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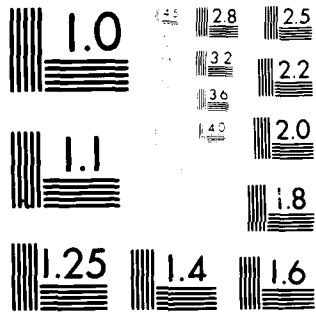
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NATIONAL DAM SAFETY PROGRAM. UPPER KESWICK DAM (NJ-00047), ATLA--ETC(U)  
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National Dam Safety Program  
D.M. (NJ-71447)  
**ATLANTIC COASTAL BASIN,  
WRANGEL BROOK, OCEAN COUNTY,  
NEW JERSEY. Phase 1  
Inspection Report.**

AD A 099 670

# UPPER KESWICK DAM

## NJ 00047

⑫ 84 | ⑨ Final report JUN 3 1981

⑬ Jan. 7 / 7/81

### PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

⑮ DACW 61-79-C-00111



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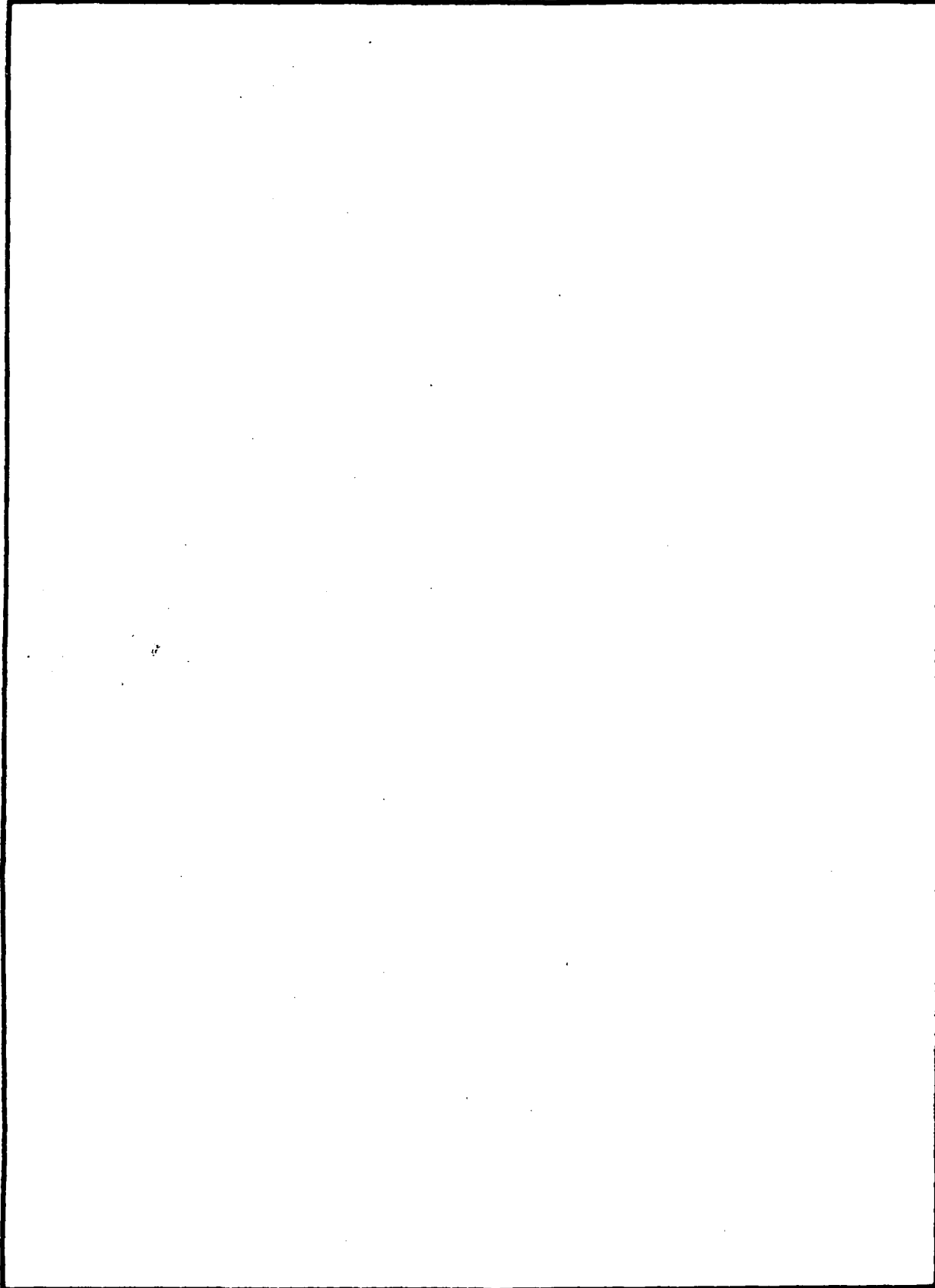
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Embankments	Spillways	
Visual Inspection	Outlet works	
Structural Analysis	Embankment	
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.		

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DEPARTMENT OF THE ARMY  
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PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO  
NAPEN-N

28 MAY 1981

Honorable Brendan T. Byrne  
Governor of New Jersey  
Trenton, New Jersey 08621

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Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Upper Keswick Dam in Ocean County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Upper Keswick Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 43 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within twelve months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. The following remedial actions should be initiated within twelve months from the date of approval of this report:

(1) The flow of seepage should be monitored monthly to determine its volume and whether it presents a problem to the safety of the dam.

(2) Construct a concrete headwall and apron at the outlet end of the discharge pipe.

(3) Fill in the eroded area of the embankment with suitable material and seed the section.

(4) All trees and brush should be removed from the side slopes to avoid problems which may develop from roots. The embankment face should then be reseeded to develop a growth of grass for surface erosion protection.



**.NAPEN-N**

Honorable Brendan T. Byrne

(5) Determine the size of the sluice gate and whether or not it is operable, and if not, institute remedial action to make it operable.

(6) Investigate the embankment for animal burrows and fill in any burrow holes with impervious material.

c. The owner should develop an emergency action plan (if one is not already available) outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months from the date of approval of this report.

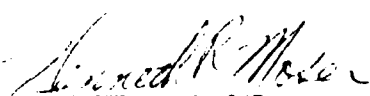
d. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam, within one year from the date of approval of this report.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Hughes of the Second District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,



KENNETH R. MOSER  
Major, Corps of Engineers  
Acting District Engineer

1 Incl  
As stated

Copies furnished:  
Mr. Dirk C. Hofman, P.E., Deputy Director  
Division of Water Resources  
N.J. Dept. of Environmental Protection  
P.O. Box CN029  
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief  
Bureau of Flood Plain Regulation  
Division of Water Resources  
N.J. Dept. of Environmental Protection  
P.O. Box CN029  
Trenton, NJ 08625

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UPPER KESWICK DAM (NJ00047)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 8 January 1981 by Harris-ECI Associates under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Upper Keswick Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 43 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within twelve months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. The following remedial actions should be initiated within twelve months from the date of approval of this report:

(1) The flow of seepage should be monitored monthly to determine its volume and whether it presents a problem to the safety of the dam.

(2) Construct a concrete headwall and apron at the outlet end of the discharge pipe.

(3) Fill in the eroded area of the embankment with suitable material and seed the section.

(4) All trees and brush should be removed from the side slopes to avoid problems which may develop from roots. The embankment face should then be reseeded to develop a growth of grass for surface erosion protection.

(5) Determine the size of the sluice gate and whether or not it is operable, and if not, institute remedial action to make it operable.

(6) Investigate the embankment for animal burrows and fill in any burrow holes with impervious material.

c. The owner should develop an emergency action plan (if one is not already available) outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months from the date of approval of this report.

d. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam, within one year from the date of approval of this report.

APPROVED: *Kenneth R. Moser*  
KENNETH R. MOSER  
Major, Corps of Engineers  
Acting District Engineer

DATE: *28 May 1981*

ATLANTIC COASTAL BASIN  
WRANGEL BROOK, OCEAN COUNTY  
NEW JERSEY

UPPER KESWICK DAM

NJ00047

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY  
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS  
PHILADELPHIA, PENNSYLVANIA 19106

MAY, 1981

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

Name: Upper Keswick Dam, I.D. NJ 00047  
State Located: New Jersey  
County Located: Ocean County  
Stream: Wrangel Brook  
River Basin: Atlantic Coastal Basin  
Date of Inspection: January 8, 1981

Assessment of General Conditions

Upper Keswick Dam is an earthfill dam with a paved roadway along the crest and a concrete capped timber drop inlet as a spillway. The overall condition of the dam is good. There are no major signs of distress or instability in the embankment. Minor seepage was observed at three different locations along the downstream toe. One location was to the left of the downstream channel and the others at each end of the dam. The low-level outlet was not open at the inspection and is not used. The hazard potential is rated as "high".

Upper Keswick Dam is considered inadequate in view of its lack of spillway capacity to pass the SDF (1/2 PMF) without overtopping the dam. The spillway is capable of passing a flood equal to 21 percent of the PMF (42 percent of the 1/2 PMF), and is assessed as "inadequate".

At present, the engineering data available is not sufficient to make a definitive statement on the stability of the dam, but based on the findings of the visual inspection, the preliminary assessment of static stability is that it is satisfactory. The following actions are recommended along with a timetable for their completion. All recommended actions should be conducted under the supervision of an Engineer who is experienced in the design, construction and inspection of dams.

1. Carry out a more precise hydrologic and hydraulic analysis of the dam within twelve months, to determine the need and type of mitigating measures necessary. Based on the results of these studies, remedial measures should be instituted. This should include the installation of a tailwater gage.
2. The flow of seepage should be monitored monthly to determine its volume and whether it presents a problem to the safety of the dam.

3. Construct a concrete headwall and apron at the outlet end of the discharge pipe. This work should be completed within twelve months.
4. Fill in eroded area of embankment with suitable material and seed the section within twelve months.
5. All brush and trees should be removed from the downstream and upstream slopes to avoid problems which may develop from roots. The embankment face should then be seeded to develop a growth of grass for surface erosion protection. This program should be started within twelve months.
6. Determine the size of the sluice gate and if it is operable. If not, institute remedial action to make it operable within twelve months.
7. Investigate embankment for animal burrows and fill in any burrow holes with impervious material.
8. The owner should develop an emergency action plan (if one is not already available) outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months.

Furthermore, while of a less urgent nature, the following additional action is recommended and should be carried out within twelve months.

The owner should develop, within one (1) year after formal approval of the report, written operating procedures and a periodic maintenance plan to insure the safety of the dam.



John P. Talerico, P.E.  
HARRIS-ECI Associates



Photo taken January 8, 1981

U P P E R   K E S W I C K   D A M

View looking from right end of dam. Drop inlet is located just beyond end of brush along upstream (left) slope.

## PREFACE

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

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. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.



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PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

UPPER KESWICK DAM, I.D. NJ 00047

S E C T I O N 1

1. PROJECT INFORMATION

1.1 General

a. Authority

The National Dam Inspection Act (Public Law 92-367, 1972) provides for the National Inventory and Inspection Program by the U.S. Army Corps of Engineers. This inspection was made in accordance with this authority under Contract C-FPM No. 35 with the State of New Jersey who, in turn, is contracted to the Philadelphia District of the Corps of Engineers, and was carried out by the engineering firm of Harris-ECI Associates of Woodbridge, New Jersey.

b. Purpose of Inspection

The visual inspection of Upper Keswick Dam was made on January 8, 1981. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

The report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an evaluation of hydrologic and hydraulic conditions at the site; presents an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

## 1.2 Description of Project

### a. Description of Dam and Appurtenances

Upper Keswick Dam is an earthfill dam 296 feet long and 12.4 feet high with a 21 foot wide paved roadway along the top of the dam. There is a 9.3 foot by 6.5 foot concrete capped timber drop inlet with a timber trash rack across the top located 177 feet from the left end of the dam. The crest of the lake side section of the inlet is 3 inches below the sidewalls and 2.3 feet below the top of roadway. The flow from the spillway discharges into the downstream channel through a 60-inch by 66-inch reinforced concrete pipe which also serves as the low-level outlet.

The embankment has a top width of 30 feet with approximate slope of 3.5H:1V on both faces. The upstream slope has a timber bulkhead extending from the spillway 30 feet to the left and 15 feet to the right.

The low-level outlet consist of the 60-inch x 66-inch reinforced concrete pipe that carries the discharge from the spillway. The low-level flow into the pipe is controlled by a small rising stem sluice gate located on the upstream face of the drop inlet. The gate is raised manually by turning a handwheel attached to the top of the frame that sits on a timber platform attached to the lakeside face of the spillway.

The outlet end of the pipe discharges into the downstream channel approximately 45 feet from the inlet. The downstream channel continues for a distance of 600 feet where it crosses under a timber roadway bridge and enters into Lower Keswick Lake. The bridge is 42 feet long and has five short spans, with the height from the bottom of the bridge to the water varying from 4.7 feet at the center to 2.7 feet at the abutments.

A generalized description of the soil conditions is contained in Report No. 8 Ocean County, Engineering Soil Survey of New Jersey by Rutgers University. The report dated 1953, indicates the immediate area of the lake and dam to be stratified recent alluvium, with the surrounding areas being alluvial stratified materials underlaid with marine stratified materials. Recent alluvium can be described as materials usually assorted by water-action and ranging in size from silt with some clay, to silt and fine sand with gravel. Alluvial stratified materials can be described as assorted, relatively homogeneous materials composed predominately of gravel and sand sizes. Marine is described as assorted homogeneous materials, ranging in texture from a uniform medium to coarse sand. The depth to bedrock in these desopits is greater than 100 feet. Geologic Overlay Sheet 32 describes the bedrock around the lake as the Tertiary formation of Cohansey Sand.

b. Location

Upper Keswick Lake Dam is located in Keswick Grove, which is an Alcoholic Rehabilitation Center, on Wrangel Brook, in the Township of Manchester, Ocean County, New Jersey. It is accessible from Route 70 at Whiting by way Pinewald-Keswick Road (Route 530) to Congasia Road at Keswick Grove.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineers, the dam is classified in the dam size category as being "small", since its storage volume of 123 acre-feet is less than 1,000 acre-feet. The dam is also classified as "small" because its height of 12.4 feet is less than 40 feet. The overall size classification of Upper Keswick Dam is "small".

d. Hazard Classification

A hazard potential classification of "high" has been assigned to the dam on the basis that a hypothetical failure would result in excessive damage to the main dining hall and the chapel located within the flood reach along Lower Keswick Lake, and to the six other buildings located, also within the flood reach, downstream of the Lower Lake. Therefore, the possibility exists of the loss of more than a few lives in the event of dam failure.

e. Ownership

Upper Keswick Dam is owned by:

America's Keswick  
Keswick Grove  
Whiting, NJ 08759

Attention: Mr. William A. Raws  
General Director  
(201) 350-1187

f. Purpose

Upper Keswick Dam is presently used for recreation purposes only.

g. Design and Construction History

Upper Keswick Dam was constructed in 1898. On March 30, 1938, the spillway failed by undermining and settling, washing out a 60 foot section of the embankment. No records exists as to whether or not there was damage downstream due to the failure. In rebuilding the embankment timber sheeting was driven along the length of the failure to a depth 12 feet below the spillway invert to prevent future undermining. The reconstruction of the dam was completed in August, 1938.

h. Normal Operating Procedures

The discharge from the lake is unregulated and allowed to naturally balance the inflow into the lake. According to the center's resident engineer, the low-level outlet is not used.

