	13.	12.	12.
11.	10.	9.	8.	8.	7.	6.	6.	5.	4.

STAGE

900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0
900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0
900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0	900.0
900.0	900.0	900.0	900.0	900.0	900.1	900.1	900.1	900.1	900.1
900.2	900.2	900.2	900.2	900.2	900.2	900.2	900.2	900.2	900.1
900.1	900.1	900.1	900.1	900.1	900.1	900.1	900.1	900.1	900.1

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	900.6	900.7	900.8	900.9
901.1	901.4	902.0	902.9	903.3	903.5	903.5	903.5	903.5	903.4
903.3	903.2	903.2	902.8	902.6	902.3	902.1	901.9	901.7	901.5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2738.	2102.	770.	383.	38349.
CMS	78.	60.	22.	11.	1086.
INCHES		6.81	9.98	10.36	10.36
MM		173.09	253.54	263.10	263.10
AC-FT		1043.	1527.	1585.	1585.
THOUS CU M		1286.	1884.	1955.	1955.

MAXIMUM STORAGE = 13.

MAXIMUM STAGE IS 903.5

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HYDROGRAPH ROUTING

CHANNEL ROUTING STN 26+00 TO STN 52+00

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

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

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0400	.0400	.0400	640.0	720.0	2600.	.06200

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
8760.00 720.00 8820.00 700.00 8860.00 680.00 8930.00 660.00 9000.00 640.00
9120.00 660.00 9250.00 680.00 9330.00 700.00

STORAGE	0.00	5.03	20.11	45.24	80.42	125.68	181.36	247.63	324.48	411.91
	509.40	613.76	724.47	841.53	964.94	1093.81	1225.95	1361.26	1499.75	1641.41
OUTFLOW	0.00	1263.32	8021.59	23650.32	50933.91	94100.32	158940.48	242679.65	347510.75	475458.99
	639358.83	840766.42	1069446.12	1325966.38	1610934.17	1938398.42	2300255.58	2691823.04	3112900.42	3563372.40
STAGE	640.00	644.21	648.42	652.63	656.84	661.05	665.26	669.47	673.68	677.89
	682.11	686.32	690.53	694.74	698.95	703.16	707.37	711.58	715.79	720.00
FLOW	0.00	1263.32	8021.59	23650.32	50933.91	94100.32	158940.48	242679.65	347510.75	475458.99
	639358.83	840766.42	1069446.12	1325966.38	1610934.17	1938398.42	2300255.58	2691823.04	3112900.42	3563372.40

STATION 5, PLAN 1, RTIO 1

OUTFLOW

1.	0.	1.	1.	1.	1.	1.	2.	2.	2.
2.	2.	3.	3.	3.	3.	4.	4.	5.	5.
6.	7.	7.	8.	8.	9.	10.	11.	12.	14.
16.	19.	24.	32.	44.	60.	81.	103.	126.	147.
164.	176.	183.	187.	187.	184.	179.	173.	167.	159.
152.	146.	141.	137.	135.	135.	136.	138.	140.	143.
147.	151.	158.	167.	180.	198.	221.	248.	277.	309.
342.	375.	408.	444.	486.	539.	611.	709.	984.	1421.
2111.	2946.	3678.	4432.	5058.	5504.	5708.	5635.	5367.	4940.
4454.	3926.	3432.	2968.	2569.	2214.	1916.	1660.	1485.	1348.

STOR

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	2.	2.	2.	2.	2.	3.	4.	5.
7.	9.	10.	12.	13.	14.	15.	15.	14.	13.
12.	11.	10.	9.	8.	7.	6.	6.	6.	5.

STAGE

640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.1	640.1	640.1	640.1	640.1	640.2	640.3	640.3	640.4	640.5
640.5	640.6	640.6	640.6	640.6	640.6	640.6	640.6	640.6	640.5
640.5	640.5	640.5	640.5	640.5	640.4	640.5	640.5	640.5	640.5
640.5	640.5	640.5	640.6	640.6	640.7	640.7	640.8	640.9	641.0
641.1	641.3	641.4	641.5	641.6	641.8	642.0	642.4	643.3	644.3
644.7	645.3	645.7	646.2	646.6	646.9	647.0	646.9	646.8	646.5
646.2	645.9	645.6	645.3	645.0	644.8	644.6	644.5	644.3	644.3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5708.	4591.	1671.	830.	83001.
CMS	162.	130.	47.	24.	2350.
INCHES		14.88	21.67	22.42	22.42
MM		377.95	550.41	569.44	569.44
AC-FT		2276.	3315.	3430.	3430.
THOUS CU M		2808.	4089.	4231.	4231.

MAXIMUM STORAGE = 15.

MAXIMUM STAGE IS 647.0

STATION 5, PLAN 1, RTIO 2

OUTFLOW

1.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	1.	1.	1.	2.	2.	2.	2.	2.	3.
3.	3.	4.	4.	4.	5.	5.	5.	6.	7.
8.	10.	12.	16.	22.	30.	40.	52.	63.	74.
82.	88.	92.	93.	93.	92.	90.	87.	83.	80.
76.	73.	70.	68.	68.	67.	68.	69.	70.	72.
74.	76.	79.	83.	90.	99.	110.	124.	139.	155.
171.	188.	204.	222.	243.	269.	305.	352.	413.	489.
585.	711.	1031.	1518.	2073.	2521.	2693.	2738.	2627.	2442.
2208.	1953.	1710.	1515.	1372.	1253.	1138.	1012.	910.	803.

STOR

0.	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	2.	2.
2.	3.	4.	6.	7.	8.	8.	8.	8.	8.
7.	7.	6.	6.	5.	5.	5.	4.	4.	3.

STAGE

640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.1	640.1	640.1	640.1	640.2	640.2	640.2
640.3	640.3	640.3	640.3	640.3	640.3	640.3	640.3	640.3	640.3
640.3	640.2	640.2	640.2	640.2	640.2	640.2	640.2	640.2	640.2
640.2	640.3	640.3	640.3	640.3	640.3	640.4	640.4	640.5	640.5
640.6	640.6	640.7	640.7	640.8	640.9	641.0	641.2	641.4	641.6
641.9	642.4	643.4	644.4	644.7	645.0	645.1	645.1	645.1	644.9
644.8	644.6	644.5	644.4	644.3	644.2	643.8	643.4	643.0	642.7

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2738.	2103.	768.	383.	38272.
CMS	78.	60.	22.	11.	1084.
INCHES		6.82	9.96	10.34	10.34
MM		173.15	253.06	262.57	262.57
AC-FT		1043.	1524.	1581.	1581.
THOUS CU M		1286.	1880.	1951.	1951.

MAXIMUM STORAGE = 8.

MAXIMUM STAGE IS 645.1

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HYDROGRAPH ROUTING

CHANNEL ROUTING STN 52+00 TO 76+00

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

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

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0400	.0400	.0400	480.0	540.0	2400.	.06700

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
7500.00 540.00 7600.00 520.00 7680.00 500.00 8000.00 480.00 8100.00 500.00
8110.00 505.00 8160.00 506.00 8210.00 520.00

STORAGE	0.00	5.77	23.08	51.92	92.31	144.23	207.69	280.85	357.87	445.97
	538.93	636.05	737.33	842.69	951.12	1062.28	1176.20	1292.87	1412.28	1534.44
OUTFLOW	0.00	1363.34	8656.65	25522.70	54966.31	99660.56	162059.06	255947.23	375903.16	522135.99
	692422.34	885908.32	1102435.60	1343052.22	1609082.31	1898412.13	2210857.70	2546317.84	2904749.37	3286151.99
STAGE	480.00	483.16	486.32	489.47	492.63	495.79	498.95	502.11	505.26	508.42
	511.58	514.74	517.89	521.05	524.21	527.37	530.53	533.68	536.84	540.00
FLOW	0.00	1363.34	8656.65	25522.70	54966.31	99660.56	162059.06	255947.23	375903.16	522135.99
	692422.34	885908.32	1102435.60	1343052.22	1609082.31	1898412.13	2210857.70	2546317.84	2904749.37	3286151.99

STATION 6, PLAN 1, RTIO 1

OUTFLOW

2.	0.	1.	1.	1.	1.	1.	2.	2.	2.
2.	2.	3.	3.	3.	3.	4.	4.	5.	5.
6.	6.	7.	8.	8.	9.	10.	11.	12.	14.
16.	19.	23.	31.	42.	58.	78.	101.	124.	145.
162.	175.	183.	186.	187.	184.	180.	174.	167.	160.
153.	146.	141.	137.	135.	135.	136.	137.	140.	143.
147.	151.	157.	166.	179.	196.	218.	245.	274.	306.
339.	372.	405.	440.	481.	533.	603.	698.	945.	1373.
2078.	2886.	3649.	4377.	5038.	5474.	5710.	5641.	5390.	4966.
4484.	3957.	3459.	2995.	2589.	2234.	1931.	1675.	1491.	1357.

STOR

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	2.	2.	2.	2.	2.	3.	3.	4.	6.
7.	9.	11.	13.	14.	16.	16.	16.	15.	14.
13.	12.	11.	10.	9.	8.	7.	7.	6.	6.

STAGE

480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
480.0	480.0	480.1	480.1	480.1	480.1	480.2	480.2	480.3	480.3
480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4
480.4	480.3	480.3	480.3	480.3	480.3	480.3	480.3	480.3	480.3
480.3	480.3	480.4	480.4	480.4	480.5	480.5	480.6	480.6	480.7
480.8	480.9	480.9	481.0	481.1	481.2	481.4	481.6	482.2	483.2
483.5	483.8	484.1	484.5	484.7	484.9	485.0	485.0	484.9	484.7
484.5	484.3	484.1	483.9	483.7	483.5	483.4	483.3	483.2	483.1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5710.	4590.	1669.	829.	82862.
CMS	162.	130.	47.	23.	2346.
INCHES		14.88	21.64	22.38	22.38
MM		377.91	549.56	568.49	568.49
AC-FT		2276.	3310.	3424.	3424.
THOUS CU M		2808.	4083.	4224.	4224.

MAXIMUM STORAGE = 16.

MAXIMUM STAGE IS 485.0

STATION 6, PLAN 1, RTIO 2

OUTFLOW

1.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	1.	1.	1.	2.	2.	2.	2.	2.	3.
3.	3.	4.	4.	4.	5.	5.	5.	6.	7.
8.	9.	12.	15.	21.	29.	39.	51.	62.	73.
81.	87.	91.	93.	93.	92.	90.	87.	84.	80.
76.	73.	71.	69.	68.	67.	68.	69.	70.	72.
73.	75.	78.	83.	89.	98.	109.	122.	137.	153.
169.	186.	202.	220.	240.	266.	301.	347.	406.	481.
574.	696.	986.	1473.	2051.	2492.	2699.	2730.	2645.	2447.
2229.	1963.	1728.	1521.	1381.	1266.	1149.	1026.	918.	816.

STOR

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	2.	2.
2.	3.	4.	6.	7.	8.	9.	9.	9.	8.
6.	7.	7.	6.	6.	5.	5.	4.	4.	3.

STAGE

480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
480.0	480.0	480.0	480.0	480.0	480.1	480.1	480.1	480.1	480.2
480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2
480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2
480.2	480.2	480.2	480.2	480.2	480.2	480.3	480.3	480.3	480.4
480.4	480.4	480.5	480.5	480.6	480.6	480.7	480.8	480.9	481.1
481.3	481.6	482.3	483.2	483.5	483.6	483.7	483.7	483.7	483.6
483.5	483.4	483.3	483.2	483.2	482.9	482.7	482.4	482.1	481.9

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2730.	2105.	767.	382.	38189.
CMS	77.	60.	22.	11.	1081.
INCHES		6.82	9.94	10.31	10.31
MM		173.27	252.53	262.00	262.00
AC-FT		1044.	1521.	1578.	1578.
THOUS CU M		1287.	1876.	1946.	1946.

MAXIMUM STORAGE = 9.

MAXIMUM STAGE IS 483.7

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

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 1 1.00	RATIO 2 .50
				RATIOS APPLIED TO FLOWS	
HYDROGRAPH AT	1	2.87	1	6169.	3085.
	(	7.43)		(174.70)(	87.35)(
ROUTED TO	2	2.87	1	5711.	2724.
	(	7.43)		(161.72)(	77.15)(
ROUTED TO	3	2.87	1	5705.	2732.
	(	7.43)		(161.54)(	77.36)(
ROUTED TO	4	2.87	1	5702.	2738.
	(	7.43)		(161.47)(	77.53)(
ROUTED TO	5	2.87	1	5708.	2738.
	(	7.43)		(161.62)(	77.54)(
ROUTED TO	6	2.87	1	5710.	2730.
	(	7.43)		(161.69)(	77.29)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1015.00	1015.00	1016.30
STORAGE	4454.	4454.	4746.
OUTFLOW	0.	0.	633.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1018.41	2.11	5244.	5711.	11.50	43.50	0.00
.50	1017.41	1.11	5004.	2724.	9.50	44.00	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	5705.	977.1	43.50
.50	2732.	975.3	44.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	5702.	904.6	43.50
.50	2738.	903.5	44.00

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	5708.	647.0	43.50
.50	2738.	645.1	44.00

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	5710.	485.0	43.50
.50	2730.	483.7	44.00

STABILITY ANALYSIS

APPENDIX E

Assumptions:

1.) The unit weight of concrete is assumed to be 145 lbs/cu ft

2) Ice load of 5000 lbs/sq ft acting about 1 foot from top of dam. (according to Corps of Engineers Criteria)

3) Angle of internal resistance of rock is assumed to be 45° based on visual examinations of the exposed rock at downstream toe and its bedding planes.

4) Dam site is Seismic zone 2

LOADING CONDITIONS

Case I Normal loading; Lake level at spillway crest El 1015.0 no ice load.

Case II Normal loading; Lake level at spillway crest El 1015.0, with ice load.

Case III Unusual loading; Lake level at 1/2 PMF

Case IV Extreme loading; Lake level at PMF

Case V Unusual loading; Lake level at Spillway Crest and earthquake forces of 0.05g.

Job No. 1511 TIPPETTS-ABBETT-McCARTHY-STRATTON ENGINEERS AND ARCHITECTS NEW YORK Sheet 2 of 11

Project Phase I Inspection Date 6/1/80

Subject Dam Stability Analysis By JP

Ch'k. by

STABILITY CRITERIA;

The stability criteria against overturning and sliding were evaluated as follows.

Overturning - Stability is considered adequate if the resultant of all forces falls within the middle third of the base under the normal loading condition and within middle half of the base under the unusual and extreme loading conditions.

Sliding - Stability along the base of the structure is evaluated using the friction factor of safety (FFS) which is equal to $V \tan\phi / H$, where V is the sum of vertical forces acting on the base, H is the sum of all horizontal forces and $\tan\phi$ is Friction Factor the stability with respect to sliding is considered adequate if the FFS exceeds 1.50 under normal loading conditions, 1.25 under unusual loading conditions and 1.1 under extreme loading conditions.

TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS NEW YORK

Job No. 1511

Sheet 3 of 11

Project Phase I Dam Inspection

Date 6/1/80

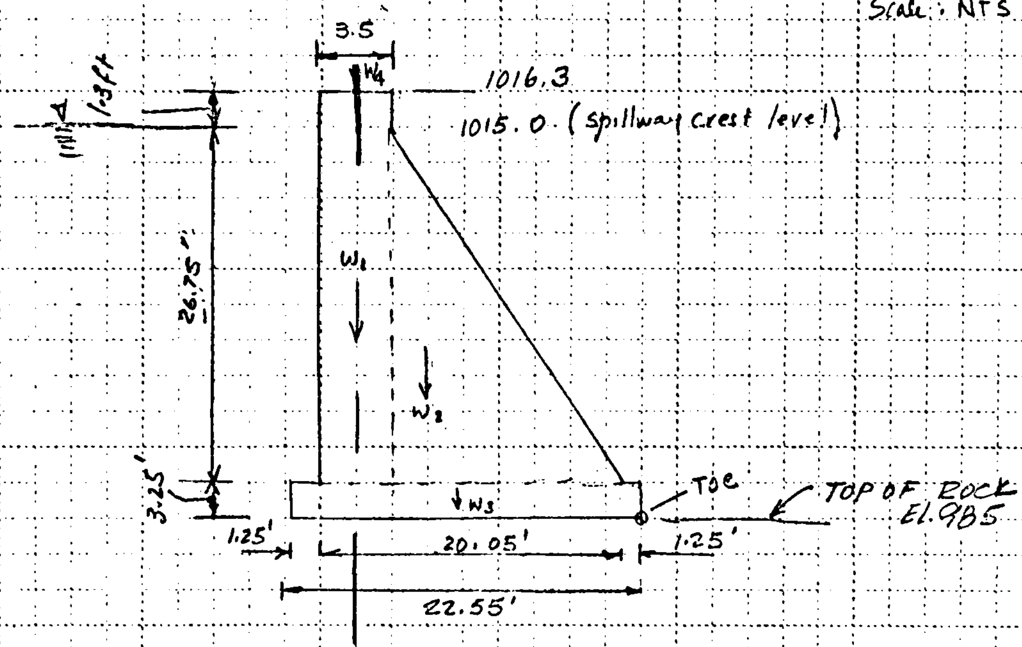
Subject

By JP

Ch'k. by

DEAD LOADS

Scale: NTS



ΣM @ Toe —

		K		KF
W_1 =	$0.145 \times 3.5 \times 28.05$ =	14.23	× 19.55 =	278.2
W_2 =	$0.145 \times \frac{1}{2} \times 16.55 \times 26.75$ =	32.09	× 12.28 =	394.1
W_3 =	$0.145 \times 3.25 \times 22.55$ =	10.63	× 11.28 =	119.9
	F_V	56.95	M_R =	792.2 KF

$\bar{x} = 13.91'$

14.23	× 17.28 =	245.9
32.09	× 12.17 =	390.5
10.63	× 1.63 =	17.3
Fv 56.95		653.7

$\bar{y} = 11.47'$

ΣM_R @ Toe due to Rock Bolt

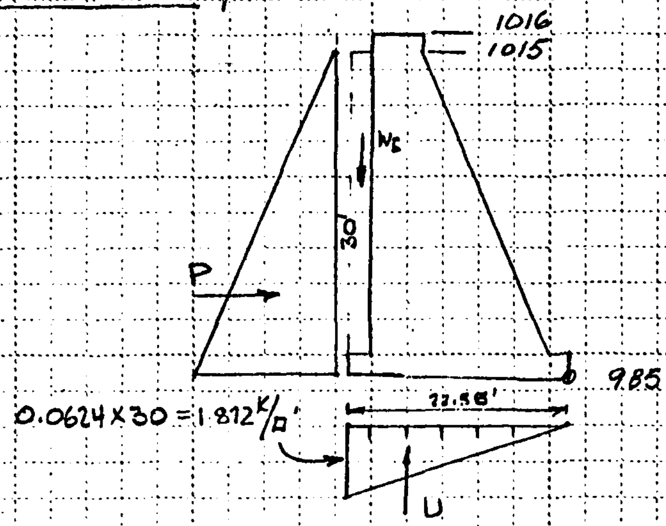
$W_4 = \frac{50000^{\#}}{10'} = 5000 \ \#/LF$

$F_V = 5^K$

$M_R = 5 \times 19.55 = 97.75 \ KF$

HYDROSTATIC FORCES

a. NORMAL LOADING ; WL at El. 1015



ΣM @ TOE

		K		KF	KF
P = ½ × 1.872 × 30	=	28.08	× 10 =	280.8	
U = ½ × 1.872 × 22.55	=	− 21.11	× 15.03 =	317.28	
W_S = 0.0624 × 1.25 × 26.75 =		2.09	× 21.93 =		45.83
				598.08	