1.3 Pertinent Data

a. Drainage Area 0.89 sq. mi.

b. Discharge at Dam Site

Ungated spillway capacity at elevation of top of dam: 486 (96.66 NGVD)

Total spillway capacity at maximum pool elevation (SDF): 1,541 (97.5 NGVD)

c. Elevation (Feet above NGVD)

Top of dam: 96.66

Maximum pool design surcharge (SDF): 97.5

Recreation pool: 93.4

Spillway crest: 93.4

Streambed at centerline of dam: 83.3 (Estimated)

Maximum tailwater: 88 (Estimated)

d. Reservoir

Length of maximum pool: 2,250 feet (Estimated)

Length of recreation pool: 1,300 feet (Estimated)

e. Storage (acre-feet)

Spillway Crest: 54

Top of dam: 123

Maximum pool (SDF): 148

f. Reservoir Surface (acres)

Top of dam: 26

Maximum pool (SDF): 31

Recreation pool: 16.5

Spillway crest: 16.5 (93.44 NGVD)

g. Dam

Type:	Earthfill with concrete capped timber drop inlet
Length:	296 ft.
Height:	12.4 ft.
Top width:	30 ft.
Side slopes - Upstream:	3.5H:1V
- Downstream:	3.5H:1V
Zoning:	Unknown
Impervious core:	None
Cutoff:	None
Grout curtain:	None

h. Diversion and Regulating Tunnel

N/A

i. Spillway

Type:	Concrete capped timber drop inlet with notched front side
Length of weir:	25.0 ft.
Crest elevation:	93.44 (NGVD)
Gates:	None
U/S Channel:	Upper Keswick Lake
D/S Channel:	Natural Channel

j. Regulating Outlets

Low level outlet:	60-inch x 66-inch R.C.P.
Controls:	Manually controlled small sluice gate
Emergency gate:	None
Outlet:	83.4 NGVD



## SECTION 2

### 2. ENGINEERING DATA

#### 2.1 Design

A drawing showing the new outlet pipe and timber sheeting details for the reconstruction of the Upper Keswick Dam in 1938 and a drawing showing details of the spillway, prepared in 1973 by the Center's Resident Engineer, are available in his files at America's Keswick, Keswick Grove, Whiting, NJ. No data from soil borings, soil tests, design computations, or other geotechnical data is available to assess the stability properly. Data concerning the hydraulic capacity of the spillway is also unavailable.

#### 2.2 Construction

Data is not available concerning the as-built construction or reconstruction of the dam. No data exists of construction methods, borrow sources, or other data pertinent to the construction of the dam.

#### 2.3 Operation

Formal operation records are not kept for the dam and reservoir. The lake is allowed to operate naturally without regulation.

#### 2.4 Evaluation

##### a. Availability

The availability of engineering data is poor. The stated drawings are available from the owner.

##### b. Adequacy

The engineering data available, together with that obtained in the field, was adequate to perform hydrologic and hydraulic computations. The data was insufficient to perform a stability analysis, but preliminary evaluation could be made based on visual observations.

##### c. Validity

Information contained in the drawings and checked by limited field measurements appears to be valid.

## SECTION 3

### 3. VISUAL INSPECTION

#### 3.1 Findings

##### a. General

The visual inspection of Upper Keswick Dam revealed the dam and spillway to be in good condition, but in need of repairs. At the time of inspection the lake level was just above the crest of the spillway.

##### b. Dam

The earth embankment appears sound. Minor surface cracking on the pavement was noted, but cracks are tight. No cracking at the toe was noted. One area of erosion approximately 55 feet left of outlet was noted on the downstream slope. No misalignment of the embankment in the horizontal or vertical plane was evident. Minor seepage in the way of ponding and wet ground was noticed at the downstream toe of the embankment in three different locations. The seepage was occurring along an 18 foot wide section approximately 120 feet left of the spillway; a 15 foot wide section approximately 40 feet left and at a point approximately 160 feet right of the spillway. Numerous trees are growing on the downstream face of the embankment and a few trees and brush are growing on the upstream slope. No evidence of burrowing by animals was observed; however, the embankment was covered with snow and therefore the possibility does exist that there may be burrow holes.

##### c. Appurtenant Structures

###### 1. Spillways

The spillway is in good condition. No cracks in the concrete caps were noted only spalling. The timber trash rack appeared in good condition.

###### 2. Outlet Works

The low-level outlet works is also the spillway. It consists of the drop inlet with a small rising stem sluice gate, operated by a handwheel attached to the top of the frame at the upstream face of the inlet, and a 60-inch by 66-inch reinforced concrete pipe that discharges the flow into the downstream channel. There is a concrete headwall at the inlet of the pipe and timber headwall across the top and at the right side of the outlet. There is some spalling of the concrete headwall, while the lower part of the timber wall on the side is missing resulting in erosion of the slope along the pipe.

d. Reservoir Area

The side slopes surrounding the reservoir are flat and sandy with a dense cover of pine trees. There is no indication of slope instability.

e. Downstream

The downstream channel from the spillway to the lower lake is in good condition. The channel widens from approximately 10 feet at the outlet to 40 feet plus/minus at the timber bridge located 600 feet downstream from the outlet. There are some tree stumps and timber branches along the bottom of the channel. The side slopes are flat and heavily wooded. The area is used for nature walks as there are timber plank walks and benches on both sides of the channel.

There are two buildings located above the flood plain left of the downstream channel. On the right bank of the lower lake are the main dining hall and chapel as well as six other camp buildings just downstream of the lower lake that are within the flood plain.

## SECTION 4

### 4. OPERATIONAL PROCEDURES

#### 4.1 Procedures

Upper Keswick Dam is used to impound water for recreational activities. The level of the lake is maintained through the unregulated flow over the main spillway.

#### 4.2 Maintenance of the Dam

There is no regular inspection and maintenance program for the dam and appurtenant structures. America's Keswick is responsible for the maintenance of the dam.

#### 4.3 Maintenance of Operating Facilities

The low-level outlet operating facilities consist of one manually operated small sluice gate. At the time of inspection, the operation of the gate was not demonstrated. According to the resident engineer, the gate has never been open in the ten years he has been at the center, therefore he does not know if the gate is operable.

#### 4.4 Evaluation

The present operational and maintenance procedures are fair with the dam and spillway being maintained in a serviceable condition.

## SECTION 5

### 5. HYDRAULIC/HYDROLOGIC

#### 5.1 Evaluation of Features

##### a. Design

The drainage area above Upper Keswick Dam is approximately 0.89 square miles. A drainage map of the water shed of the dam site is presented on Plate 1, Appendix D.

The topography within the basin is generally mildly sloped. Elevations range from approximately 167 feet above NGVD at the north end of the watershed to about 93 feet at the dam site. Land use patterns within the watershed are mostly woodland.

The evaluation of the hydraulic and hydrologic features of the dam was based on criteria set forth in the Corps guidelines and additional guidance provided by the Philadelphia District, Corps of Engineers. The SDF for the Dam falls in a range of 1/2 PMF to PMF. In this case, the low end of the range, 1/2 PMF, is chosen since the factors used to select size and hazard classification are on the low-side of their respective ranges.

The Probable Maximum Flood (PMF) was calculated from the probable maximum precipitation using Hydrometeorological Report No. 33 with standard reduction factors. Due to the small drainage area, the SCS triangular hydrograph transformed to a curvilinear hydrograph was adopted for developing the unit hydrograph, with the aid of the HEC-1-DB Flood Hydrograph Computer Program.

Initial and constant infiltration loss rates were applied to the Probable Maximum Precipitation to obtain rainfall excesses. The rainfall excesses were applied to the unit hydrograph to obtain the PMF and various ratios of PMF utilizing program HEC-1-DB.

The SDF peak outflow calculated for the dam is 1,541 cfs. This value is derived from the half PMF, and results in overtopping of the dam, assuming that the lake was originally at the spillway crest elevation.

The stage-outflow relation for the spillway was determined from the geometry of the spillway and dam utilizing HEC-1 Dam Safety Version Program.

The reservoir stage-storage capacity relationship was computed directly by the conic method, utilizing the HEC-1-DB program. The reservoir surface areas at various elevations were measured by planimeter from a U.S.G.S. Quadrangle topographic map. Reservoir storage capacity included surcharge levels exceeding the top of the dam, and the spillway rating curve was based

on the assumption that the dam remains intact during routing. The spillway rating curve is presented in the Hydrologic Computation, Appendix D.

A breach analysis indicates that the stage of the stream where it crosses the center's road at the beginning of the Lower Lake is 2 feet higher, due to dam failure from overtopping at 0.3 PMF than it would be without failure at 0.3 PMF. This does not jeopardize the road downstream significantly more than without failure. The discharge facility is thus rated "inadequate".

Drawdown calculations could not be done due to the size of the gate is unknown and could not be determined at the time of inspection.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site.

c. Visual Observations

The downstream channel is in good condition. It widens from 10 feet at the outlet to approximately 40 feet at the timber bridge at the beginning of the Lower Lake. The side slopes are flat and heavily wooded. The area is also used for nature walks.

There are two buildings on the right shore of the Lower Lake and six others immediately downstream.

The side slopes surrounding the reservoir are flat and sandy with a dense cover of pine trees. There is no indication of slope instability.

d. Overtopping Potential

A storm of magnitude equivalent to the SDF would cause overtopping of the dam to a height of 0.84 feet. Computations indicate that the dam can pass approximately 21 percent of the PMF without overtopping the dam crest. Since the 1/2 PMF is the Spillway Design Flood (SDF) for this dam, according to the Recommended Guidelines for Safety Inspection of Dams by the Corps of Engineers, the spillway capacity of the dam is assessed as "inadequate".

## SECTION 6

### 6. STRUCTURAL STABILITY

#### 6.1 Evaluation of Structural Stability

##### a. Visual Observations

There are no major signs of distress in the embankment of the Upper Keswick Dam. Minor seepage was observed along the toe of slope at three different locations; at the left and right ends of the embankment and approximately 40 feet left of the downstream channel. The seepage has not been monitored and no information was uncovered concerning its flow rates. The numerous trees growing on both sides of the embankment could pose a threat to stability. The spillway was in good condition.

##### b. Design and Construction Data

No design computations relating to stability were uncovered during the report preparation phase. No embankment or foundation soil parameters are available for carrying out a conventional stability analysis on the embankment.

##### c. Operating Records

No operating records are available relating to the stability of the dam.

##### d. Post-Construction Changes

There are no known post-construction changes since the dam was rebuilt in 1938.

##### e. Static Stability

A static stability analysis was not performed for Upper Keswick Dam because the lack of data on which to base assumptions of material properties within embankment zones might produce misleading results, but based on the findings of the visual inspection, the preliminary assessment of static stability is that it is satisfactory.

##### f. Seismic Stability

The dam is located in Seismic Zone 1, as defined in Recommended Guidelines for Safety Inspection of Dams, prepared by the Corps of Engineers. In general, projects located in Seismic Zones 0, 1 and 2 may be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory and conventional safety margins exist, and based on the findings of the visual inspection, the preliminary assessment of the static and seismic stabilities is that they are satisfactory.

## SECTION 7

### 7. ASSESSMENT/REMEDIAL MEASURES

#### 7.1 Dam Assessment

##### a. Safety

The dam has been inspected visually and a review has been made of the available engineering data. This assessment is subject to the limitations inherent in the visual inspection procedures stipulated by the Corps of Engineers for a Phase 1 report.

Upper Keswick Dam is inadequate because the dam does not have the spillway capacity to pass the SDF, one half of the PMF, without overtopping. Overtopping of the dam carries with it the danger of a likely progressive failure of the dam. The present spillway capacity of the dam is approximately 21 percent of the PMF.

No definitive statement pertaining to the safety of the embankment can be made without acquisition of embankment material engineering properties, but based on the findings of the visual inspection, preliminary assessment of the static stability is that it is satisfactory.

##### b. Adequacy of Information

The information uncovered was adequate to perform hydrologic and hydraulic computations. The data was insufficient to perform even an approximate computation of the stability of the dam. A preliminary assessment of the dam could be made by visual observation only.

##### c. Urgency

The remedial measures and recommended actions along with a timetable for their completion are detailed below. All recommended action should be conducted under the supervision of an engineer who is experienced in the design, construction and inspection of dams.

#### 7.2 Remedial Measures

##### a. Alternatives for Increasing Spillway Capacity

Alternatives for increasing spillway capacity are as follows:

1. Increase the embankment height of the dam thus permitting a higher discharge to pass.



2. Lower the spillway crest elevation.
3. Increase the effective spillway crest length.
4. A combination of any of the above alternatives.

b. Recommendations

1. Carry out a more precise hydrologic and hydraulic analysis of the dam within twelve months, to determine the need and type of mitigating measures necessary. If required, conduct a study of the means of increasing spillway discharge capacity and develop alternative schemes for construction. This should include the installation of headwater and tailwater gages. The ability of the dam to withstand overtopping should also be studied.
2. The flow of seepage should be monitored monthly to determine its volume and whether it presents a problem to the safety of the dam.
3. Construct a concrete headwall and apron at the outlet end of the discharge pipe within twelve months.
4. Fill in eroded area of the embankment with suitable material and seed the section within twelve months.
5. All trees and brush should be removed from the side slopes to avoid problems which may develop from roots. The embankment face should then be reseeded to develop a growth of grass for surface erosion protection. This program should be started within twelve months.
6. Determine the size of the sluice gate and whether or not it is operable, and if not, institute remedial action to make it operable within twelve months.
7. Investigate embankment for animal burrows and fill in any burrow holes with impervious material.

The following additional action is recommended:

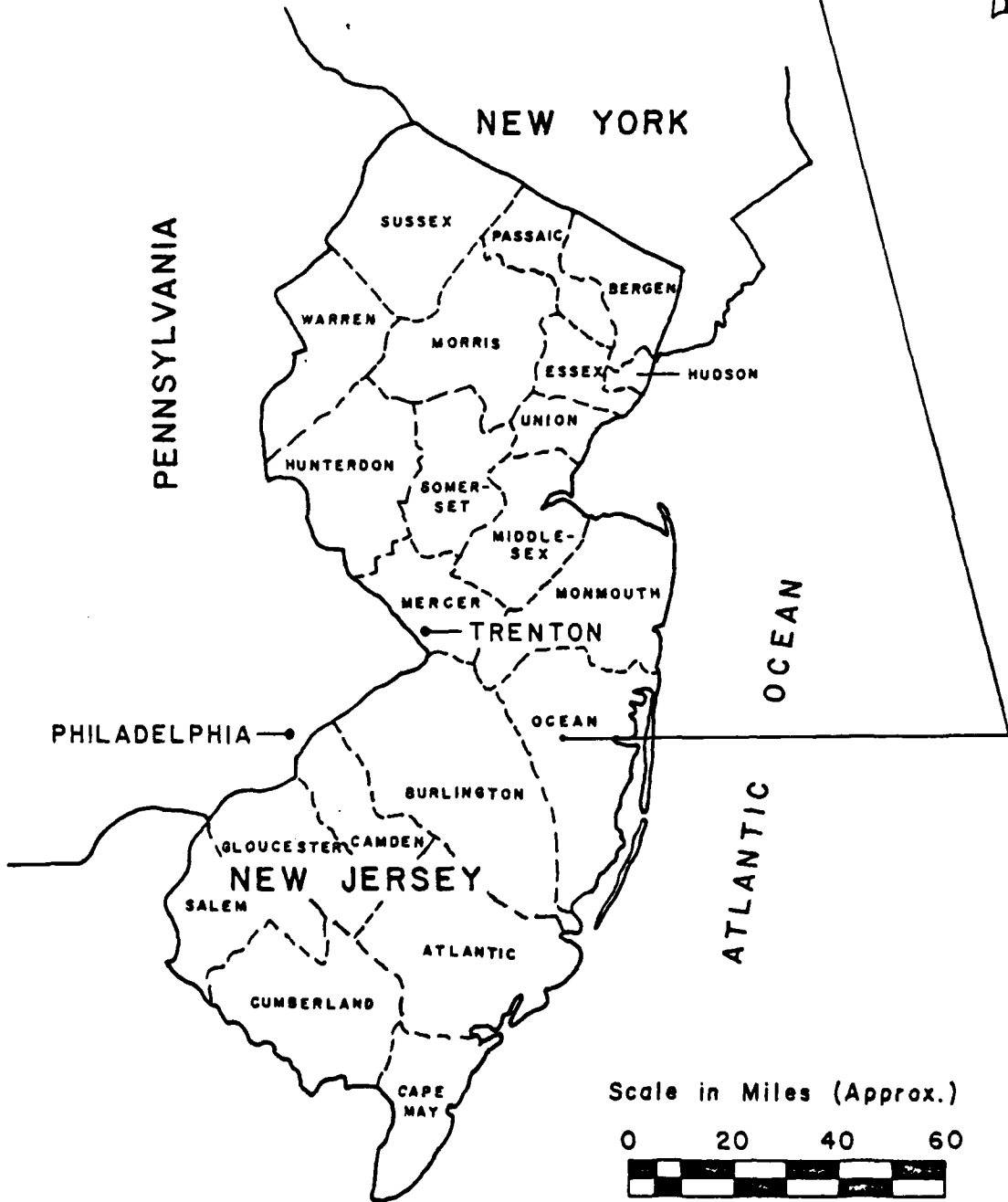
The owner should develop an emergency action plan (if one is not already available) outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months.