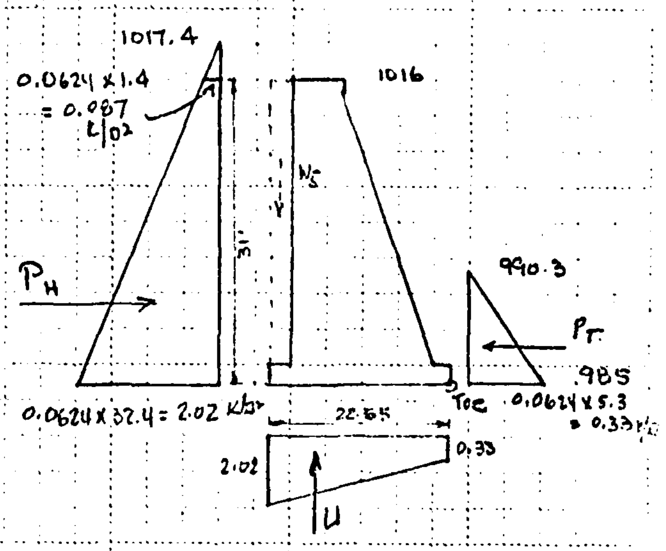
F_V = −19.02 K ↑

F_H = 28.08 K →

N_R = 45.83 KF

N_O = 598.08 KF

Maximum Loading : 1/2 PMF WL @ El. 1017.4 ; tail water El. 990.3

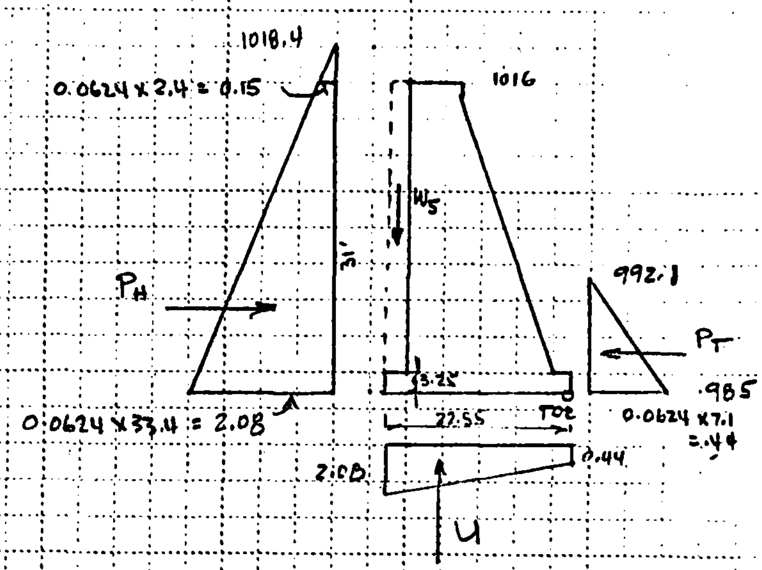


ΣM @ Toe

		K		KF	
P_H	$= \left[\frac{0.087 + 2.02}{2}\right] 31$	= 32.65 →	x 10.76	= 351.3	
P_T	$= \left(\frac{1}{2} \times 0.33 \times 5.3\right) 0.6$	= 0.52 ←	x 1.76	= 0.9	60% tail water pressure
U	$= \left(\frac{0.33 + 2.02}{2}\right) 22.55$	= -26.50 ↑	x 13.98	= 370.47	
W_S	= 0.0624 x 1.25 x 27.75	= 2.16 ↓	x 21.93	____	47.37 ↑

$F_V = -24.34^K$ ↑
$F_H = 32.13^K$ →
$M_R = 48.27^{KF}$
$M_O = 721.77^{KF}$

Maximum loading : PMF WL @ 1018.4 ; tailwater El. 992.1



Σ M @ Toe

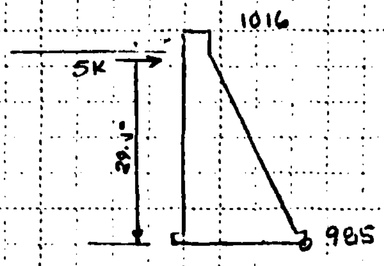
		K		KF	KF
P_H	$= \left[\frac{0.15 + 2.08}{2}\right] 31$	= 34.57	× 11.0	= 380.27	
U	$= \left[\frac{0.44 + 2.08}{2}\right] 22.55$	= 28.41	× 13.72	= 389.79	
P_T	$= \frac{1}{2}\left[0.44 \times 7.1\right] 0.6$	= 0.93	× 2.37	= 2.20	
W_S	= 0.0624 × 1.25 × 27.75	= 2.16	× 21.93		47.37

$F_V = -26.25^K \uparrow$
$F_H = 33.64^K \rightarrow$
$M_R = 49.57^{KF}$
$M_O = 770.06^{KF}$

ICE LOAD

ΣM @ Toe

$5.0 \times 29.5 = 147.50$ KF



CASE I NORMAL LOADING – WITHOUT ICE

	F_V	F_H	M_R	M_O
Dead load	56.95	0.0	792.2	0
Hydrostatic	-19.02	28.08	45.83	598.08
Rock Bolt	5.00	0	97.75	0
	42.93	28.08	935.78	598.08

$\Sigma M = 935.78 - 598.1 = 337.68$ KF

$e = \frac{22.55}{2} - \frac{337.68}{42.93} = 11.28 - 7.87 = 3.41'$ downstream from base ℄

Resultant Location

$\frac{337.68}{42.93} - \frac{22.55}{3} = 7.87 - 7.52 = 0.35'$ inside middle third. OK

$p = \frac{42.93}{22.55}\left(1 \pm \frac{6 \times 3.41}{22.55}\right) \times \frac{1000}{144} = 13 \pm 12$ { 25 psi @ Toe, 1 @ Heel. OK

Friction Factor of Safety

$FFS = \frac{42.93 \times \tan 45°}{28.08} = 1.53$ OK

CASE II NORMAL LOADING WITH ICE LOAD

	F_V	F_H	M_R	M_O
Dead load	56.95	0.0	792.2	
Hydrostatic	-19.02	28.08 →	45.83	598.08
Rock Bolt	5.0	0	97.75	0
Ice load		5.0 →		147.50
	42.93	33.08	935.78	745.58

$\Sigma M = 935.78 - 745.58 = 190.2$

$e = \frac{22.55}{2} - \frac{190.2}{42.93} = 11.28 - 4.43 = 6.85'$ downstream from base ℄

Resultant location $= \frac{190.2}{42.93} - \frac{22.55}{3} = 4.43 - 7.52 = -3.09'$ out side middle third.

$p = \frac{42.93}{22.55}\left(1 \pm \frac{6 \times 6.85}{22.55}\right) \times \frac{1000}{144} = 13 \pm 24$ 37 psi @ Toe, −11 psi @ Heel

Friction Factor of Safety

$FFS = \frac{42.93 \times \tan 45^\circ}{33.08} = 1.30$

∴ For resultant to lie within middle third, the additional force the rock bolt would be subject = V

$7.52 = \frac{190.2 + 19.55V}{42.93 + V}$

$322.83 + 7.52V = 190.2 + 19.55V$

$V = 11.0$ Kips

$50.0 + 11.0 = 61.0$ Kips << (Max Ultimate load ≈ 75 Kips)

OK.

CASE III 1/2 PMF

	F_V	F_H	M_R	M_O
Dead load :	56.95	0.0	792.2	0
Hydrostatic :	-24.34	32.13	48.27	721.77
Rock bolt :	5.0	0	97.75	0
	37.61	32.13	938.22	721.77

$\Sigma M = 938.22 - 721.77 = 216.45$

$e = \frac{22.55}{2} - \frac{216.45}{37.61} = 11.28 - 5.76 = 5.52'$ downstream from base ℄.

Resultant Location $\frac{216.45}{37.61} - \frac{22.55}{3} = 5.76 - 7.52 = -1.76'$ outside middle third.

$p = \frac{37.61}{22.55}\left(1 \pm \frac{6 \times 5.52}{22.55}\right) \times \frac{1000}{144} = 12 \pm 17$ 29 psi @ Toe, -5 psi @ heel. OK

Friction Factor of Safety

$FFS = \frac{37.61 \tan 45^\circ}{32.13} = 1.17$

CASE IV PMF

	F_V	F_H	M_R	M_O
Dead load :	56.95	0.0	792.2	0
Hydrostatic :	-26.25	33.64	49.57	770.06
Rock bolt :	5.0	0	97.75	0
	35.70	33.64	939.52	770.06

$\Sigma M = 939.52 - 770.06 = 169.46$ KF

$e = \frac{22.55}{2} - \frac{169.46}{35.70} = 11.28 - 4.75 = 6.53'$ downstream from base ℄.

PMF – Continued.

Resultant Location: $\frac{169.46}{35.70} - \frac{22.55}{3} = 4.75 - 7.52 = -2.77'$ outside middle third.

$p = \frac{35.70}{22.55}\left[1 \pm \frac{6 \times 6.53}{22.55}\right] \times \frac{1000}{144} = 11 \pm 19$ 30 psi @ Toe, −8 psi @ heel.

FRICTION FACTOR OF SAFETY

$F.F.S = \frac{35.70 \tan 45^\circ}{33.64} = 1.06$

CASE V ; Normal loading with Earthquake. Reservoir level at El. 1015

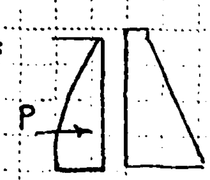
Zone 2 : 0.05

Zangers Method ; $C = 0.726$ when $\theta = 0^\circ$

(1) Hydrodynamic Forces :

$P = 0.726 \times 0.05 \times 0.0624 \times 30^2 = 2.03$ kips

$M_P = 2.03 \{0.4 \times 30\} = 24.36$ KF



(2) Dynamic Forces

$W_D = 0.05(56.95) = 2.85$ K

$M_{WD} = 2.85 \times \bar{y} = 2.85 \times 11.47 = 32.69$ KF

		F_V	F_H	M_R	M_O
	Dead Load	56.95	0.0	792.2	
	Hydrostatic	-19.02	28.08	45.83	598.08
	Rock Bolt	5.0	0	97.75	0
Earthquake	Hydrodynamic		2.03		24.36
Earthquake	Dynamic		2.85		32.69
		42.93	32.96	935.78	655.13

$\Sigma M = 935.78 - 655.13 = 280.65$

Resultant Location

$\frac{280.65}{42.93} - \frac{22.55}{3} = 6.54' - 7.52' = -0.98'$ outside middle third

$e = \frac{22.55}{2} - 6.54 = 11.28 - 6.54 = 4.74'$ downstream from base ℄

$p = \frac{42.93}{22.55}\left(1 \pm \frac{6 \times 4.74}{22.55}\right) \times \frac{1000}{144} = 13 \pm 17$

30 psi @ Toe
-4 psi @ Heel

FRICTION FACTOR OF SAFETY

$FFS = \frac{42.93 \tan 45^\circ}{32.96} = 1.30$

OTHER DATA:

(1) AVAILABLE STABILITY ANALYSIS
(2) CORRESPONDENCE BETWEEN OWNER AND ENGINEER DURING 1978-79 REPAIRS

APPENDIX F

April 3, 1978 3308-001-1

Stability Analysis of the Lake Welch Gravity Dam

The Lake Welch Dam was analyzed for both sliding and overturning stability. Three conditions of loading were considered:

- Case I — Normal condition of dead hydrostatic forces, including uplift.
- Case II — Extreme condition of normal loading plus ice forces of 3,000 pounds per lineal foot.
- Case III — Extreme condition of normal loading plus earthquake forces of 0.05g.

The analysis showed that the ratio of the horizontal forces tending to cause sliding to the vertical forces are, for the three conditions respectively, 0.78, 0.86 and 0.97. While there are no codes, or universally accepted standards, mandating the design of gravity dams, these values are somewhat higher than modern practice would dictate.

The analysis showed further that the corresponding ratios of moments resisting overturning to the moments tending to cause overturning are 1.36, 1.18 and 1.18. These values are lower than considered prudent in modern practice.