c. O & M Procedures

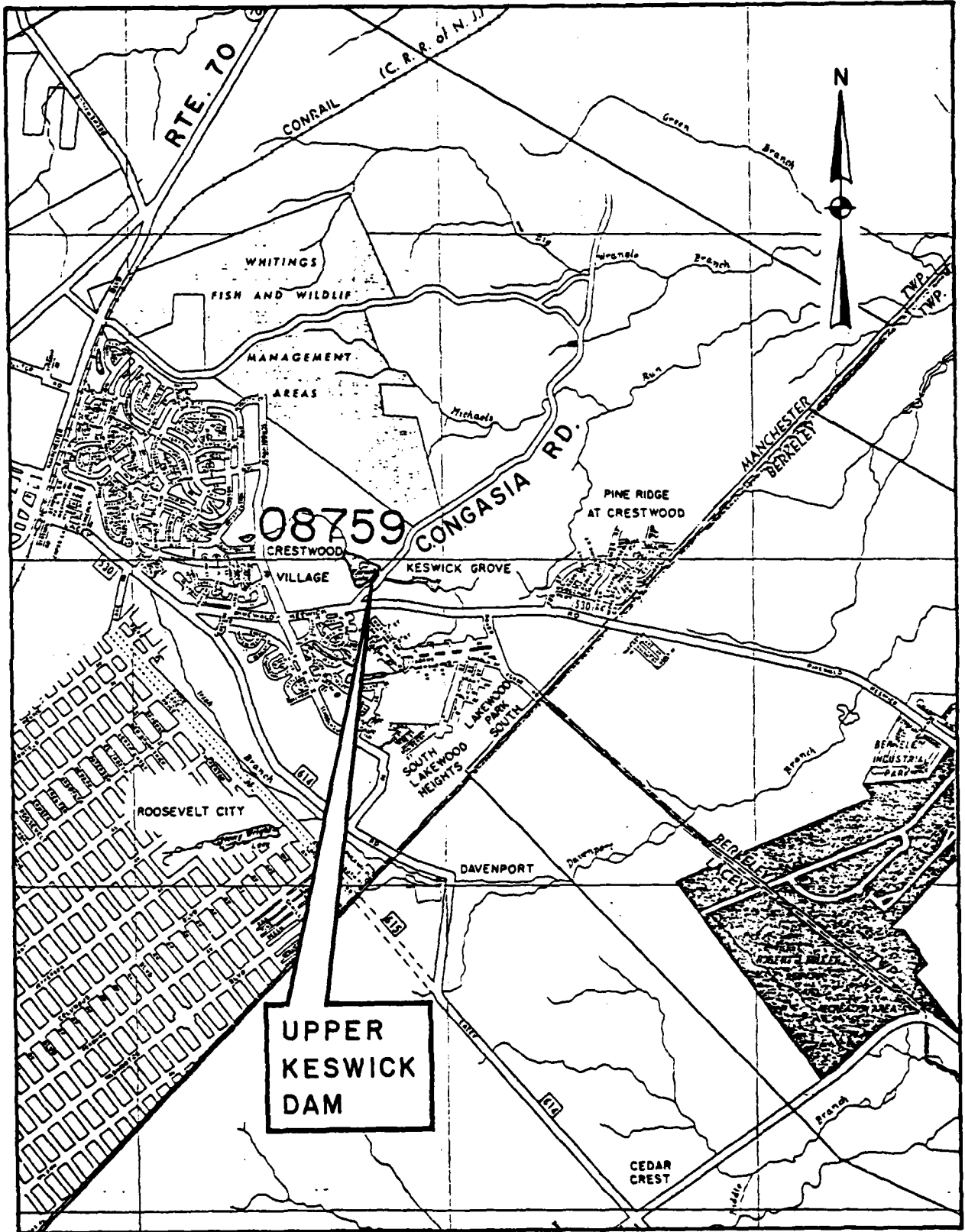
The owner should develop, within one (1) year after formal approval of the report, written operating procedures and a periodic maintenance plan to insure the safety of the dam.

P L A T E S

UPPER KESWICK DAM  
MANCHESTER TOWNSHIP  
OCEAN COUNTY, N. J.



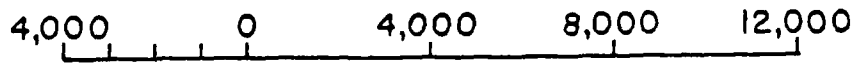
KEY MAP

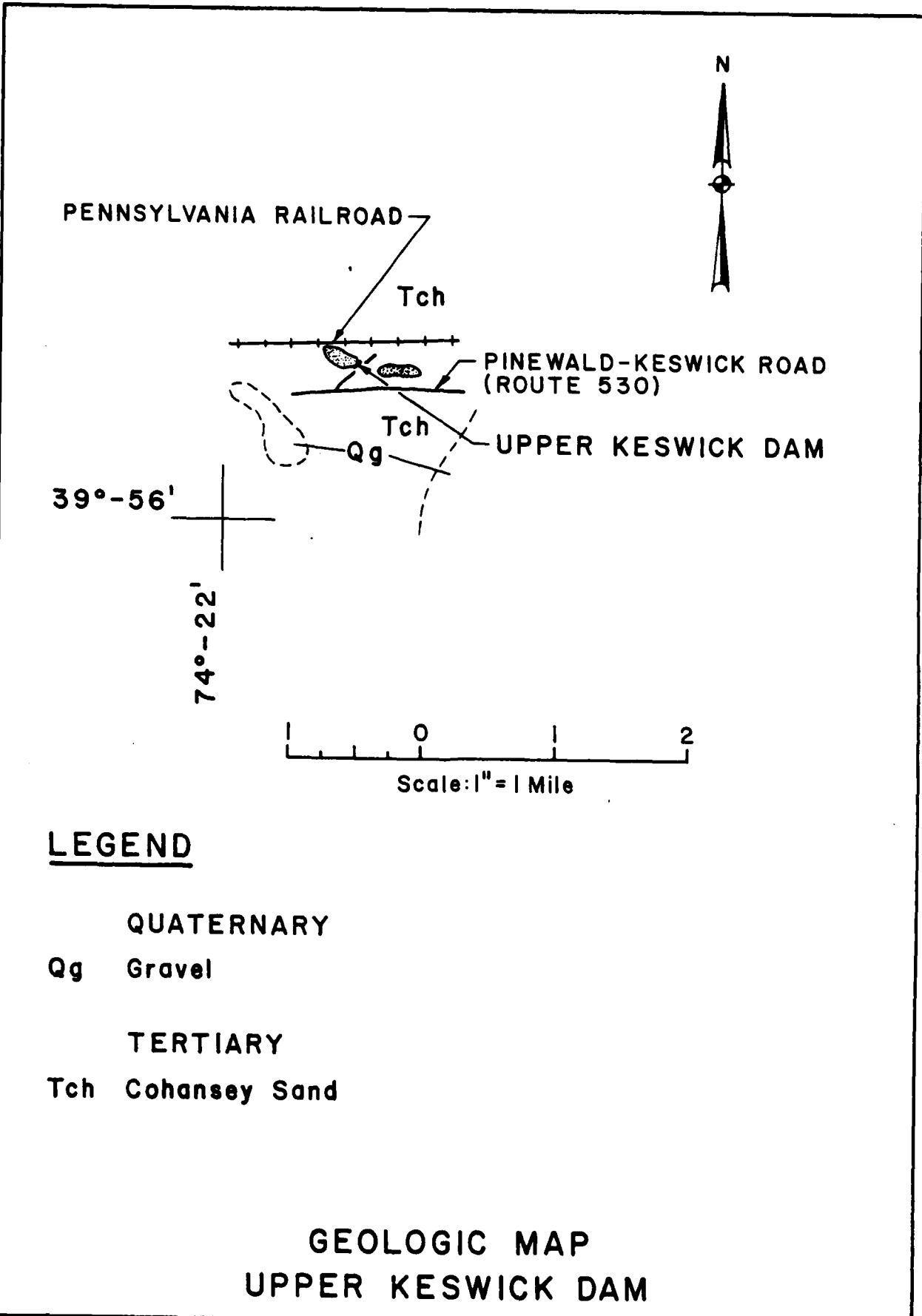


08759

UPPER  
KESWICK  
DAM

Scale in Feet (Approx.)





PENNSYLVANIA RAILROAD



Tch

PINEWALD-KESWICK ROAD  
(ROUTE 530)

Tch

UPPER KESWICK DAM

Qg

39°-56'

74°-22'



Scale: 1" = 1 Mile

LEGEND

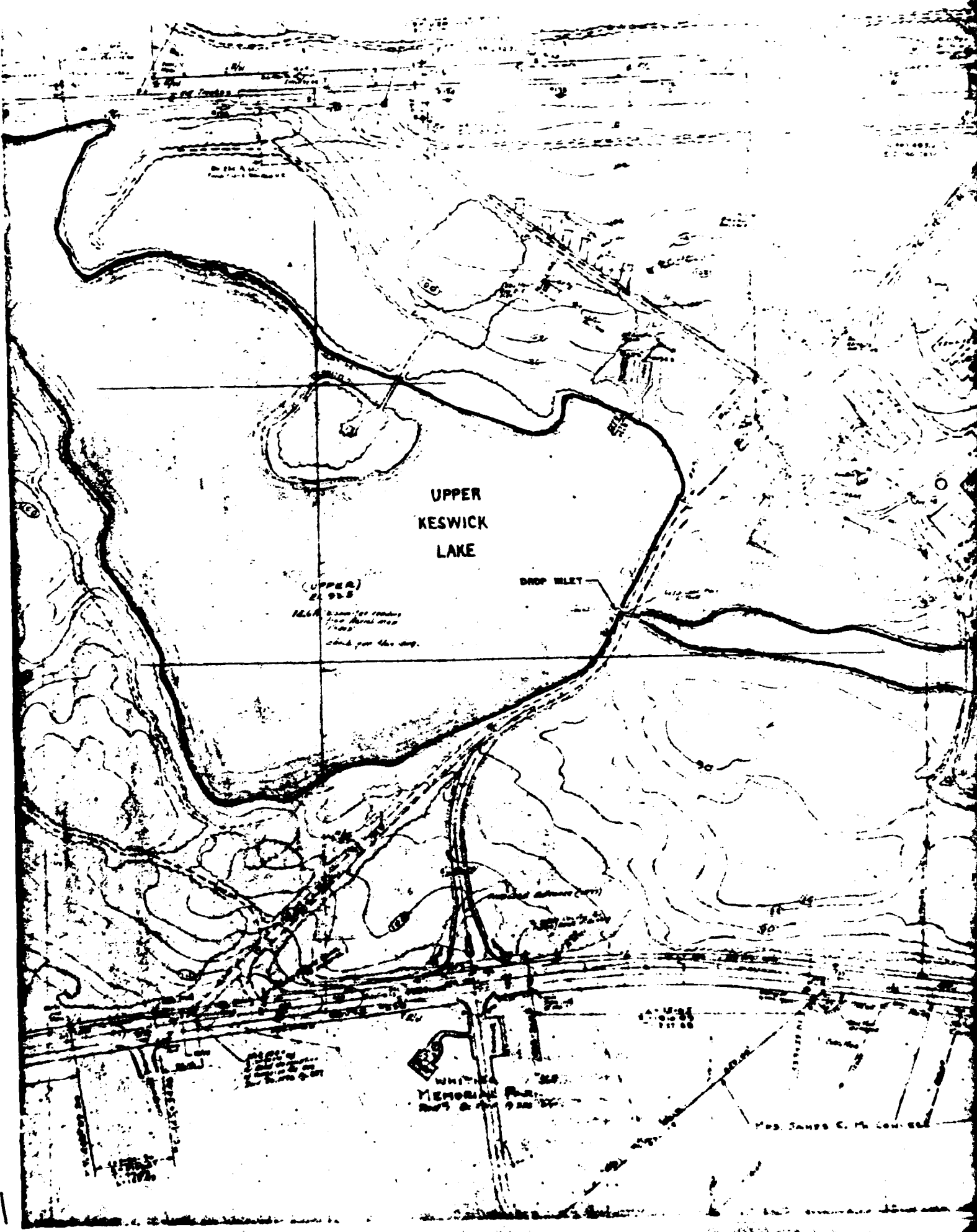
QUATERNARY

Qg Gravel

TERTIARY

Tch Cohansey Sand

GEOLOGIC MAP  
UPPER KESWICK DAM



UPPER  
KESWICK  
LAKE

(UPPER)  
21,925  
12.66 1/2 mile for road  
from April 1964  
check for the map.

DROP WLEY

WHITNEY  
MEMORIAL PARK

MRS. TAMM C. H. COMBES



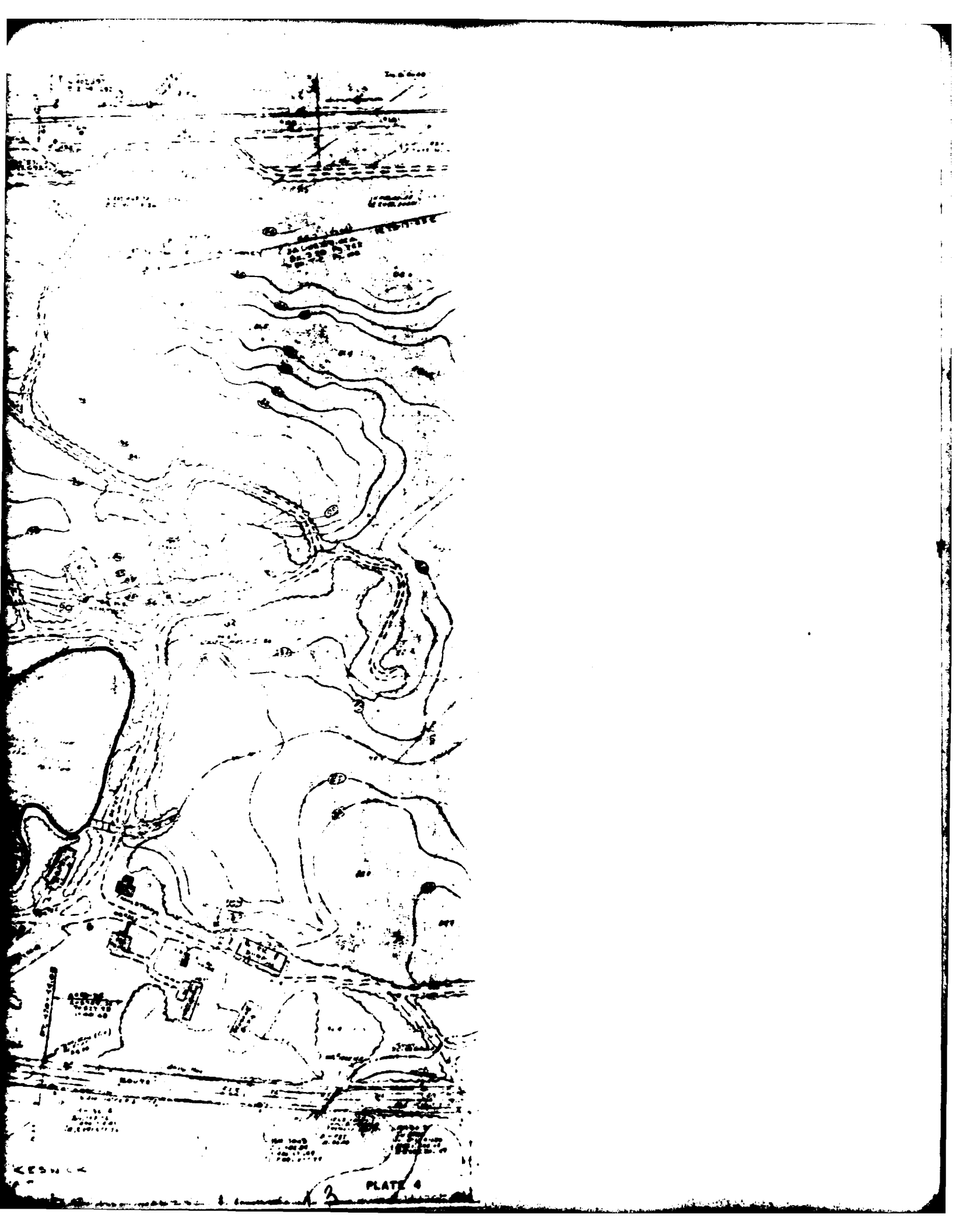
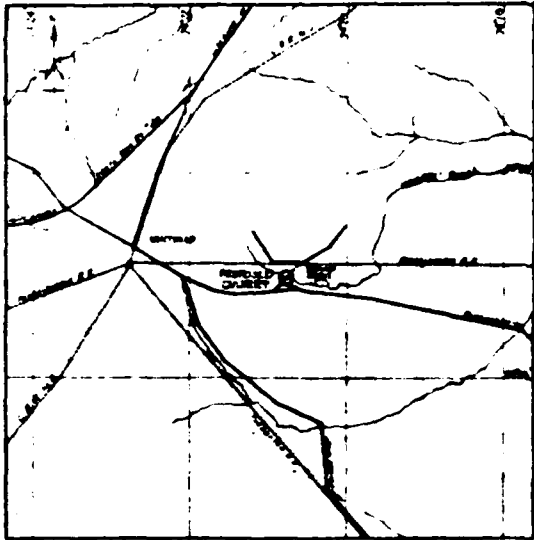


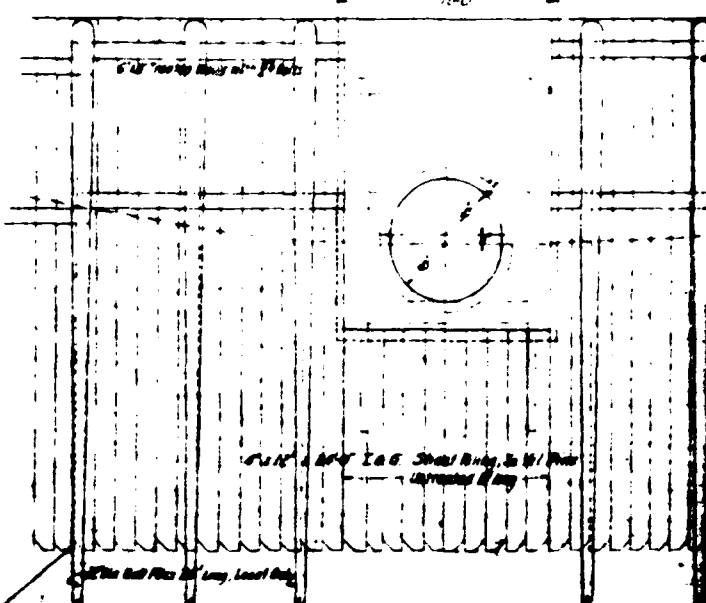
PLATE 4

2

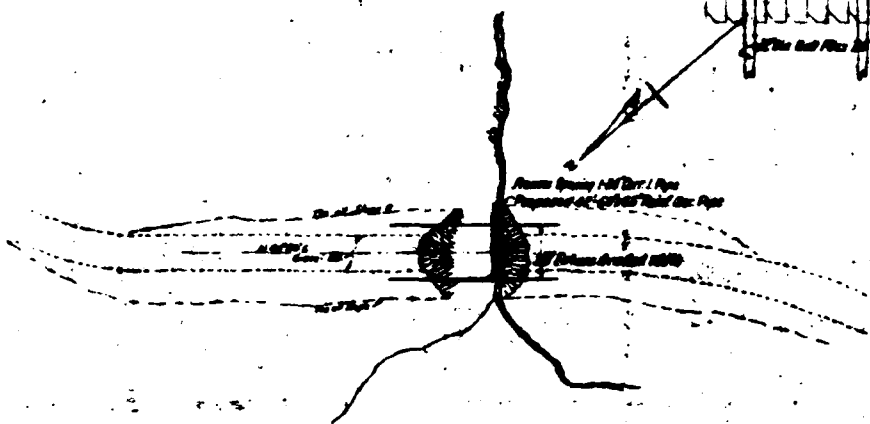




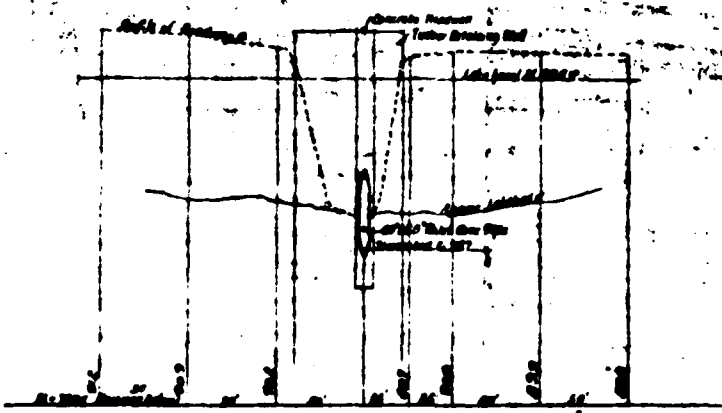
**LOCATION SKETCH**  
Scale 1"=100'



**SECTION B-B**  
Scale 1"=10'

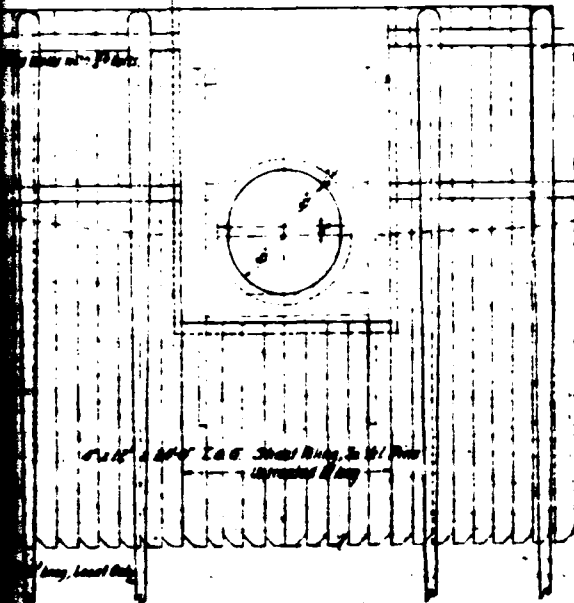


**PLAN OF SITE**  
Scale 1"=50'

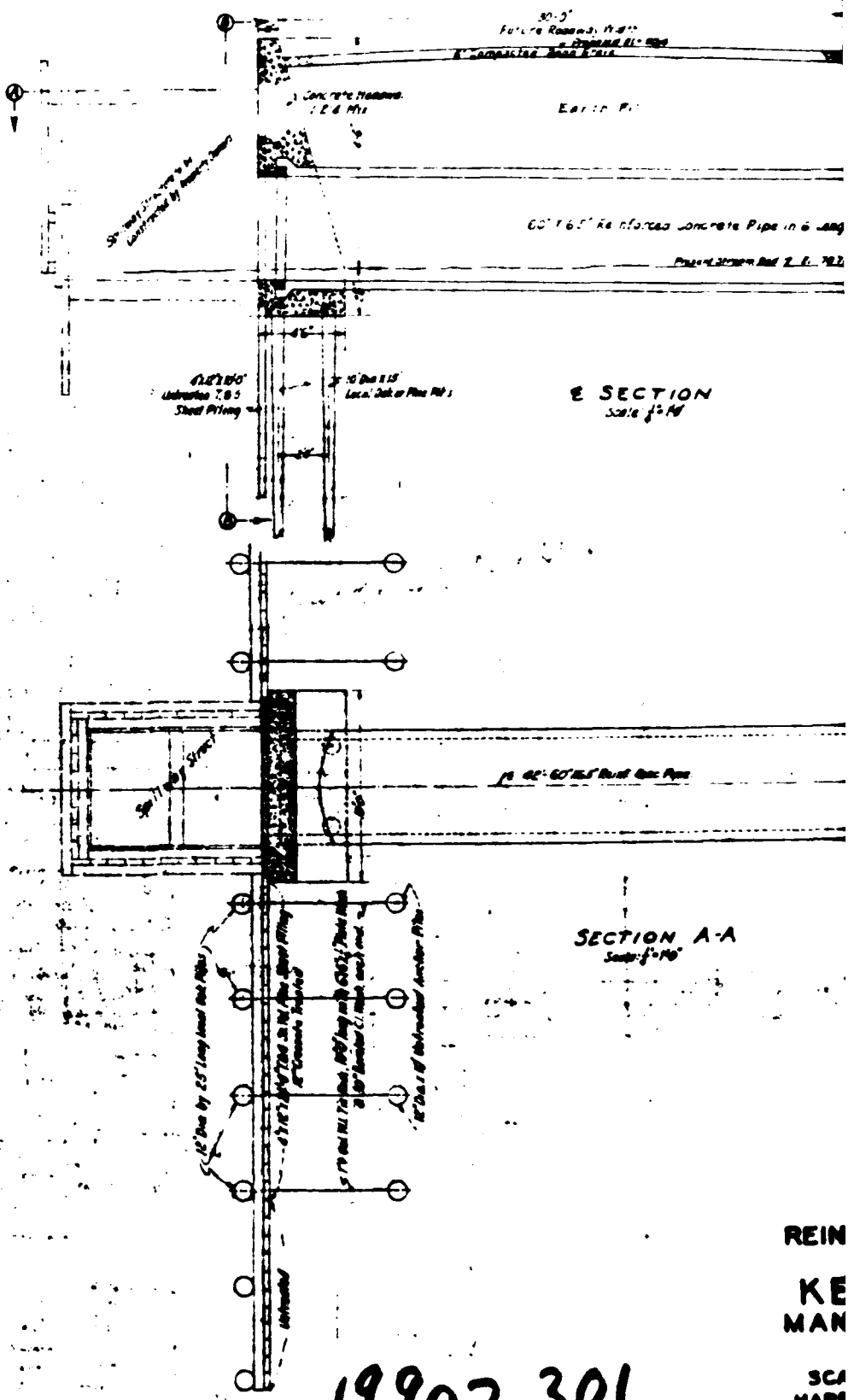


**PROFILE OF ROADWAY**  
Scale 1/2"=10'

100



SECTION B-B  
Scale 1/2" = 1'-0"



SECTION A-A  
Scale 1/2" = 1'-0"

30'-0"  
Future Roadway 14'-0"  
+ 16'-0" = 30'-0"  
+ 1'-0" compacted Sand 5'-0"

Concrete Slab  
12" x 18"

Earth Fill

60" x 60" Reinforced Concrete Pipe in 6' Long

Pressure 2.0 x 10<sup>2</sup> PSI

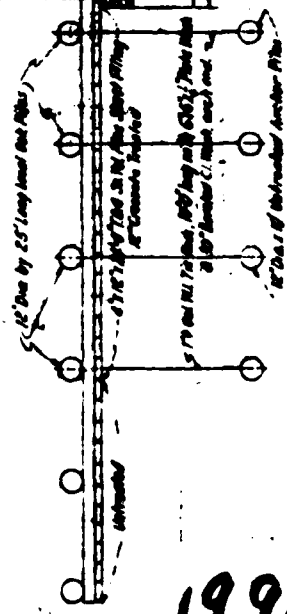
50' x 100' x 100' in  
Controlled by Access Road

41/2" Dia  
Underdrain T.B.S.  
Steel Piling

10" Dia 115'  
Local Soil or Pipe 10'

E SECTION  
Scale 1/2" = 1'-0"

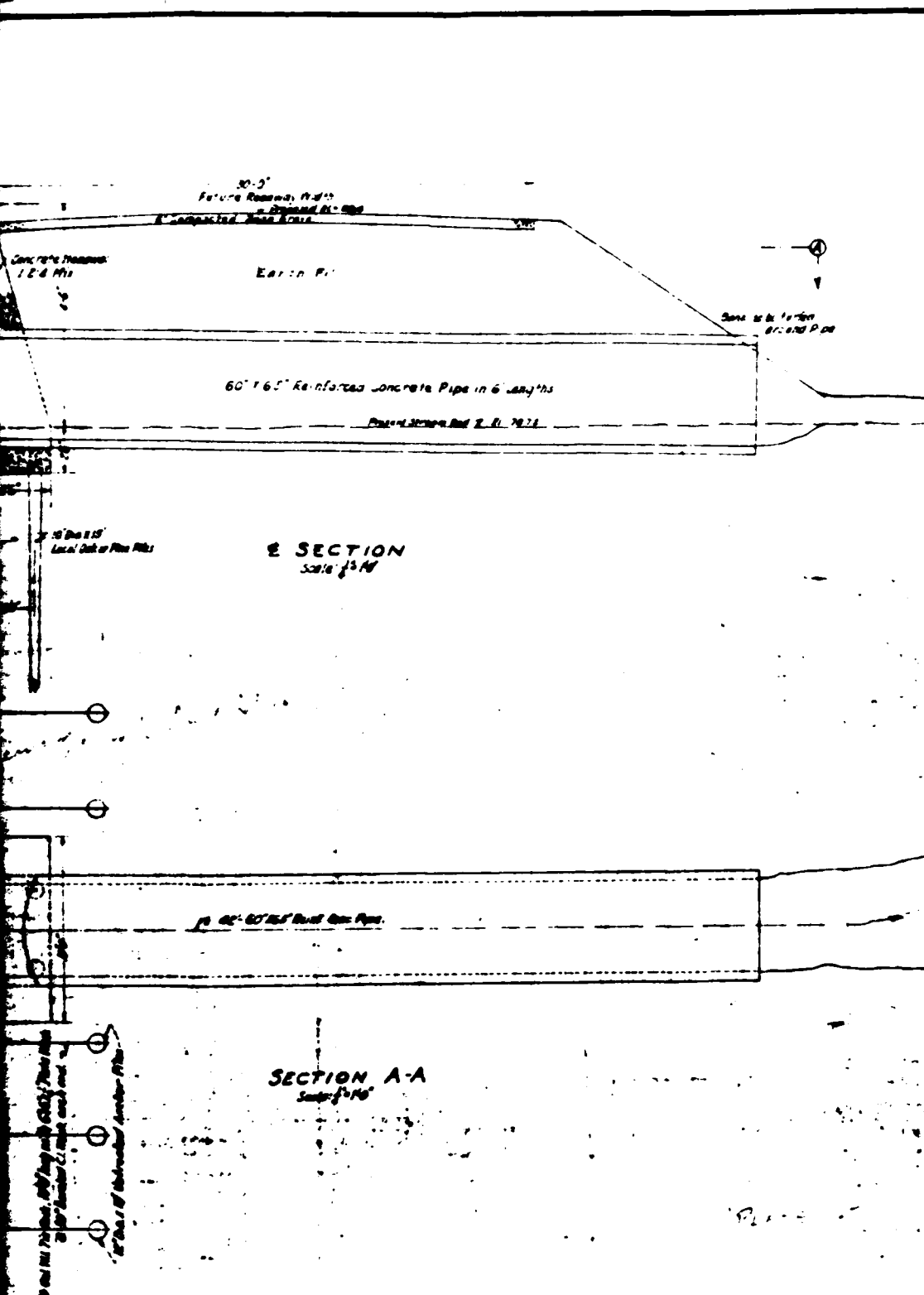
14" 40' x 60' Dia. 10' Long



10" Dia. by 25' Long Steel Pipe  
 41/2" Dia. 115' Local Soil or Pipe 10'  
 15" Dia. 115' Local Soil or Pipe 10'  
 10" Dia. 115' Local Soil or Pipe 10'  
 10" Dia. 115' Local Soil or Pipe 10'

REIN  
 KE  
 MAN  
 SCA  
 HARS

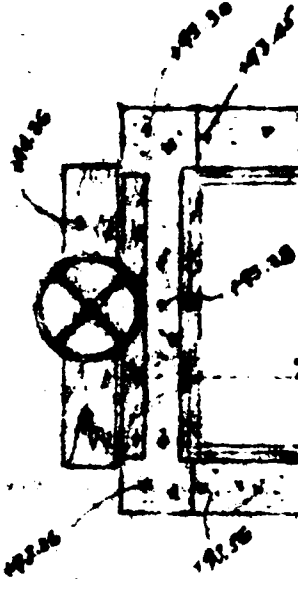
19902301



PLANS OF  
 REINF. CONC. PIPE CULVERT  
 AT  
 KESWICK GROVE  
 MANCHESTER TOWNSHIP  
 OCEAN COUNTY  
 SCALES AS SHOWN MAY 1938  
 HARRY C. SHANN COUNTY ENGINEER