These figures indicate that, while not in accordance with today's thinking, the dam is not approaching the point of incipient failure from either sliding or overturning. The factors found for Case I are conservative as the uplift forces applied in the analysis were determined in an accepted and conservative manner. Effects of ice in Case II can be mitigated to any degree desired by drawing down the lake in winter, either fully or partially. Regarding Case III, there has been little seismic activity in this area.

MAIN

Client: Palisades Interstate Park Commission — Job No. 3308-1 — Sheet 1 of 16
Subject: Lake Welch Dam Repairs — By [illegible] — Date 3/31/7?
Dam Stability Analysis — Chkd. — Rev.

Loading Combinations - Dam in Present Condition

Case I (Normal) — Dead Load & Hydrostatic
Case II (Extreme) — " " " & Seismic
Case III (Extreme) — " " " & Ice

Loading Combination - Reinforcement Added

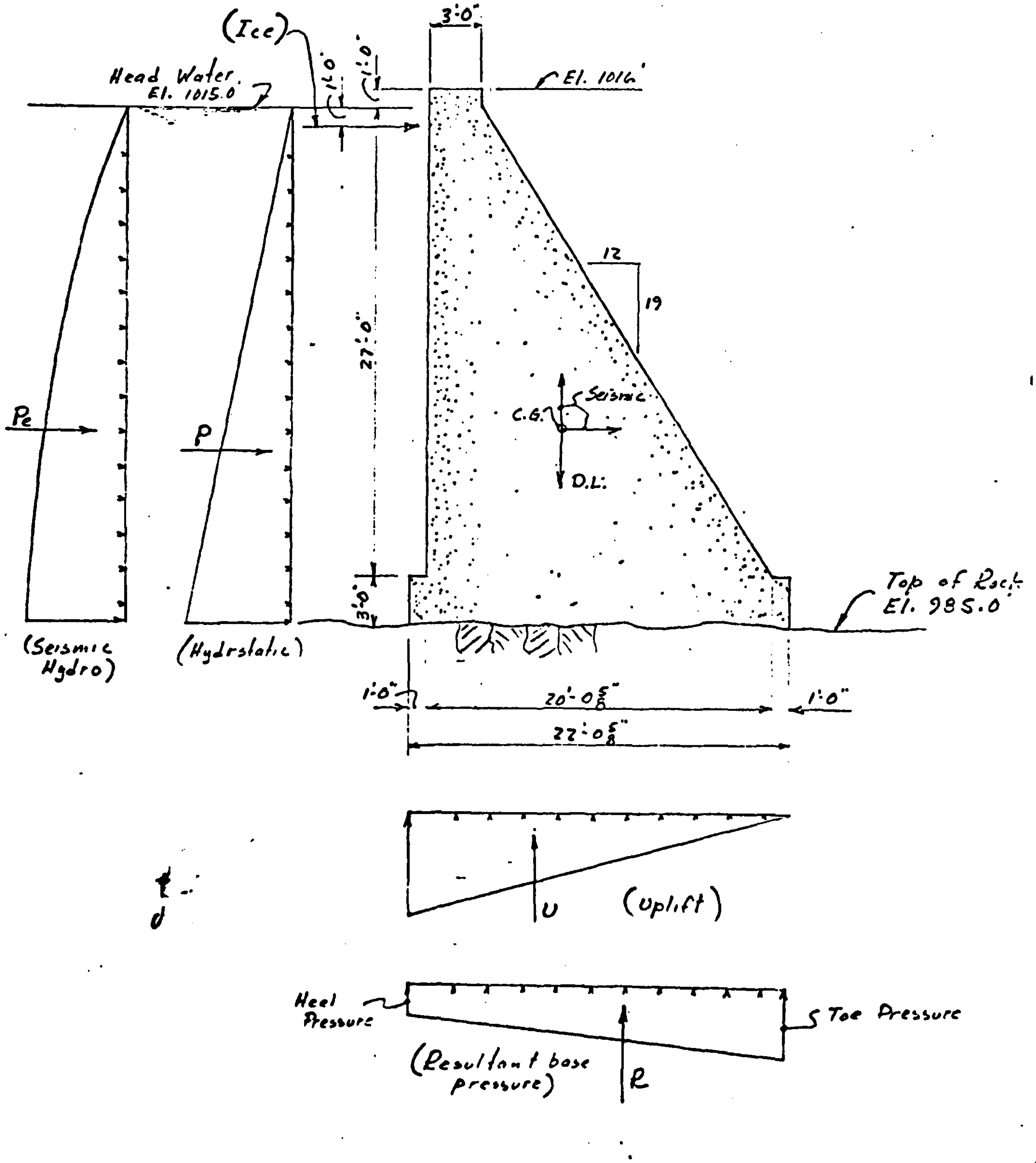
Case IV (Normal) — Case I & Reinforcement
Case V (Extreme) — Case II & "
Case VI (Extreme) — Case III & "

Criteria for Analysis Results

	Normal Operation	Extreme Operation
Heel or Toe Stress (Compression)	≤ 500 P.S.I.	≤ 750 P.S.I.
Heel or Toe Stress (Tension)	None	≤ 20 P.S.I.
Sliding Coefficient (f)	≤ .70	≤ .75
Overturning $\left(\frac{M_R}{M_o}\right)$	≥ 1.50	≥ 1.25

Client: Palisades Interstate Park Commission Job No. 3308-1 Sheet 2 of 16
Subject: Lake Welch Dam Repairs By: [illegible] Date 3/13/78
Dam Stability Analysis Chk. Rev.

Forces acting on dam & Concrete Outline

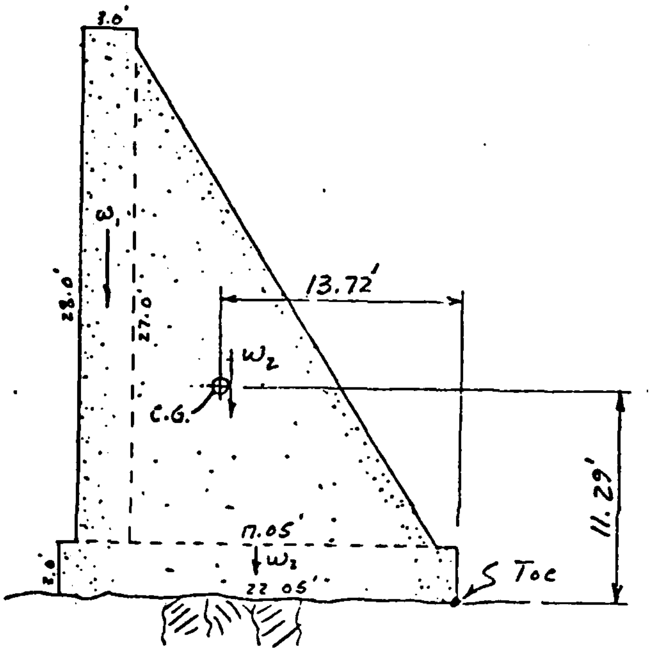


TYPICAL DAM CROSS SECTION

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 3 of 16
Subject Lake Welch Dam Repairs By [illegible] Date 3/13/78
Dam Stability Analysis Ckd. Rev.

Dead Loads

Concrete weight · 145 #/ft.³



ΣM @ Toe

ω_1 = .145 × 3.0 × 28.0	= 12.18^k	× 19.55	= 238.1'^k	
ω_2 = ½ × .145 × 17.05 × 27.0	= 33.38	× 12.37	= 412.9	
ω_3 = .145 × 22.05 × 3.0	= 9.57	× 11.025	= 105.7	
F_v	= 55.15^k		M_R = 756.7	

$$e_h = \frac{756.7}{55.15} = 13.72'$$

℄	12.18	× 17.0	= 207.1
	33.38	× 12.0	= 400.6
	9.57	× 1.5	= 14.3
	55.15		622.4

$$e_v = \frac{622.4}{55.15} = 11.29'$$

Summary

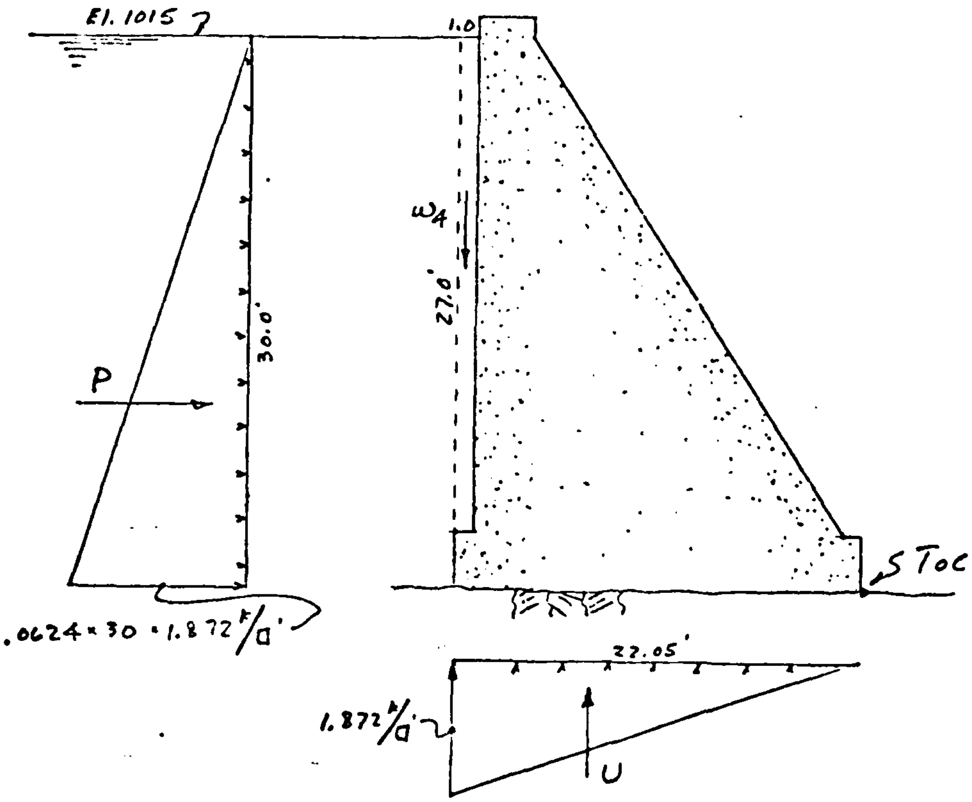
F_v = 55.15^k

M_R = 756.7'^k

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 4 of 16
Subject Lake Welch Dam Repairs By [illegible] Date 3/13/78
Dam Stability Analysis Ckd. Rev.