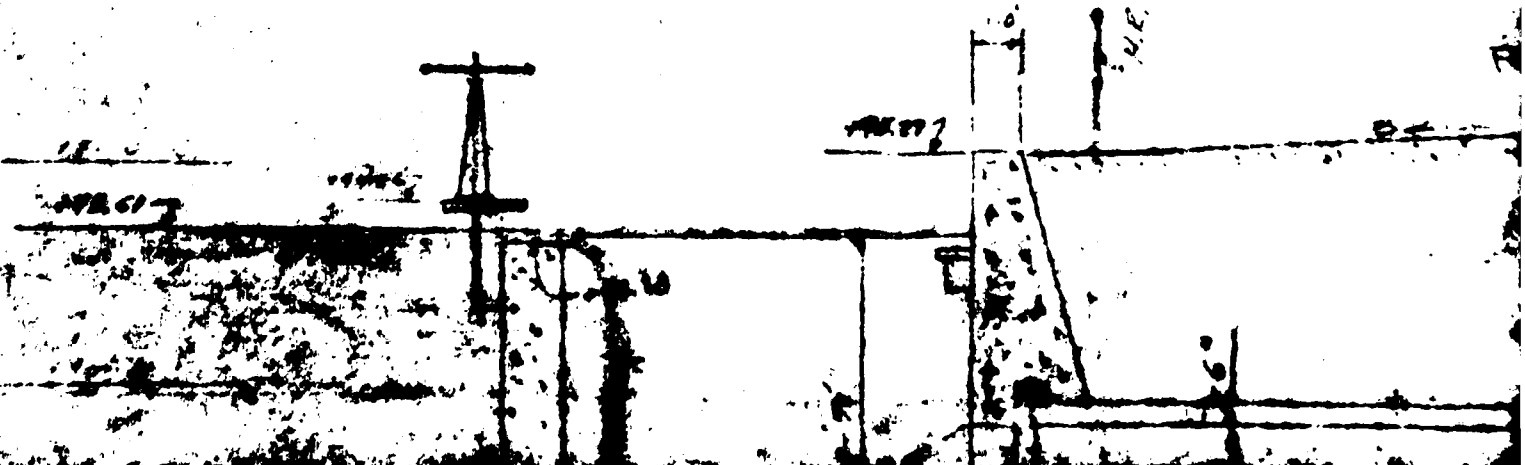
19902301

"A"



B.M. 15 21.95.29

SPILL



15 81.96.29

5'0" 6'

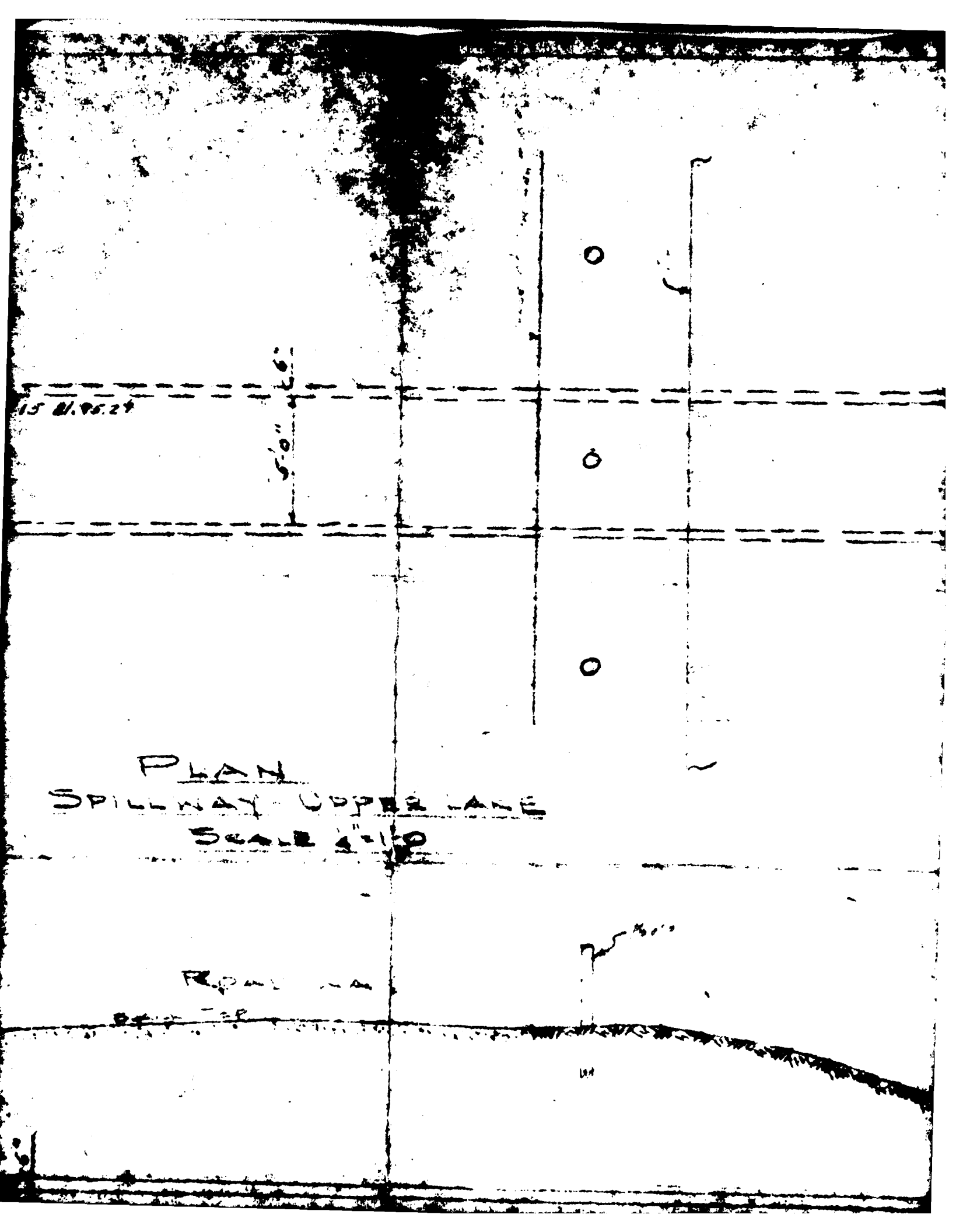
PLAN  
SPILLWAY UPPER LAKE  
SCALE 1"=10'

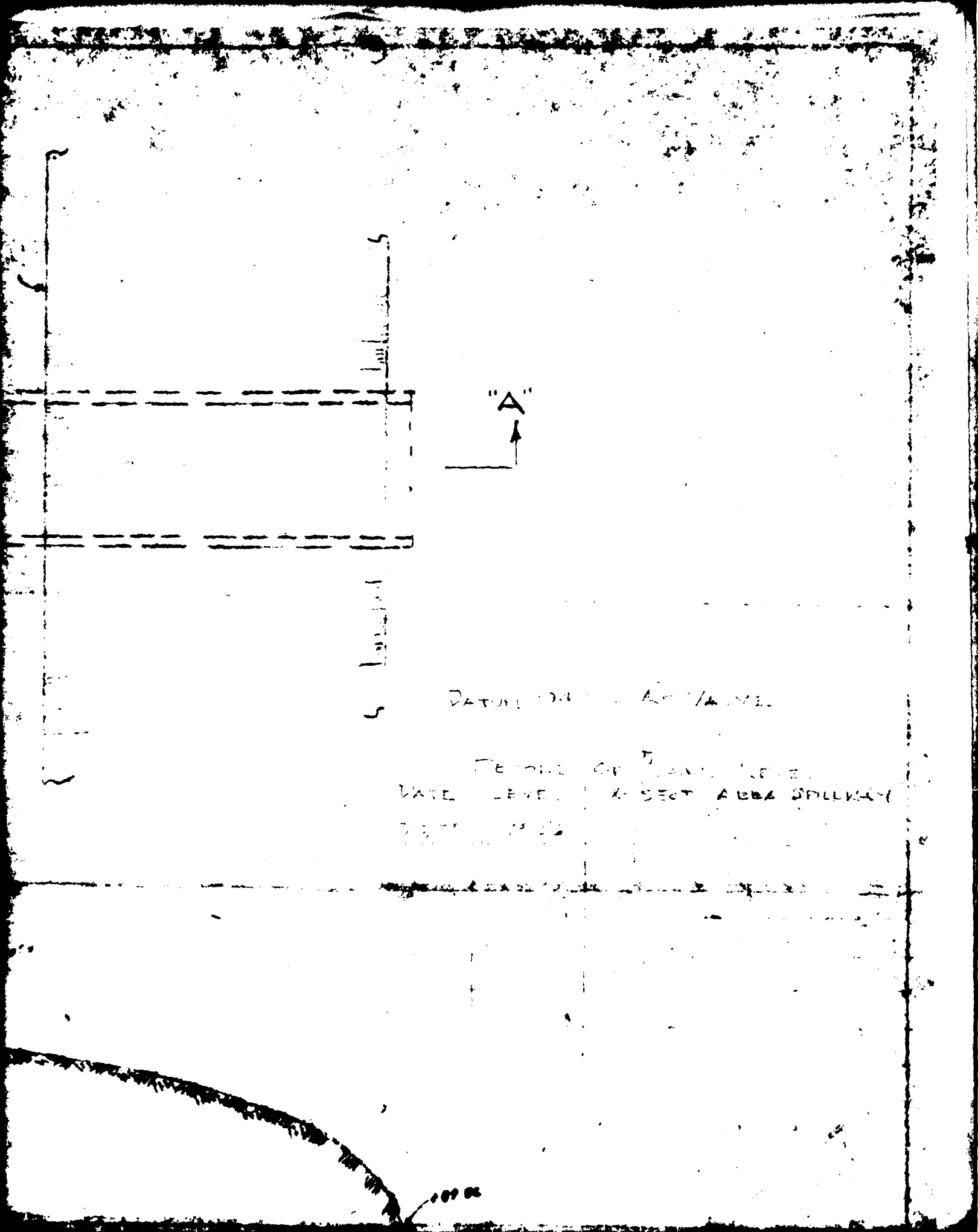
R. P. ...

... ..

25 30 10

100





"A"



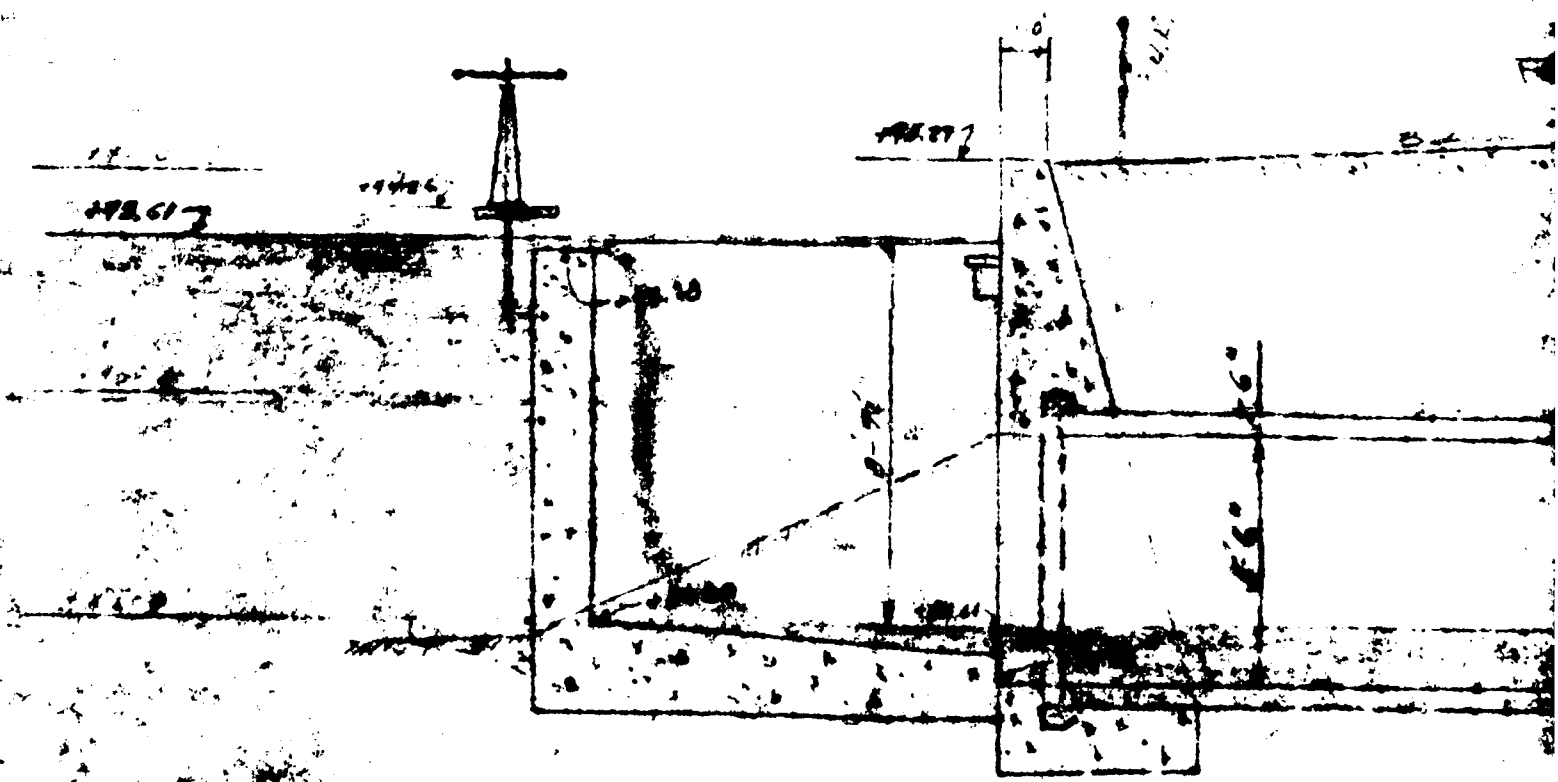
DATE 1912

SECTION OF SPILLWAY  
DATE 1912

1912



S.P. 11 2 1/2



MAY 1913

0

PLAN  
SPILLWAY COVER LANE  
SCALE 1"=10'

ROAD

250'

SECTION A

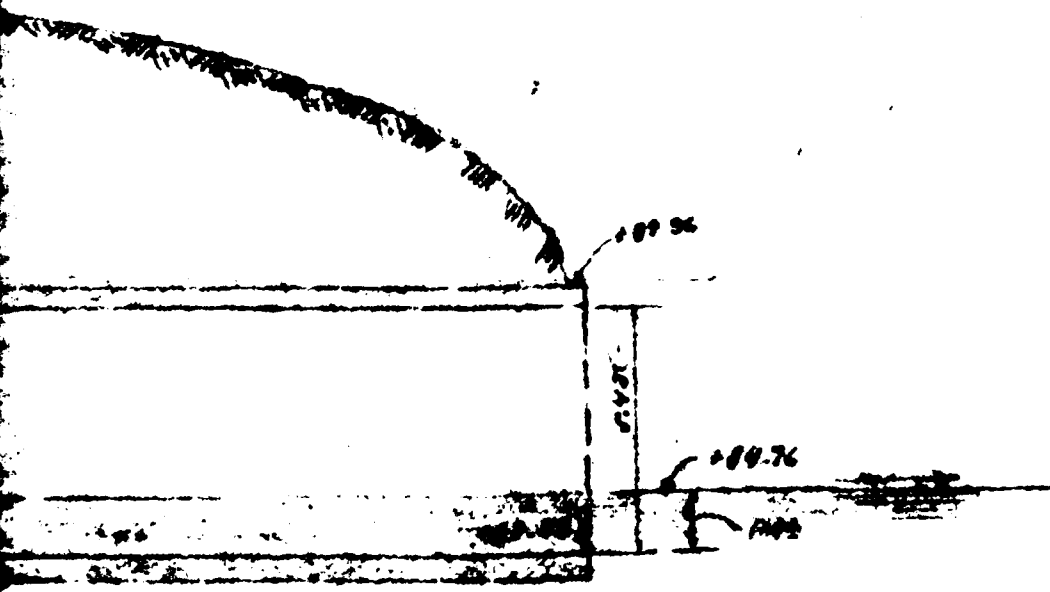
AMERICAN  
WH

Mount South



DATUM: 1941 ...

RECORD OF LEVEL ...  
DATE LEVEL ...



AMERICAS KESSICK

WHITING, N J

08159

APPENDIX A  
CHECK LIST - VISUAL OBSERVATIONS  
CHECK LIST - ENGINEERING, CONSTRUCTION  
MAINTENANCE DATA

CHECK LIST  
VISUAL INSPECTION  
PHASE 1

Name Dam Upper Keswick Dam County Ocean State New Jersey Coordinators NJ-DEP

Date(s) Inspection January 8, 1981 Weather Clear Temperature 5<sup>o</sup>F

Pool Elevation at Time of Inspection 94.11 NGVD Tailwater at Time of Inspection 85.77 NGVD

Inspection Personnel:

January 8, 1981  
William Birch  
Thomas Moroney  
Joseph Sirianni (Recorder)

Owner  
OWNER/REPRESENTATIVE:

January 8, 1981  
Michael Sudol  
Resident Engineer  
Keswick Grove  
Whiting, NJ 08759

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SURFACE CRACKS	Top of embankment is a paved road. Some minor cracks in pavement. Cracks were tight.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noticed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Erosion at one downstream location left of spillway. Erosion appears to be caused by runoff from road.	Refill eroded area with appropriate materials and seed area.
VERTICAL & HORIZONTAL ALIGNMENT OF THE CREST	Horizontal and vertical alignments good.	
RIPRAP FAILURES	None	

EMBANKMENT

VISUAL EXAMINATION OF	REMARKS AND RECOMMENDATIONS
<p><b>EARTH EMBANKMENT</b>                      Heavy growth of trees and brush on downstream slope. Some tree and brush growing on upstream slope near top.</p>	<p>Remove trees and brush.</p>
<p><b>JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM</b>                       Good condition.</p>	
<p><b>ANY NOTICEABLE SEEPAGE</b>                      Minor seepage was visible at downstream toe at three locations. 1. A 15-foot wide area of soft wet ground 40+ feet left of spillway. 2. A 18-foot wide section of ponded water. 120+ feet left of spillway. 3. An area 160+ feet right of spillway - very slight flow.</p>	<p>Monitor seepage for clearance and quantity.</p>
<p><b>STAFF GAGE AND RECORDER</b>                       None</p>	
<p><b>DRAINS</b>                       None</p>	<p>3.</p>

OUTLET WORKS

VISUAL EXAMINATION OF	REMARKS AND RECOMMENDATIONS
<p>CRACKING &amp; SPALLING OF CONCRETE SURFACES IN STILLING BASIN</p>	
<p>N/A - Spillway (also outlet works) discharges directly in downstream channel.</p>	
<p>INTAKE STRUCTURE</p> <p>Spillway is drop inlet with sluice gate, spalling of top and inside faces of concrete caps.</p>	
<p>OUTLET STRUCTURE</p> <p>60-inch x 66-inch reinforced concrete pipe in good condition. Concrete headwall at inlet with timber headwall across top and right side of pipe at outlet. Lower part of timber wall on side gone and slope eroded along the pipe.</p>	<p>Fill in eroded area with appropriate materials. Provide concrete headwall and apron for pipe.</p>
<p>OUTLET FACILITIES</p> <p>None</p>	
<p>EMERGENCY GATE</p> <p>None</p>	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE WEIR	Spillway is a timber drop inlet with concrete cap and sluice gate- top and inside faces of caps are spalled	
APPROACH CHANNEL	Lake is approach channel for spillway.	
DISCHARGE CHANNEL	60-inch by 66-inch reinforced concrete pipe, in good condition, is discharge channel and low-level outlet.	
BRIDGE AND PIERS	Timber trash rack across top of inlet is in good condition.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
MONUMENTATION*/ SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	



RESERVOIR

REMARKS AND RECOMMENDATIONS	OBSERVATIONS
	<p><u>VISUAL EXAMINATION OF SLOPES</u></p> <p>Flat with heavy growth of pine trees.</p>
	<p><u>SEDIMENTATIONS</u></p> <p>None visible.</p>

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	REMARKS AND RECOMMENDATIONS
<p>CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)</p> <p>Channel in good condition with some tree stumps and branches along bottom. Channel widens from approximately 10 feet at the outlet to 40 feet at the bridge at beginning of lower lake.</p>	
<p>SLOPES</p> <p>Flat and heavily wooded. Area is also used for nature walk as there are board walks and benches on both sides of channel.</p>	
<p>APPROXIMATE NUMBER OF HOMES AND POPULATION</p> <p>Two buildings(out of flood plain)left of channel, two main buildings (dining hall and chapel) on right shore of lower lake and also six other camp buildings downstream of lower lake.</p>	

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	None Available.
REGIONAL VICINITY MAP	Available - Ocean County Map and U.S.G.S. Quadrangle Sheet for Keswick Grove, New Jersey
CONSTRUCTION HISTORY	Original dam built 1898, spillway rebuilt 1938, no other information available.
TYPICAL SECTIONS OF DAM	None available.
HYDROLOGIC/HYDRAULIC DATA	None available.
OUTLETS - PLAN	Available at Resident Engineer's office-America's Keswick Keswick Grove, Whiting, NJ 08759
- DETAILS	Not available.
- CONSTRAINTS	None
- DISCHARGE RATINGS	Not available.
RAINFALL / RESERVOIR RECORDS	Not available.

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION  
(continued)

ITEM	REMARKS
DESIGN REPORTS	None Available.
GEOLOGY REPORTS	Available U.S.G.S. Geologic Overlay Sheet No. 32 and Engineering Soils Survey of New Jersey, Report No. 8 Ocean County, by Rutgers University (New Brunswick, NJ)
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available.
POST-CONSTRUCTION SURVEYS OF DAM	None
BORROW SOURCES	Unknown.
SPILLWAY PLAN - SECTIONS - DETAILS	Available at Resident Engineer's office-Keswick Grove None available.

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION  
(continued)

ITEM	REMARKS
OPERATING EQUIPMENT PLANS AND DETAILS	None available
MONITORING SYSTEMS	None
MODIFICATIONS	None
HIGH POOL RECORDS	None kept.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OF FAILURE OF DAM - DESCRIPTION - REPORTS	Spillway & dam failed in 1938 due to undermining and settling.
MAINTENANCE OPERATION RECORDS	None known to exist.

APPENDIX B

PHOTOGRAPHS

(Taken on January 8, 1981)

UPPER KESWICK DAM

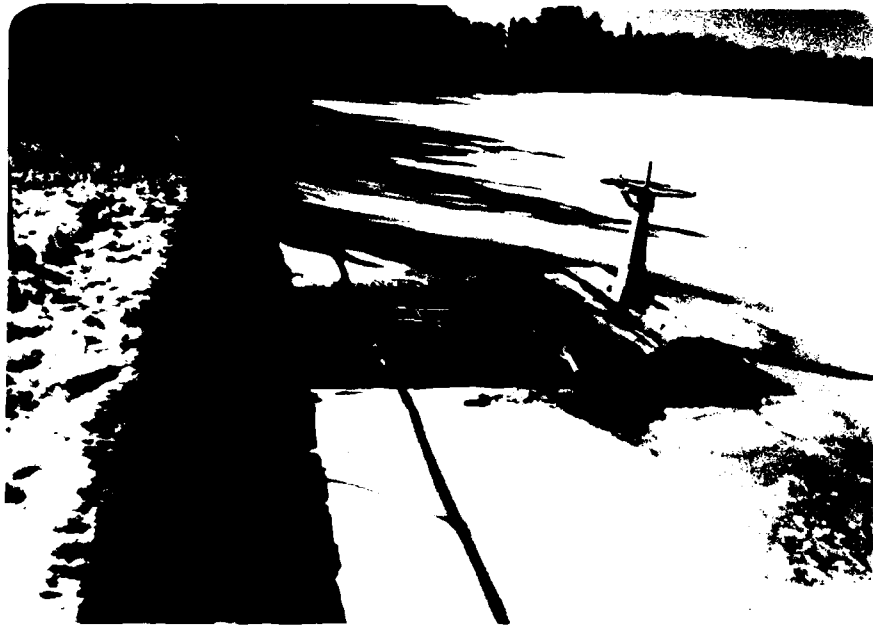


Photo 1 - View of spillway, lake and upstream slope of dam looking to the right. Note brush and small trees on slope.



Photo 2 - View of spillway, lake and upstream slope of dam looking to the left. Note brush and trees on slope.

UPPER KESWICK DAM

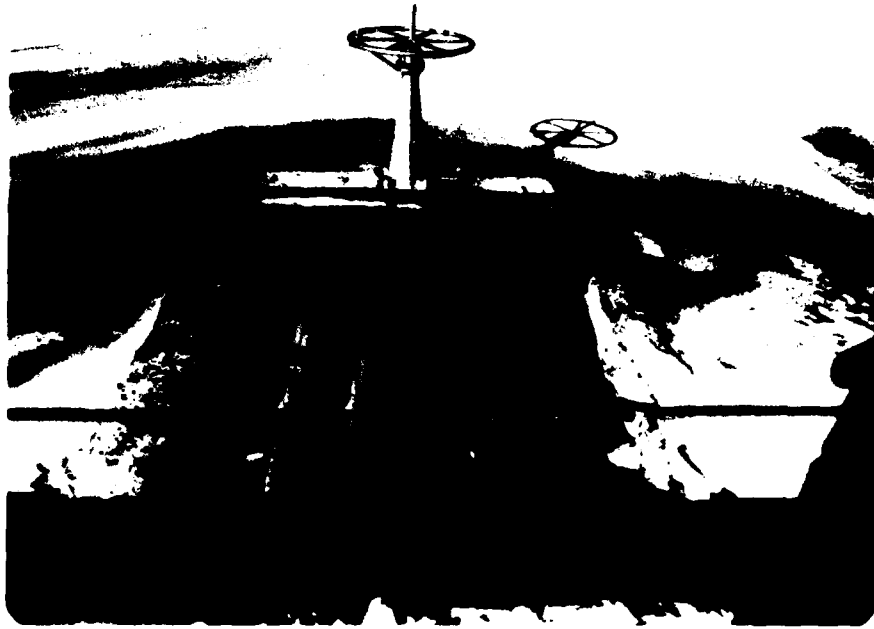


Photo 3 - View of spillway from top of dam.



Photo 4 - View of downstream slope looking from right of discharge channel (at bottom of picture). Note trees on slope.



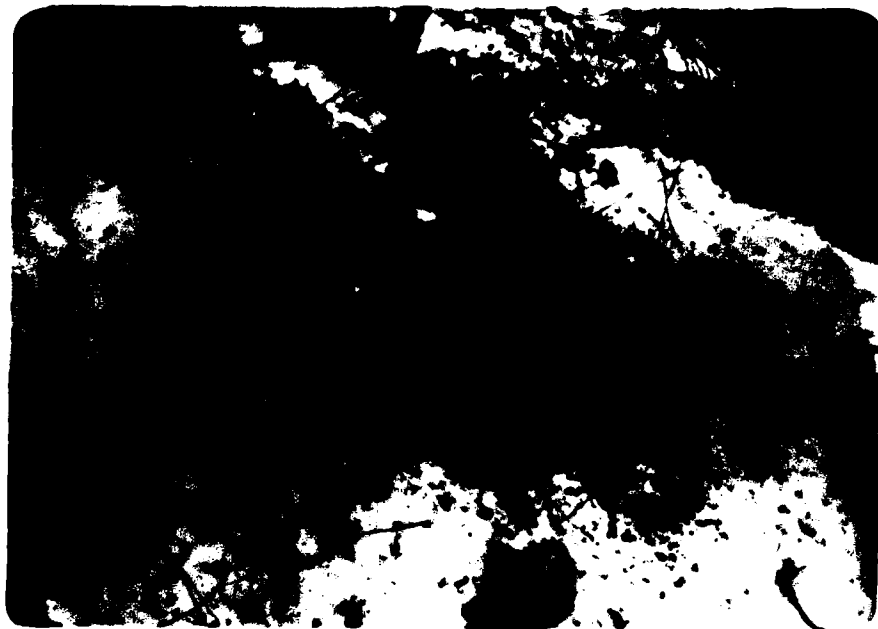


Photo 5 - Seepage area at downstream toe approximately 40 feet left of spillway.



Photo 6 - Seepage area at downstream toe at left end of dam. View is looking towards discharge channel with the embankment on the right.

UPPER KESWICK DAM



Photo 7 - View of low-level outlet (60-inch x 66-inch R.C.P.)  
Note deterioration of timber headwall and erosion  
at the left side of pipe.



Photo 8 - View of downstream channel from top of embankment.  
Note roadway bridge in center.

UPPER KESWICK DAM



Photo 9 - View of timber bridge where the downstream channel enters the lower lake.

APPENDIX C

SUMMARY OF ENGINEERING DATA

CHECK LIST  
HYDROLOGIC AND HYDRAULIC DATA  
ENGINEERING DATA

Name of Dam: UPPER KESWICK DAM

Drainage Area Characteristics: 0.89 square miles

Elevation Top Normal Pool (Storage Capacity): 93.4 NGVD (54 acre-feet)

Elevation Top Flood Control Pool (Storage Capacity): N/A

Elevation Maximum Design Pool: 97.5 NGVD (SDF pool 148 acre-feet)

Elevation Top Dam: 96.66 NGVD (123 acre-feet)

SPILLWAY CREST:

a. Elevation 93.4 NGVD

b. Type Concrete Capped Timber Drop Inlet with notched front side.

c. Width 9.25 feet

d. Length 25.0 feet

e. Location Spillover Both sides and front

f. No. and Type of Gates None

OUTLET WORKS:

a. Type 60-inch x 66-inch R.C.P.

b. Location At spillway

c. Entrance Inverts 84.61 NGVD

d. Exit Inverts 83.43 NGVD

e. Emergency Draindown Facilities small sluice gate-60"x66" R.C.P.

HYDROMETEOROLOGICAL GAGES:

a. Type None

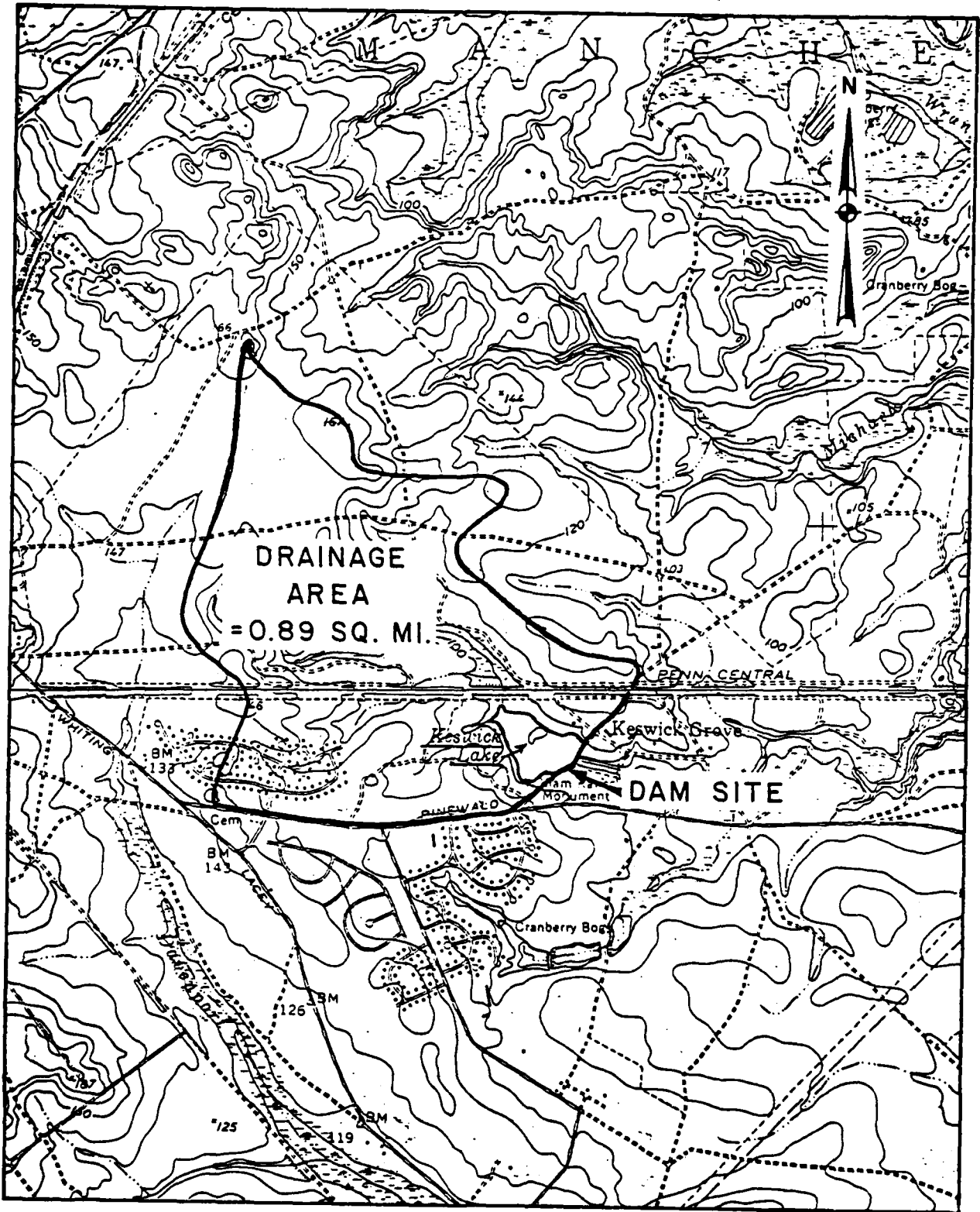
b. Location None

c. Records None

MAXIMUM NON-DAMAGING DISCHARGE: 486 cfs at elevation 96.66 NGVD

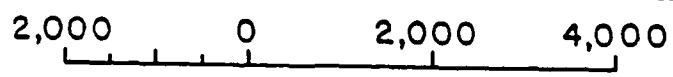
APPENDIX D

HYDROLOGIC COMPUTATIONS



DRAINAGE  
AREA  
= 0.89 SQ. MI.