Hydrostatic Forces

Weight of Water = 62.4 #/ft³



ΣM @ Toe

$P = \frac{1}{2} \times 1.872 \times 30.0 = 28.08^k \times 10.00 = 280.8'^k$

$U = \frac{1}{2} \times 1.872 \times 22.05 = -20.64^k \times 14.70 = 303.4$

$W_4 = .0624 \times 1.0 \times 27.0 = 1.68 \times 21.55 = 36.3'^k$

Σ = −18.96 ... 584.2

Summary

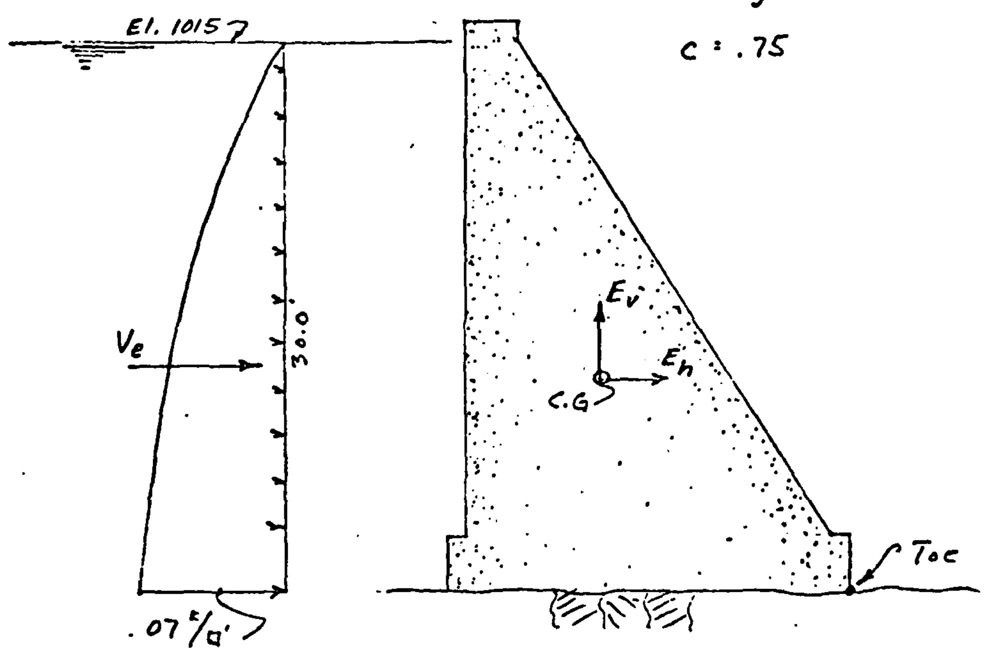
$F_V = -18.96^k$
$F_H = 28.08^k$
$M_R = 36.3'^k$
$M_O = 584.2'^k$

Client Palisades Interstate Park Commission Job No. 3309.1 Sheet 5 of 16
Subject Lake Welch Dam Repairs By W. Palmer Date 3/14/78
Dam Stability Analysis Chkd. Rev.

Seismic Forces

$\lambda = \frac{a}{g} = .05$

$c = .75$



$P_e = .15 \times .05 \times .0624 \times 30.0 = .07\ ^k/_{\square'}$

ΣM @ Toe

$V_e = .726 \times .07 \times 30.0 = 1.53^k$ $\quad M_e = .299 \times .07 \times \overline{30.0}^2 = 18.8'^k$

$E_h = .05 \times 55.15 = 2.76 \times 11.29 = 31.2$

$F_H = 4.29$

$E_v = .05 \times 55.15 = F_v = 2.76^k \times 13.72 = 37.9$

$M_o = 87.9'^k$

Summary

$F_v = -2.76^k$

$F_H = 4.29^k$

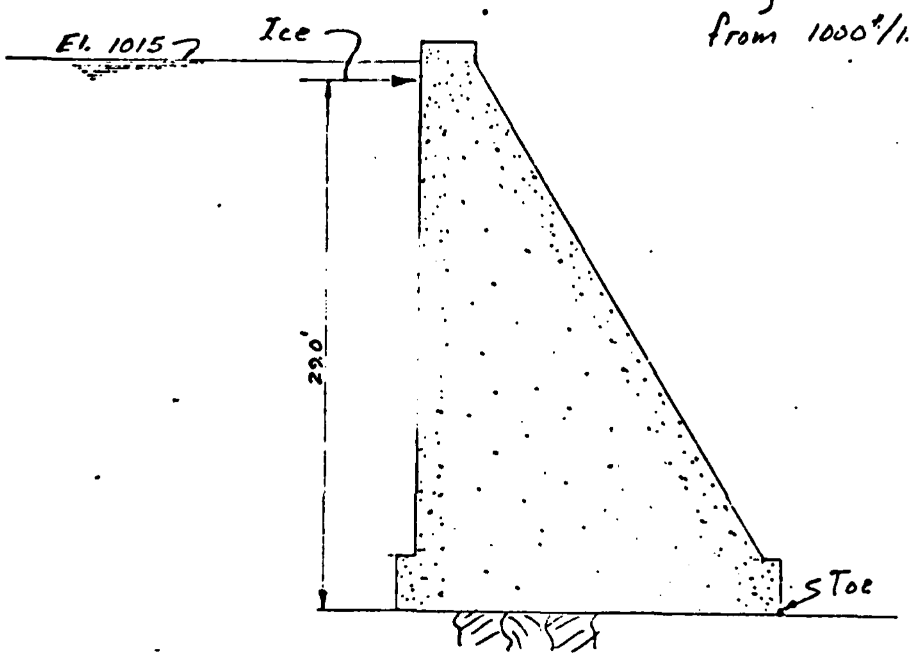
$M_o = 87.9'^k$

MAIN

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 6 of 16
Subject Lake Welch Dam Repairs By [illegible] Date 3/12/78
Dam Stability Analysis Ckd. Rev.

Ice Forces

Ice Pressures
Vary in 1000# increments
from 1000#/l.f. to 10000#/l.f.



ΣM@ Toe
Summary

	F_H		M_o
(a)	1^k ×	29.0	= 29'k
(b)	2 ×	29.0	= 58'k
(c)	3 ×	29.0	= 87'k
(d)	4 ×	29.0	= 116'k
(e)	5 ×	29.0	= 145'k
(f)	6 ×	29.0	= 174'k
(g)	7 ×	29.0	= 203'k
(h)	8 ×	29.0	= 232'k
(i)	9 ×	29.0	= 261
(j)	10 ×	29.0	= 290'k

9

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 7 of 16
Subject Lake Welch Dam Repairs By W.O. Palmer Date 3/14/78
Dam Stability Analysis Ckd. Rev.

Case I Normal D.L. & Hydrostatic Forces Combined

	F_V	F_H	M_R	M_O
D.L.	55.15	0.0	756.7	0.0
Hydrostatic	-18.96	28.08	36.3	584.2
	36.19	28.08	793.0	584.2

$\Sigma M = 793.0 - 584.2 = 208.8^{\prime K}$ @ Toe

$e = \frac{22.05}{2} - \frac{208.8}{36.19} = 5.26'$ downstream from base ℄

Resultant Location $= \frac{208.8}{36.19} - \frac{22.05}{3} = -1.58'$ outside kern

OK

$p = \frac{36.19}{22.05}\left(1 \pm \frac{6 \times 5.26}{22.05}\right)\frac{1000}{144} = 11 \pm 16 = \begin{cases} 27 \text{ PSI @ Toe} \\ -5 \text{ PSI @ Heel} \end{cases}$

N.G.

Sliding $= \frac{28.08}{36.19} = .78 > .70$ N.G.

$\frac{M_R}{M_O} = \frac{793.0}{584.2} = 1.36 < 1.50$ N.G

MAIN

Client: Palisades Interstate Park Commission Job No. 3308-1 Sheet 8 of 16
Subject: Lake Welch Dam Repairs By: DC Palmer Date: 3/14/78
Dam Stability Analysis Ckd. Rev.

Case II D.L., Hydrostatic & Seismic Forces Combined
Extreme

	F_V	F_H	M_R	M_O
D.L.	55.15^k	0.0^k	756.7'^k	0.0'^k
Hydrostatic	-18.96	28.08	36.3	584.2
Seismic	-2.76	4.29	0.0	87.9
	33.43	32.37^k	793.0'^k	672.1'^k

$\Sigma M = 793.0 - 672.1 = 120.9'^k$ @ Toe

$e = \frac{22.05}{2} - \frac{120.9}{33.43} = 7.41'$ downstream from base ℄

Resultant Location $= \frac{120.9}{33.43} - \frac{22.05}{3} = -3.73'$ outside kern

OK

$p = \frac{33.43}{22.05}\left(1 \pm \frac{6 \times 7.41}{22.05}\right)\frac{1000}{144} = 11 \pm 21 = \begin{cases} 32 \text{ PSI @ Toe} \\ -10 \text{ PSI @ Heel (Te[illegible]} \end{cases}$

OK

Sliding $= \frac{32.37}{33.43} = .97 > .75$ N.G.

$\frac{M_R}{M_O} = \frac{793.0}{672.1} = 1.18 < 1.25$ N.G.

Case IIKa) D.L., Hydrostatic & Ice (1000#/l.f.) Combined
Extreme

	F_V	F_H	M_R	M_O
D.L.	55.15 ᴷ	0.0	756.7	0.0
Hydrostatic	-18.96	28.08	36.3	584.2
Ice (1000#/l.f.)	0.0	1.0	0.0	29.0
	36.19	29.08	793.0	613.2

$\Sigma M = 793.0 - 613.2 = 179.8$ ᴷ' @ Toe

$e = \frac{22.05}{2} - \frac{179.8}{36.19} = 6.06'$ downstream from base ℄

Resultant location $= \frac{179.8}{36.19} - \frac{22.05}{3} = -2.38'$ outside kern

OK

$p = \frac{36.19}{22.05}\left(1 \pm \frac{6 \times 6.06}{22.05}\right)\frac{1000}{144} = 11 \pm 19 = \begin{cases} 30 \text{ PSI @ Toe} \\ -8 \text{ PSI @ Heel} \end{cases}$

OK

Sliding $= \frac{29.08}{36.19} = .80 > .75$ N.G.

$\frac{M_R}{M_O} = \frac{793.0}{613.2} = 1.29 > 1.25$ OK

Client: Palisades Interstate Park Commission Job No. 3308-1 Sheet 10 of 16
Subject: Lake Welch Dam Repairs By: [illegible] Palmer Date 3/14/78
Dam Stability Analysis Ckd. Rev.

Case III(b) D.L., Hydrostatic & Ice (2000#/l.f.) Combined Extreme

	F_V	F_H	M_R	M_O
D.L.	55.15^K	0.0^K	756.7'^K	0.0'^K
Hydrostatic	-18.96	28.08	36.3	584.2
Ice (2000#/l.f.)	0.0	2.0	0.0	58.0
	36.19^K	30.08^K	793.0'^K	642.2'^K

$\Sigma M = 793.0 - 642.2 = 150.8'^K$ @ Toe

$e = \frac{22.05}{2} - \frac{150.8}{36.19} = 6.86'$ downstream from base ℄.