DAM SITE



Scale: 1" = 2,000 FT.

UPPER KESWICK DAM  
DRAINAGE BASIN

Area of the Lake at normal pool level

Area measured from U.S.G.S Quad (EL = 93.5)  
= 16.53 AC

Height of the Dam =  $96.66 - 84.28 \approx 12.4$  ft

Small Dam, High Hazard

$$S.D.F = \frac{1}{2} PMF$$

Hydrologic Analysis:-

D.A = 0.89 sq miles

Inflow Hydrograph at Reservoir was determined using HEC 1 DB program.  
Inflow routed through the Lake

### Elevation Area - Capacity Relationship

Information obtained from U.S.G.S

Ele	83.5	93.5	100	110
Surface Area(AC)	0	16.53	41.32	168.96

HEC - 1 DB program will develop storage capacity from surface area and elevation.



Determination of PMP

Probable Maximum ppt. (inches) for an area of  
10 square miles and 6 hour duration  
= 26"

D.A = .89 sq miles

ZONE = C

The corps of Engineers recommended that  
20% reduction to be applied to the  
report value for a 10 sq miles drainage  
area in order to provide for the imperfect  
fit of the storm isohyetal patterns to the  
shape of the particular basin.

Because of the unlikelihood of a perfect  
strike of a storm center on any particular  
small basin, no variation is assumed between  
point and 10 square miles precipitation

P.M.P. =  $26'' \times (1 - 0.2) = 20.8''$  (This reduction is  
done by the HEC 1 DB Program)

Depth area duration relationship.

Percentage to be applied to the above 6 hr PMP

6 hr = 100 %

12 hr = 108 %

24 hr = 117 %

48 hr = 127 % (Not necessary)

INFILTRATION :- High (Discussed with local people  
during inspection)

Initial Infiltration = 1.5 inch

Const. infiltration = .15 inch/hr.

DETERMINATION OF Tc

1. Estimating Tc from velocity estimate and watercourse length. (Ref: Design of Small Dam Fig 30)

	<u>Slope</u>	<u>Vel</u>	<u>Remarks</u>
Overland flow	$\frac{167-140}{2400} \times 100 = 1.125\%$	1.5	upper portion of watershed
Reach 1	$\frac{140-95}{5600} \times 100 = .80\%$	1.0	Natural channel (Neglect flow through Lake)

$$T_c = \frac{2400}{1.5 \times 3600} + \frac{5600}{1 \times 3600}$$

$$= 2.0 \text{ hrs.}$$

2. Estimating Tc assuming same velocity

$$T_c = \frac{8000}{1 \times 3600} = 2.22 \text{ hrs.}$$

3. From Nomograph of design of Small Dam (S.C.S. Guide) - same as Kirpich

$$T_c = \left( \frac{11.9 L^3}{H} \right)^{.385}$$

L in miles = 1.52 miles  
(Lake excluded)

$$= \left[ \frac{11.9 \times (1.52)^3}{72} \right]^{.385}$$

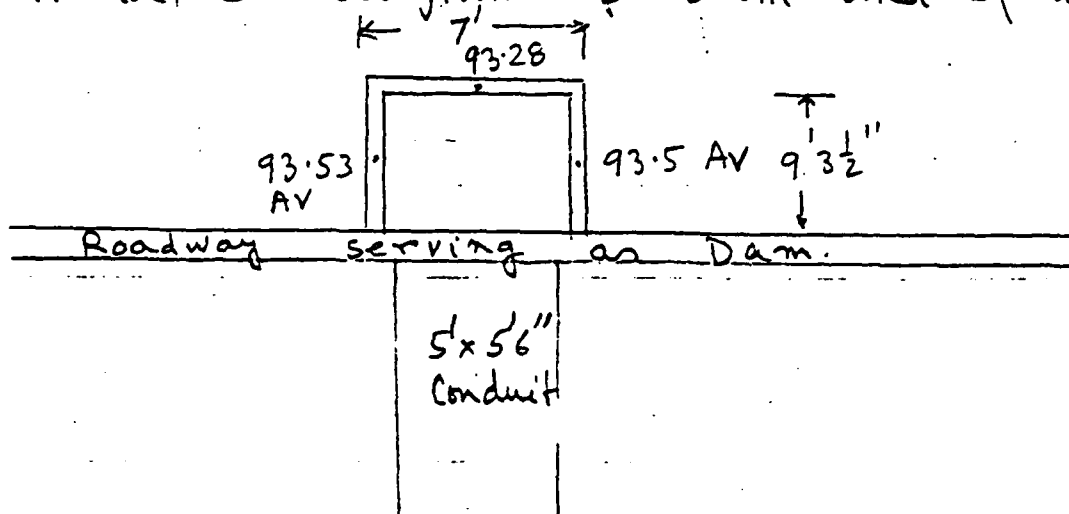
H in ft = 72 ft

$$= .81 \text{ hrs.}$$

Use Tc = 2 hrs.

Lag = 0.6 x 2 = 1.2 hrs.

### Schematic Diagram of Dam and Spillway



Water is entering through three sides of the box type spillway.

Total Length of spillway = 25.5 Ft  
Average Top of spillway = 93.44 Ft

Length of Dam = 177 + 119 - 7 = 289 Ft  
Top of Dam = 96.66

Flow over the spillway  $Q_s = C_1 L_1 H_1^{3/2}$

$C_1 = 3.3$       $L_1 = 25.5$

Flow over the Dam  $Q_D = C_2 L_2 H_2^{3/2}$

$L_2 = 275$       $L_2 = 289$

Full Normal Capacity of the pipe

Pipe is approximately circular (5'6" x 5'0")  
of dia 5.25 Ft.

$$R = \frac{5.25}{4} = 1.3125 \text{ Ft} \quad R^{2/3} = 1.2$$

$$A = \frac{\pi}{4} \times (5.25)^2 = 21.65 \text{ sqft.}$$

$$S = \frac{84.28 - 83.43}{45} = .01888$$

$$S^{1/2} = .1374$$

$$Q_f = \frac{1.486}{.013} \times 1.2 \times .01888 \times 21.65 = 56 \text{ cfs}$$

Considering Pressure flow Conduit

$$Q = \frac{1.486}{n} R^{2/3} \sqrt{S_f} \times A \quad L = 45$$

$$= \frac{1.486}{.013} \times 1.2 \times 21.65 \times \frac{\sqrt{h}}{\sqrt{L}}$$

$$= 442.7 \sqrt{h}$$

Tailwater Depth is assumed as the o/s reservoir  
= 84.76

Elevation	SPILLWAY CONTROL		PIPE CONTROL	
	H <sub>1</sub> At over spillway	Q <sub>s</sub> 84.15 H <sub>1</sub> <sup>3/2</sup>	h <sub>p</sub>	Q <sub>p</sub> 442.7 √h <sub>p</sub>
93.44	-	-	8.68	1304
95	1.56	164	10.24	1417
96.66	3.22	486	11.9	1527
97	3.56	563	12.24	1549
99	5.56	1103	14.24	1670
101	7.56	1749	16.24	1784
103	9.56	2487	18.24	1891
105	11.56	3307	20.24	1992
107	13.56	4202	22.24	2088

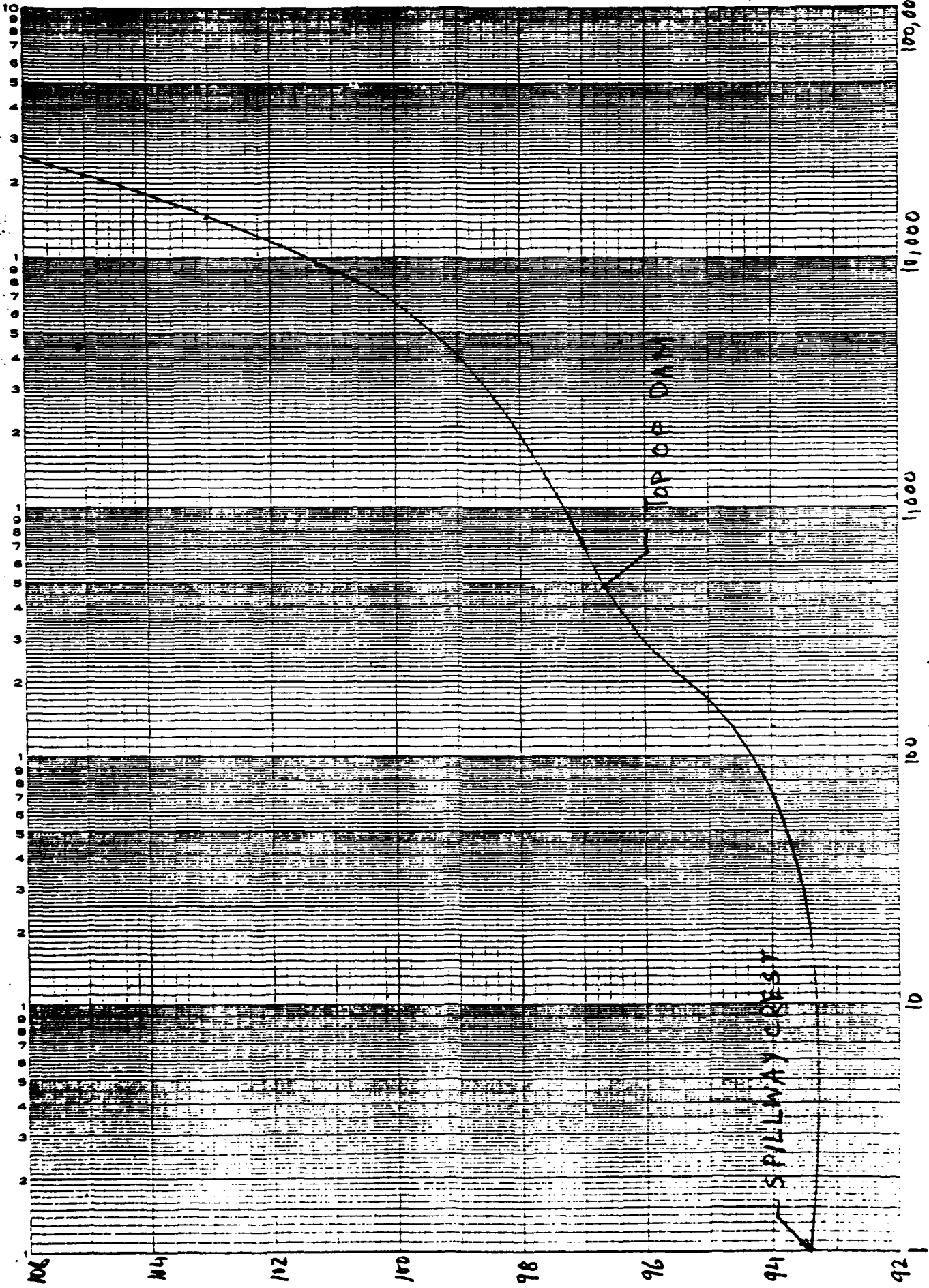
It is observed that up to elevation 101  
it is spillway control after that it is  
pipe control

FINAL RATING CURVE

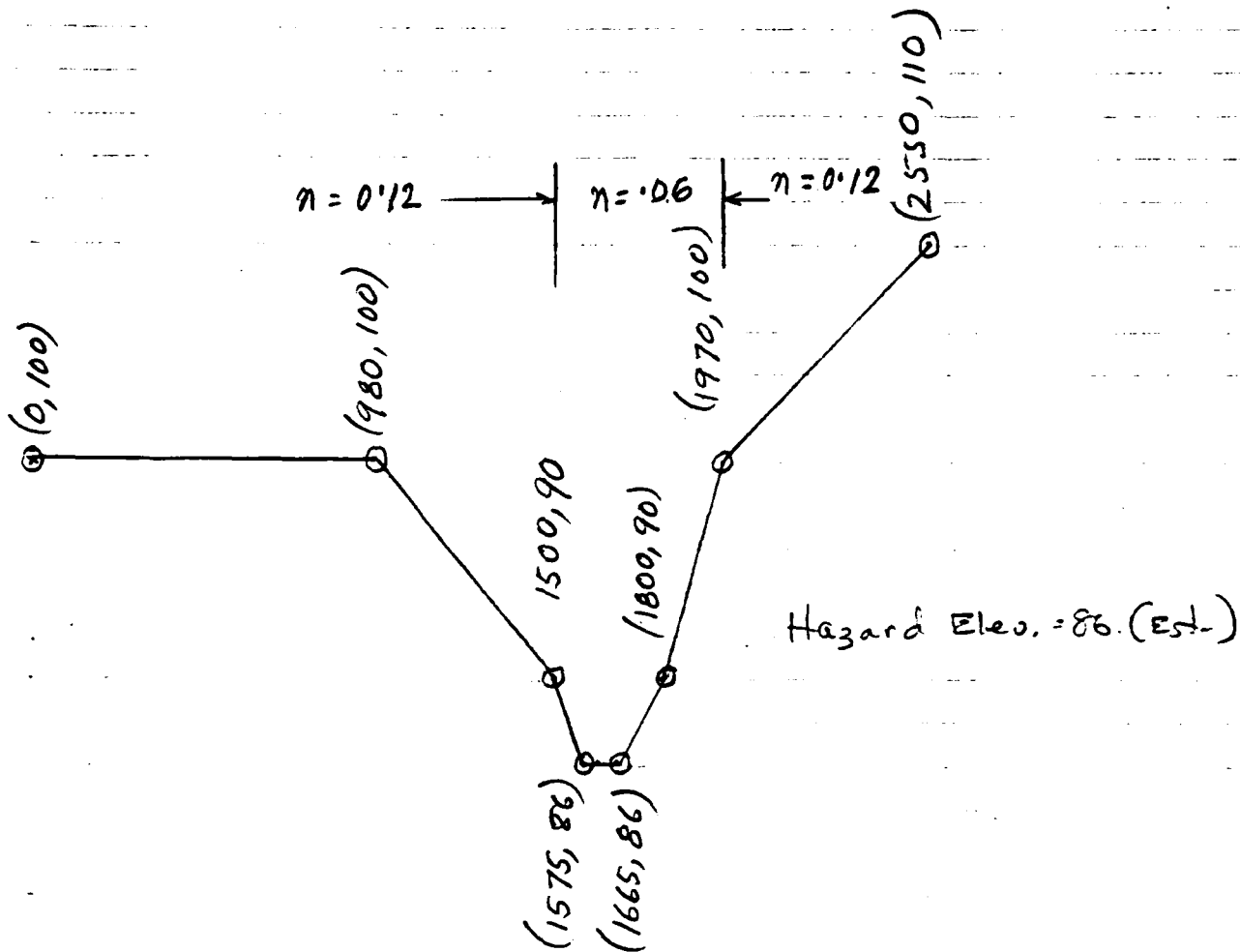
Elevation	Flow Thro Spillway	Ht over Dam HD	Flow over Dam $794.75 H_D^{3/2}$	Total Flow
93.44	0			0
95	164			164
96.66	486	0	0	486
97	563	0.34	157	720
99	1103	2.34	2,845	3,948
101	1749	4.34	7,186	8,935
103	1891	6.34	12,687	14,578
105	1992	8.34	19,142	21,134
107	2088	10.34	26,425	28,513

EUBENE DIETZGEN CO.  
MADE IN U. S. A.

NO. 3410-LS10 DIETZGEN GRAPH PAPER  
SEMI-LOGARITHMIC  
5 CYCLES X 10 DIVISIONS PER INCH



Cross Section at D/S Reach

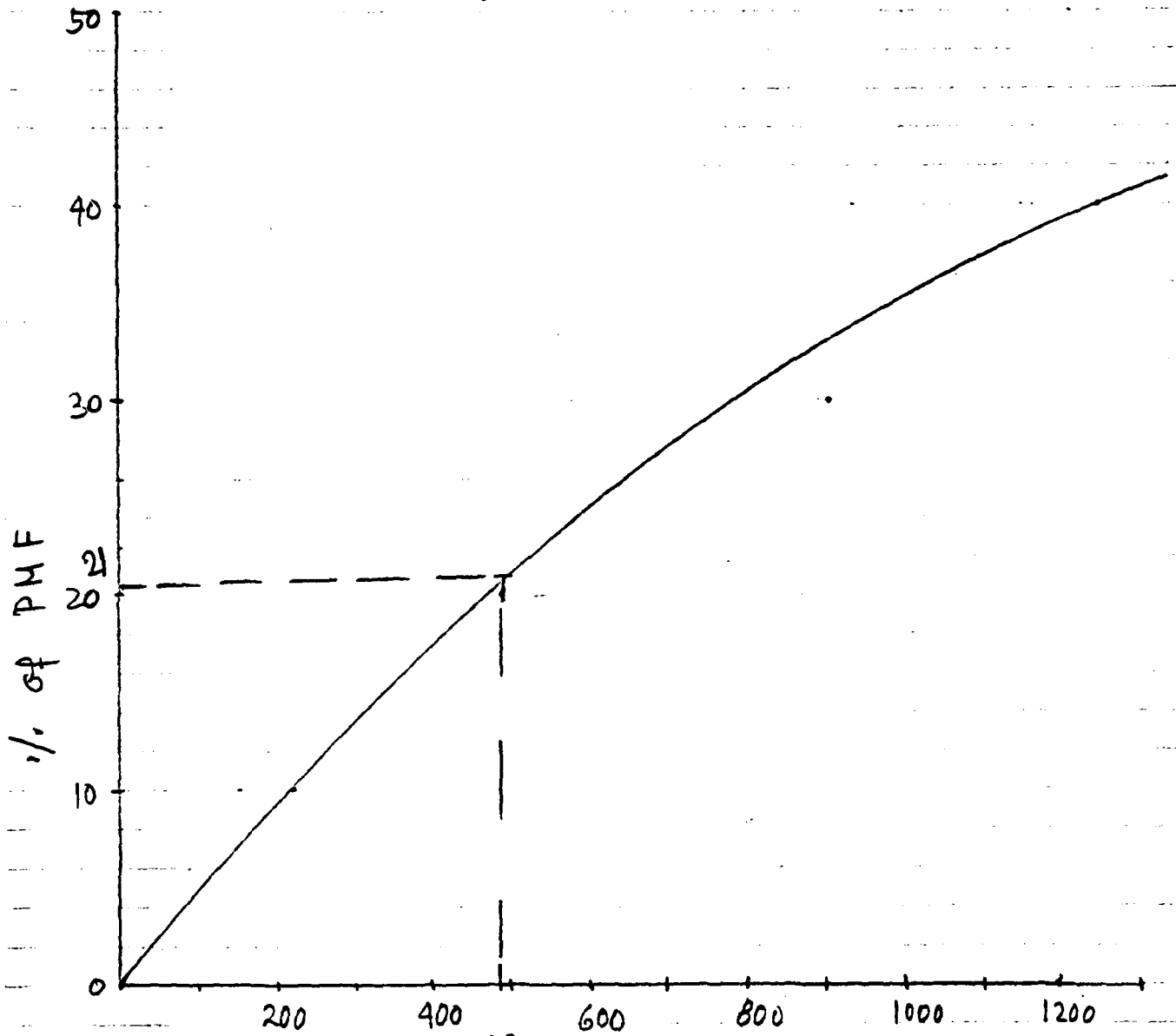


REACH 1

$$L = 700 \text{ FT}$$
$$S = \frac{20}{2000} = .01$$



Overtopping Potential



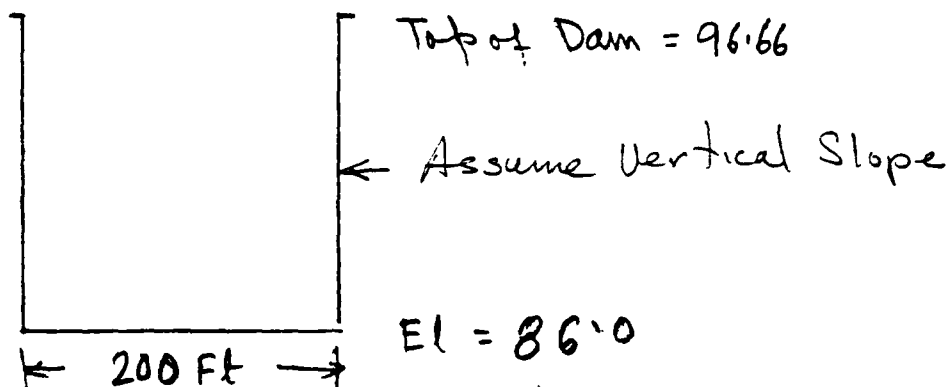
OUTFLOW → CFS

Overtopping of Dam occurs at El = 96.66

Q = 486 at 21% of PMF

## Breach Analysis

Assume breach begins to develop when reservoir stage reaches above the dam.  
Time of Failure = 16.75 hrs



Effect of breach was analysed at 700 ft D/S of Dam.

Maximum stage without Dam break = 87.8

Maximum stage with Dam break = 89.8

There will be 2.0 ft increase in stage due to Dam failure. at 0.3 PMP



.....  
FLOOD HYDROGRAPH PACKAGE (HEC-1)  
LAST VERSION JULY 1978  
LAST MODIFICATION 26 APR 79  
.....

RUN DATE: TUE, APR 07 1981  
TIME: 09:16:37  
  
N.J. DAM INSPECTION  
UPPER KESWICK DAM  
MULTI RATIO PHE ROUTING

JO1 SPECIFICATION  
.....  
INFL INFL IMAE IECN IIAPE JPLI JFRT INAME ISTAGE IAUTO  
100 0 15 JUPFR NRT LROPT TRACE 0 0  
IPRT USTAN 0  
.....

MULTI-PLAN ANALYSES TO BE PERFORMED  
PLANES (RATIOS) LEFT TO 1  
RATIO 0.50 0.40 0.30 0.20 0.10

.....  
US-AREA RUNOFF COMPUTATION  
.....

LOCAL INFLOW  
.....  
IHDG IUNG IAREA SNAP IRSD IKSPI RATIO I-MOM ISAMF LOCAL  
1 3 0.84 0.0 0.0 0.0 0.0 0.0 0.0

PRECIP DATA  
.....  
SPEFF PRS MRS PIZ AZA RAT RTA R96  
0.00 26.00 100.00 100.00 117.00 0.00 0.00 0.00 0.00

LOSS DATA  
.....  
IPROD STRKR ELKRO R10L CHAIN SIMPS R10W SIRL CUSTL ALSM R1MD  
0.00 0.00 1.00 1.00 0.00 1.00 1.50 0.15 0.00 0.00

UNIT HYDROGRAPH DATA  
.....  
LTC 0.00 LAG 1.00  
RECSSION DATA  
START= 1.00  
.....

UNIT HYDROGRAPH % END OF PERIOD ORIGINATES ICE 0.00 HOURS LAGE 1.00 VOLE 1.00  
36. 32. 34. 32. 32. 37. 27. 217. 159. 110.  
41. 44. 53. 24. 17. 15. 7. 5.  
1. 2. 2. 1. 0. 0.

FIND-OFF-PIERIOD FLOW  
.....  
PC-DA HR-RN PERIOD RAIN EXCS LOSS COMP % PC-DA HR-RN PERIOD RAIN EXCS LOSS COMP %  
1.01 0.10 1 0.23 2.66 7.83 1.01 1.46 51 0.53 0.46 0.24 215  
1.01 0.10 2 0.23 0.10 0.05 1.01 13.00 52 0.52 0.46 0.04 445  
1.01 0.10 3 0.23 0.00 0.05 1.01 13.11 53 0.62 0.34 0.04 435



TABLE 1. SUMMARY OF RESULTS FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 LOSS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	PLAN	RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIOS APPLIED TO FLOWS	
						RATIO 5	RATIO 6
PERFORMANCE AT	1	15.85	126.0	950.	633.	317.	
ROUTE TO	1	15.85	126.0	950.	633.	317.	17.93
ROUTE TO	1	15.85	126.0	950.	633.	317.	17.93
ROUTE TO	1	15.85	126.0	950.	633.	317.	17.93
ROUTE TO	1	15.85	126.0	950.	633.	317.	17.93
ROUTE TO	1	15.85	126.0	950.	633.	317.	17.93

SUMMARY OF DAM SAFETY ANALYSIS

PLAN	ELEVATION STORAGE OUTFLOW	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	MAXIMUM RETRACTOR	MAXIMUM STAGE	MAXIMUM OUTFLOW	DURATION OVER-TOP	TIME OF MAX OUTFLOW	TIME OF FAILURE
1	99.24	93.44	94.44	96.66	1581.	161.	1231.	4.00	17.00	0.00
2	97.05	91.25	92.25	94.47	1395.	142.	1025.	3.25	17.00	0.00
3	97.05	91.25	92.25	94.47	1395.	142.	1025.	3.25	17.25	0.00
4	96.84	91.04	92.04	94.26	1380.	141.	1010.	3.20	17.75	0.00
5	99.24	93.44	94.44	96.66	1581.	161.	1231.	4.00	18.00	0.00

PLAN STATION PEACH

RATIO	PLAN	MAXIMUM FLOW	MAXIMUM STAGE	MAXIMUM TIME
0.50	1	1581.	161.	17.00
0.50	2	1395.	142.	17.00
0.50	3	1395.	142.	17.25
0.50	4	1380.	141.	17.75
0.50	5	1581.	161.	18.00



.....  
 FLOOD MAP SECTION (HEC-1)  
 BA SUFFY VERSED, JULY 1976  
 LAST MODIFICATION 26 FEB 79  
 .....

.....  
 RUN DATE: 14C APR 67 1981  
 TIME: 1:09:26  
 .....

.....  
 NJJ... DAM INSPECTION  
 UPPER KESWICK DAM  
 CIVIL ENGINEERING  
 .....

.....  
 JOB SPECIFICATION  
 PU NBR MMIN IDAY IHR JMIN METRC IPLI IPRI NSTAN  
 110 0 15 0 0 0 0 0 0 0 0  
 JOPLR NMT LKROPT TRACE  
 5 0 0 0  
 .....

.....  
 MULTI-PLAN ANALYSIS TO BE PERFORMED  
 REASON FOR NOTING LAG= 1  
 .....

.....  
 RTIOSE 0.30  
 .....

.....  
 SUB-AREA RUN-OFF COMPUTATION  
 .....

.....  
 LOCAL INFLOW  
 ISTRG ICOMP IECGN ITAPE JPLT JERT INAME ISTAGE IAUTO  
 0 0 0 0 0 0 0 0 0 0  
 .....

.....  
 HYDROGRAPH DATA  
 IUNCG IUNG TAREA SNAP TRSDA TRSPC RATIO IKNOW ISAME LOCAL  
 1 2 3.89 0.0 0.0 0.0 0.0 0.00 0.00 0  
 .....

.....  
 PRECIP DATA  
 SFFP PMS R6 R17 R24 R4R R72 R96  
 0.00 26.00 100.00 109.00 117.00 0.00 0.00 0.00 0.00  
 TRSPC COMPUTED BY THE PROGRAM IS 0.000  
 .....

.....  
 LOSS DATA  
 IADPT IEMPO OLTRN RTIOL CLARA STRMS RTIOL SIRT1 CASSTL ALSMK RTIMP  
 0.00 0.00 0.00 1.00 0.00 0.00 1.00 1.50 0.15 0.00 0.02  
 .....

.....  
 UNIT HYDROGRAPH DATA  
 ICE 0.00 LAG= 1.20  
 .....

.....  
 RECESION DATA  
 STRIJSF 1.100 RUCSWR 8.05 RTIOF= 2.00  
 .....

.....  
 UNIT HYDROGRAPH TO END OF PERIOD ORIGINATE. ICE 0.00 HOURS LAG 1.20 VOLE 1.00  
 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100.  
 .....

.....  
 END-OF-PERIOD FLOW  
 MO-DA IRR-VN IUNION MAIN EXCS LOSS COMP 1.00-DA HR-ME PERIOD RAIN EXCS LOSS COMP G  
 1.01 0.01 0.01 0.03 3.73 1.01 12.4F 51 0.52 0.48 0.84 0.15  
 1.01 0.01 2 0.03 0.00 6.03 1.01 13.00 52 0.52 0.48 0.84 0.45  
 1.01 0.03 3 0.03 0.00 6.03 1.01 13.11 53 0.62 0.59 0.84 0.43  
 .....





STATION OAP

(01) INTERPOLATED BREACH HYDROGRAPH (01) POINTS AT NORMAL TIME INTERVAL  
(02) COMPUTED BREACH HYDROGRAPH

| TIME (HRS) | 1200. | 1600. | 2000. | 2400. | 2800. | 3200. | 3600. | 4000. | 4400. | 4800. | 5200. | 5600. | 6000. | 6400. | 6800. | 7200. | 7600. | 8000. | 8400. | 8800. | 9200. | 9600. | 10000. |  |  |
|------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--|--|
| 17.75      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.77      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.79      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.81      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.83      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.85      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.87      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.89      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.91      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.93      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.95      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.97      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 17.99      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.01      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.03      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.05      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.07      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.09      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.11      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.13      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.15      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.17      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.19      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.21      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.23      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.25      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.27      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.29      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.31      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.33      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.35      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.37      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.39      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.41      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.43      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.45      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.47      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.49      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.51      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.53      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.55      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.57      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 18.59      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.01      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.03      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.05      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.07      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.09      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.11      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.13      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.15      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.17      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.19      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.21      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.23      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.25      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.27      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.29      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.31      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.33      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.35      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.37      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.39      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.41      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.43      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.45      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.47      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.49      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.51      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |
| 19.53      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |  |  |

PEAK FLOW AND STORAGE (EQU. OF 10.1109) SUMMARY FOR MULTIPLE PLAN-RATE ECONOMIC COMPUTATIONS  
 FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

| OPERATION     | SECTION | AREA           | PLAN RATE | PLAN RATE |
|---------------|---------|----------------|-----------|-----------|
| OVER-DRAIN AT | MES     | 0.09<br>(2.33) | 1         | 0.30      |
| ROUTED TO     | DAM     | 0.09<br>(2.33) | 1         | 0.30      |
| ROUTED TO     | REACH   | 0.09<br>(2.33) | 1         | 0.30      |

SUMMARY OF DAM SAFETY ANALYSIS

| PLAN 1 | ELEVATION | INITIAL VALUE | SHILLWAY CREST | TOP OF DAM |
|--------|-----------|---------------|----------------|------------|
|        |           | 95.00         | 95.00          | 95.00      |
|        | STORAGE   | 119.          | 54.            | 123.       |
|        | OUTFLOW   | 455.          | 0.             | 486.       |

| PLAN 1 | STATION REACH | MAXIMUM STORAGE | MINIMUM STORAGE | DURATION OVER TOP | TIME OF FAILURE |
|--------|---------------|-----------------|-----------------|-------------------|-----------------|
|        |               | 12%             | 12%             | HOURS             | HOURS           |
|        |               | 0.15            | 0.15            | 0-40              | 17-25           |
|        |               | 38.02           | 3259.           |                   | 16.75           |

| PLAN 1 | STATION REACH | MAXIMUM FLOW | MINIMUM FLOW | STAGE | TIME  |
|--------|---------------|--------------|--------------|-------|-------|
|        |               | 3367.        | 89.8         | FT    | HOURS |
|        |               | 0.30         | 89.8         |       | 17-25 |

345.2 24.00