Resultant location $= \frac{150.8}{36.19} - \frac{22.05}{3} = -3.18'$ outside kern

$p = \frac{36.19}{22.05}\left(1 \pm \frac{6 \times 6.86}{22.05}\right)\frac{1000}{144} = 11 \pm 21 = \begin{cases} 32 \text{ P.S.I. @ Toe (OK)} \\ -10 \text{ P.S.I. @ Heel (OK)} \end{cases}$

Sliding $: \frac{30.08}{36.19} = .83 > .75$ N.G.

$\frac{M_R}{M_O} = \frac{793.0}{642.2} = 1.23 < 1.25$ N.G.

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 11 of 16
Subject Lake Welch Dam Repairs By [illegible] Date 3/14/78
Dam Stability Analysis Ckd. Rev.

Case III(c) D.L., Hydrostatic & Ice (3000#/l.f.) Combined Extreme

	F_V	F_H	M_R	M_O
D.L.	55.15 k	0.0 k	756.7 'k	0.0 'k
Hydrostatic	-18.96	28.08	36.3	584.2
Ice (3000#/l.f.)	0.0	3.0	0.0	87.0
	36.19 k	31.08 k	793.0 'k	671.2 'k

$\Sigma M = 793.0 - 671.2 = 121.8$ 'k @ Toe

$e = \frac{22.05}{2} - \frac{121.8}{36.19} = 7.66'$ downstream from base ℄

Resultant location $= \frac{121.8}{36.19} - \frac{22.05}{3} = -3.98'$ outside kern.

OK

$p = \frac{36.19}{22.05}\left(1 \pm \frac{6 \times 7.66}{22.05}\right)\frac{1000}{144} = 11 \pm 24 = \begin{cases} 35 \text{ PSI @ Toe} \\ -13 \text{ PSI @ Heel} \end{cases}$

OK

Sliding $= \frac{31.08}{36.19} = .86 > .75$ N.G.

$\frac{M_R}{M_O} = \frac{793.0}{671.2} = 1.18 < 1.25$ N.G.

MAIN

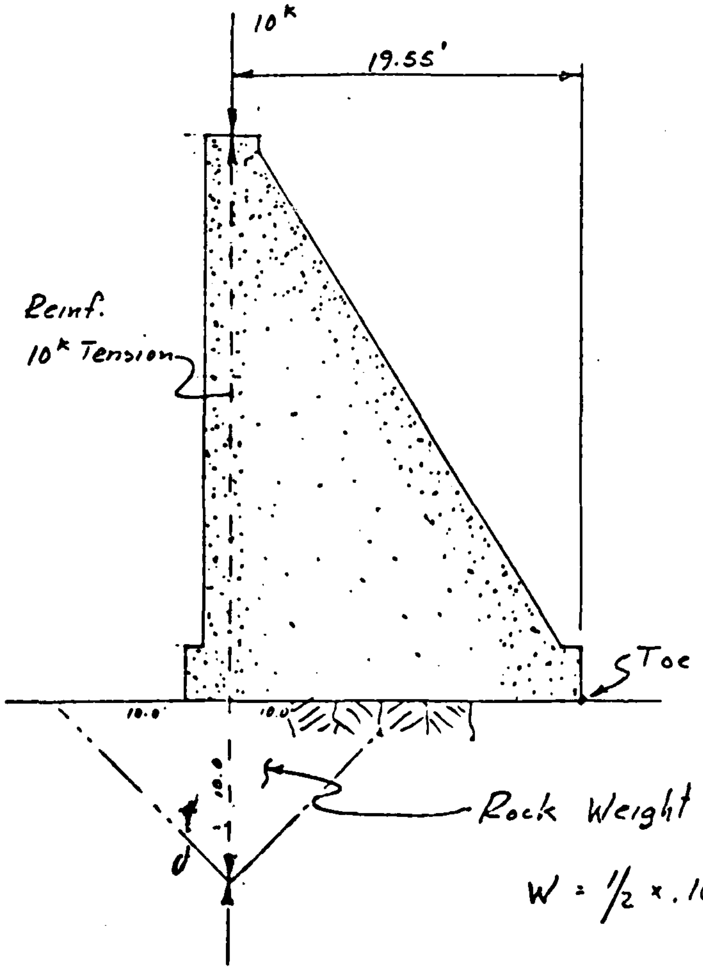
Client: Palisades Interstate Park Commission   Job No. 3308-1   Sheet 12 of 16
Subject: Lake Welch Dam Repairs   By: PF Palmer   Date: 3/31/78
Dam Stability Analysis   Ckd.   Rev.

Reinforcement - Williams Rock Bolt US-11-HC-SCS-200
Max. Working Load: 74.000#

Design Load = 2/3 × 74000 = 49333# ±
Use 50000#

Bolt spacing @ 5' o.c

Load per ft = $\frac{50000}{5}$ = 10000#/l.f.



M_R = 10.0 × 19.55 = 195.5'k

Wt. of Granite Rock = 165#/ft³

W = 1/2 × .165 × 10.0 × 20.0 = 16.5^k > 10^k O.K.

Summary

F_v = 10^k

M_R = 195.5'k

(MAIN)

Client: Palisades Interstate Park Commission — Job No. 3308-1 — Sheet 13 of 16

Subject: Lake Welch Dam Repairs — By: R.O. Palmer — Date: 3/31/78

Dam Stability Analysis — Ckd. — Rev.

Case IV D.L., Hydrostatic & Reinforcement Combined
Normal (Case I & Reinf.)

	F_V	F_H	M_R	M_O
Case I	36.19[k]	28.08[k]	793.0'[k]	584.2'[k]
Reinf.	10.00	0.0	195.5	0.0
	46.19[k]	28.08[k]	988.5	584.2

$\Sigma M = 988.5 - 584.2 = 404.3$ @ Toe

$e = \frac{22.05}{2} - \frac{404.3}{46.19} = 2.27'$ downstream from base ℄

Resultant location $= \frac{404.3}{46.19} - \frac{22.05}{3} = 1.40'$ inside kern OK

$p = \frac{46.19}{22.05}\left(1 \pm \frac{6 \times 2.27}{22.05}\right)\frac{1000}{144} = 15 \pm 9 = \begin{cases} 24 \text{ PSI @ Toe} & \text{OK} \\ 6 \text{ PSI @ Heel} & \text{OK} \end{cases}$

Sliding (f) $= \frac{28.08}{46.19} = .61 < .70$ OK

Overturning $\left(\frac{M_R}{M_O}\right) = \frac{988.5}{584.2} = 1.69 > 1.5$ OK

MAIN

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 14 of 16
Subject Lake Welch Dam Repairs By [signature] Date 3/31/78
Dam Stability Analysis Ckd. Rev.

Case VI — D.L., Hydro, Seismic & Reinforcement Combined
Extreme — (Case II + Reinf)

	F_V	F_H	M_R	M_O
Case II	33.43k	32.37k	793.0'k	672.1'k
	10.00	0.0	195.5	0.0
	43.43	32.37	988.5	672.1

$\Sigma M = 988.5 - 672.1 = 316.4'^{k}$ @ Toe

$e = \frac{22.05}{2} - \frac{316.4}{43.43} = 3.74'$ downstream from base ℄

Resultant location $= \frac{316.4}{43.43} - \frac{22.05}{3} = -.06'$ outside kern

$p = \frac{43.43}{22.05}\left(1 \pm \frac{6 \times 3.74}{22.05}\right)\frac{1000}{144} = 14 \pm 14 = \begin{cases} 28 \text{ PSI @ Toe} \\ -0 \text{ PSI @ Heel} \end{cases}$

Sliding (f) $= \frac{32.37}{43.43} = .75$ OK

Overturning $\left(\frac{M_e}{M_o}\right) = \frac{988.5}{672.1} = 1.47 > 1.25$ O.K.

(MAIN)

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 15 of 16
Subject Lake Welch Dam Repairs By RD Palmer Date 3/31/78
Dam Stability Analysis Ckd. Rev.

Case VI (c) D.L., Hydro, Ice (3000#/l.f) & Reinf. Combined
Extreme (Case III(c) & Reinf.)

	F_V	F_H	M_R	M_O
Case III (c)	36.19	31.08	793.0	671.2
Reinf	10.00	0.0	195.5	0.0
	46.19	31.08	988.5	671.2

$\Sigma M = 988.5 - 671.2 = 317.3'^{k}$ @ Toe

$e = \frac{22.05}{2} - \frac{317.3}{46.19} = 4.16'$

Resultant location $= \frac{317.3}{46.19} - \frac{22.05}{3} = -.48'$ outside kern

$p = \frac{46.19}{22.05}\left(1 \pm \frac{6 \times 4.16}{22.05}\right)\frac{1000}{144} = 15 \pm 16 = \begin{cases} 31 \text{ PSI @ Toe} & \text{ok} \\ -1 \text{ PSI @ Heel} & \text{ok} \end{cases}$

Sliding (f) $= \frac{31.08}{46.19} = .67 < .75$ ok

Overturning $\left(\frac{M_R}{M_O}\right) = \frac{988.5}{671.2} = 1.47 > 1.25$ ok

MAIN

Client: Palisades Interstate Park Commission — Job No. 3308-1 — Sheet 16 of 16

Subject: Lake Welch Dam Repairs — By: [illegible] — Date: 3/15/78

Dam Stability Analysis — Ckd. — Rev.

	Dead Load	Hydro-static	Earth-quake	Ice (#/l.f.)	Toe Pressure (PSI)	Heel Pressure (PSI) ①	Sliding F_H/F_V	Overturning M_R/M_O	Resultant Location to D.S. Kern ②
se I (rmal)	✓	✓			27	- 5 ③	.78 ③	1.36 ③	- 1.58'
se II (treme)	✓	✓	✓		32	- 10	.97 ③	1.18 ③	- 3.73'
se III (a) (treme)	✓	✓		1000	30	- 8	.80 ③	1.29	- 2.38'
(b)				2000	32	- 10	.83 ③	1.23 ③	- 3.18'
(c)				3000	35	- 13	.86 ③	1.18 ③	- 3.98'
se IV (ormal)	✓	✓			24	6	.61	1.69	1.40'
e V (teme)	✓	✓	✓		28	- 0	.75	1.47	-.06'
se VI(c) (treme)	✓	✓		3000	31	- 1	.67	1.47	-.48'

① Minus (-) Sign indicates tension.

② Minus (-) Sign indicates resultant outside kern. & tension at heel.

③ Does not meet criteria

Palisades Interstate
Park Commission
Administration Building
Bear Mountain, NY 10911
914 786-2701

Nash Castro
General Manager

April 25, 1980

Mr. J. Patel
Tippetts-Abbett-McCarthy-Stratton
Engineers and Architects
The Tams Building
655 Third Avenue
New York, New York 10017

Dear Mr. Patel:

As requested, enclosed are the following documents:

1. Sheet 1 of consultant design agreement showing scope of services.

2. Correspondence from Chas. T. Main, Inc. dated October 5, 1977, March 31, 1978 and April 7, 1978.

3. Copies of diary sheets from October 9, 1978 to November 12, 1978.

Please call if you need any additional information.

Very truly yours,

Robert Santoro
Senior Park Engineer

RS:mgs
Encs:

REGION – Palisades
PROJECT NAME – Repairs to the Lake Welch Dam
P. F. NO. –

THIS AGREEMENT made this __________ day of ______________ 19______, by and between the State of New York, acting by and through the Office of Parks and Recreation, hereinafter referred to as "PARKS", whose office is at Administration Building Bear Mountain, New York 10911

and Chas. T. Main of N.Y. Inc. with offices at 125 E. 38th Street, New York, New York 10016

hereinafter referred to as the "CONSULTANT."

WITNESSETH:

WHEREAS, PARKS is charged by the law with the construction, maintenance and operation of state parks, parkways, historic sites, marine facilities and other recreational facilities and desires to obtain technical and professional services therein as hereinafter specified, and is authorized to engage such services in accordance with the provisions of the Parks and Recreation Law of the State of New York.

NOW, THEREFORE, in consideration of the premises and the mutual covenants and conditions contained herein the parties hereto agree as follows:

1. SCOPE OF SERVICES — PARKS agrees to employ and hereby does employ the CONSULTANT for the services hereinafter described, and the CONSULTANT agrees to furnish and perform such services upon the following described project:

Repairs to the Lake Welch Dam

The consultant will furnish services related to the repair of the Lake Welch Dam by means of chemical and cement grouting of horizontal construction joints and sealing of vertical expansion joints.

The method to be recommended by the consultant will enable the repair work to be carried out without the necessity of emptying the lake.

More specifically, the scope of the consultants' services shall consist of four parts, itemized as follows:

Item 1 – Inspection of the dam, attendance at meetings, and other work required to propose a solution to the leakage problems, all performed prior to January 1, 1978.

Item 2 – Performance and documentation of a stability analysis of the dam so as to determine the basic soundness and integrity of the dam.

Item 3 – Under the assumption that the results of the analysis described in Item 2 show the dam to be essentially sound and capable of repair, the consultant will prepare drawings and specifications for the drilling, grouting and sealing of the dam. If the results of the work performed under Item 2 indicate that the dam is not sound or that some other means of repair are indicative, this agreement may be terminated or amended as appropriate to the conditions at this point.

Item 4 – Field surveillance of the drilling, grouting and sealing work after the award of the construction contract by Parks.

The Consultant will furnish contract drawings in reproducible form after approval of preliminary drawings by Parks.

The Consultant will also furnish five (5) copies each of detailed contrac

MAIN
Engineers

CHAS. T. MAIN OF NEW YORK, INC.

UHL, HALL & RICH DIVISION
125 EAST 38TH STREET, NEW YORK, NEW YORK 10016

5 October 1977 9010205-150

OCT 7 1977
ENGINEERING
P. I. P. C.

Mr. Robert Santoro
Palisades Interstate Park Commission
Administration Building
Bear Mountain, NY 10911

Dear Sir:

In compliance with your request we have undertaken a study of the leakage problem at Lake Welch Dam. The site was visited and we inspected the concrete cores obtained from the dam. We understand the need to reduce leakage through the dam and its foundation to a minimum and we appreciate the desirability of avoiding draining the lake. Considering both of these requirements, we offer the following solution:

1. Sealing of the horizontal construction joints of the dam, and the foundation of the dam and its abutments, by a combination of cement and chemical grouting.
2. Sealing of the vertical contraction joints by drilling a large (6") hole vertically through each joint and backfilling with a non-setting sealant.
3. The above procedures are to be performed in the early Spring of 1978 without the lake being drained.
4. Observation of the dam, foundation and sluice gate leakage through September 1978 when decisions can be made relative to:
    a. Draining the lake to effect additional grouting or repairs, if indicated, to the upstream face of the dam.
    b. The need for a new sluice gate, or the repair of the existing gate.
    c. Refacing or repairing the downstream face of the dam for aesthetic reasons.
    d. Performing other remedial work, also for aesthetic reasons.

It is our opinion that steps 1 and 2 above will successfully reduce leakage to a practicable minimum at the least cost. This solution has the further advantage of not requiring the draining of the lake during the recreation season. Should additional work requiring the draining of the lake be necessary, such can be performed early next Fall and the lake refilled before the 1979 season. We estimate the cost of steps 1 and 2 to be not in excess of $225,000.

It is proposed that MAIN write the specification for the grouting program and provide a resident engineer for the surveillance of the field work. We estimate that the total cost of our services will not exceed $30,000 up to and including steps 1 and 2. This figure is based on an estimate of 55 working days to perform steps 1 and 2.

We will be happy to discuss this subject with you and are available to meet with you at your convenience.

Yours very truly,
CHAS. T. MAIN OF NEW YORK, INC.

Gustav A. Diezemann

GAD:dc

cc: Mr. Thomas F. Connors
New York State Park & Recreation

FRIDAY, OCTOBER 14, 1977

Name	Representing
Ivan Vamos	OPR Central Office / Dept. Commis.
Dr. Peter J. R. Buttner	" " " / Dr Env. Mgt.
W. Roland Seng	OGS - D&C / Engr.
JOHN J TROY	PIPC
Bob Santoro	P.I.P.C.
Gus Diezemann	Chas. T. Main
CHARLES P. BENZIGER	" " "
MARTIN W. MOELLER	OGS - D&C.
John J. Schnorr	OGS D&C
James E. Cassidy	OGS - D&C
THOMAS F. CONNORS	OPR - DEVELOPMENT
THOMAS STODDARD	OPR - DEVELOPMENT
NASH CASTRO	PALISADES INTERSTATE PARK COMM.
Mark Lawton	OPR

9T A RS

MAIN *Engineers* | CHAS. T. MAIN OF NEW YORK, INC.

125 EAST 38TH STREET, NEW YORK, NEW YORK 10016

March 31, 1978 3308-001-1

RECEIVED
APR 7 1978
ENGINEERING

Mr. Robert Santoro
Palisades Interstate Park Commission
Administration Building
Bear Mountain, New York 10911

Dear Mr. Santoro:

Further to the draft of the report on our stability analysis of the Lake Welch Dam, we wish to advise you that post-tensioned rock bolts, five feet on centers and ten feet into rock, placed in reamed grout holes through the top of the dam would produce the following ratios of forces:

	Sliding	Overturning
Case I	1.64	1.69
Case II	1.33	1.47
Case III	1.49	1.47

The addition of the rock bolts improve the resistance to sliding and overturning significantly, as the above figures indicate. While there is nothing to assure that the dam would fail without the rock bolts, there is similarly no guarantee that the dam will never fail with the rock bolts installed. Considering the age and condition of the Lake Welch Dam, it is obviously prudent to install the bolts during the rehabilitation procedure. We estimate the cost of installation to be $93,000.

Very truly yours,

CHAS. T. MAIN OF NEW YORK, INC.

Gustav A. Diezemann

Gustav A. Diezemann

CAD:vc

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L.S.
9T ✓

MAIN *Engineers* | **CHAS. T. MAIN OF NEW YORK, INC.**

125 EAST 38TH STREET, NEW YORK, NEW YORK 10016

April 7, 1978 3308-001-1

APR 10 1978
ENGINEERING
P. I. P. C.

Mr. Robert Santoro
Palisades Interstate Park Commission
Administration Building
Bear Mountain, New York 10911

Dear Mr. Santoro:

Reference is made to our letter of October 5, 1977 in which we stated that, if the recommended sealing of the horizontal and vertical joints and the foundation of the Lake Welch Dam did not satisfactorily stop the leakage, the lake could be drained to effect additional grouting or repairs.

We also stated in that letter that we believed that the recommended sealing would reduce the leakage to a practicable minimum. We are still of that opinion. We cannot, however, for obvious reasons, guarantee that it will.

Should additional repairs be necessary, and we repeat that we believe the recommended will be successful, it is not possible to estimate the cost of such repairs until the problem, if any, is known.

Very truly yours,

CHAS. T. MAIN OF NEW YORK, INC.

Gustav A. Diezemann

Gustav A. Diezemann
Vice President

GAD:vc

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Sunday

[illegible]

[illegible] skipping [illegible]
in Morning 4 men on [illegible]
DRILLED 1/2 23 ft.

Started grouting about 9-10 G.
THEN 7-8 gals water 1 CEMENT
2 SAND, KEPT BLOWING HOSES
CUT SAND DOWN TO 1 SHOVEL.
per mix, GROUTED
SECTION 1, 2, 3, 2 HOLES ON
ON SECTION 4 GROUT NEVER
CAME OUT OF LIFT SEAMS
TOOK PRESSURE UP to 65 lbs
HOLES HOLDING PRESSURE,
GROUTED SECTION 4 2 STAGES 13 FT
& 3 ft

64 Cu FT

All Holes are filled from
bottom up

[illegible]

OCTOBER 10

Clear Warm

Started Grouting 12:0.
Grouting Hole 4/3 Grout Came
up 4/4. Lowered Packer in 4/3
to 12 FT Then Put Packer
in 4/4. Grouted 50 lbs for
15 min then 35 lb for 15 min
no grout came out of Lift Joint
water slowed down in 12 holes
about 12 Cu Ft
Grouted 5/1 25 lb the 45 lbs slur
Started Chipping 4 men

Lost Packer in hole on 5/2
broke pipe off when trying
to jack out. will have to
drill hole along side of it.

All Holes are filled from bottom
up
Grouted in 2 Stages 13 ft 3 ft

GL

OCTOBER 11

Clear Warm.

Started Chipping 8.00 4 men
decided to take all of spillway
Shotcrete and make each section
One Slab. dont like to patch
spillway on account of
water going in cracks
if any appear

Started Grouting 12-30
no packers, had to make one
again

reaming out grout holes
told him to wash holes out
after done (didnt do)

All holes are filled from bottom
up grout pack 12 ft down
and from 5 1/2 ft down
Jim Conway & Chuck Bengenger

OCTOBER 12

Clear Warm

chipping shotcrete 2 men
Started Grouting at 10

Grouted section 8, 9, 10,
going okay but slow
hose blocked up, Air Track
reaming holes out told him
he should wash out right
after reaming (didnt do)
pump broke down 4:20

Drilled 5/2 31 ft.
Brought Small Pump on Job

asked him where Anchor Bolts
are and 14" or 12" Bits Sales
said they are coming

[illegible]

OCTOBER 13

Clear Warm

No Grouting To-Day.
Chipping Spillway 3 men
Air Track Went Back and
Redrilled All Hole & Washed Out
Section 1, 2, 3, 4, 5/1

Grouted By Small Pump Hole 5/2,

Supt & Lab Took Pump Back To
N.J. Bearing in Transmission Broke

Same

[illegible]

OCTOBER 16

Clear Cold in Morning (Warm in Aft)

Grouted 11/1 11/2 11/3

12/1 12/2 12/3

Grout from 11/2 came up 11/3)
used double packer.
in 2 holes used 26 Cu. Ft. }
Started 10 gals to 1 cement dropped
to 8 gals then 6 then 5.
held for 5 min a 20/6 no
more grout taken.

Redrilling 5/2 5/3 then redrilling
grouted holes & also washing
them out now as they are completed.

[illegible]

asked him where other equipment
is said it was coming told
him no work on holes until
auction [illegible] are in & grouted.

drill was here

Total 21 Ft 1?? 1/2 Pumped.

4 Cu Ft To
Fill in Holes [illegible]
[illegible]

OCTOBER 17

Clear Cold.

Started Chipping

Reaming out grouted holes also
washing them out.

O.C.

OCTOBER 18

Vine Calif

Started skipping spillway
8 a 3 men

Reaming grout out of holes

JB

OCTOBER 19

Vine Calif

Started skipping spillway
8-00
3 men
Brought platform back
to Section 6.

Let them drill some of
the chemical grout hole
far enough apart so that
there is no runups in
between holes. told him
he could do it and he
would be responsible for
the holes he said Okay.

7/1	Chem	23
6/1	"	23
6/3	"	23
6/6	"	23
6/8	"	23
5/6	"	22
5/3	"	22
5/1		22

Clear Cold r.6-30

Started chipping spillway
also No 2 section roughing up

drilled 6 grout holes

3/6	16
3/4	16
3/1	16
2/6	14
2/5	14
2/3	14
2/1	14
1/5	13
1/4	12
1/3	12
1/2	12
1/1	13
	166

9 hrs

166 [illegible]

18

3 [illegible]

Clear Cold.
Started chipping granite of spillway
Contractor asked if he could build a road down from Beaver side of lake so he could build his float said alloy as long as he fixes up the grounds as before, filled in along side of washed out part of dam,

9 hrs

OCTOBER 22

[illegible] warm

Drilling 12" Holes 4 done. Large pieces of rock in Concrete some boulders, very hard drilling around 2 hrs per hole. Section 1 completed.

Building Float for drill, Cond of 9 275 gal Oil drums don't think it will hold weight of drill.

9 hrs

OCTOBER 23

[illegible] warm

Drilling 12" holes, hard drill very slow. Section 2 complete started on section 3.

trouble with union straighteners[illegible]

9 hrs

OCTOBER ~~24~~ 23

[illegible] Warm

Building Float for drill Rig completed Float and put Rig on at 4 30 did not hold weight of drill had to unload. Blasting 12" holes out, Called Chuck Bergenger, told him 12" holes are very hard drilling and I would let them drill a series of 20' 3/4 inch holes around Template to make it easier on diamond bit and it cuts faster, works ok so far. 3/4 holes are 6 to 7" in deep

Complete Section 3, part Section 4

Contractor came to look at dam for Epoxy Coat & sand blasting he said he needed at least 5 to 7 days of 70 degrees to cure epoxy

Chipping & [illegible]

Still think [illegible] will not [illegible] done this year.

OCTOBER ~~25~~ 24

Clear Cold [illegible]

Chipping Spilling 2 Drumers 2 Helpers

Building float had to get extra oil dr tanks (500 gals.) [illegible]

Diamond drilling holes Complete section 4 & 5

[illegible]

Chipping spillway 4 crews

Drilling large holes drilling small holes ahead seems to help, completed Section 6 started Section 7, loaded Drill on float about 1 ft out of water, Started making bottom of Large Diameter Level ready for Rock Bolts

noted bottom of Rock Bolts are 2½ Cone & 2 Expander 8 [illegible]

Oct 26th Rain ✓

Started Chipping 3 Crews
Drilling Grout [illegible] of Section 11
& 12 then Drilling 12" holes
Rain all day.

[illegible]

11/1
11/2
11/3
12/1
12/2

[illegible]

Chipping Spillway 1 Crew
Started Diamond Drilling,

Started on Section 13 Pack [illegible]

13/1	32	44 ✓	[illegible]	
13/2	34	44 ✓	15/1	37
14/1	34	44 ✓	15/2	[illegible]
14/2	32	42		

Started to [illegible] Rock Anchors in on Section 5. 1 2 - 3

Put 600 lb Torque on Gauge put Hydraulic Jack pumped anchor Bolt, Hyd. Gauge did not Register.

252 ft.

[illegible]

OCTOBER 30

Slices Meld

15/3	26+10	36	
16/1	25+10	35	33
16/2	22+10	32	30
16/3	20+10	30	28
17/1	12+12	24	24 27
17/2			

Chipping Spillway 4 Crews

Put 650 lbs on No. 3 Rock Bolt in section 5. does not hold Bolt Keeps coming up, on No 1 & 2 Tens Bolts to 28 tons on 56,000 hold okay. Might have to grout bottom of No. 3 to hold down cone [illegible] expander, drilled some 12" holes

Rock Bolt 1	30 ft	Grouted	8 lbs
2	30 ft	Not Grouted	
3	30 ft	bottom grouted	

Williams Bolt Man Come, doing everything right except gauge, [illegible]

OCTOBER 31

[illegible] Crew – [illegible]

Started Chipping 4 crews

17/2	12 · 1 – 10	–		23 · 2
17/3	7	10		17 · 1
18/1	8 –	10	16	18
18/2	8 + 1	9		18
19/1	9 + 2 –	19		18
19/2	5 –	10		15

Anchor Bolt Come Installed

Section	Hole No	Depth
1	1	26
	2	24
	3	21
2	1	26
	2	22
	3	24
3	1	24
	2	25
4	1	24
	2	27
	3	27
	4	30
6	1	30

86

Drilled 6" Hole 19 : 8 ft
18 [illegible]

Clear Mild

Started chipping

GROUTED SECTION 13, 14, 15, 16, 17, 18, 19,

TORQUED ROCK ANCHOR BOLTS

SECT. 1, 2, 3, 4, 5, & 1 in 6

Ghs

Instable Clear Cold

Chipping Spillway. 4 Crews

Drilled rock Bolts

6/2	31 ft ✓
6/3	32 ✓
7/1	32 ✓
7/2	33 ✓
7/3	33 ✓
8/1	34 ✓

GROUTED Rock Bolts

1/2	3/1	4/1
1/3	3/2	4/2
2/1		4/3
2/2		4/4
2/3		5/2
		5/3
		6/1

CHEM GROUT HOLES DRILLED

19/1	8	18/1	10	17/1	1[illegible]
19/2	8	18/2	9	17/2	[illegible]
19/3	8	18/3	9	3	[illegible]
19/4	6	18/4	9	4	[illegible]
19/5	5	18/5	8	5	[illegible]
19/6	5	18/6	8	6	[illegible]
19/7	5	18/7	8	7	[illegible]
	45	18/8	8		
			69		

Electric Machine broke down. sent to shop [illegible] 12 [illegible]

Clear.

Stripping . Spillway 3 levers

7/2	33 ft.	torqued to 600 lb 28	
8/3	32 ft	"	28
9/1	34 ft	"	28 Tons
9/2	36 ft	"	28 Tons
9/3	36 ft.	"	28 Tons

94
126
220
220

13/1 : 30 ft ✓
13/2 : 34 ft ✓

14/1 ✓ 30 ft. (BOTTOM)
14/4 ✓ 30 ft
14/5 ✓ 34 ft

14/6 ✓ 32
14/7 ✓ 32
14/8 ✓ 32
14/9 ✓ 30

15/1 30 ft.
15/2 28
15/3 28 ft.

GL

New Electric Machine arrived.

Clear Warm

Drilling 12" Holes Completed 6

Leveled Bottom's

Clear Warm

Chipping 4 Crews

Cleaning 12 Holes out
washing Threads ready for
Plastic Grease

Grouted up to 9/3

Installed Rock Bolts
10/1 34 ft
10/2 32 ft
10/3 31 ft

11/1 31 ft
11/2 32 ft
11/3 32 ft
12/1 32
BackHoe Cleaning ditch Etc.
alongside dam,

Drilling Grouted Holes
out ready for Rock Bolts
13 Rods [illegible]

Chipping 2 Crews
4 Men Cleaning
1 Dynahoe 2 men
1 man cleaning 12" holes

600 lbs Long
Tightened 10/1 11/1 12/1 Pullouts
10/2 11/2
10/3 11/3
All 28 Tons
Grouted 10/1 2, 3, 11/1 2, 3,
Grouted Bottom 12/1

Drilled Chem Holes

8/8	26 ft
8/2	26 ft
8/6	26 ft
8/5	26 ft
8/4	26 ft
8/3	26 ft
8/2	26
8/1	26

6 hrs

Chipping, Cleaning up concrete from chipping

Drilling 13" Holes

Drilling Chem grout holes

7/2	24	4/10	21 ✓
7/3	24	4/8	19 ✓
7/4	24	4/6	18
7/5	24	4/4	18
7/6	24	4/1	16
7/7	24		
7/8	24		

13/1 42 FT Torque 600 lb 28 T
13/ " " " 4
14/2 " " " " 4
14/2 Torqued 600 Pulled 28 Tons. 4

314 NOVEMBER 3

Clear Mild

Cleaning up site

Drilling Shen Holes

10/1	26	9/8	28
10/3	24	9/7	28
10/6	24	9/5	28
10/8	24	9/4	28
	98	9/2	27
11/1	24	9/1	26
11/4	24		165
11/6	24		
11/9	24		
	96		

98
96
165
TOTAL 359

TORQUED & PULLED 28 Tons

13/1	42	Greased
13/2	42	
14/1	42	
14/2		

8 lbs

NOVEMBER 10

Clear Mild

chipping some of edges off rough cuts.

drilling Shem Grout holes

Greasing Tie bolts also putting plastic bags over threads, fill in 12 holes

13/1 25	12/3 24	16/8 2[illegible]
13/2 25	12/5 24	16/7 2[illegible]
13/3 24	12/8 25	16/4 2
13/6 34		16/5 [illegible]
		16/6 2
		16/1
		16/9

17/1 15

14/1 30

15/9 26
15/1 30
15/4 30

61

NOVEMBER 11
Veterans' Day

Clear Cold Ths

Drilling 12" Holes

6 Holes Drilled

8h

[illegible signature]

NOVEMBER 12

No work

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APPENDIX G

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